Theoretical and Applied Economics
Volume XXVII (2020), No. 2(623), Summer, pp. 263-280

Determinants of economic growth in India: A time series perspective

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Abstract. *Indian is one of the fastest growing economies of the world and recent growth rate of the Indian economy has been decelerated. To better understand the growth process, an empirical model using time series approach has been used. The study has used quarterly observations of Real Gross Domestic Product (GDP) at factor cost, Foreign Direct Investment (FDI) inflows to India, Gross Fixed Capital Formation (GFCF), GDP Deflator, Trade Openness and Real Effective Exchange Rate (REER) from 1996-97 to 2017-18 to analyse direction of relationship among these variable. It is observed that the Trade Openness affects GDP positively but Trade Openness is negatively impacted by GDP where as FDI inflow to India has a positive impact on Trade Openness. Further, the REER has negative impact on FDI inflows whereas it is found that GFCF has positive impact on REER. GDP is the major variable that influences the other variables under study. FDI inflow is the outcome of GDP growth. To make the FDI beneficial, the government must improve the absorptive capacity of the country and change the policy related to FDI.*

Keywords: FDI, GDP, exchange rate, trade openness.

JEL Classification: E01, E20, E60, F430.

1. Introduction

At the end of the 20th century it is observed that the more affluent countries were growing robustly while others were growing more slowly or even stagnating. The growing disparities in Economic Growth can be attributed to many factors including determinates of growth. Many factors inhibiting and facilitating economic growth have been suggested by economists. But the fundamental question still persists that why does income grow faster in some countries than others? But researchers disagree on the explanatory variables that are most important a priori, there is usually only partial overlap among the variables considered in different empirical works. It is therefore natural to try and see which of the explanatory variables suggested in emerge as growth determinants when all are treated symmetrically a priori. The idea is to find out in which direction the data guides an agnostic. Many potential explanatory variables have been suggested, which creates lots of confusion and therefore empirical approaches inevitably need to start out with a long list of variables. To better understand the growth process, we develop an empirical model using time series approach, which attempts to explain some of the necessary ingredients for economic growth and to explore the economic relationship among selected macroeconomic variables in India.

Empirical studies are conducted by Bhat (1995), Chandra (2003), Padhan (2004), Pandey (2006), Pradhan (2010), Ray (2007), Kaur and Sidhu (2012) and Devi (2013) to examine the relationship between the growth of exports and the growth of output in India. They used Co-integration technique; Error Correction Modelling and Granger Causality analysis to conclude in support of Export-led Growth hypothesis for India. However, studies conducted by Ghatak and Price (1997), Dhawal and Biswal (1999), Nataraj et al. (2001), Sharma and Panagiotidies (2003) and Mishra (2011) do not substantiate the Export-led Growth hypothesis for India. Almost all of them cited that difference in time periods, variable definitions and methodologies adopted could be the plausible reasons. But the analysis by Kumari and Malhotra (2014) on Export Led Growth in India for the period 1980 to 2012 using Johansen co-integration and Granger causality approach had put forward mixed and inconclusive results. It was found that there is no existence of long run equilibrium relationship between exports and economic growth but Granger causality test exhibited bidirectional causality between the two.

Most of the literature which reflect on the impact of FDI on economic growth showed that FDI stimulated economic growth through transfer of technology and spill over effect (Wei et al., 2001; Bende-Nabende and Ford, 1998). FDI was seen as an important element in the solution to the problem of scarce local capital and overall low productivity in many developing economies (De Mello, 1999; Eller et al., 2005). While some papers reported that FDI enhanced GDP growth, others reported that there was no direct evidence of such a relationship.

Empirical research works carried out on capital formation and economic development has established a critical linkage between the two. Khan and Reinhart (1990); Ghura and Hadji Michael (1996); Ben-David (1998); Collier and Gunning (1999); Hernandez-Cata (2000) and Ndikumana (2000) conducted studies in Africa, Asia and Latin America confirming the aforesaid statement. Ghura and Hadji Michael (1996); Ghura (1997) and

Beddies (1999) used econometric methodologies to reveal that private capital formation has a stronger and more favourable effect on growth rather than government capital formation.

Economic theories reach a variety of conclusions about the responsiveness of output growth to inflation. The inflation-growth relationship has been one of the most debated macroeconomic themes.

There are numerous studies that have assessed the relationship between exchange rate movements and economic growth. Connolly (1983), Gylfason and Schmid (1983), Krueger (1978), and Taylor and Rosensweig (1984) supported that devaluation has expansionary effects on economic growth of the nation. But Gylfason and Radetzki (1985), Atkins (2000), Kamin and Roger (2000), Odusola and Akinlo (2001), Berument and Pasaogullari (2003), El-Ramly and Abdel-Haleim (2008) brought contractionary effects of devaluation on economic growth to picture. A number of studies are witness to mixed results also. Edwards (1986) and Rhodd (1993) found negative output response to devaluation in the short-run but in the long-run the output response to devaluation appeared to be positive. El-Ramly and Abdel-Haleim (2008) revealed negative response of output to devaluation for several years before expansionary effects showed up. Bahmani-Oskooee and Miteza (2006) used a panel of 42 countries to find that in the long-run devaluations are contractionary in non-OECD countries, while for OECD economies the results are mixed.

In the light of the above, we try to study the macroeconomic determinants of economic growth in India and conduct an empirical analysis using quarterly observations of Real Gross Domestic Product (GDP) at factor cost, Foreign Direct Investment (FDI) inflows to India, Gross Fixed Capital Formation (GFCF), GDP Deflator, Trade Openness and Real Effective Exchange Rate (REER) from 1996-97 to 2017-18.

2. Methodology

Time series quarterly data on the selected variable from 1996-97 to 2017-18 are obtained from the RBI web site. The variables considered are:

- Real Gross Domestic Product (GDP) at factor price which is a measure of economic growth or output. Its quarterly estimates are taken at 2004-05 base year prices.
- Trade Openness is taken as ratio of sum up Export Values and Import Values to Real GDP (Export + Import) / Real GDP.
- For foreign direct investment (FDI) inflows to India the quarterly estimates of net FDI inflows to India are considered which include FDI in India – Equity b) FDI in India – Reinvested Earnings and c) FDI in India – Other Capital.
- Real Gross Fixed Capital Formation (GFCF) is another variable considered as an indicator of domestic investment.
- Real Effective Exchange Rate (REER) is used as a measure of India's overall competitiveness where the REER data used for the study is a Trade based Weight adjusted for price differentials between India and its six major trading partners.

- GDP Deflator is used as an indicator of Inflation. GDP Deflator is a ratio obtained by dividing Nominal GDP at factor prices with Real GDP at factor prices.

All the actual values of the six variables in time series data are transformed into log form for reducing the wide variation of data and eliminating the problem of heteroscedasticity. The study employs Real GDP at factor cost as a measure of economic growth where as FDI inflows and GFCF as measures of domestic investment and foreign investment respectively, GDP Deflator as an indicator of inflation, REER as a measure of exchange rate and Trade Openness as a pure ratio measuring the sum of exports and imports to GDP at factor cost. The choice of the control variables is motivated by existing theoretical and empirical work in macroeconomic literature.

Unit root test for stationarity conducted primarily because the time series data considered for the analysis should have mean and variance that do not vary systematically over time rendering it fit for further econometric analysis and forecasting. Stationarity of the data set has been checked by using Dickey-Fuller (1979) Test, Augmented Dickey-Fuller Test and the Phillips-Perron (1988) test. A time series which turns stationary after differencing is known as "integrated time series". If such a time series becomes stationary after differencing once then it is said to be integrated of order one I(1). If it has to be differenced twice to transform to a stationary series, it is said to be integrated of order two I(2). Hence the number of times a time series has to be differenced before it becomes stationary, the time series is integrated of that order. Then Johanssen (1988) proposed the test of Co-integration test for inspection of any existence of long-run association-ship among the variables present in the time series data are performed.

A VECM is a restricted Vector Auto-Regressive Model (VAR) designed for the use with non-stationary series that are known to be co-integrated. The co-integrating equation gives long-run relationship between the two variables. However, co-integrating equation does not shed any light on short-run dynamics although its existence indicates that there must be short-term forces that are responsible for keeping long-run relationship intact. So the VECM is a more comprehensive model which combines short-run and long-run dynamics.

If there are two series X_t and Y_t which are I (1) so that their linear combination is

$$\widehat{\epsilon_t} = Y_t - \hat{a} - \hat{b}X_t \tag{1}$$

Then the long-run equilibrium relationship between the two variables is represented by $\widehat{Y_t} = \hat{a} + \hat{b}X_t$ (2)

Corresponding to this long-run equilibrium relationship, the VECM can be written as

$$\widehat{Y_t} = \emptyset + \gamma\Delta X_t + \lambda\widehat{\epsilon_{t-1}} + w_t \tag{3}$$

Where $\widehat{\epsilon_{t-1}} = \left(Y_{t-1} - \widehat{Y_{t-1}}\right) = (Y_{t-1} - \hat{a} - \hat{b}X_{t-1})$ is the lagged value of the error term by one period from the co-integrating regression and W_t is the error term in the ECM. The ECM equation states that ΔY_t depends not only on ΔX_t but also on the equilibrating error term $\widehat{\epsilon_{t-1}}$. Inclusion of $\widehat{\epsilon_{t-1}}$ is unique to ECM. When $\widehat{\epsilon_{t-1}}$ is non-zero (positive or negative), there is disequilibrium in the short-run. However, equilibrium will be restored in the long-run if and only if λ < 0. On the other hand, if λ > 0, then equilibrium errors will be magnified.

Suppose ΔX_t = 0 and Y_{t-1} is positive. In this situation, Y_{t-1} is too high to be in equilibrium, i.e. $Y_{t-1} > \widehat{Y_{t-1}}$. But as λ < 0, the error term $\lambda\widehat{\epsilon_{t-1}}$ is negative and so ΔY_t will be negative to restore equilibrium. Thus, if Y_{t-1} is above its equilibrium level, it will fall in the next period and the equilibrium error will be corrected in the model. Similarly, if $\widehat{\epsilon_{t-1}}$is negative, i.e. $Y_{t-1} < \widehat{Y_{t-1}}$, then $\lambda\widehat{\epsilon_{t-1}}$ will be positive, which will cause ΔY_t to be positive, leading $\widehat{Y_{t-1}}$ to rise in the period t.

Thus, the ECM has both long-run and short-run properties built into it. The long-run properties are embedded in the $\widehat{\epsilon_{t-1}}$ term. The short-run behaviour is partially captured by the equilibrium error term, which says that, if Y_t is out of equilibrium, it will be pulled towards it in the next period. Further aspects of short-run behaviour are captured by the inclusion of ΔX_t as an explanatory variable. This term implies that, if X_t changes, the equilibrium value of Y_t will also change and that Y_t will change accordingly. It is clear that γ captures the impact of short-run disturbances of X_t on Y_t, while λ captures the adjustment towards long-run equilibrium. It is to be noted that since X_t are Y_t are co-integrated, the equilibrium error is stationary. Since all the variables in the ECM are stationary, we can estimate the ECM by Ordinary Least Square and conduct tests of significance of estimated coefficients using the usual t-test procedure. The VECM has co-integration relations built into the specification so that it restricts the long-run behaviour of the endogenous variables to encourage their co-integrating relationships while allowing for short-run adjustment dynamics. The ECT shows the speed of adjustment since the deviation from long-run equilibrium is corrected gradually thorough a series of partial short-run equations.

Then we run Granger Causality test between the variables to detect the causal relationship among the variables. The following pairs of equations best capture the concept.

$$X_t = a_2 + \sum_{i=1}^{n} \alpha_i Y_{t-i} + \sum_{i=1}^{m} \beta_j X_{t-1} + \varepsilon_{1t} \quad (3)$$

$$Y_t = a_2 + \sum_{i=1}^{n} \gamma_i Y_{t-i} + \sum_{i=1}^{m} \delta_j X_{t-j} + \varepsilon_{2t} \quad (4)$$

Where ε_{1t} and ε_{2t} are uncorrelated white noise error terms. The equation (3) implies that X at time t depends on past values of itself and that of Y. The equation (4) implies that Y at time t depends on past values of itself and that of X. Four different cases can be visualised in the above context. First, $\widehat{\alpha_i}$s in equation (3) are statistically significantly different from zero (i.e. statistically significant) and the $\hat{\delta_j}$s in equation (4) are not statistically significantly different from zero (not significant). In this case, there is unidirectional causality from Y to X and we say that 'Y (Granger) causes X'. Second, $\widehat{\alpha_i}$s in equation (3) is not statistically significantly different from zero and $\hat{\delta_j}$s in equation (4) is statistically significantly different from zero. This shows unidirectional causality from X to Y and we can say that 'X (Granger) causes Y'. Third, $\widehat{\alpha_i}$s, $\widehat{\beta_j}$s, $\widehat{\gamma_i}$s and $\hat{\delta_j}$s are statistically significantly different from zero (i.e. statistically significant). This represents the case of bilateral or feedback causality. Fourth, $\widehat{\alpha_i}$s, $\widehat{\beta_j}$s, $\widehat{\gamma_i}$s and $\hat{\delta_j}$s are not statistically significantly different from zero (statistically not significant). This is the situation of independence where X and Y are independent of each other. It is to be noted that both X and Y have to be stationary variables to apply this test. If they are non-stationary, they have to be first differenced to be stationary. The direction of causality may depend critically on the number of lagged terms included. If the disturbance terms $\varepsilon_{1t}$and ε_{2t} are correlated, appropriate transformation of the variables would be required.

Since the individual coefficients in the estimated VAR models are often difficult to interpret, the practitioners of this technique estimate the Impulse Response Function (IRF). The IRF traces out the response of the dependent variable in the VAR system to shocks in the error terms, such as ε_{1t}andε_{2t}.

3. Results and discussion

3.1. Results of stationarity tests

Three stationarity tests such as Dickey-Fuller (DF) unit root test, Augmented Dickey-Fuller (ADF) unit root test and Phillips-Perron (PP) unit root test are conducted to detect the presence of unit-root in all the six variables under study. ADF is used because of its wide usage where as PP is useful in the series containing trends and it is more powerful (Perron, 1988). The results are shown in Table 1.

Table 1. *Unit root test results*

Variables	**DF Test**		**ADF Test**		**PP Test (rho-test statistic)**		**PP Test t-test statistic**	
	Level values	First order difference	Level values	First order difference	Level values	First order difference	Level values	First order difference
Real GDP	0.956 (0.769)	9.403 (0.000)	1.131 (0.702)	20.688 (0.000)	0.232 (0.908)	46.523 (0.000)	0.412 (0.908)	26.413 (0.000)
Trade Openness	0.956 (0.768)	10.569 (0.000)	0.771 (0.827)	8.536 (0.000)	0.718 (0.791)	71.987 (0.000)	0.889 (0.791)	12.196 (0.000)
FDI inflows	1.282 (0.637)	12.837 (0.000)	0.964 (0.766)	7.972 (0.000)	1.653 (0.782)	96.646 (0.000)	0.915 (0.782)	13.678 (0.000)
GFCF	1.002 (0.752)	12.184 (0.000)	0.969 (0.764)	8.971 (0.000)	0.670 (0.682)	84.470 (0.000)	1.178 (0.682)	14.453 (0.000)
REER	0.898 (0.788)	7.311 (0.000)	1.418 (0.573)	5.183 (0.000)	4.891 (0.652)	63.971 (0.000)	1.249 (0.652)	7.315 (0.000)
GDP Deflator	0.160 (0.943)	9.892 (0.000)	0.038 (0.961)	6.724 (0.000)	0.035 (0.950)	78.549 (0.000)	0.092 (0.950)	10.114 (0.000)

Note: The values in the parentheses are P-values.
Source: Calculated by author.

DF test for stationarity assumes that the values of the error term in the model are uncorrelated which means the error terms are independently and identically distributed. But ADF test statistic adjusts the DF test statistic to take care of the possible serial correlation in the error terms by adding lagged difference terms of the regressand. The PP test uses non-parametric statistical methods to take care of the serial correlation in the error terms without adding lagged differenced terms. All the three tests of stationarity to find unit root shows that all the variables under consideration are non-stationary in level form but are stationary in their first order difference form. This means that the time series data is integrated of first order i.e. I (1) and the data is subject to a valid co-integration test.

3.2. Co-integration test

The Johanssen Co-integration test is used to find out whether there is any long-run equilibrium relationship amongst the variables or not. Table 2 shows the results of Johanssen Co-integration Test with Trace statistic.

Table 2.*Johanssen co-integration test results*

Co-integrated Equations	Trace Statistic	5% Critical Value
None (π = 0)	152.28	94.15
At most One (π = 1)	77.77	68.52
At most Two (π = 2)	47.19	47.21

The Table 2 shows that there are two co-integrating equations or Error Correction Terms (ECTs) present among the variables as per Johanssen co-integration test. This means that the series are cointegrated and move together in long term and regression analysis performed will not have spurious regression problem.

3.3. Vector Error Correction Model (VECM)

A principal feature of co-integrated variables is that their time paths are influenced by the extent of deviation from long-run equilibrium. The Vector Error Correction Model (VECM) estimates the speed at which the dependent variable returns to equilibrium after any discrepancy from the long-run equilibrium relationship and hence explains relationship between the short-run and long-run coefficients. As the variables are found to be co-integrated, Vector Error Correction Model (VECM) is used to detect the relationship among the variables. Table 3 shows the obtained VECM results.

Table 3. *Results of Vector Error Correction Model (VECM)*

Dependent Variables→	GDP	Trade Openness	FDI inflows	GFCF	REER	GDP Deflator
ECT 1 (Lag1)	-1.039 (0.237) [-4.39***]	2.335 (0.344) [6.78***]	1.813 (2.169) [0.84#]	0.602 (0.313) [1.92#]	0.436 (0.191) [2.28*]	0.320 (0.093) [3.45***]
ECT 2 (Lag1)	0.104 (0.030) [3.42***]	-0.314 (0.044) [-7.10***]	-0.584 (0.279) [-2.09*]	-0.050 (0.040) [-1.48#]	-0.014 (0.025) [-0.59#]	-0.049 (0.012) [-4.14***]
GDP (Lag 1)	0.445 (0.172) [2.59*]	-1.021 (0.249) [-4.09***]	0.204 (1.571) [0.13#]	0.044 (0.227) [0.20#]	-0.213 (0.138) [-1.54#]	-0.213 (0.067) [-3.16***]
GDP (Lag2)	-0.543 (0.147) [-3.70*]	-0.447 (0.214) [-2.09*]	0.804 (1.347) [0.60#]	-0.660 (0.195) [-3.39***]	-0.069 (0.118) [-0.59#]	-0.136 (0.058) [-2.36*]
Trade Openness (Lag 1)	0.031 (0.089) [0.35#]	-0.008 (0.120) [-0.06#]	0.526 (0.818) [0.64#]	0.016 (0.118) [0.13#]	-0.034 (0.072) [-0.47#]	0.060 (0.035) [1.73#]
Trade Openness (Lag 2)	-0.201 (0.080) [-2.24*]	0.083 (0.130) [0.64#]	1.235 (0.822) [1.50#]	-0.078 (0.119) [-0.66#]	0.058 (0.072) [0.81#]	-0.059 (0.035) [-1.69#]
FDI inflows (Lag 1)	-0.021 (0.013)	0.065 (0.010)	-0.354 (0.123)	0.020 (0.018)	-0.000 (0.011)	0.015 (0.005)

Dependent Variables→	GDP	Trade Openness	FDI inflows	GFCF	REER	GDP Deflator
	[-1.59#]	[3.35***]	[-2.88***]	[1.13#]	[-0.06#]	[2.82***]
FDI inflows (Lag 2)	-0.008 (0.012) [-0.58#]	0.040 (0.019) [2.63***]	-0.096 (0.118) [-0.81#]	0.026 (0.017) [1.54#]	-0.014 (0.010) [-1.31#]	0.014 (0.005) [2.73***]
GFCF (Lag 1)	0.069 (0.121) [0.57#]	-0.093 (0.177) [-0.53#]	-1.466 (1.112) [-1.32#]	-0.288 (0.161) [-1.79#]	0.196 (0.098) [2.01*]	0.030 (0.048) [0.63#]
GFCF (Lag 2)	-0.046 (0.114) [-0.40#]	0.067 (0.166) [0.40#]	-2.028 (1.047) [-1.94#]	-0.056 (0.151) [-0.37#]	-0.094 (0.092) [-1.02#]	-0.016 (0.045) [-0.36#]
REER (Lag 1)	0.163 (0.155) [1.06#]	-0.263 (0.224) [-1.17#]	2.154 (1.415) [1.52#]	0.104 (0.204) [0.51#]	0.243 (0.124) [1.96#]	-0.136 (0.061) [-2.24*]
REER (Lag 2)	-0.100 (0.160) [-0.68#]	-0.172 (0.233) [-0.74#]	-3.003 (1.466) [-2.05*]	-0.045 (0.212) [-0.21#]	0.265 (0.129) [2.06*]	-0.044 (0.063) [-0.70#]
GDPD (Lag 1)	-0.036 (0.325) [-0.11#]	1.546 (0.472) [3.27***]	-2.347 (2.975) [-0.79#]	1.240 (0.420) [2.91***]	0.384 (0.262) [1.47#]	0.051 (0.127) [0.40#]
GDPD (Lag 2)	-0.248 (0.343) [-0.72#]	0.051 (0.498) [0.10#]	-4.948 (3.137) [-1.58#]	-0.061 (0.453) [-0.14#]	0.026 (0.276) [0.09#]	0.214 (0.134) [1.60#]
Constant	0.019 (0.008) [2.22*]	-0.003 (0.012) [-0.24#]	0.001 (0.076) [0.02#]	0.025 (0.011) [2.19*]	0.015 (0.007) [2.20**]	0.008 (0.003) [2.46*]
R-Square	0.875	0.790	0.430	0.692	0.353	0.726
Test Statistic (P-value)	405.014 (0.000)	218.731 (0.000)	43.849 (0.000)	130.413 (0.000)	31.616 (0.007)	153.267 (0.000)

Note: The values in parenthesis are Standard Errors and the values in square brackets are z-test statistic.
***, * and # shows significant at 1%, 5% and 10% level.

Table 3 shows that when GDP or real GDP at factor cost is the dependent variable, the first ECT is -1.039 and is statistically significant at 1% critical value which means that 103% of the disequilibrium in the long-run is corrected within a quarter, suggesting a very fast rate of adjustment towards the equilibrium. But the second ECT is positive and statistically significant revealing that divergence from the long-run equilibrium occurred to render the system ultimately unstable. All the short-run coefficients are statistically insignificant except Trade Openness at two lags and the dependent variable itself at both the lags. An intercept value of 0.019 is statistically significant at 5% critical value. The R-square value of the model is 0.875 suggesting that the fitted model is a good one and the p-value of the test statistic shows that it is statistically significant.

When Trade Openness is the dependent variable, the first ECT is positive and statistically significant suggesting that deviation from long-run equilibrium takes place due to any external disturbance in the system. But the second ECT is negative and statistically significant at 1% critical value, i.e. -0.314. This means that 31% of the deviation from long-run equilibrium is corrected within a quarter or in other words the rate of adjustment towards equilibrium is 31%. The statistically significant short-run coefficients of GDP at one lag and two lags are -1.021 and -0.447 respectively which means that when GDP increases, it has a negative impact on Trade Openness. The statistically significant short-run coefficients of FDI inflows at one lag and two lags are 0.065 and 0.040 respectively showing that increase in FDI inflows has a positive impact on Trade Openness. The statistically significant short-run coefficient of GDP Deflator at one lag is 1.546 showing a highly positive relationship between inflation and Trade Openness. All the other short-run coefficients are statistically not significant. The R-square value of 0.790 shows that the model is properly fitted and the p-value of the test statistic show that the model is significant.

With FDI inflows as the dependent variable, the first ECT is positive and statistically not significant but the second ECT is negative and statistically significant at 5% critical value. The 58.4% of the deviation from long-run equilibrium is corrected within a quarter. All the short-run coefficients are statistically not significant except FDI inflows at one lag and REER at two lags. The R-square of the model is 0.430 and the p-value of the test statistic is significant. With GFCF as the dependent variable, the first ECT is positive and statistically not significant but the second ECT is negative and statistically also not significant. All the short-run coefficients are statistically not significant except GDP at two lags and GDP Deflator at one lag. The R-square of the model is 0.692 showing that the model captures two third effects with the p-value of the test statistically significant.

When REER is considered as the dependent variable, the first ECT is positive and statistically significant (at 5%) which means that divergence from long-run occurred to render the system unstable. The second ECT is negative and statistically not significant. Further, all the short-run coefficients are statistically not significant except GFCF at one lag and REER at two lags. This means that rise in GFCF at one lag and REER at two lags has positive effect on REER as a whole in the short-run. With GDP Deflator as the dependent variable, the first ECT is positive and statistically significant (at 1%) which means that disequilibrium in the long-run occurred due to some external disturbance in the system. The second ECT is negative and also statistically significant (at 1%). The short-run coefficients of GDP at both the lags, FDI inflows at both the lags and REER at one lag are statistically significant. The R-square of the model is found to be 0.726 with the p-value of the test statistic significant.

3.4. Granger causality test

For the empirical investigations of cause-effect relationships, the Granger causality test has been used. The results of causality among the variables and its direction as determined by Granger causality test is shown in Table 4.

Table 4. *Granger causality results*

Sl. No.	Null Hypothesis (Ho)	Test Statistic	P-value	Decision
1	GDP does not Granger cause Trade Openness	44.411	0.000	Reject H_O
2	Trade Openness does not Granger cause GDP	7.498	0.058	Reject H_O
3	GDP does not Granger cause FDI inflows	7.659	0.054	Reject H_O
4	FDI inflows does not Granger cause GDP	2.824	0.420	Accept H_O
5	GDP does not Granger cause GFCF	24.804	0.000	Reject H_O
6	GFCF does not Granger cause GDP	20.636	0.000	Reject H_O
7	GDP does not Granger cause REER	3.625	0.305	Accept H_O
8	REER does not Granger cause GDP	4.073	0.254	Accept H_O
9	GDP does not Granger cause GDP Deflator	7.358	0.061	Reject H_O
10	GDP Deflator does not Granger cause GDP	15.128	0.002	Reject H_O

Sl. No.	Null Hypothesis (Ho)	Test Statistic	P-value	Decision
11	Trade Openness does not Granger cause FDI inflows	5.083	0.166	Accept Ho
12	FDI inflows does not Granger cause Trade Openness	22.098	0.000	Reject Ho
13	Trade Openness does not Granger cause GFCF	1.954	0.582	Accept Ho
14	GFCF does not Granger cause Trade Openness	5.148	0.161	Accept Ho
15	Trade Openness does not Granger cause REER	2.178	0.536	Accept Ho
16	REER does not Granger cause Trade Openness	2.237	0.525	Accept Ho
17	Trade Openness does not Granger cause GDP Deflator	16.084	0.001	Reject Ho
18	GDP Deflator does not Granger cause Trade openness	24.769	0.000	Reject Ho
19	FDI inflows does not Granger cause GFCF	5.073	0.167	Accept Ho
20	GFCF does not Granger cause FDI inflows	3.806	0.283	Accept Ho
21	FDI inflows does not Granger cause REER	4.745	0.191	Accept Ho
22	REER does not Granger cause FDI inflows	14.693	0.002	Reject Ho
23	FDI inflows does not Granger cause GDP Deflator	8.293	0.040	Reject Ho
24	GDP Deflator does not Granger cause FDI inflows	16.38	0.001	Reject Ho
25	REER does not Granger cause GFCF	1.755	0.625	Accept Ho
26	GFCF does not Granger cause REER	8.353	0.039	Reject Ho
27	GDP Deflator does not Granger cause REER	3.277	0.351	Accept Ho
28	REER does not Granger cause GDP Deflator	4.591	0.204	Accept Ho
29	GDP Deflator does not Granger cause GFCF	15.084	0.002	Reject Ho
30	GFCF does not Granger cause GDP Deflator	1.379	0.710	Accept Ho

Source: Calculated by author.

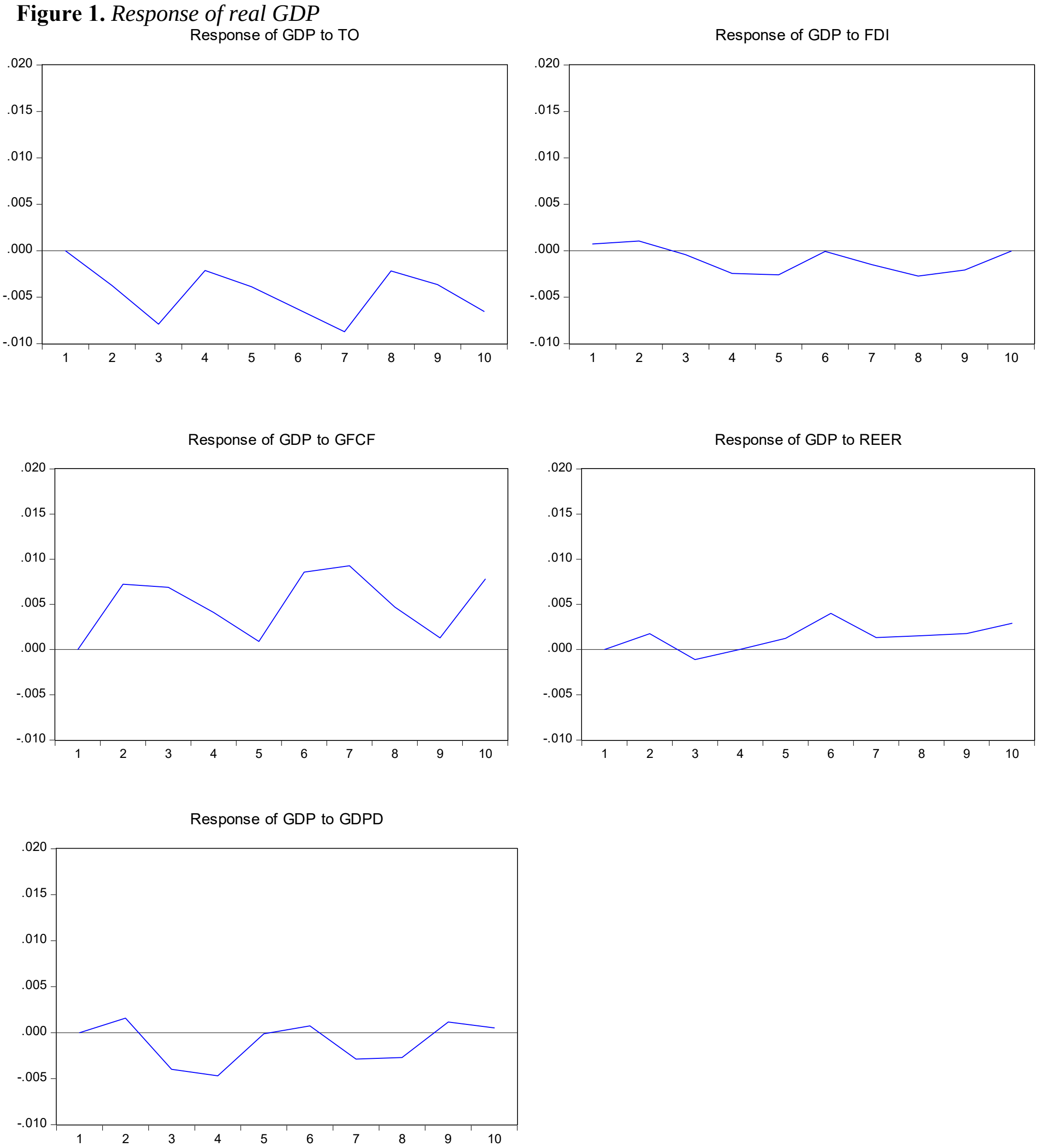
The Table 4 shows that there exist bidirectional causality between Real GDP at factor cost and trade openness; Gross Fixed Capital Formation and GDP; GDP deflator and GDP at Factor cost; Trade Openness and GDP Deflator; and FDI inflows and GDP Deflator. Further unidirectional causality exists from Real GDP at factor cost to FDI inflows; from FDI inflows to Trade Openness; from GDP Deflator to Real GDP at factor cost; from FDI inflows to Trade Openness; from Real Effective Exchange Rate to FDI inflows; Gross Fixed Capital Formation to Real Effective Exchange Rate; from GFCF to ERRR and from GDP Deflator to Gross Fixed Capital Formation. It is evident from the above that GDP cause inflow of FDI but not vice-versa. So with the growth of Indian economy we can expect more FDI inflow to the country. Similarly the trade openness of the country is expected to grow with the growth of the size of the economy. But one concern is that the growth of the GDP will cause rise in price level causing inflation spiral as it is evident GDP growth causes higher value of GDP deflator. Thus appropriate policy measures will be required to grip the inflation with the increasing size of the economy caused by rise in GDP.

3.5. Impulse response function

The Impulse Response Function identifies the responsiveness of each of the dependent variable in the VECM when a unit shock or innovation is applied to the independent variables involved in the model. The reaction of the dependent variable is shown for the future time horizon. For this analysis 10 time periods are taken into consideration (values of 10 quarters).

Figure 1 shows the response of Real GDP as a dependent variable when one standard deviation shock is given to the other independent variables. When one unit of innovation or shock is given to FDI inflows, the GDP follows an increasingly negative path for most of the time period after being positive for only the first two quarters. GDP responds in a peculiarly fluctuating manner when one unit shock is given to domestic investment (GFCF). It remains positive and increases continuously till third quarter but then decreases till fifth quarter to recover in an increasing trend till it falls again in the ninth quarter. GDP is predicted to remain largely negative in an increasing rate in response to innovation or shock in Trade Openness. GDP mostly remains around scale of origin but majorly in the negative region in response to one unit shock in GDP Deflator. GDP also hovers around the scale of origin in response to one unit shock in REER but remains in the positive region.

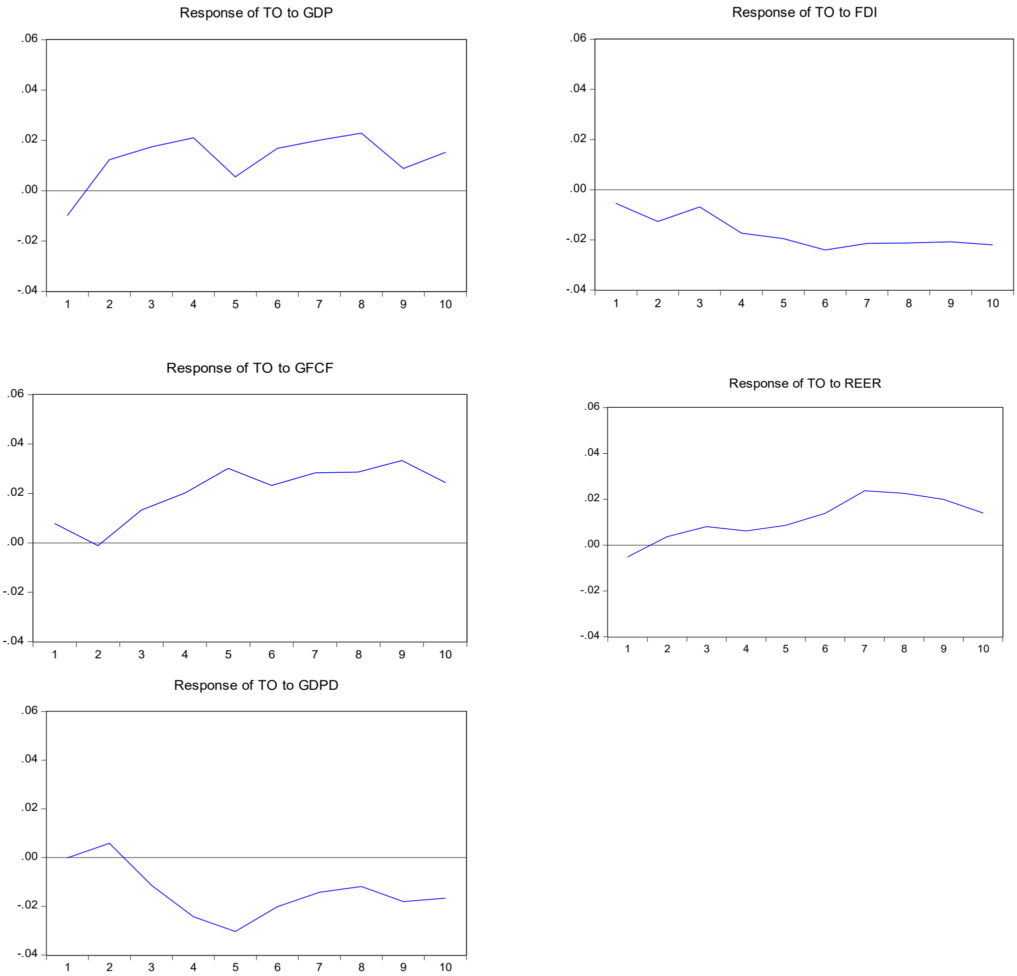
Figure 1. *Response of real GDP*



Source: Calculated by author.

Figure 2 shows the response of Trade Openness to one unit shock or innovation in the other independent variables. When one unit shock or innovation in is given to FDI and GDP Deflator, Trade Openness follows an increasingly positive path over the time period. When one unit shock or innovation is given to GDP the Trade Openness follows a severely fluctuating path in the positive scale within the value of 0.02 throughout the over the time period.

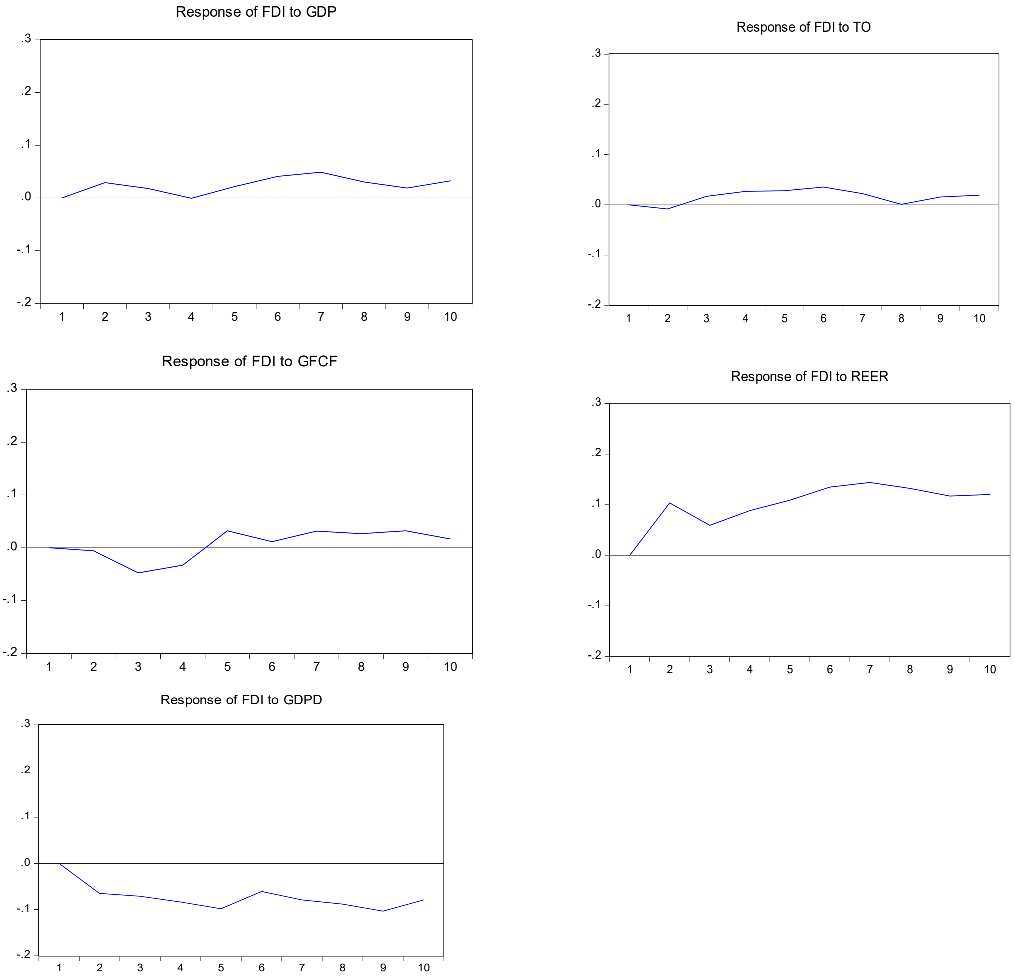
Figure 2. *Response of trade openness*



Source: Calculated by author.

Figure 3 shows the response of FDI inflows as a dependent variable when one standard deviation shock is given to each of the other independent variables. When one standard deviation innovation or shock is given to Real GDP at factor prices, then FDI inflows remains positive for the next 10 quarters but hovers around the neutral bar i.e. scale of origin or zero. But when one standard deviation innovation or shock is given to the inflation measure i.e. GDP Deflator, FDI inflows follows an increasingly negative trend throughout the next ten quarters. On the other hand, when the same unit of shock is given to domestic investment or Gross Fixed Capital Formation, FDI inflows is predicted to be negative for the first four quarters and then rises to positive levels for the next six quarters. The response of FDI inflows follows an increasingly positive trend when one standard deviation innovation is given to Real Effective Exchange Rate. The predicted path of FDI inflows for the next 10 quarters hovers around zero but remains strictly positive after being negligibly negative in the first two quarters.

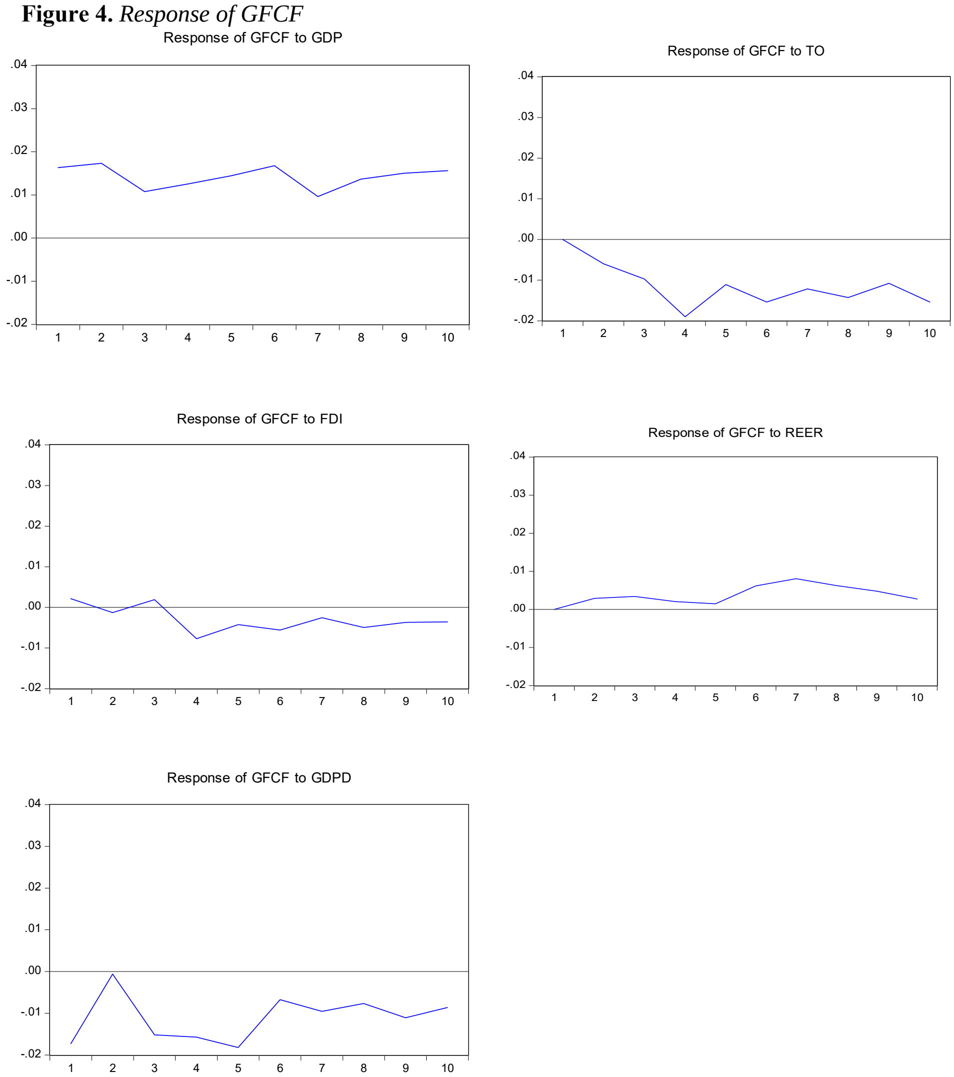
Figure 3. *Response of FDI inflows*



Source: Calculated by author.

Figure 4 shows the response of GFCF to one unit shock or innovation in the other independent variables. GFCF is predicted to be increasingly negative to one unit innovation in GDP deflator, Trade Openness and FDI inflows whereas it follows a positive path hovering around 0.01 to 0.02 in reaction to one unit innovation in REER and GDP.

Figure 4. *Response of GFCF*



Source: Calculated by author.

Figure 5 shows the response of REER to one unit of shock or innovation in the other independent variables. When one unit shock or innovation is given to FDI, REER is negative for the first five quarters and positive for the last five quarters but it hovers around the neutral value of zero. When one unit of shock or innovation is given to GDP Deflator, REER remains positive throughout the ten quarters but hovers around the zero neutral value. When one unit shock or innovation is given to GFCF, REER remains at high figures in the positive scale in the first five quarters but at low figures in the same positive scale in the last five quarters. When one unit shock or innovation is given to GDP, REER is positive for the first five quarters and negative for the last five quarters but it hovers around the neutral value of zero. When one unit shock is given to Trade Openness, REER follows an increasing path with flatter slope throughout the next ten quarters.

Figure 5. *Response of REER*

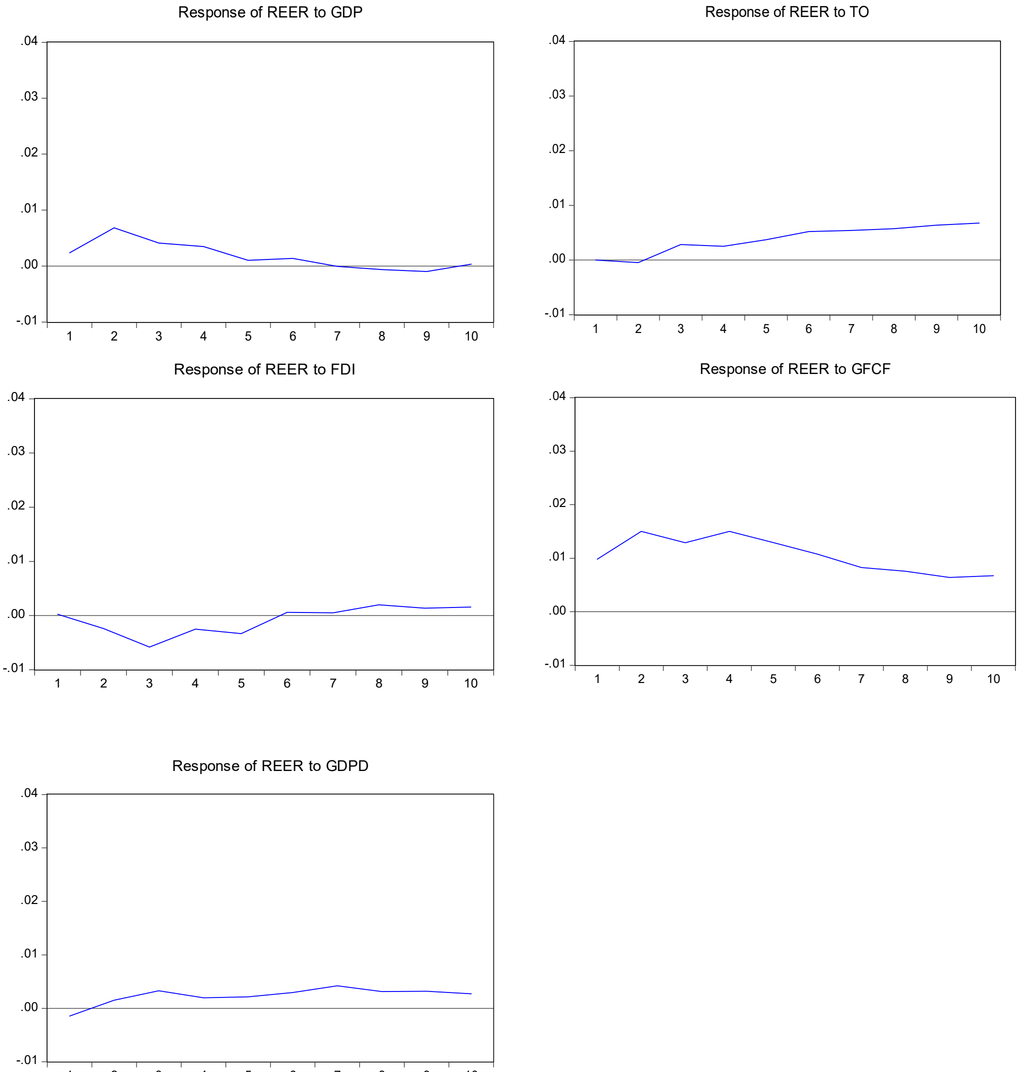
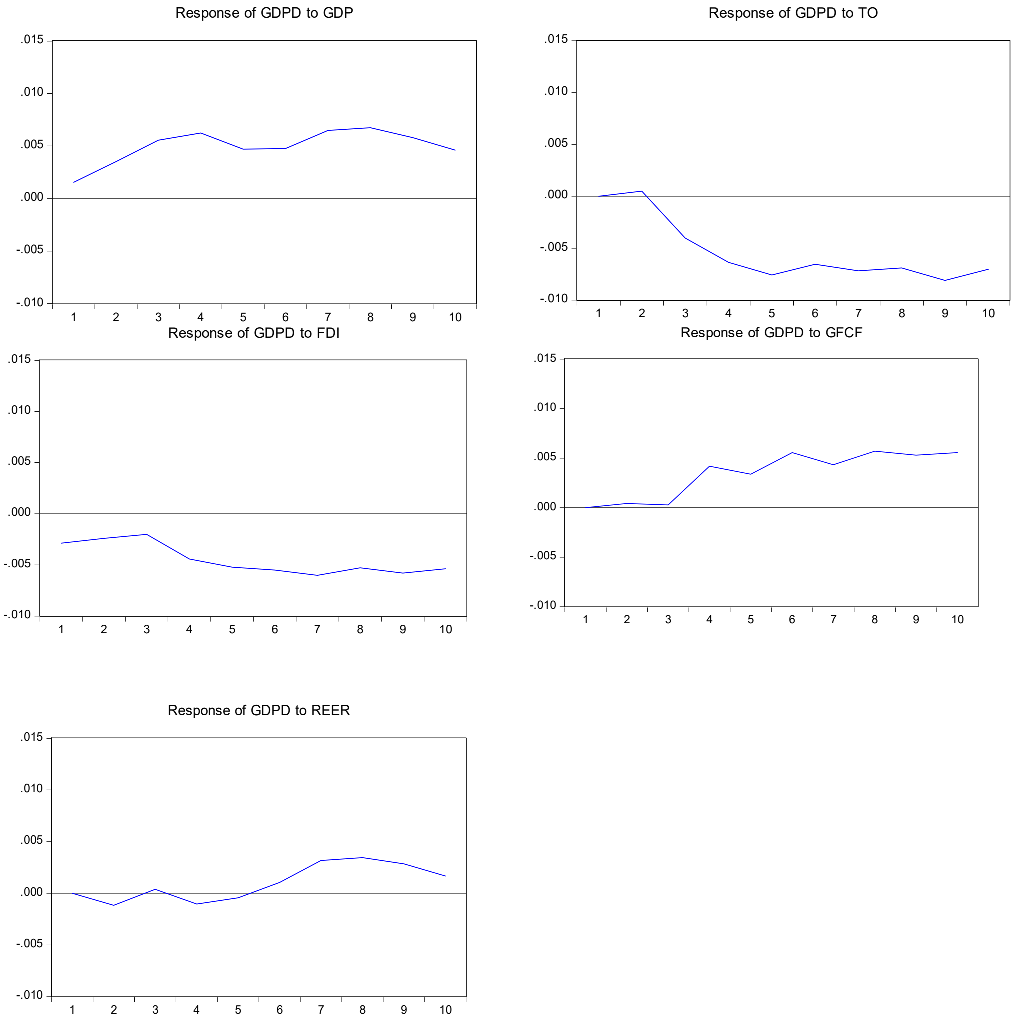


Figure 6 shows the response of GDP deflator to one unit shock in the other independent variables. GDP Deflator falls rapidly in the negative trend to one unit of innovation in Trade Openness and FDI inflows. But the same dependent variable i.e. GDP Deflator responds in an increasingly positive trend to one unit innovation in GFCF and GDP for the next 10 quarters. The reaction of GDP Deflator to one unit shock or innovation in REER is that it fluctuates and remains negligibly negative in 2nd quarter and 4th quarter till it maps an increasingly positive path further.

Figure 6. *Response of GDP deflator*



Source: Calculated by author.

4. Conclusion

It is observed that the Trade Openness affects GDP positively but Trade Openness is negatively impacted by GDP where as FDI inflow to India has a positive impact on Trade Openness. GDP deflator in the first lag shows a highly positive relationship with Trade Openness. Further, the REER has negative impact on FDI inflows at two lags. GDP at two lags has negative impact on the GFCF whereas GDP Deflator has positive impact on GFCF. IRF results reveals that when one unit shock of is given to GDP, the GFCF responds in the positive way but when one unit of shock is given to GDP Deflator the GFCF responds in the negative way over the period under study. Similarly it is found that GFCF at one lag has positive impact on REER. The GDP at both the lags has a negative impact on GDP Deflator but FDI inflows at both the lags have a positive impact on GDP Deflator. REER at first lag has a negative impact on GDP Deflator. GDP is major variable that influence the other variables under study. FDI inflow is the outcome of GDP growth. Similarly trade openness and GDP deflator are influenced by GDP. Real effective exchange rate has little impact on GDP. But capital formation plays very important role in GDP. Therefore more importance may be given to stimulate capital formation in India. Reform and appropriate policy implications would advance the functionality of foreign investment in the nation. To make the FDI beneficial, the government must improve the absorptive capacity of the country and change the policy related to FDI.

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