Economic Growth and Macro Variables in India: An Empirical Study

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Abstract

The research objective of this paper is to explore the empirical linkages between economic growth and foreign direct investment (FDI), gross fixed capital formation (GFCF) and trade openness in India (TOP) over the period 1980 to 2013. The study reveals a positive relationship between economic growth and FDI, GFCF and TOP. This study establishes a strong unidirectional causal flow from changes in FDI, trade openness and capital formation to the economic growth rates of India. The impulse response function traces the positive influence of these macro variables on the GDP growth rates of India. The study also reveals that the volatility of GDP growth rates in India is mainly attributed to the variation in the level of GFCF and FDI. The study concludes that the FDI inflows and the size of capital formation are the main determinants of economic growth. In view of this, it is expected that the government of India should provide more policy focus on promoting FDI inflows and domestic capital formations to increase its economic growth in the long-term.

Keywords: GDP growth; FDI; capital formation; trade openness; India.

1. Introduction

The opening up of economies has been argued both theoretically as well as empirically both by the majority of developed country economists and multilateral agencies as a remedy for achieving a higher growth rate. Since 1956, the determinants of economic growth have always been a policy focus and have attracted increasing attention in both theoretical and empirical research. The growth determining variable varies in its importance in each research and depends on the data base used, the methodologies adopted and the country specific stage of development. However, it has been generally argued that Foreign Direct Investment (FDI), Trade Openness (TOP), and Gross Fixed Capital Formation (GFCF) have a positive effect on the economic growth rate. Growth theories, neoclassical and endogenous, also provide multiple explanations for positive associations of macro variables and growth rates. However, sometimes empirical studies of linkages have produced opposing results. Economic literature often suggests that certain exogenous factors, such as stability and an efficient macroeconomic environment, determine the outcome of FDI, GFCF and TOP in an economy.

Since the 1990s, India has observed a remarkable increase in FDI inflows. FDI inflows are expected to increase productivity through the spillover of advanced technology. FDI can play a considerable role in building capital formation in capital scarce economies along with needed technology and skills, which generally push economic growth. Similarly, trade openness is expected to promote economic growth by efficient allocation of resources, diffusion of knowledge and technological progress. Among economists, it is generally assumed that opening up of the economy to trade and capital flows promotes allocative efficiency and can speed growth by absorbing new technologies at higher rate compared to a closed economy. As far as capital accumulation is concerned, it directly results in an increase in investment which ultimately influences economic returns positively. In growth literature, it is stated that a country having a lower initial level of capital stock tends to have higher productivity and growth rates if capital stock is increased.

Many studies have made attempts to explore empirical linkages between FDI, trade openness, capital formation and economic growth, taking one macro variable at a time. To the best of our knowledge, the joint effect of FDI, capital formation and trade openness on economic growth has not been examined in India specific studies. In view of this, the study will add to the existing body of literature on the subject by investigating India specific evidence of this relationship.

The remainder of the paper is structured as follows: Section 2 provides a review of theoretical and empirical literature. Section 3 describes data and econometric techniques used. Section 4 reports the empirical results and discussion. Finally, concluding remarks have been presented in section 5.

2. Review of theoretical and empirical literature

Economic scholars have long been interested in identifying crucial factors which cause differential growth rates in different countries over time. There are arguments supporting the hypothesis that macroeconomic factors do have some effect on economic growth. In a growth oriented theoretical framework, the neoclassical growth model explains the long-run growth rate of output based on two exogenous variables, namely, the rate of population growth and the rate of technological progress; while an endogenous growth model explains the long-run growth rate of an economy on the basis of endogenous factors. FDI, trade or capital formation is expected to increase the level of income only, but the long-run growth rate of the economy remains unaffected while the endogenous growth models do emphasise their role in advancing growth on a long-run basis (Romer, 1990; Grossman and Helpman, 1991; Aghion and Howitt, 1992; Barro, 1990). Researchers try to assess the impact of macro policy variables such as TOP, FDI and capital accumulation on economic growth under various theoretical frameworks.

Theoretical and empirical examination of causal linkages between TOP and the economic growth is one of the oldest research questions in economics. The impact of TOP on the rate of economic growth is not very explicit, and the outcome depends on many other factors. There is an ongoing debate on the possible relationship between the trade openness of an economy and its pattern of growth in GDP. Ricardian theory and Hecksher-Ohlin theory of international trade point out that liberalising international trade leads to only a one-time increase in output, also it does not suggest any certain implications for economic growth in the long-run. However, many scholars have propagated the significant role played by international trade in accelerating economic growth in their own words. For example: Robertson (1938) characterized exports as an engine of growth and Minford et al. (1995) pronounced foreign trade as an elixir of growth. Various studies have elucidated positive outcomes of liberalising international trade, such as easy access to factors of production and their services from abroad, better opportunities for allocation of resources, and increased transfer of technology from developed to developing economies, which ultimately expedites growth (Chuang, 2000; Chuang, 2002; Ismail, 2012).

A large number of scholars found that economies that have more liberalised international trade and flow of capital have higher per capita GDP and grow at a faster pace (e.g., Massell et al.,1972; Voivodas, 1973; Michaely, 1977; Tyler, 1981; Salvatore, 1983; Sachs and Warner, 1995; Hassan, 2007). There are number of empirical studies covering various countries of the world to provide evidence for export led economic growth. Empirical studies such as those of Michaely (1977), Feder (1982) and Marin (1992) observed that countries having high exports generally have a higher rate of economic growth than others. Thornton (1996) examined export led growth in Mexico during 1895-1992 and found positive granger causality from real exports to real GDP. Awokuse (2007) used quarterly data of three OECD countries, i.e. Bulgaria, the Czech Republic and Poland, to test the causal relationship between export, import and economic growth and observed statistically significant causality running from exports and imports of these countries to their economic growth.

There are a number of empirical studies covering various countries of the world to provide evidence for economic growth led exports. Krugman (1984) and Bhagwati (1988) were early scholars to notice that a rise in GDP often leads to a subsequent expansion of the volume of international trade. Later on, empirical studies such as that of Konya (2006) used data of 24 OECD countries and applied a panel data approach based on SUR systems and Wald tests to show causality running from GDP growth to exports for countries including Austria, France, Greece, Norway, Mexico, Portugal and Japan. Another very interesting type of relationship between trade openness and economic growth is the two-way causality between GDP growth and openness to international trade, which is termed as the feedback effect. Ramos (2001) observed the feedback effect in Portugal during the period 1865 to 1998 between exports, imports and economic growth using the Granger causality test. Konya (2006) also depicted the feedback effect for countries such as Canada, the Netherlands and Finland.

It has been revealed that besides trade openness, FDI played a crucial role in internationalising economic activities and acted as a primary source of technology transfer and economic growth. FDI is also treated as a source of human capital accumulation and development of new technology for developing countries. The "contagion effect" of foreign firms in less developed host countries in terms of technical advancement and management practices, could also lead to the economic growth of these countries (Findlay, 1978). The empirical results of Kumar and Pradhan (2002) indicate that FDI flows lead to the flow of a package of advantages through Multinational Corporations (MNCs) to host countries in the form of technical know-how, organisational skills, managerial ability and marketing skills, which leads to economic growth. FDI flows cause positive economic externalities such as learning by watching or doing and various other spillover effects such as managerial know-how and marketing capabilities (Asiedu, 2002).

FDI boosts technological spillover benefits, increases international competition and the supply side capabilities of a host country, which result in higher economic growth (Paugel, 2007). FDI increases volume and also the efficacy of physical investment which promotes economic growth in a capital scarce economy (e.g., Romer, 1986; Lucas, 1988; Grossman and Helpman, 1991; Barro and Salai-I-Martin, 1995). There are many research studies revealing a significant positive link between FDI and growth (e.g., Borensztein et al., 1995; Hermes and Lensink, 2003; Alguacil et al., 2002; Lensink and Morrissey, 2006). This causal link becomes stronger when host countries follow liberalised trade regimes, improve conditions for human capital formation, give boost to export oriented FDI, and ensure macroeconomic stability (Zhang, 2001). Dritsaki et al. (2004) observed this causality in Greece during the period 1960-2002. Bhat et al. (2004) found significant independent causality between foreign investment and economic growth in India during 1990 to 2002. Bosworth et al. (2007) suggested that foreign investment boosts household savings which are necessary to maintain the pace of economic growth in India. Contrary to which, Prasad et al. (2007) provided evidence that the absorption capacity of non-industrial developing economies (including India, Pakistan, South Africa and even successful ones like China, Singapore, Korea, Malaysia, Thailand etc.) for foreign capital, is often low owing to their underdeveloped financial markets or overvaluation of economies due to larger capital inflows. The authors could not find any evidence that an increase in foreign capital inflows directly boosts growth, which is contrary to the predictions of conventional theoretical models.

Economic theories have illustrated that capital formation plays a significant role in the economic growth models and assumes that capital is a prerequisite for economic growth. Simply, if in an economy there is no capital, then there will be no investment and no growth will take place. The rationale behind this argument is that capital accumulation widens the total factor productivity of different sectors of the economy by increasing opportunities for new firms to enter the industry. Capital formation is a key to economic growth. A large number of empirical studies have established the causal linkage between capital formation and the rate of economic growth (Kormendi and Meguire, 1985; Eberts and Fogarty, 1987; Barro, 1991; Levine and Renalt, 1992; Munnel, 1992; Ghura and Hadjimichael, 1996; Ben-David, 1998; Collier and Gunning, 1999; Hernandez-Cata, 2000; Chandra and Thompson, 2000; Ndikumana, 2000; Wang, 2002).

Sahoo et al. (2010) justified China's huge investment in public infrastructure due to its growth spillovers during 1975 to 2007 and also suggested to design economic policies that improve human capital formation, not only the physical capital formation. Kendrick (1993) proposed that capital formation alone does not accelerate economic growth; rather it is the allocation of capital to more productive sectors in the economy which determines growth in GDP. Blomstrom et al. (1996) finds a one way causal relationship between fixed investment and economic growth but only for high income countries, and no impact of FDI on economic growth in low income countries. However, fixed investment in physical assets makes greatest offerings to economic growth only if it comes with technical innovations (Ding and Knight, 2011). Not only this, the empirical results of Kim and Lau (1994) suggest that capital accumulation is the most significant source of economic growth in newly industrialised East-Asian economies which accounts for 48 to 72 % of the economic growth of countries like Hong-Kong, Singapore, Taiwan and South Korea. Various studies provide empirical evidence that capital formation has played a significant role in raising the rate of economic growth of developing countries such as Bangladesh and Pakistan (Adhikary, 2011; Ghani and Musleh-us din, 2006).

Despite broad consensus at a theoretical level, the empirical literature on the linkages between trade openness, FDI, capital formation and economic growth does not provide a very unambiguous picture. Results vary on the basis of data, period of study, methodology used, country specific characteristics, etc. Many argued that there is a positive relationship, while others do not trace it. In such scenario, the present study will add to the existing empirical literature by analysing India specific linkages.

3. Empirical methodology and data

In the context of India, an attempt has been made to examine the causal relationship between FDI, TOP, GFCF, and economic growth. Time series data over the period 1980-2013 has been considered in the study. In this analysis, a change in real GDP is treated as an indicator of economic growth. The time series data on FDI, TOP and GFCF is standardized by GDP to remove the problems associated with absolute measurement. Data have been extracted from World Development Indicators published by the World Bank.

As part of the empirical analysis, our base estimating equation in log-linear form is specified as follows:

$$LnGDPC_t = \alpha + \beta LnFDIGDP_t + \gamma LnGFCFGDP_t + \lambda LnTOP_t + \varepsilon_t \quad (1)$$

Where, GDPC = changes in real GDP, FDIGDP = foreign direct investment as a percentage of GDP, GFCGDP = gross fixed capital formation over GDP, and TOP = trade over GDP. Variables are converted into natural logs so that the coefficients of the co-integrating vector can be interpreted as long-term elasticities and the first difference of variables can be interpreted as growth rates. The expected signs of the parameters are positive.

The nature of data distribution is examined by using standard descriptive statistics. Normality of data distribution is also ascertained by the Jarque–Bera test. The Quandt-Andrews breakpoint test was applied to test structural breaks in the time series data. Test statistics indicate no structural break during the period of study. The time series property of each variable has also been investigated before proceeding further with the analysis. It is well known in the literature that the time series data must be based on stationary[1] for drawing any useful inferences. In doing so, three unit root tests were applied to ascertain whether the data series under consideration are stationary or not.

3.1. Unit root tests

Augmented Dickey Fuller (ADF), Phillips – Perron (PP) and KPSS unit root tests have been applied in the present study (Dickey and Fuller, 1981; Phillips and Perron, 1988; Kwiatkowski et al., 1992).

Augmented Dickey Fuller test

The ADF test is a modified version of the Dickey–Fuller (DF) test. It makes a parametric correction in the original DF test for higher-order correlation by assuming that the series follows an AR(p) process. The following regression equation (1) is fitted for ADF.

$$\Delta y_t = \alpha_0 + \lambda y_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta y_{t-i} + u_t \quad (2)$$

It controls for higher-order correlation by adding lagged difference terms of the dependent variable to the right-hand side of the regression.

Phillips-Perron (PP) test

Phillips and Perron (1988) adopt a nonparametric method for controlling higher-order serial correlation in a series. The test regression for the Phillips-Perron (PP) test is the AR (1) process. It makes a correction to the t-statistic of the coefficient from the AR(1) regression to account for the serial correlation in u_t. The advantage of the Phillips-Perron test is that it is free from parametric errors. In view of this, PP values have also been checked for stationarity.

KPSS test

A major criticism of the ADF unit root testing procedure is that it cannot distinguish between unit root and near unit root processes, especially when using short samples of data. This prompted the use of the KPSS test, where the null is of stationarity against the alternative of a unit root. This ensures that the alternative will be accepted (null rejected) only when there is strong evidence for (against) it (Kwiatkowskiet et al.,1992).

3.2. Co-integration test

Using non-stationary series, co-integration analysis has been used to examine whether there is any long-run equilibrium relationship. For instance, when non-stationary series are used in regression analysis, one as a dependent variable and the other as an independent variable, statistical inference becomes problematic (Granger and Newbold, 1974). Cointegration analysis becomes important for the estimation of error correction models (ECM). The concept of error correction refers to the adjustment process between short-run disequilibrium and a desired long run position. As Engle and Granger (1987) have shown, if two variables are co-integrated, then there exists an error correction data generating mechanism, and vice versa. Since, two variables that are co-integrated, would on average, not drift apart over time, this concept provides insight into the long-run relationship between the two variables and testing for the co-integration between two variables. In the present case, Johansen's maximum likelihood procedure for co-integration has been applied.

The Johansen (1988, 1991) method can be illustrated by considering the following general autoregressive representation for the vector Y.

$$Y_t = A_0 + \sum_{j=1}^{p} A_j Y_{t-j} + \varepsilon \quad (3)$$

where Y_t is an $n\times1$ vector of non stationary I(1) variables, A_0 is an $n\times1$ vector of constants, p is the number of lags, A_j is a (n x n) matrix of coefficients and ε_t is assumed to be a $(n\times1)$ vector of Gaussian error terms.

In order to use Johansen's test, the above vector autoregressive process can be reparametarized and turned into a vector error correction model of the form:

$$\Delta Y_t = A_0 + \sum_{j=1}^{p-1} \Gamma_j \Delta Y_{t-j} + \Pi Y_{t-p} + \varepsilon_t \quad (4)$$

Where,

$$\Gamma_j = -\sum_{i=j+1}^{p} A_j$$

and

$$\Pi = -I + \sum_{i=j+1}^{p} A_j$$

Δ is the difference operator, and I is an (n x n) identity matrix.

The issue of potential co-integration is investigated by comparing both sides of equation (4). As $Y_t \sim I(1), \Delta Y_t \sim I(0)$, so are ΔY_{t-j}. This implies that the left-hand side of equation (4) is stationary. Since ΔY_{t-j} is stationary, the right-hand side of equation (4) will also be stationary if $\Pi \Delta Y_{t-p}$ is stationary. The Johansen test centers on an examination of the Πmatrix. The Π can be interpreted as a long run coefficient matrix, since in equilibrium, all the ΔY_{t-j} will be zero, and setting the error terms, ε_t, to their expected value of zero will leave $\Pi \Delta Y_{t-p} = 0$. The test for co-integration between the Y's is calculated by looking at the rank of the Πmatrix via Eigen values. The rank of a matrix is equal to the number of its characteristic roots that are different from zero. There are three possible cases to be considered: Rank (Π) = p and therefore vector Xt is stationary; Rank (Π) = 0 implying the absence of any stationary long run relationship among the variables of X_t or Rank (Π) < p and therefore r determines the number of cointegrating relationships. Thus, if the rank of Π equals to 0, the matrix is null and equation (4) becomes the usual VAR model in first difference. If the rank of Π is r where r < n, then there exist r co-integrating relationships in the above model.

The test for the number of characteristic roots can be conducted using the following two statistics, namely, the trace and the maximum Eigen value test.

$$\lambda_{trace}(r) = -T\sum_{j=r+1}^{p}\ln(1-\hat{\lambda}_j) \quad (5)$$

and

$$\lambda_{\max}(r, r+1) = -T\ln(1-\hat{\lambda}_{r+1}) \quad (6)$$

Where $\hat{\lambda}_j$ is the estimated values of the characteristic roots (also called the Eigenvalue) obtained from the estimated Π matrix, T is the number of usable observations. r is the number of co-integrating vectors.

The trace test statistics test the null hypothesis that the number of distinct co-integrating vectors is less than or equal to r against the alternative hypothesis of more than r co-integrating relationships. From the above, it is clear that λ_{trace} equals zero when all $\hat{\lambda}_j$= 0. The farther the estimated characteristic roots are from zero, the more negative is ln(1-$\hat{\lambda}_j$) and larger the λ_{trace} statistics. The maximum Eigenvalue statistics test the null hypothesis that the number of co-integrating vectors is less than or equal to r against the alternative of r +1 co-integrating vectors. Again, if the estimated value of the characteristic root is close to zero, $\lambda_{\max}$ will be small.

3.3. Vector error correction model (VECM) model

The VECM model has been fitted to explore short-run and long-run causal linkages. The VECM model has been specified in first differences as the variables are co-integrated as given in equations 7, 8, 9 and 10.

$$\Delta Y_t = \alpha^y + \beta^y ECT_{t-1}^y + \sum_{j=1}^{m}\delta_j^y \Delta Y_{t-j} + \sum_{s=1}^{q}\gamma_s^y \Delta F_{t-s} + \sum_{v=1}^{r}\lambda_v^y \Delta C_{t-v} + \sum_{i=1}^{n}\theta_i^y \Delta Tr_{t-v} + u_t \quad (7)$$

$$\Delta F_t = \alpha^f + \beta^f ECT_{t-1}^f + \sum_{j=1}^{m}\delta_j^f \Delta Y_{t-j} + \sum_{s=1}^{q}\gamma_s^f \Delta F_{t-s} + \sum_{v=1}^{r}\lambda_v^f \Delta C_{t-v} + \sum_{i=1}^{n}\theta_i^f \Delta Tr_{t-v} + u_t \quad (8)$$

$$\Delta C_t = \alpha^c + \beta^c ECT_{t-1}^c + \sum_{j=1}^{m}\delta_j^c \Delta Y_{t-j} + \sum_{s=1}^{q}\gamma_s^c \Delta F_{t-s} + \sum_{v=1}^{r}\lambda_v^c \Delta C_{t-v} + \sum_{i=1}^{n}\theta_i^c \Delta Tr_{t-v} + u_t \quad (9)$$

$$\Delta Tr_t = \alpha^{tr} + \beta^{tr} ECT_{t-1}^{tr} + \sum_{j=1}^{m}\delta_j^{tr} \Delta Y_{t-j} + \sum_{s=1}^{q}\gamma_s^c \Delta F_{t-s} + \sum_{v=1}^{r}\lambda_v^{tr} \Delta C_{t-v} + \sum_{i=1}^{n}\theta_i^{tr} \Delta Tr_{t-v} + u_t \quad (10)$$

Where $Y_t = LnGDPC_t$, $F_t = LnFDIGDP_t$, $C_t = LnGFCFGDP_t$ and $Tr_t = LnTOP_t$ and u_t's are the stochastic error terms. The stochastic error terms are known as the impulse response or innovations or shock in the language of VAR/VECM.

The dynamic linkage is examined using the concept of Granger's causality test (1969, 1988). A time series x_t Granger-causes another time series y_t if series y_t can be predicted with better accuracy by using past values of x_t rather than by not doing so, other information is identical. In other words, variable x_t fails to Granger-cause y_t if

$$\Pr(y_{t+m} | \Omega_t) = \Pr(y_{t+m} | \Psi_t) \quad (11)$$

Where $\Pr(y_{t+m} | \Omega_t)$ denotes the conditional probability of y_t, where Ω_t is the set of all information available at time t, and $\Pr(y_{t+m} | \Psi_t)$ denotes the conditional probability of y_t obtained by excluding all information on x_t from y_t. This set of information is depicted as Ψ_t. In the present study, the Wald test has been applied to test short run causality on VECM parameter estimates.

The variance decomposition and impulse response function has been utilized for drawing inferences. Impulse response functions have been estimated to trace the effects of a shock to one endogenous variable on to the other variables in the VECM. The impulse response functions can be used to produce the time path of the dependent variables in the VECM, to shocks from all the explanatory variables. If the system of equations is stable, any shock should decline to zero; an unstable system would produce an explosive time path.

Variance decomposition (Choleski Decomposition) is the alternative way in which to separate the variation in an endogenous variable into the component shocks to the VECM. Thus, the variance decomposition which provides information about the relative importance of each random innovation in affecting the variables in the VECM, has also been presented. In the econometric literature, both impulse response functions and variance decomposition together are known as innovation accounting.

4. Empirical results

4.1. Descriptive statistics

The descriptive statistics for all four variables are calculated and presented in Table 1. These variables are growth rates, foreign direct investment, gross fixed capital formation and trade openness. The skewness coefficient, in excess of unity, is taken to be fairly extreme (Chou, 1969). A high or low kurtosis value indicates an extreme leptokurtic or extreme platykurtic distribution (Parkinson, 1987). Generally values for zero skewness and kurtosis at 3 represents that the observed distribution is normally distributed. It is seen that the frequency distribution of the GDPC and GFCF variables are found to be normally distributed while FDI and TOP are not found to be normally distributed. Jarque-Bera statistics also indicate that the frequency distribution of the underlying series does not fit a normal distri-

Table 1: Descriptive statistics (1980-2013)

Statistics	GDPC	FDI	GFCF	TOP
Mean	37283540882.22	0.77	24.70	20.60
Median	26776077940.05	0.60	23.68	17.80
Maximum	115727090179.96	3.55	32.92	42.25
Minimum	3701461309.67	0.00	17.92	9.80
Std. Dev.	28838034267.78	0.87	4.43	10.30
Skewness	1.02	1.37	0.53	0.95
Kurtosis	3.03	4.48	2.05	2.65
Jarque-Bera	5.92	13.74	2.91	5.31
Probability	0.05	0.00	0.23	0.07
Observations	34	34	34	34

bution.

4.2. Stationarity results

All four variables for stationarity were tested by applying the ADF, PP unit root test and KPSS stationarity test. ADF, PP and KPSS statistics are given in Table 2. On the basis of ADF statistics and the PP test, all the series are found to be non-stationary at levels. Finally, the KPSS test is applied which has null stationarity. In this case, all variables are non stationary in levels and stationary in first differences. As a result, all the variables have been differenced once to check their stationarity. At first differencing, the calculated ADF, PP and KPSS tests statistics clearly reject the null hypothesis of the unit root at a 1 or 5 per cent level of significance. Thus, the ADF, PP and KPSS tests decisively confirm the stationarity of each variable at first differencing and depict the same order of integration, i.e. I (1) behaviour. Assuming all the variables are non-stationary at levels and stationary at first differences, Johansen's approach of co-integration, the Granger causality test and VAR/VECM modelling for variance decomposition/impulse response functions, have been applied.

4.3. Co-integration test results

To explore whether there is any long-run relationship between economic growth and macro variables under consideration, such as foreign direct investment to GDP ratio, gross fixed capital formation to GDP ratio and trade to GDP ratio, Johansen's cointegration test has been applied. The number of lags in cointegration analysis is chosen on the basis of Akaike Information Criteria. Before discussing the results, it is important to discuss what is implied when variables are cointegrated and when they are not. When variables are cointegrated, it implies that the time series cannot wander off in opposite directions for very long without coming back to a mean distance, eventually. But it doesn't mean that on a daily basis the two series have to move in synchrony at all. When series are not cointegrated it implies that the two time series can wander off in opposite directions for a very long time without coming back to a mean distance eventually. Table 3 presents the result of Johansen co-integration test results. Both the trace and maximum eigenvalue statistics detect two cointegrating relationships at the 5% level. In other words, results indicate that GDP Growth, FDI, GFCF and TOP are

Table 2: Unit root test results

Variables	Null Hypothesis: Unit Root		Null Hypothesis: Unit Root		Null Hypothesis: No Unit Root		Conclusion
	ADF Test		PP Test		KPSS Test		
	Level	FD	Level	FD	Level	FD	
LNGDPC	-1.24	-9.38*	-1.84	-22.46*	0.73**	0.26	I(1)
LNFDI	-1.51	-6.37*	-1.35	-8.18*	0.65**	0.22	I(1)
LNGFCF	-1.56	-5.82*	-1.56	-5.84*	0.65**	0.13	I(1)
LNTOP	0.66	-7.57*	0.31	-7.62*	0.66**	0.16	I(1)

*Notes: * denotes significance at 1% and ** denotes significance at 5%.*

Table 3: Unrestricted cointegration rank test

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	Critical Value	Trace Statistic	Critical Value
None *	0.868533	58.84	27.58	91.69	47.85
At most 1 *	0.554269	23.43	21.13	32.85	29.79
At most 2	0.236910	7.84	14.26	9.41	15.49
At most 3	0.052984	1.57	3.84	1.57	3.84

*Notes: Max-Eigenvalue and Trace Statistics indicates 2 cointegrating eqn(s) at the 0.05 level; * denotes rejection of the hypothesis at the 0.05 level.*

Table 4: Vector error correction estimates for GDP equation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ECT(-1)	-5.595630	0.993923	-5.629845	0.0002
D(LNGDPC(-1))	3.958837	0.826385	4.790550	0.0006
D(LNGDPC(-2))	2.964279	0.643608	4.605723	0.0008
D(LNGDPC(-3))	1.913996	0.496921	3.851713	0.0027
D(LNGDPC(-4))	0.765177	0.266725	2.868787	0.0153
D(LNFDI(-1))	-0.643320	0.195200	-3.295689	0.0071
D(LNFDI(-2))	-0.653853	0.163981	-3.987377	0.0021
D(LNFDI(-3))	-0.146253	0.142900	-1.023466	0.3281
D(LNFDI(-4))	-0.205559	0.125554	-1.637221	0.1298
D(LNGFCF(-1))	-5.094908	2.044332	-2.492212	0.0299
D(LNGFCF(-2))	4.174061	1.651257	2.527808	0.0281
D(LNGFCF(-3))	4.338290	1.813337	2.392435	0.0357
D(LNGFCF(-4))	4.594950	1.859377	2.471231	0.0311
D(LNTOP(-1))	-4.077518	1.165032	-3.499919	0.0050
D(LNTOP(-2))	-3.771188	1.184475	-3.183848	0.0087
D(LNTOP(-3))	-4.451657	1.062747	-4.188819	0.0015
D(LNTOP(-4))	-2.290744	0.874842	-2.618467	0.0239
Constant	0.151206	0.100828	1.499648	0.1618
R-squared	0.879954	Mean dependent var		0.069929
Adjusted R-squared	0.694428	S.D. dependent var		0.603203
S.E. of regression	0.333442	Akaike info criterion		0.913283
Sum squared resid	1.223019	Schwarz criterion		1.761950
Log likelihood	4.757395	Hannan-Quinn criter.		1.179075
F-statistic	4.743030	Durbin-Watson stat		2.624087
Prob(F-statistic)	0.006009			

Table 5: Short Run Causality-Wald Test

Null Hypothesis	Chi-square Test Statistics	Probability
FDI does not cause change in GDP	20.33	0.0004
GFCF does not cause change in GDP	15.60	0.0036
TOP does not cause change in GDP	24.03	0.0001
GDP does not cause change in FDI	6.24	0.1814
GDP does not cause change in GFCF	4.13	0.3885
GDP does not cause change in TOP	3.71	0.4457

co-integrated in the long run. As a result, the vector error correction model is estimated.

4.4. Vector error correction model (VECM)

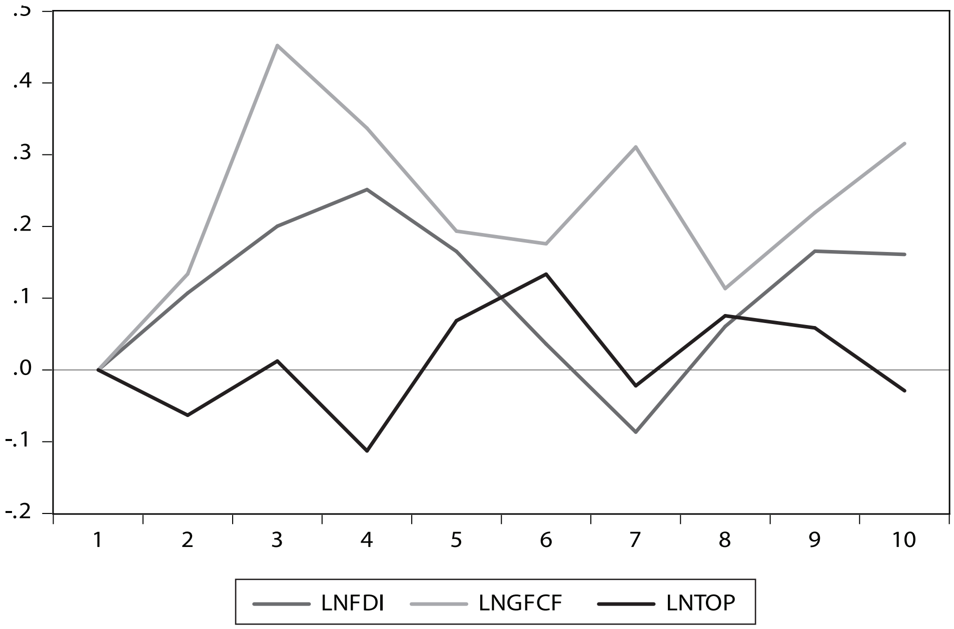
The VECM results confirm a long-run equilibrium relationship among the variables where a unidirectional long-term causal flow runs from changes in the FDI, capital formation and trade openness to the GDP growth rates of India (Table 4). This is revealed by the estimated coefficient of the error correction term, which is negative, as expected, and statistically significant in terms of its associated t-value. The purpose of the VECM model is to indicate the speed of adjustment from the short-run equilibrium to the long-run equilibrium state. The greater the coefficient of the parameter, the higher the speed of adjustment of the model from the short-run to the long-run. The adjusted R square is 0.70 which shows a very high explanatory power of the model. The F statistics at 4.74 suggest that a moderate interactive feedback effect exists within the system.

In an effort to determine the short run causality among the macro variables, the Granger causality/Block exogeneity Wald tests based upon the VEC model is performed. The optimum number of lags is determined by the SIC criterion. The significance of Chi-square statistics indicates Granger causality among variables. According to the test results in Table 5, short run causality is from the FDI, GFCF and TOP to economic growth.

4.5. Impulse response and variance decomposition

To investigate dynamic responses further between the variables, the Impulse Response of the VAR system has also been estimated. An Impulse Response function traces the effect of a one-time shock to one of the innovations of current and future values of the endogenous variables. So, for each variable from each equation separately, a unit shock is applied to the error, and the effects upon the VAR system over time is noted. A shock to the i-th variable not only directly affects the i-th variable but is also transmitted to all of the other endogenous variables through the dynamic (lag) structure of the VAR. Figure 1 reports impulse responses. It shows how a one-time positive shock of one standard deviation (± 2 S. E. innovations) to the FDI, capital formation and trade openness, endures on the economic growth rates of India. A cursory examination of Figure 1 shows that the impulse response of trade openness on

Figure 1: Response of LNGDPC to Cholesky One S.D. Innovations

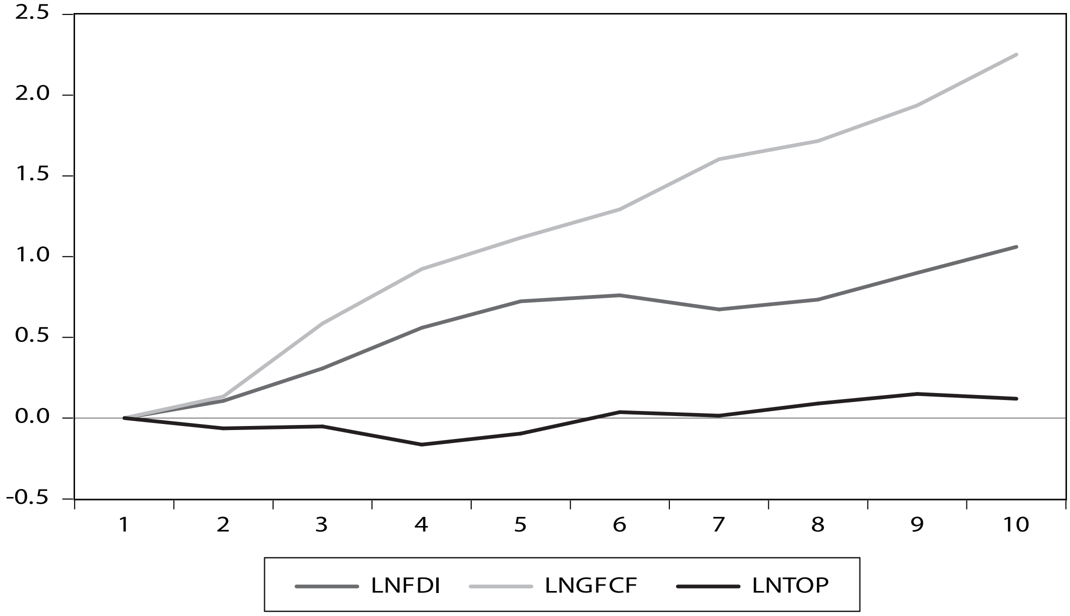


GDP growth rates is mildly negative. Figure 1 further reveals that the initial positive shock given to the capital formation raises economic growth rates to its peak at approximately 0.45% by the end of the second year or the beginning of the third year. Figure 1 shows that the initial positive shock given to the FDI raises economic growth rates to its peak at approximately 0.25% by the end of the third year or the beginning of the fourth year. Figure 1, however, unearths a positive but fluctuating and diminishing influence on changes in real GDP over time. Overall, the impulse response function traces positive influence of the response variables on the GDP growth rates of India.

In our model it might be particularly interesting to analyze accumulated impulse responses. Accumulated impulse responses at time horizon *h* are obtained by summing up all impulse responses from 0 to *h*. The accumulated response of LNGDPC to Cholesky one S.D. innovations of LNGFCF to GDP change is almost double the accumulated response of LNGDPC to Cholesky one S.D. innovations of LNFDI. The period by period effect of TOP is fluctuating, but the accumulated effect is positive (Figure 2).

In the context of varying causal links of both GDP growth rates with macro variables, VECM were applied and short run causal links were explored using Variance decomposition. Variance decomposition determines how much of the k-step ahead forecast error variance of a given variable is explained by innovations to each explanatory variable. In practice, it is usually observed that own series shocks most of the (forecast) error variance of the series in the VAR. Variance decomposition separates the variation in an endogenous variable into the component shocks to the VAR and provides

Figure 2: Accumulated Response of LNGDPC to Cholesky One S.D. Innovations



information about the relative importance of each random innovation in affecting the variables in the VAR. The variance decomposition results at the end of 6 periods are shown in Table 6. The columns provide the percentage of the forecast variance due to each innovation in the VAR framework, with each row adding up to 100. The variance of GDP growth rates is always caused by 100 per cent by itself in the first year. In the second year, the GDP growth variance is decomposed into its own variance (80.26%) followed by level of capital formation (10.55%), FDI (6.81%) and TOP (2.37%). However, in subsequent years, the share of GDP growth rates remains constant to approximately 20% followed by the volume of FCF, FDI and TOP contributing 55%, 20% and 5.37 % respectively. On the other hand, the share of

Table 6: Variance decomposition of LNGDPC

Period	S.E.	LNGDPC	LNFDI	LNGFCF	LNTOP
1	0.333442	100.0000	0.000000	0.000000	0.000000
2	0.411305	80.26422	6.810032	10.55620	2.369547
3	0.647142	33.55584	12.34254	53.10896	0.992661
4	0.779879	23.10689	18.88285	55.23035	2.779907
5	0.823224	20.75484	20.97238	55.08566	3.187121
6	0.856835	20.02519	19.53738	55.06589	5.371542

trade openness in explaining the variation of real GDP remains low but explains around a stable 5%. Broadly it seems that the volatility of GDP growth rates is mainly caused by the level of GFCF and FDI variation, as it always accounts for the major portion (above 75%) of the fluctuations.

5. Concluding remarks

The present study is an attempt to explore the linkages between FDI, GFCF, TOP and GDP growth empirically in the context of India by analyzing time series data for the period 1980-2013. The study reveals that there is a significant relationship between economic growth and the macro variables under consideration. The results of the study reveals a trong unidirectional causal flow from changes in FDI, trade openness and capital formation to the GDP growth rates of India. Empirical results indicate a significant and high speed of adjustment from the short-run equilibrium to the long-run equilibrium state. The results of this study reveal short run causality from the FDI, GFCF and TOP to economic growth. The impulse response function traces the positive influence of the response variables on the GDP growth rates of India. Broadly it seems that the volatility of GDP growth rates is mainly caused by the level of GFCF and FDI variation, as it always accounts for the major portion (above 75%) of the fluctuations. Trade openness, however, provides less importance, as compared to the degree of capital formation and FDI, in changing GDP growth rates. With the volume of international capital and the magnitude of capital formation, in general, being the robust determinants of economic growth, it is expected that the government of India should provide more emphasis on the above factors to increase its economic growth.

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Notes:

1. Broadly speaking a data series is said to be stationary if its mean and variance are constant (non-changing) over time and the value of covariance between two time periods depends only on the distance or lag between the two time periods and not on the actual time at which the covariance is computed.

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