India's Foreign Direct Investment Inflows: Cointegration and Vector Error Correction Analysis

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Abstract

In this paper author explained the trend lines, random walk, stationarity, structural breaks and volatility of FDI inflows in India during 1971-2015.Both log linear and exponential trends are significant. FDI inflows is stationary and showed four structural breaks in 1985,1994,2000 and 2006.Author found the relation among FDI inflows, growth rate, interest rate, inflation rate, exchange rate, fiscal deficit, external debt and trade openness with the help of Granger causality, Johansen cointegration test and vector error correction models. Trace statistic has four cointegrating equations and Max Eigen Statistic has three cointegrating equations. The speed of the vector error correction process is more or less slow except for change in interest rate and change in inflation rate which are significant where VECM is stable and diverging. Limitations and future scope of research are added. Policy recommendations are included.

Key words- Foreign Direct Investment Inflows, ARIMA, structural breaks, causality, cointegration, vector error correction

JEL- E23,E24,F13,F4,F2,O54

I.Introduction

Conceptually, Foreign Direct Investment (FDI) is an investment in a business by an investor from another country for which the foreign investor has control over the company purchased. More simply, foreign direct investment is a category of cross border investment associated with a resident in one economy having control or a significant degree of influence on the management of an enterprise that is resident in another economy. Broadly, FDI includes "merger, reinvesting profits earned from overseas operations and intra company loans"[1]. FDI provides a win – win situation to the host and the home countries. FDI as a strategic component of investment is

[1] FT Lexicon

needed by India for its sustained economic growth and development. FDI is necessary for creation of jobs, expansion of existing manufacturing industries and development of the new one. Indeed, it is also needed in the healthcare, education, R&D, infrastructure, retailing and in long term financial projects. Need of FDI depends on saving and investment rate in any country. Foreign Direct Investment acts as a bridge to fulfill the gap between investment and saving. In the process of economic development foreign capital helps to cover the domestic saving constraint and provide access to the superior technology that promotes efficiency and productivity of the existing production capacity and generate new production opportunity. Foreign investments mean both foreign portfolio investments and foreign direct investments (FDI). FDI brings better technology and management, marketing networks and offers competition, the latter is helping Indian companies to improve for future innovation and efficiency. The effectiveness of FDI in bringing about the desired growth may be constrained by the level of infrastructural developments and other macroeconomic variables. Infrastructural development, openness and domestic market size are major determinants of FDI. Even, exchange rate and interest rate may influence FDI inflows. Besides, balance of payments adjustment is a good correlation with FDI inflows and outflows. Political instability and financial crises influence FDI flows negatively. Alongside opening up of the FDI regime, steps were taken to allow foreign portfolio investments into the Indian stock market through the mechanism of foreign institutional investors. The objective was not only to facilitate non-debt creating foreign capital inflows but also to develop the stock market in India. The lower the cost of capital for Indian enterprises, the higher is the improvement of corporate governance structures. FDI have helped India to attain a financial stability and economic growth with the help of investments in different sectors. FDI has boosted the economic life of India.

The general observations of some eminent economists are that by allowing MNC in Indian economy, the government of India with the help of World Bank and IMF introduced the macro-economic stabilization and structural adjustment program although it is controversial and debatable. As a result of these reforms India opens its door to FDI inflows and adopted a more liberal foreign policy in order to restore the confidence of foreign investors in the globalised world.

Last but not the least, FDI should be judged from the view point of its dimension such as,source of flows, nature of amount, direction of inflows, or sectors of inflows, policies of

implementation, how much it is regulated and so on. Impact of FDI in the free trade zone/bloc is rather different from restricted trade or financially integrated blocs. Even the control and impact of MNC dominated FDI is crucial to evaluate in today's globalised world. Yet, the history of capital inflows teaches us to explain that in most of the financial crises, both FDI inflows and outflows reduced where the source of the financial crises are primary to clarify the impact of FDI. But China is the exception in recent financial crises where there was no fall of FDI inflows. Therefore, there is no universal rule so as to judge the impact of FDI in an individual country or bloc. There are number of determining factors by which FDI and its impact depend upon.

II.Objective of the study

In this paper, the author endeavours to explain the patterns of behavior of India's foreign direct investment inflows during 1971-2015. Besides, the author tries to relate FDI inflows with macro variables like growth rate, interest rate, inflation rate, exchange rate, fiscal deficit, external trade and trade openness of India during the specified period with the help of causality, cointegration and vector error correction models. It tried to show limitations, future scope and policy implications relating to the model.

III.Literature review

There are innumerable economic literature on FDI and other related variables in general and in country specific. The author showed some important literatures which are related with Indian economy. Basu, Chakraborty and Reagle (2003) found a cointegration relationship between FDI and GDP for 23 developing countries during 1978-1996.Moreover, Hansen and Rand (2006) found that there is a cointegration relationship between FDI and GDP for 31 developing countries from 1970-2000. Their findings indicated that FDI inflows are positively correlated with GDP, whereas GDP has no long-run effect on FDI. Chakraborty and Mukherjee(2012) argued that foreign direct investment (FDI) inflow influences positively on economic growth through technology diffusion, human capital formation, etc., and found that there is a unidirectional causality from India's economic growth to FDI and from FDI to domestic investment. In case of policy implications, the paper concluded that higher FDI inflow in India facilitated the relatively stable GDP growth rate which in turn boosted high domestic investment. Chakraborty and Basu(2010) linked between foreign direct investment and growth for India using a structural cointegration model with vector error correction mechanism. They found two

cointegrating vectors among GDP, FDI, the unit labour cost and the share of import duty in tax revenue which captures the long run relationship between FDI and GDP.Their VEC model has three important features: (1) GDP in India is not Granger caused by FDI; the causality runs more from GDP to FDI; (2) trade liberalization policy of the Indian government leads to positive short run impact on the FDI inflow; and (3) FDI lowers the unit labour cost which implies that FDI in India is labour displacing. Sarbapriya Ray(2012) analyzed the causal relationship between Foreign Direct Investment (FDI) and economic growth in India during 1990-91 to2010-11 and found an existence of long run equilibrium relationship between the two . The Granger causality test finally confirmed the presence of uni-directional causality which runs from economic growth to foreign direct investment. The error correction estimates showed that the Error-Correction Term is statistically significant and has a negative sign. If FDI boosts growth, India must emphasize on improving infrastructure, human resources, developing local entrepreneurship, creating a stable macroeconomic framework and conditions favourable for productive investments to accelerate the process of development. Wang (1990) studied the FDI-growth relationship in China.He found that there are two potential channels by which FDI affects economic growth ,[i]rate of physical capital accumulation and [ii]productivity growth. He showed that FDI is not only an additional source of financing growth, but also helps increase productivity. Dash, R.K. & Parida, P.C. (2013) examined the linkages between inward FDI, services trade (export and import) and economic output using co-integration,causality and VEC model. Their study confirmed the long-run relationship among those variables. They showed bi-directional causal relationship between FDI and economic output as well as between services exports and economic output. The results also bring out feedback relationship between services export and FDI, reconfirming the presence of complementary relationship between the two. At the sectoral level, they found at least a unidirectional causality from FDI and services exports to both manufacturing and services output and also cross-sectoral spill over effects from manufacturing output to services output and vice versa. Bhattacharjee and Bhattacharjee(2011) investigated whether the volume of merchandise trade and FDI inflows influences economic growth during in India 1996-97:Q1 to 2008-09:Q3. The authors found the stationarity of the variables, cointegration of CI(1) and vector error correction and Granger Causality (unidirectional causality from merchandise trade to economic growth and bidirectional between FDI inflows and economic growth). T.G.Saii(2013) investigated the causal relations between

foreign direct investment and economic growth in a developing country like India through Johansen's cointegration test using 21 years of data covering the post reform era of the country. He found strong positive relation between FDI and economic growth in India. He suggested that the policy makers in India should develop investor friendly environment to attract more amount of capital from the developed countries. Osinubi & Amaghionyeodiwe (2009) studied empirically on the effect of exchange rate volatility on foreign direct investment (FDI) in Nigeria, using secondary time series data from1970 to 2004 which revealed a significant positive relationship between real inward FDI and exchange rate. Author found that depreciation of the Naira increases real inward FDI. The Central Bank of Nigeria should stabilise exchange rate that will boost domestic production, real inward FDI and maintain internal and external balance. Froot and Stein (1991) showed that the level of exchange rate may influence FDI because depreciation of the host country currency against the home currency increases the relative wealth of foreigners thereby increasing the attractiveness of the host country for FDI. Many empirical studies have supported this view. Cushman (1988) and Stokman and Vlar (1996) find a significantly positive relationship between exchange rate volatility and FDI flows into and out of the US and the Netherlands. Siddiqui,Hira. Aijaz, Ahmed & Aumeboonsuke ,Vesarach (2014) relate foreign direct investment (FDI) inflow and its determinants in ASEAN 5 covering data from 1986 to 2012 using Vector Auto regression (VAR) Technique. Low interest rates attract the FDI inflow which was not fitted to Singapore and Malaysia. There is unidirectional causality between FDI inflow and inflation in Thailand, Singapore and Indonesia which implies that due to increase in FDI inflow inflation decreases and interest rate decreases that calls for the price stability target. Tripathi,V., Seth,Ritika & Bhandari,Varun(2015) showed that there exists a significant correlation between FDI and some macroeconomic variables (except for Exchange rate). Causality results show that Index of Industrial Price/GDP, Wholesale Price Index and S&P CNX 500 Equity Index Granger cause FDI inflows in India while Trade Openness is Granger caused by the same. Johansen cointegration test proved that there is long-run relation between FDI and Index of Industrial Prices; FDI and S&P CNX 500 Equity, FDI and Trade Openness and FDI and WPI. VAR and impulse response function analysis show that FDI is caused more by its own lagged values rather those of other macroeconomic factors. Shanta Parajuli(2012) verified a unidirectional Granger causality between GDP and exports. Thus, there is a significant and positive Granger causal relationship running from exports to GDP in Mexico during the period

from 1970 to 2008. The causality relationship from GDP to FDI has disappeared in the presence of imports; just then the hypothesis of export-led FDI is supported where the growth in exports spurs growth in FDI through import channel. That is, there is a positive long-run relationship between gross fixed capital formation to imports and labor force to imports. This suggests that Granger causality between GDP and exports, FDI and GDP, exports to FDI derived from bivariate and multivariate frameworks .Khan and Mitra (2014) showed that there prevails long run equilibrium among the concerned variables. The Granger-causality test concluded that exchange rate and GDP significantly influence FDI, whereas, inflation rate is insignificant variable to predict FDI inflows. Their growth model claims that the total FDI inflows grow exponentially at a rate of 23% per annum. However, Chow test for 1991-92 (the year of initiation of New Economic Policy in India) is a statistically significant structural break year in the context of FDI inflows in India. Uwubanmwen, Ahmed E. & Ajao, Mayowa G.(2012) showed that the exchange rate, interest rate, inflation and openness of the economy are the major and important determinants of the inflow of FDI into Nigeria during 1972-2009. The GDP and government size exhibited positive but insignificant influence on FDI. The analysis showed unidirectional causality between FDI and GDP in Nigerian economy during this period. The study therefore recommends that government should ensure stable macroeconomic policies and should increase its expenditure in the area of infrastructural development to accelerate the growth of Nigerian economy which will reduce the excessive dependence of Nigeria on FDI.

IV.Methodology and Data

Semi-log linear model and exponential model are taken for computing trend of FDI inflows in India during1971-2015 .Random walk with drift model was used to verify random walk hypothesis. ARIMA (1,1,1) and ARIMA(2,1,2) model were used to find stationary of the series. Bai-Perron(2003) model was applied to show structural breaks. Hodrick-Prescott Filter(1997) model was taken for minimizing cyclical behavior to get smooth trend path. Johansen(1988, 1991) models were used to find cointegration and Vector Error Correction of the determinants of FDI during 1971-2015.Granger model(1969) was used to find causality of the determinants of FDI. Even the residual tests were shown for finding autocorrelation, serial correlation and normality. Assume,x_1=GDP growth rate per cent per year,x_2=interest rate per cent per year(discount rate),x_3=exchange rate of rupee per US dollar,x_4=inflation rate(per cent change of

CPI),x_5=fiscal deficit per cent of GDP,x_6=external debt per cent of GDP,x_7= trade openness per cent ,y= FDI inflows in India in million US dollar. Data have been collected from the World Bank, and International Financial Statistics of IMF from 1971 to 2015.

V. Observations from Econometric models

[A]Nature of FDI Inflows in India

India's FDI inflows have been increasing at the 21.56% per year during 1971-2015 which is significant at 5% level.

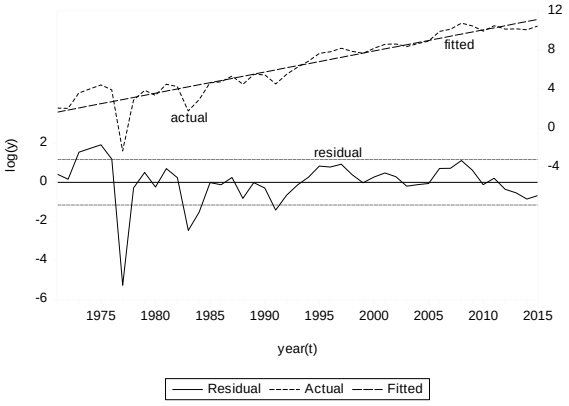
Log(y)=1.4485+0.215672t

(4.11)* (16.16)*

R^2=0.858,F=261.37* , DW=1.53 ,*=significant at 5% level, y=FDI inflows in million dollars. , t=year(time).

In Fig-1,the actual and fitted trend lines have been plotted. The fitted line is steeply rising upward.

Fig-1:Trend line of FDI inflows



Source-Computed by author

The exponential fitted trend line of Indian FDI inflows during 1971-2015 is also significant and it is exponentially rising at the rate 0.6044% per year. The same test was done by Khan and Mitra(2014).

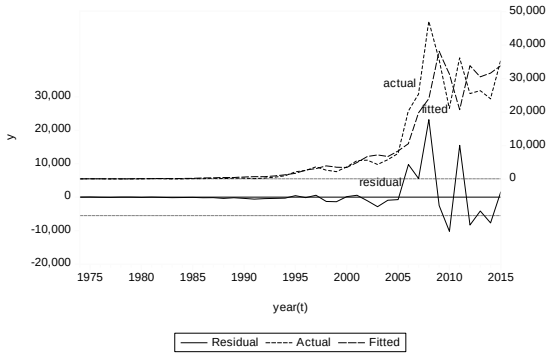
$$y = e^{0.6651+t^{0.604473+ut}}$$

where U_t=-0.117016U_{t-1}

(-0.7077)

R^2=0.828 , DW=2.13,Inverted AR root=0.50±0.30i , -0.34 , the t values of 0.6651 and 0.604473 are 5.064583 and 112.5020 respectively which are significant at 5% level. The estimated exponential trend line as well as actual line is shown in Fig-2.

Fig-2: Exponential trend of FDI inflows



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The FDI inflows do not follow random walk with a drift during 1972-2015 which is estimated below.

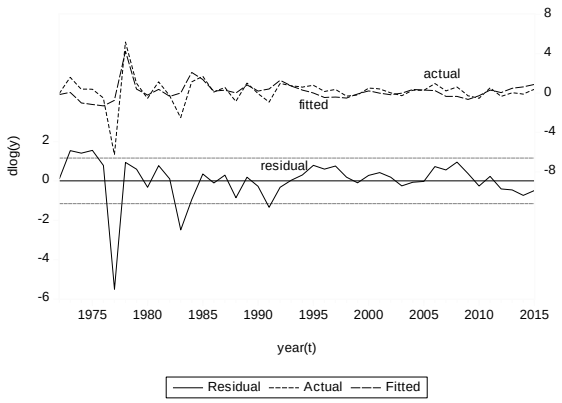
dlog(y_t)=1.134923-0.772167log(y_{t-1})+0.16737t

(2.768)* (-5.063)* (4.65)*

R^2=0.38 ,F=12.82* DW=1.93 and *=significant at 5% level

In Fig-3,the random walk with drift is seen clearly if we observe the fitted and actual lines of dlog(y_t) .

Fig-3:Random walk with drift



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The FDI inflow in India from 1971 to 2015 is stationary , convergent and stable which is proved by the Autoregressive Integrated Moving Average i.e. ARIMA(1,1,1) model.

$Log(y_t)=282.1647+0.999log(y_{t-1})+\varepsilon_t-0.970609\varepsilon_{t-1}$

(0.08) (100.96)* (-35.92)*

R^2=0.84 , DW=1.53 ,F=114* , Inverted AR root=1.0 ,Inverted MA root=0.97 ,*=significant at 5% level. The t values of coefficients of AR and MA are found significant.

But in AR(2) process, the FDI inflows is convergent and significant but MA(2) process is convergent while MA(1) process is divergent ,thus why ARIMA(2,1,2) is non stationary but the model is stable.

$Log(y_t)=17.91567+0.3378log(y_{t-1})+0.6367log(y_{t-2})+\varepsilon_t+0.2061\varepsilon_{t-1}-0.7938\varepsilon_{t-2}$

(0.88) (2.76)* (5.45)* (1.36) (-5.28)*

R^2=0.858 ,F=57.63* ,Inverted AR roots = ,0.98 , -0.65 , Inverted MA root=0.79,-1.0,*=significant at 5% level.

Applying Bai-Perron test(2003) of L+1 vs.L sequential determined breaks selecting Trimming 0.15,maximum breaks 5 with 5% significant level, we found 4 upward breaks in 1985, 1994, 2000,2006 following HAC standard errors and covariance and Newey-West fixed band width=4.0. In Table-1, the significant values are given.

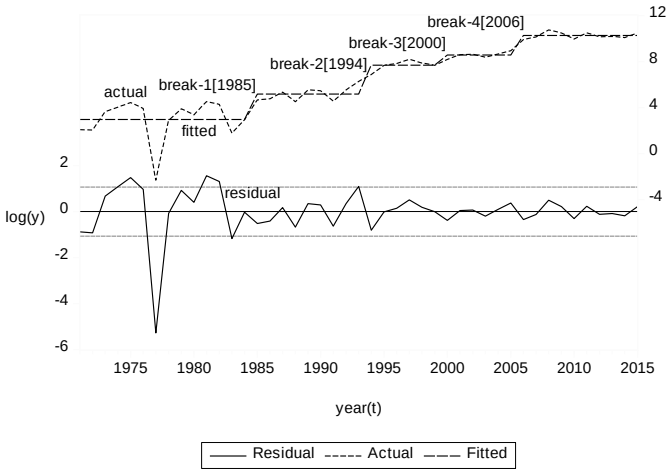
Table-1:Structural breaks

Variable	Coefficient	Std. Error	t-Statistic	Prob.
		1971 - 1984 -- 14 obs		
C	2.968555	0.483099	6.144817	0.0000
		1985 - 1993 -- 9 obs		
C	5.184334	0.198430	26.12671	0.0000
		1994 - 1999 -- 6 obs		
C	7.690081	0.173512	44.32012	0.0000
		2000 - 2005 -- 6 obs		
C	8.566927	0.102723	83.39861	0.0000
		2006 - 2015 -- 10 obs		
C	10.26461	0.087104	117.8438	0.0000
		R^2=0.889,F=80.4*,DW=1.99		
Break test: Sequential F-statistic determined breaks:4				
Break Test	F-statistic	Scaled F-statistic	Critical Value**	
0 vs. 1 *	136.9461	136.9461	8.58	
1 vs. 2 *	133.9357	133.9357	10.13	
2 vs. 3 *	19.38291	19.38291	11.14	
3 vs. 4 *	18.00003	18.00003	11.83	
4 vs. 5	0.999666	0.999666	12.25	

Source-Computed by author,*=significant at 5% level

In Fig-4,the successive four upward breaks have been plotted in the fitted line showing actual line and residual lines of FDI inflows in terms of log.

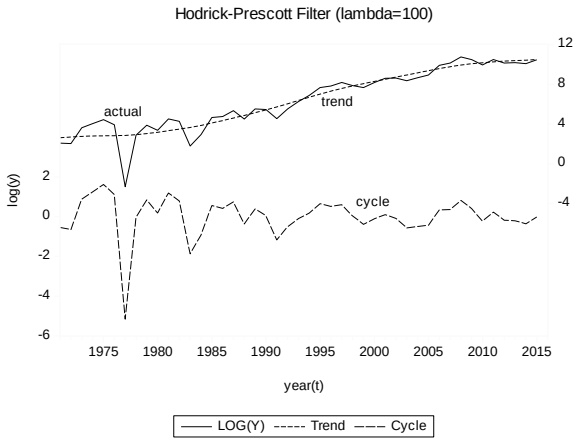
Fig-4:Structural breaks in FDI inflows



Source-Computed by author.

The cyclical path is minimized by the smooth trend line by using Hodrick Prescott Filter model and we got the smooth nonlinear trend line shown in Fig-5.

Fig-5:Hodrick-Prescott Filter model



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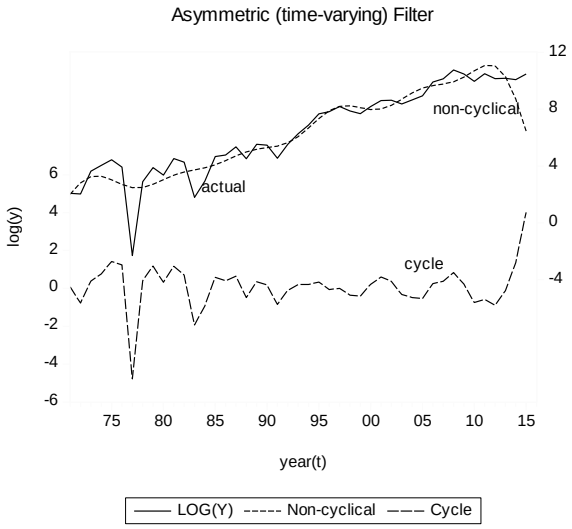
For Stationary I(0),the Hodrick-Prescott-Filter is made to asymmetric non cyclical rather than cyclical model shown in Fig-6.

Fig-6:Asymmetric filter



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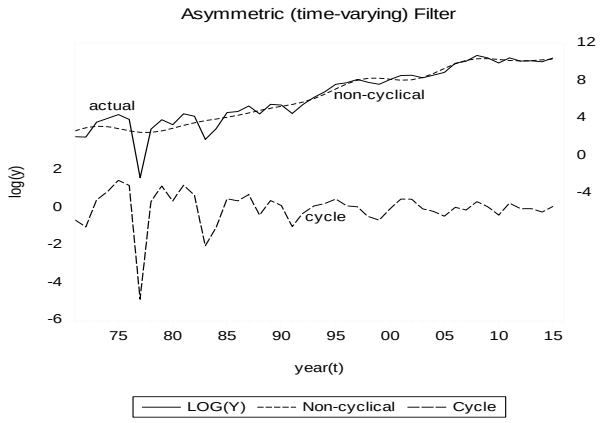
For Random walk I(1) process the Hodrick-Prescott - Filter model is changed to asymmetric non cyclical trend line which is more than the previous asymmetric model.It is plotted in Fig-7.

Fig-7:Random walk asymmetric filter



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FDI inflows in India during 1971-2015 showed high volatility as measured by Generalised Autoregressive Conditional Heteroscedasticity i.e. GARCH(1,1) model which is estimated below.

$h_t=3.932117+0.894068\sigma^2_t+0.045933h_{t-1}$

(0.137) (0.242) (0.0127)

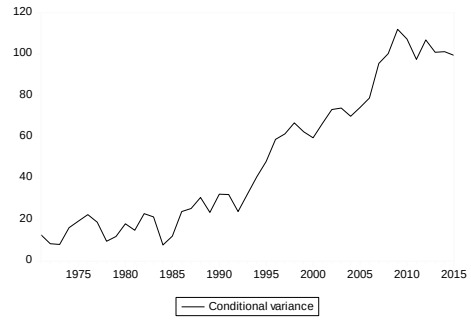
R^2=-4.49 , loglikelihood=-144.71 ,h_t=conditional variance of $\varepsilon_t=E_{t-1}\varepsilon_t^2$ and σ^2 = variance

And $\varepsilon_t=v_t\sqrt{h_t}$ where $\sigma^2_v=1$ and v_t= white noise process.

Since the z statistics of the coefficients are insignificant, therefore, the model shows volatile.

In Fig-8,the conditional variance showed the nature of volatility of FDI inflows during 1971-2015.

Fig-8:Conditional variance



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[B] Cointegration and Vector Error Correction among FDI and its determinants

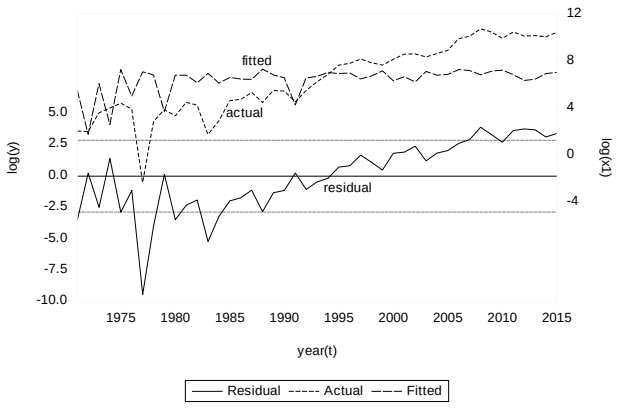
In India, growth-FDI nexus is positive in the sense that one percent increase in GDP growth rate per year in India led to 1.204 per cent increase in FDI inflows per year during 1971-2015 which is significant at 5% level. The estimated regression equation is given below.

$Log(y)=4.574+1.204228\log(x_1)$

(5.72)* (2.71)*

$R^2=0.14$,F=7.34* ,DW=0.63,where x_1= GDP growth rate ,y=FDI inflows in India,*=significant at 5% level.

In Fig-9, the growth-FDI nexus is plotted



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Granger causality test assured that there are no causality between growth rate(x_1) and interest rate(x_2),growth rate and openness(x_7),FDI inflows(y) and openness respectively but there exists uni-directional causality between growth and exchange rate(x_3),growth and inflation(x_4),interest rate and openness, exchange rate and external debt(x_6),exchange rate and FDI inflows, fiscal deficit(x_5) and FDI inflows, fiscal deficit and external debt respectively during 1971-2015 and rest of variables showed bi-directional causality. In Table-2,the results of Granger causality test are given. This observation is similar to the studies of Sarbapriya Ray (2012).

Table-2:Granger causality test

Null Hypothesis:	Obs	F-Statistic	Prob.
X_2 does not Granger Cause X_1	44	1.73801	0.1947

X_1 does not Granger Cause X_2		0.74632	0.3927
X_3 does not Granger Cause X_1	44	7.62229	0.0086
X_1 does not Granger Cause X_3		0.14968	0.7008
X_4 does not Granger Cause X_1	44	0.97870	0.3283
X_1 does not Granger Cause X_4		4.78031	0.0346
X_5 does not Granger Cause X_1	44	0.42533	0.5179
X_1 does not Granger Cause X_5		0.01272	0.9107
X_6 does not Granger Cause X_1	44	1.16506	0.2867
X_1 does not Granger Cause X_6		0.59396	0.4453
X_7 does not Granger Cause X_1	44	7.10295	0.0110
X_1 does not Granger Cause X_7		4.14904	0.0481
Y does not Granger Cause X_1	44	3.76020	0.0594
X_1 does not Granger Cause Y		2.65379	0.1110
X_3 does not Granger Cause X_2	44	6.02424	0.0184
X_2 does not Granger Cause X_3		4.80786	0.0341
X_4 does not Granger Cause X_2	44	0.40073	0.5302
X_2 does not Granger Cause X_4		0.25303	0.6176
X_5 does not Granger Cause X_2	44	0.33362	0.5667
X_2 does not Granger Cause X_5		0.55810	0.4593
X_6 does not Granger Cause X_2	44	0.17375	0.6790
X_2 does not Granger Cause X_6		0.06494	0.8001
X_7 does not Granger Cause X_2	44	0.70864	0.4048
X_2 does not Granger Cause X_7		8.90190	0.0048
X_7 does not Granger Cause X_3	44	0.60191	0.4423
X_3 does not Granger Cause X_7		1.21653	0.2765
Y does not Granger Cause X_2	44	0.06276	0.8034
X_2 does not Granger Cause Y		3.24339	0.0791
X_4 does not Granger Cause X_3	44	1.91647	0.1737
X_3 does not Granger Cause X_4		1.69565	0.2001
X_5 does not Granger Cause X_3	44	2.33792	0.1339
X_3 does not Granger Cause X_5		0.09696	0.7571
X_6 does not Granger Cause X_3	44	4.87837	0.0328
X_3 does not Granger Cause X_6		0.35427	0.5550
X_7 does not Granger Cause X_3	44	0.60191	0.4423
X_3 does not Granger Cause X_7		1.21653	0.2765
Y does not Granger Cause X_3	44	0.27972	0.5997
X_3 does not Granger Cause Y		3.35859	0.0741
X_5 does not Granger Cause X_4	44	0.07100	0.7912
X_4 does not Granger Cause X_5		0.97114	0.3302
X_6 does not Granger Cause X_4	44	0.08489	0.7723
X_4 does not Granger Cause X_6		1.06878	0.3073
X_7 does not Granger Cause X_4	44	0.35750	0.5532
X_4 does not Granger Cause X_7		0.21981	0.6417
Y does not Granger Cause X_4	44	0.10544	0.7470
X_4 does not Granger Cause Y		1.27829	0.2648

X_6 does not Granger Cause X_5	44	0.38607	0.5378
X_5 does not Granger Cause X_6		7.22076	0.0104
X_7 does not Granger Cause X_5	44	1.87525	0.1783
X_5 does not Granger Cause X_7		0.68293	0.4134
Y does not Granger Cause X_5	44	9.75678	0.0033
X_5 does not Granger Cause Y		0.00764	0.9308
X_7 does not Granger Cause X_6	44	0.18516	0.6692
X_6 does not Granger Cause X_7		0.02489	0.8754
Y does not Granger Cause X_6	44	0.53797	0.4674
X_6 does not Granger Cause Y		0.07397	0.7870
Y does not Granger Cause X_7	44	6.74823	0.0130
X_7 does not Granger Cause Y		14.6940	0.0004

Source-Computed by author

Johansen unrestricted cointegration rank test showed that Trace statistic has four cointegrating equations and Max Eigen Statistic has three cointegrating equations which is shown in Table-3.Therefore the variables are cointegrated in order of CI(1). According to Trace statistic,there must be three linear combinations and according to Max Eigen statistic there must be two linear combinations.This result is more or less similar to researches of Basu, Chakraborty and Reagle (2003), T.G.Saii(2013) ,Hansen and Rand (2006) and Chakraborty and Basu(2010).

Table-3:Johansen Cointegration test

Hypothesized No. of CE(s)	Eigen value	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.732982	219.9294	159.5297	0.0000
At most 1 *	0.659855	163.1505	125.6154	0.0000
At most 2 *	0.612689	116.7800	95.75366	0.0008
At most 3 *	0.495951	75.99326	69.81889	0.0148
At most 4	0.348309	46.53476	47.85613	0.0662
At most 5	0.309576	28.12279	29.79707	0.0770
At most 6	0.240770	12.19346	15.49471	0.1479
At most 7	0.008086	0.349106	3.841466	0.5546
Hypothesized No. of CE(s)	Eigen value	Max Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.732982	56.77893	52.36261	0.0166
At most 1 *	0.659855	46.37050	46.23142	0.0483
At most 2 *	0.612689	40.78672	40.07757	0.0415
At most 3	0.495951	29.45849	33.87687	0.1540
At most 4	0.348309	18.41197	27.58434	0.4612
At most 5	0.309576	15.92934	21.13162	0.2290
At most 6	0.240770	11.84435	14.26460	0.1166
At most 7	0.008086	0.349106	3.841466	0.5546

* denotes rejection of the hypothesis at the 0.05 level, **MacKinnon-Haug-Michelis (1999) p-values, H0=No cointegration, Source-Computed by author

Since the variables are cointegrated , thus the estimated vector error correction model is given below. The study of VECM was also tested by Dash, R.K. & Parida, P.C. (2013) and Sarbapriya Ray(2012)in India.

[1]Δx_{1t}=-0.024378-0.46107Δx_{1t-1}-0.0624Δx_{2t-1}+0.2556Δx_{3t-1}+0.1718Δx_{4t-1}+0.3480Δx_{5t-1}

(-0.043) (-2.75)* (-0.089) (1.048) (1.94) (0.78)

-0.28909Δx_{6t-1}-0.0729Δx_{7t-1}+2.28E-05Δy_{t-1}-0.2381EC

(-0.714) (-0.29) (-1.02) (-1.02)

R^2=0.48, F=3.4 ,AIC=5.14 ,SC=5.55,*=significant at 5% level , Δx_{1t} and Δx_{1t-1} are negatively related significantly.

[2]Δx_{2t}=-0.0924+0.1129Δx_{1t-1}-0.2025Δx_{2t-1}+0.0076Δx_{3t-1}+0.0068Δx_{4t-1}+0.0207Δx_{5t-1}

(-0.72) (2.88)* (-1.27) (0.137) (0.337) (0.203)

-0.0855Δx_{6t-1}+0.0303Δx_{7t-1}+ 3.02E-05Δy_{t-1}-0.23196EC

(-0.92) (0.529) (1.129) (-4.33)*

R^2= 0.49, F=3.6, AIC=2.19, SC=2.6,*=significant, Δx_{2t} and Δx_{1t-1} are positively related significantly.

[3]Δx_{3t}==1.3603+-0.00155Δx_{1t-1}+0.711074Δx_{2t-1}+ 0.2534Δx_{3t-1}-0.05331Δx_{4t-1}-0.762132Δx_{5t-1}

(2.92)* (-0.011) (1.23) (1.25) (-0.72) (2.06)*

-0.39126Δx_{6t-1}-0.157501Δx_{7t-1}-0.157501Δy_{t-1}-0.179943EC

(-1.16) (-0.76) (-0.51) (-0.92)

R^2= 0.19, F=0.87, AIC=4.7, SC=5.1,*=significant , Δx_3 and Δx_{5t-1} are negatively related significantly.

[4]Δx_{4t}=0.388400-0.007038Δx_{1t-1}-0.907988Δx_{2t-1}+ 0.079949Δx_{3t-1}-0.246616Δx_{4t-1}-

(2.92)* (-0.082) (0.68) (0.17) (-1.47)

0.097889Δx_{5t-1}-0.952970Δx_{6t-1}-0.442524Δx_{7t-1}+0.000244Δy_{t-1}-1.025525EC

(-0.115) (-1.24) (-0.93) (1.10) (-2.31)*

R^2= 0.26, F=1.33, AIC=6.42, SC=6.83,*=significant

[5]Δx_{5t}=-0.106383+0.007038Δx_{1t-1}+-0.071309Δx_{2t-1}+ 0.109699Δx_{3t-1}+0.013372Δx_{4t-1}

(-0.49) (0.109) (-0.26) (1.17) (0.17)

$+ 0.158234\Delta x_{5t-1} - 0.053390\Delta x_{6t-1} - 0.016278\Delta x_{7t-1} + 0.000125\Delta y_{t-1} - 0.004321EC$

(0.92) (-0.34) (-0.17) (2.8)* (-0.04)

R^2= 0.33, F=1.86, AIC=3.22, SC=3.68,*=significant, Δx_{5t} and Δy_{t-1} are positively related significantly.

$[6]\Delta x_{6t} = 0.325363 + 0.204180\Delta x_{1t-1} - 0.386254\Delta x_{2t-1} - 0.073751\Delta x_{3t-1} + 0.010424\Delta x_{4t-1} -$

(0.87) (1.83) (-0.83) (-0.073) (0.17)

$0.134339\Delta x_{5t-1} + 0.175616\Delta x_{6t-1} - 0.059622\Delta x_{7t-1} + 2.09E\text{-}05\Delta y_{t-1} - 0.277907EC$

(-0.45) (0.65) (-0.36) (0.27) (-1.79)

R^2= 0.2 F=1.04, AIC=4.31, SC=4.72

$[7]\Delta x_{7t} = 1.557461 + 0.064348\Delta x_{1t-1} - 0.445270\Delta x_{2t-1} - 0.675446\Delta x_{3t-1} + 0.033164\Delta x_{4t-1}$

(4.24)* (0.58) (-0.97) (-4.22)* (0.57)

$-0.264192\Delta x_{5t-1} + 0.345774\Delta x_{6t-1} + 0.345774\Delta x_{7t-1} - 0.000255\Delta y_{t-1} + 0.051273EC$

(-0.90) (0.49) (2.11)* (-3.33)* (0.33)

R^2= 0.59, F=5.32*, AIC=4.29, SC=4.7,*=significant , Δx_{7t} and Δx_{7t-1} are positively related significant and Δx_{7t} and Δy_{t-1} are negatively related significantly.

$[8]\Delta y_t = 2834.112 - 89.85084\Delta x_{1t-1} + 842.2183\Delta x_{2t-1} - 1391.315\Delta x_{3t-1} - 174.3453\Delta x_{4t-1} - 1692.335\Delta x_{5t-1}$

(2.86)* (-0.3) (0.68) (-3.22)* (-1.11) (-2.14)*

$+155.3180\Delta x_{6t-1} + 147.5783\Delta x_{7t-1} - 0.348757\Delta y_{t-1} + 202.9272EC$

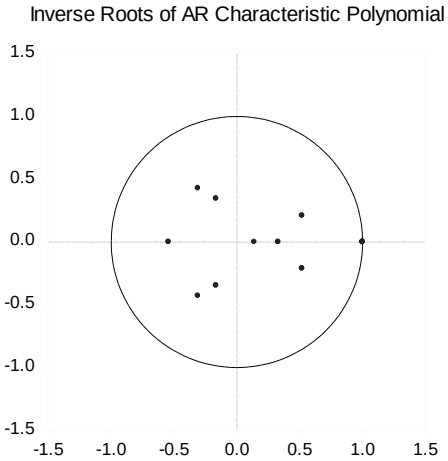
(0.21) (0.33) (-1.69) (0.49)

R^2= 0.42 F=2.71, AIC=20.09, SC=20.50,*=significant, Δy_t ,$\Delta x_{5t-1}$and Δx_{3t-1} are negatively related significantly.

This VECM is non-stationary.The speed of the vector error correction process is more or less slow except for Δx_{2t} and Δx_{4t} which are significant but most of the estimated equations are poor fit except Δx_{1t},Δx_{2t} and Δx_{7t} in this vector error correction model. Δx_{2t} has been correcting the error by 23.16% per year and Δx_{4t} has been correcting the error by 102.55% per year respectively.

Yet this VECM is stable since it has 7 unit roots in which six roots are imaginary (0.518961 ± 0.209573i, -0.308760 ± 0.428752i, -0.165298 ± 0.346439i)and other three roots (-0.543200, 0.328063, 0.138599) are less than one ,all of which lie in the unit root circle. It is shown in the Fig-10.

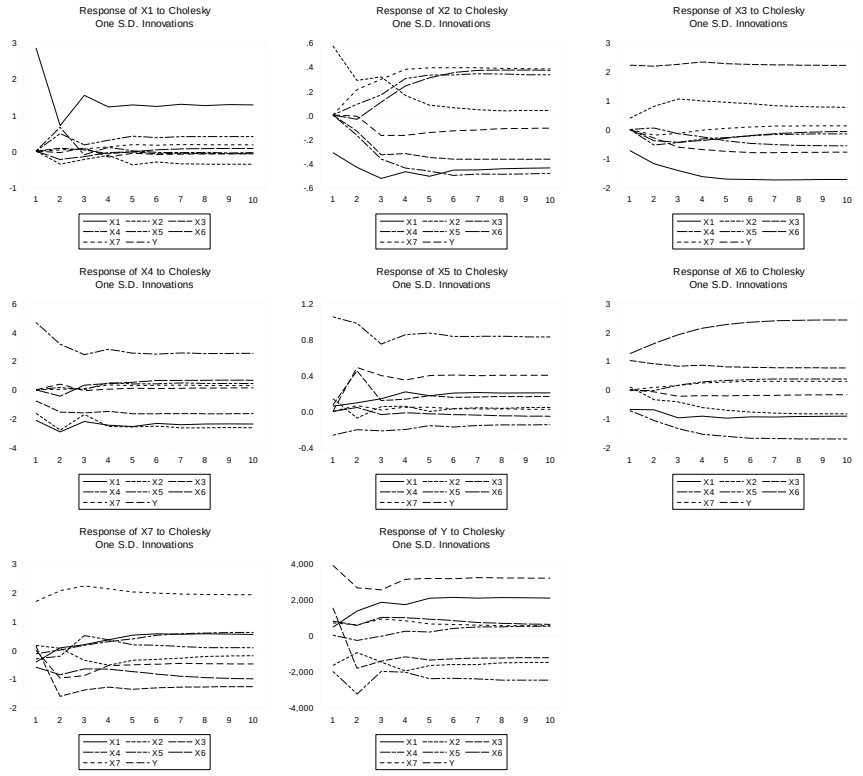
Fig-10:Unit root circle



Source-Computed by author

The Impulse Response Functions of VECM have been diverging away from equilibrium which means that exogenous shocks do not turn the model into equilibrium. It is shown in Fig-11(response of x_1…….x_7,y to Cholesky one SD innovations).These lines are moving away from zero.

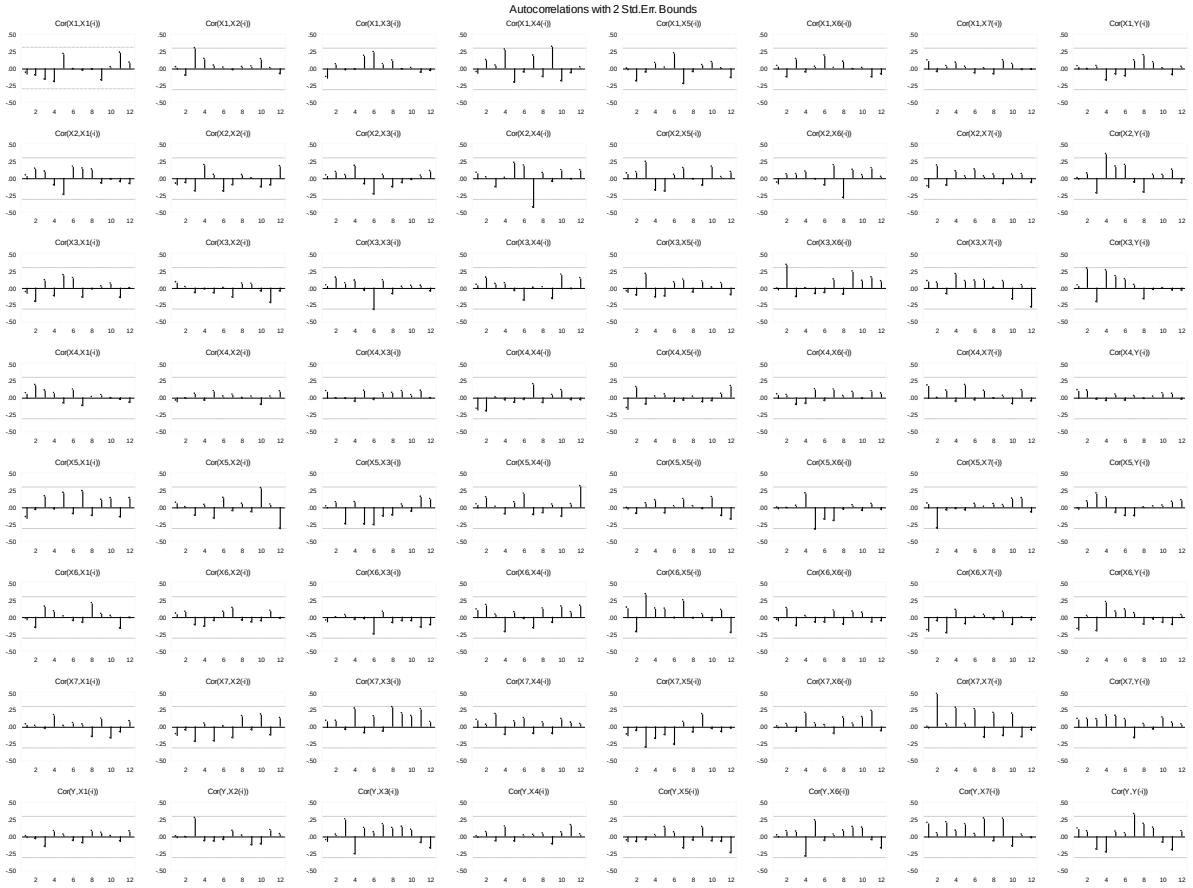
Fig-11:Impulse Response Functions.



Source-Computed by author.

Residual tests of this VECM assure that the residuals have the problem of autocorrelations which is shown in Fig-12.

Fig-12: Autocorrelations problem



Source-Computed by author

Vector Error Correction Residual Serial correlation LM test suggested that the variables are serially correlated which is seen in the Table-4.

Table-4:VEC residual serial correlation LM test

Lags	LM-Stat	Prob
1	69.08543	0.3097
2	76.00517	0.1447
3	60.44998	0.6028
4	67.75267	0.3504
5	51.45797	0.8709
6	82.35328	0.0610
7	63.05198	0.5100
8	61.63928	0.5605
9	56.77821	0.7272
10	42.09907	0.9844
11	65.69198	0.4180
12	75.12452	0.1612

Source-Computed by author

The VEC residual normality test as done by Doornik-Hansen has shown that the joint components of kurtosis and Jarque-Bera are significant but most of the other components of Skewness , Kurtosis and Jarque-Bera are not significant according to the values of Chi-square distribution, therefore , the residuals are not multivariate normal. In Table-5, their values are given.

Table-5:Doornik-Hansen normality test

Component	Skewness	Chi-square	df	Probability.
1	-0.084242	0.064756	1	0.7991
2	-0.194496	0.341888	1	0.5587
3	0.158327	0.227451	1	0.6334
4	-0.642132	3.360874	1	0.0668
5	-0.460680	1.822804	1	0.1770
6	0.710372	4.022242	1	0.0449
7	0.395926	1.367554	1	0.2422
8	0.672477	3.650127	1	0.0561
Joint		14.85770	8	0.0620
Component	Kurtosis	Chi-square	df	Prob.
1	2.806869	0.180811	1	0.6707
2	3.673029	3.119953	1	0.0773
3	2.743956	0.054829	1	0.8149
4	8.172222	31.27463	1	0.0000
5	3.160990	0.104753	1	0.7462
6	5.533883	7.996608	1	0.0047
7	2.384901	1.219767	1	0.2694
8	3.384075	0.017875	1	0.8936
Joint		43.96922	8	0.0000
Component	Jarque-Bera	df	Probability.	
1	0.245568	2	0.8845	
2	3.461841	2	0.1771	
3	0.282280	2	0.8684	
4	34.63550	2	0.0000	
5	1.927557	2	0.3814	
6	12.01885	2	0.0025	
7	2.587321	2	0.2743	
8	3.668003	2	0.1598	
Joint	58.82692	16	0.0000	

Source-Computed by author

VI. Limitations and future scope

In India, FDI inflows have much impact on balance of payments and on three sectors of the economy which were not explained in this model separately. Results will be different if whole sale price index and GDP deflator are taken for indicators for inflation rate. The paper could be divided into pre reform and post reform parts so that comparison would be available for two periods. These may emerge different package of policies. Multiple determinants of FDI in this econometric model are rather different from the economic reality of the utilization of inflows in India. The nexus between External debt and FDI inflows has a great scope of research field which is to be explored along with growth-FDI inflows nexus.

VII. Some recommended policies

Some general economic policies are urgent like [i] to reduce current account deficit,[ii] to reduce external debt,[iii] to cut down fiscal deficit,[iv] to fix target rate of inflation,[v] to follow monetary policy to reduce interest rate when needed,[vi] to increase trade openness respectively to get fruitful outcome of FDI inflows, [vii] to increase weight on infrastructure improvements, training productive workers, and encouraging domestic firms to invest in technology in order to achieve sustained benefits from FDI,[viii] to relate productivity with FDI inflows, and employment with FDI inflows,[ix]to stimulate knowledge transfer in labour training and skill development,[x] to introduce alternative management practices.

VIII. Conclusion

The paper concludes that India's FDI inflows from 1971 to 2015 has been increasing at the rate of 21.56 % per year and exponentially stipulating at the rate of 0.604% per year which are significant at 5% level. It has no random walk with drift. It is stationary as suggested by ARIMA(1,1,1) model. It has four upward structural breaks in 1985,1994,2000 and 2006 respectively. It is highly volatile as shown by GARCH(1,1) model. Granger causality test assured that there are no causality between growth rate and interest rate, growth rate and openness, FDI inflows and openness respectively but there exists uni-directional causality between growth and exchange rate, growth and inflation, interest rate and openness, exchange rate and external debt, exchange rate and FDI inflows, fiscal deficit and FDI inflows, fiscal deficit and external debt respectively during 1971-2015 and rest of variables showed bi-directional causality. Johansen unrestricted cointegration rank test showed that Trace statistic has four cointegrating equations and Max Eigen statistic has three cointegrating equations. The speed of the vector error

correction process is more or less slow except for Δx_{2t} and Δx_{4t} which are significant but most of the estimated equations are poor fit except Δx_{1t}, Δx_{2t} and Δx_{7t} in the vector error correction model. Yet, the VECM is stable and diverging.VEC residuals are not multivariate normal having problems of autocorrelations and serial correlations. Fiscal and monetary policy reform might be useful to stabilize the relation between FDI inflows and its determinants in India.

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