Relationship Between Inward FDI and Research and Development: A Case of India

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Abstract

Abstract: FDI has been treated as a source of growth and development for the host countries. It provides advantageous status in terms of skills, technology, and way to foreign market; FDI inflow may hasten host country's research operations. The main objective of this paper is to empirically analyze the relation between Indian R&D activities and FDI inflows for the period 1996-2014. This study applied the Unit root ADF test to check the stationarity of the data used in the analysis. Cointegration technique was applied to evaluate the long run relationship among the variables. To search for the nature of the association between these variables, we have implemented the VECM Granger Causality test. The results showed there is no causality observed from inward FDI to R&D expenditure and from R&D expenditure to inward FDI in India. The results draw important implications that rise in inflows of FDI in India is not because of increase in R&D activities in the nation but because of the measures undertaken by the Indian government. Indian Government has designed supportive and liberal policies towards FDI and R&D activities in various sectors. The evidence shows us that there was indeed no connection between India's R&D expenses and foreign investment inflows. But FDI plays important role in promoting economic growth, technological transfer and creation of employment.

INTRODUCTION

India has adopted its economic reforms since 1991 which have been progressive in nature. With the continuous opening up of its economy it has turned as an important participant in the global market. Following the rapid globalization process, featured by increasing technological advancement, new production, organizational and management structures and a constantly growing role for competition, India is now well engaged in trade with its partner countries and at the same time hosts substantial amounts of overseas activities. In terms of inward foreign direct investment (FDI)–trade relations, India offers an interesting case. In 1990, when Indian government started to open its economy to the outside world, there was little inward FDI inflow of US$ 1,657 million. In terms of inward foreign direct investment (FDI)–trade relations, India offers an interesting case. In 1990, when Indian government started to open its economy to the outside world, there was little inward FDI inflow of US$ 1,657 million. Foreign investors behaviour towards India altered somewhat noticeably as an outcome of the transformation in the policy system. Inflows of FDI have enhanced significantly contrast to the former regime in which the range for FDI was somewhat limited.

A report by UNCTAD has revealed that FDI inflows increased year on year to $1.45tn in 2013 (UNCTAD Handbook of Statistics Report, 2014). India received total FDI inflows, since April, 2000 comprising equity inflows, other capital and reinvested

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earnings, of US $ 355.42 billion (April, 2000-December, 2014). In 2014, India received FDI equity inflows of US $ 28.78 billion. This represents increase of 31% over the FDI equity inflows of US $ 22.04 billion received during the corresponding period (January-December-2013) of the previous calendar year (2013) (DIPP, Annual Report 2014-15). According to the Financial Times, 2015, India overhauled China and US as the prime destination for the foreign investment. For emerging countries, FDI is predominantly important as it stimulates faster economic reformation and encourages better corporate governance for facilitating the acquisition of advanced technology. The new reforms in India with respect to FDI were projected to attain such transformations. The FDI inflows into the nation have progressively increased persuading many transnational corporations (TNCs) establishing up affiliates in India. In order to compete with these overseas entities, local affiliations have to adopt or upgrade technologies. The function of technology in nurturing economic growth is well acknowledged. Literature proposes that only those economies that aggressively support technical undertaking of their local firms can maintain progress in the long run. According to Indian Brand Equity Foundation Report, 2016, overall India-based R&D Globalization and R&D Services market recorded US$ 20 billion in 2015, increase by 9.9 per cent over 2014. R&D Services market reached at US$ 7.76 billion and R&D globalization market (Captives) recorded at US$ 12.25 billion.

Till late 1990's, it was not supposed that developing countries could emerge as attractive locations for R&D activities of multinational companies (MNCs). The situation steadily changed and by early 2000's it was recognized that India and China are rising as the two most attractive targets for the MNCs. The international companies in high-tech areas are approaching these two nations for establishing up their dedicated R&D centres.

Underlying Framework: Inward FDI and Research & Development Activities Relationship in India

Theoretically, a positive association between inward FDI and R&D may be present. FDI is the procedure by which a national firm becomes a multinational enterprise possessing industrious assets in many nations. An inward FDI involves a foreign body either investing in or acquiring the goods of a local market. This occurs when one corporation acquires another business or set up new actions for an existing business in a nation unlike than the investing company's country. FDI is a package that involves technology, capital and administrative skills and has been treated as a considerable source of technology and knowledge transfers. It has been proclaimed that developing nations can gain significantly from FDI because it not only transfers production know-how and management skills but also produces externalities, or spillover effects (Wang and Blomström, 1992).

Imitation is the usual transmission instrument for new products and for processes. A transmission mechanism is generally attributed to reverse engineering technology diffusion process (Wang and Blomström, 1992). Clearly the degree of imitation depends very much on product and process complexity, which means that simple manufacturing techniques and manufacture processes rather easier to replicate than more complex ones. The similar behavior is assumed in case of managerial and organizational innovations, the simple innovations are easier to imitate in comparison to complex ones. However, any improvement to indigenous technology accruing from replication could produce a positive spillover from the foreign affiliations to the host economy, with resultant benefits on the efficiency of the host economy. Higher FDI inflows may also enhance the R&D capability of the home country to undertake production by using new advanced methods of production as introduced by foreign firms. The positive effect of FDI inflows on R&D is predictable as it aids in long term survival, indigenous firms attempt to optimally utilize their resources and start improving quality of their products by undertaking R&D.

R&D has been seen as an imperative source of knowledge generation and productivity enhancement. Recently, endogenous growth theory has emphasized the significance of commercially driven innovation efforts and R&D activities in explaining countries' productivity. R&D helps in improving productivity by upgrading existing products and processes or creating new products and processes that increase profits or shrink costs. R&D not only affects the efficiency of the organization that undertakes R&D, but may also create spillover effects that enhance other firms' productivity. The technical advancements developed in one enterprise may transmit to other enterprises through reverse engineering, imitation or employment of the investing entities' workforce. Higher R&D activities may induce FDI inflows in the host nation as it provides support to MNCs research-intensive production and to further gain from the local science and

technology (S&T) and infrastructure. The host country with innovative local industries draws more inward investment by the MNCs if investing nation and the host nation have extremely evolved and technologically competitive markets. The research oriented environment in India offers a considerable opportunity for MNCs across the globe owing to its intellectual capital offered in the nation. Indian engineers working across the world highlight the highly skilled manpower accessible at competitive costs. As a result, several MNCs have moved or are moving their R&D base to India.

The positive impact of R&D on inward FDI is also predictable as MNCs would like to invest in the countries which are backed by advanced and innovative technology as it helps in increasing productivity as well as efficiency.

Literature has examined the relationship between FDI and R&D for India and other countries. A large number of studies empirically carried out on Brazil, India and China have found a complementary association between R&D and FDI. Indian studies include firm-level analyses by Katrak (1989), Aggarwal (2000), Kumar and Saqib (1996), and Kumar and Aggarwal (2005) and industry-level analyses by Deolalikar and Evenson (1993) and Katrak (1985). In the framework of other economies, Nelson (2004), Bertschek (1995) for Germany, Braga and Wilmore (1992) for Brazil, and Zhao (1995) for China also established a weak but positive relationship between R&D and FDI. Seng (2017) has found that growth effect of FDI is adequately supported in Cambodia. On the other hand, studies by Basant and Fikkert (1996), Kumar (1991) for India, found a substitution effect of FDI on domestic R&D. Though, some studies by Kumar and Saqib (1996), Katrak (1997), have found neither a complementary or substitutable relationship between technology import/ FDI and R&D. Pohit and Biswas (2016) have found that in india MNCs are majorly investing in non-core R&D operations which will not aid India in building innovation culture.

Most of the studies for India have used data from the pre-liberalization period. Before 1990, the main concern in the pre-reform period was on import substitution and the FDI policy was also restricted in nature. Therefore post-liberalization data may give vary results, especially as the focus has now changed from adaptive to self driven R&D. The FDI policy has also changed from being selective to promote inflows of FDI. Hence, the present study undertakes an empirical analysis using post-liberalization data to account for economic relationship between in FDI inflows and R&D.

The Trends in FDI Inflows and R&D in India

Since the introduction of financial reforms and shift towards market oriented policies in early 1990s, the number of countries investing in India increased. Though the liberal policy position and strong economic ground rules emerge to have motivated the sharp rise in FDI flows in India over past one decade and continued their momentum even during the phase of worldwide economic crisis (2008-09 and 2009-10), the consequent control in investment flows in spite of quicker recovery from the crisis period appears somewhat unexplained.

While India's share in worldwide FDI has enlarged significantly, but the speed of FDI inflows has been slower than China, Singapore, Brazil, and Russia. India has seen a decade of 7 plus percent of economic growth because of sustained economic liberalization since 1991. In fact, India's economy has been growing more than 9 percent for three successive years since 2006 which makes the nation a well-known actor amongst international countries.

Table 4.1 Cumulative FDI Inflows

Year	Amount of FDI Inflows Rs. Crore	Amount of FDI Inflows US$ million
August 1991 – March 2000	58471	15483
April 2000 – March. 2009	559474	125329
August 1991 – March 2009	617945	140812

Source: Various FDI Fact Sheets (DIPP)

The annual fluctuations until 2003-04 make it hard to recognize an obvious movement; however, inflows have been growing constantly since 2004-05. During 2008-09, India recorded FDI inflows of $33.6 billion and overall collective inward FDI from August 1991 to March 2009 have been to the amount of $155 billion. (Table 4.1)

Inward FDI grew gradually during the early years of the 90s but stagnate between 1996-97 and 2003-04(Table 4.2).

Table 4.2 FDI Inflows of India

Year	Amount of FDI Inflows		Annual Growth $ Value
	Rs. Crore	US$ million	
1991-92	375	129	
1992-93	1051	315	144.2
1993-94	2041	586	86.0
1994-95	4241	1314	124.2
1995-96	7317	2144	63.2
1996-97	10170	2821	31.6
1997-98	13317	3557	26.1
1998-99	10550	2462	-30.8
1999-00	9409	2155	-12.5
2000-01	18404	4029	87.0
2001-02	29269	6130	52.1
2002-03	24681	5035	-17.9
2003-04	19830	4322	-14.2
2004-05	27234	6051	40.0
2005-06	39730	8961	48.1
2006-07	103037	22826	154.7
2007-08	137935	34362	50.5
2008-09	159354	33613	2.2

Source: Various FDI Fact Sheets (DIPP)

India has been positioned at the second place in receiving FDI in 2010 and will sustain to stay among the top five destination for global investors during 2010-12 period, according to UNCTAD report on world investment prospects titled, 'World Investment Prospects Survey 2009-2012'.

During April-December 2010, Mauritius made an FDI investment of US$ 5,746 million. The second largest country is Singapore which has FDI in India for US$ 1,449 million and followed by US with US$ 1,055 million, as per the reports of DIPP(Table 4.3).

Table 4.3 Country-Wise Inward FDI April, 2000 to March, 2014

Country	Percentage
Mauritius	37%
Singapore	12%
U.S.A.	5%
U.K.	10%
Netherlands	5%
Japan	7%
Others	24%

Source: Fact sheet on FDI from April, 2000 to March, 2014 (DIPP)

Mauritius has made the maximum amount of investment in India. However, other countries like Singapore, UK and other developed countries like the USA, Japan and the Netherlands, which are India's main trading associates have also made huge investments.

Table 4.4 Sector-Wise Inward FDI April, 2000 to March, 2014

Sector	Percentage
Services Sector	18.14
Construction Development	10.71
Telecommunications	6.51
Computer Software & Hardware	5.89
Drugs & Pharmaceuticals	5.33
Others	53.42

Source: Fact sheet on FDI from April, 2000 to March, 2014 (DIPP)

From a sectoral perspective, FDI in India mainly flowed into services sector which amounts to 39,459.70 (US$ million) followed by construction development such as townships, housing, built-up, infrastructure and construction-development projects. FDI inflows into the service sector have shown tremendous growth during 2005-08. Its share in total FDI inflows in India increased from 16.4 per cent in 2005 to an astounding 35.4 per cent in 2006, but this share declined in 2013 to 18.14 per cent. Sectors like computer software & hardware, construction activities and housing & real estate are also receiving huge amount of foreign inflows (Table 4.4).

India is also performing well in the area of basic and advanced research. Indian Science has been considered as one of the most prominent instruments of growth and development, especially in the emerging market and competitive scenario.

Table 4.5 National Expenditure on Research and Development Sector wise in India (Rs. Millions)

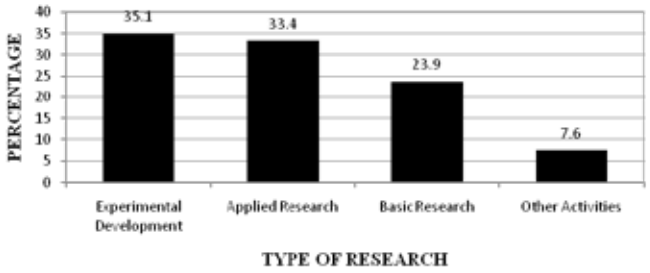
Sector	1990-91	2001-02	2011-12
Central Sector	30582.7	115363.3	426145.3
State Sector	3659.2	14943.3	50908.4
Private Sector	5499.8	32926.9	219653.1
Higher Education Sector	-	7148	29497.6
Total	39741.7	170381.5	726204.4

Source: National Science & Technology Management Information System, Research and Development Statistics 2011-2012

In Table 4.5, the contribution of the different sectors in the total R&D expenditure for the year 1990-91 is shown. The central sector industry recorded R&D expenditure at Rs. 30582.7 million, private sector at Rs. 5499.8 million, and the state governments at Rs. 3659.2 million. In 1990-91, Higher education sector has recorded no expenditure R&D. In 2001-02, the share in the total R&D expenditure has rose to Rs. 115363.3 million in Central sector, Rs. 14943.3 million in State sector and Rs. 32926.9 million in Private sector.

During 2001-02, Higher education sector has also spent Rs 7148 million in R&D activities. The share of all sectors in the total national R&D expenditure increased from Rs 170381.5 million in 2001-02 to Rs. 726204.4 million in 2011-12.

Figure 4.1 Percentage Share of National R&D Expenditure by Type of Work, 2009-10



Source: National Science & Technology Management Information System, Research and Development Statistics 2011-2012

Figure 4.1 gives the breakup of R&D expenditure by type of work for the year 2009-10. The expenditure for R&D activities have been classified by type of work depends on the estimates presented by the R&D institutions and centres in the central and state governments excluding higher education. During the year 2009-10, the percentage share of experimental development 35.1%, applied research 33.4%, basic research was 23.9%, and the interrelated supporting activities were 7.6%.

It may be observed from Table 4.6 that during 2010-11, USA accounted for 33.5% of the overall applications received from foreign nationals. USA along with Germany, Switzerland, Japan, France and Netherlands marked about 73.2% of total applications from foreigners during 2010-11. During the year 2009-10, 7044 applications for patents were filed by Indian nationals and it has been increased to 8312 applications in 2010-11.

Table 4.6 Country Wise Number of Applications Filed for Patents in India

		Number of applications filed	
S.No	**Name of the country**	**2009-10**	**2010-11**
1	**U.S.A.**	9154	10405
2	**Germany**	3111	3653
3	**Japan**	3040	4117
4	**Switzerland**	1579	1651
5	**France**	1394	1609
6	**Netherlands**	1316	1336
7	**U.K.**	972	965
8	**Italy**	560	608
9	**Russia**	45	55
10	**Other countries**	6072	6689
11	**Total of foreign countries**	27243	31088
12	**India**	7044	8312
Total Applications	34287	39400	

Source: National Science & Technology Management Information System, Research and Development Statistics 2011-2012

Section I provide the introduction of the study and theoretical framework, and undertake critical review of the literature. It also describes the trends in FDI inflows and R&D of India. Section II provides objectives of the study. Chapter III presents the hypotheses to be tested in the present study. Chapter IV discusses the analytical framework, the empirical model and research methodology and the database for examining the relationship between FDI inflows and R&D. Chapter V shows the empirical results and talks about the relationship between these variables. Chapter VI summarizes the main findings of the paper and puts forth the policy implications.

OBJECTIVES OF THE STUDY

The objective of the present study is to investigate the links between inward foreign direct investment and R&D in Indian context. The paper analyzes whether causality exists from India's FDI inflows to R&D or from R&D to inward FDI. The paper also aims to study the trends of FDI inflows and R&D in India.

HYPOTHESES BASED ON ESTIMATING RELATIONSHIP AMONG VARIABLES

Null Hypothesis (H*01*): There is no unidirectional causality from FDI inflows to R&D.

Alternate Hypothesis (Ha1): There is a unidirectional causality from FDI inflows to R&D.

Null Hypothesis (H02): There is no unidirectional causality.

Alternate Hypothesis (Ha2): There is a unidirectional causality from R&D to FDI inflows.

Null Hypothesis (H03): There is no bilateral causality between FDI inflows and R&D.

Alternate Hypothesis (Ha3): There is a bilateral causality between FDI inflows and R&D.

Null Hypothesis (H04): There is no independence between FDI inflows and R&D.

Alternate Hypothesis (Ha4): There is independence between FDI inflows and R&D.

DATA DESCRIPTION AND RESEARCH METHODOLOGY

Data Description and Variables

Time series data is used to find the association between FDI inflows and R&D of India for the period of 1996-2014 in this study. The data is taken from online database of World Bank, Reserve Bank of India, Department of Industrial Policy and Promotion (DIPP). FDI inflows are defined as the net inflows of investment required to obtain a long-term control (10 percent or more of voting stock) in an organization operating in the nation other than that of the investor. The FDI series presents net inflows (overall inward investment less disinvestment) made by foreign investors in India and are divided by GDP. R&D expenditures include both public and private current as well as capital expenditures on resourceful work carried scientifically to increase knowledge, and are divided by GDP. R&D includes applied research, basic research and experimental development.

Data Methodology

We have used time series data which explain the characteristics of non-stationarity in levels and the resulted estimates generally give spurious results. Thus, the initial step in any time series empirical analysis is to check for presence of unit roots to remove the problem of inaccurate estimates. The other significant step is to check the order of integration of all variables in a time series to know whether the given data has unit root and to know about the number of times it is required to be differenced to attain stationarity.

Prior to applying cointegration and Granger causality model, econometric framework requires to check the stationarity for each individual time series since the majority of macroeconomic variables are non-stationary, i.e., they are likely to show a deterministic and/or stochastic trend. Moreover, a time series is believed to be stationary if its mean which is time-invariant reverts around a constant long run average, its variance is time-invariant and the autocovariances of the series between two time periods based only on the time interval and is independent of time. A nonstationary series is the one which is not stationary in nature. A nonstationary time series will have a mean which is time dependent and/ or a time dependent variance that approaches infinity as time goes to infinity. It has no definite pattern into which the series returns.

In statistics, a unit root test checks whether a time series variable is non-stationary using an autoregressive model. If a series has a unit root, it is nonstationary, so the mean and variance are changing over time. As a far preliminary stationary analysis is concerned, the integration properties of the data are tested by using conventional unit root tests. Because of the possible structural breaks in the series, unit roots are performed by using Augmented Dickey Fuller (ADF) statistic.

The stationarity of series applied in the study is determined with the estimation of a unit root. The unit root test might be estimated from the following form of equation.

Without constant and trend;

$$Yt = \rho Yt\text{-}1 + \varepsilon t \qquad \ldots (1.1)$$

Where: $(-1 \leq \rho \leq 1)$, Yt is the relevant time series, T is time trend and ε t is the residual term.

The null hypothesis assumes that the variable has a unit root i.e. $\rho = 1$ and assumes that the alternative hypothesis has no unit root. If null hypothesis is accepted, then Yt series is non- stationary time series. The null and alternative hypotheses are stated as:

Null Hypothesis**:** H0: $\rho = 1$

Alternative hypothesis: H1: $\rho \neq 1$

The decision rule for testing these hypotheses is framed as: The null hypothesis is not accepted and implies that unit root not existed if ADF > t critical value and null hypothesis is accepted and implies that unit root existed in case of ADF < t critical value**.**

Equation 1.1 might be transformed into differenced equation by subtracting Yt-1 on each side of these equations and are given in the following form to obtained result.

Without constant and trend;

$\Delta Yt = \delta Yt\text{-}1 + \varepsilon t \quad \ldots (1.2)$

Where: $\Delta Yt = Yt - Yt\text{-}1$ and $\delta = \rho - 1$

The null and alternative hypotheses formulated in the light of new regression form equation are:

Null Hypothesis: H0: $\delta = 0$ (Unit Root)

Alternative hypothesis: H1: $\delta \neq 0$ (No Unit Root)

Now, to estimate equation (1.2) we apply the Dickey-Fuller test.

Dickey and Fuller have revealed that under the null hypothesis $\delta=0$, the expected *t* value of the coefficient of Y_{t-1} in equation (1.2) follows the τ (tau) statistic. Dickey and Fuller have calculated the significant values of the *tau statistic* on the basis of Monte Carlo simulations.

Reject the hypothesis that $\delta=0$, If the computed absolute value of the tau statistic ($|\tau|$) exceeds the absolute DF critical tau values in which case the time series in stationary

We accept the null hypothesis if the computed $|\tau|$ does not exceed the absolute critical tau value, then, in which case the time series is non-stationary.

Cointegration is a prerequisite for the sustenance of an equilibrium or long run association between two or more variables having unit roots. Two or more random variables are considered to be cointegrated if each series are themselves non-stationary, although a linear arrangement of them is stationary. The stationary linear combination is known as the cointegrating equation and might be treated as a long-run equilibrium association between the variables.

In 1960's, Granger causality (or "G-causality") was propounded and since then it has been extensively applied in econometrics framework. Granger causality is a model of statistics that is framed on the basis of forecast. As per Granger causality, if a signal X1 "Granger-causes" a signal X2, then previous values of X1 should hold information that assists in predicting X2 above and beyond the information possessed in previous values of X2 alone. The statistical formulation of this model is framed on linear regression framework of stochastic processes (Granger 1969). He formulated a time series data related approach for evaluating causality. In the granger sense if X1 is the cause of X2 if it is useful in forecasting X2. In this structure useful mean X1 is capable to raise the accurateness of prediction ofX2 with respect to a forecast, considering only previous values of X2.

The trend of causality between FDI and R&D remain unspecified. One mode of dealing with such an issue is to find out the direction of causality using Granger causality method. The empirical analysis presented in the paper based on simple Granger causality in order to examine whether inward FDI "granger causes" R&D or R&D "granger causes" inward FDI. The following two equations can be specified:

$$R\&Dt = \sum_{i=1}^{n} \alpha \, i \, FDIt - i + \sum_{j=1}^{n} \beta \, j \, R\&Dt - j + u1t \quad \ldots (2.1)$$

$$FDIt = \sum_{i=1}^{n} \lambda \, i \, FDIt - i + \sum_{j=1}^{n} \delta \, j \, R\&Dt - j + u2t \quad \ldots (2.2)$$

Whereas it is assumed that the disturbances u_{1t} and u_{2t} are uncorrelated. Since we have taken only two variables i.e., R&D (R&D expenditure) and inward FDI so we are dealing with bilateral causality.

Based on the estimated OLS coeffcients for the equations (2.1) and (2.2) four different relationship between inward FDI and R&D can be formulated: First, there can be a unidirectional Granger-causality from inward FDI to R&D. In this case inward FDI increase the prediction of the R&D but not vice versa. Second, there can be a unidirectional Granger-causality from R&D to inward FDI. In this case the R&D of the Indian economy increases the prediction of the inward FDI but not vice versa. Third, there can be bidirectional (or feedback) causality. In this situation, the FDI inflows in the India increase the prediction of the R&D and vice versa. Fourth, there can be independence between R&D and inward FD implies that there is no causality in any direction. Thus by acquiring one of these results it becomes likely to discover the causality relationship between R&D and inward FDI of India.

EMPIRICAL RESULTS AND INTERPRETATION

In this study, we have chosen to estimate an ADF test that includes a time trend and an intercept in the level form and only the intercept in the first difference of each variable. We first checked stationarity of inward FDI. The

results of the ADF are displayed in Table 6.1(Appendix). The ADF test shows that inward FDI is stationary, while the null hypothesis for the unit root cannot be rejected. The computed absolute ADF test-statistic 1.826977 is lower than the absolute critical tau values (3.857386, 3.040391, and 2.660551) at 1%, 5% and 10% significance level respectively. So we cannot reject the null hypothesis. This implies that the inward FDIs series has a unit root and it is non-stationary.

The problem of unit root can be removed by generating the first difference series of inward FDI i.e. "DF". Applying the ADF test on the differenced series, the results in the table below indicate that the computed ADF test statistic absolute value is 4.766480 which are greater than the absolute critical tau values (3.886751, 3.052169, and 2.666593) at 1%, 5% and 10% significance level respectively (Table 6.2). So we can reject the null hypothesis as P value is also less than 5%. This implies that the first differenced inward FDIs series has no unit root and it is stationary.

Next step is to perform the ADF test on the R&D series. The results of the ADF are displayed in Table 6.3. The ADF test shows that R&D is stationary, while the null hypothesis for the unit root cannot be rejected. The computed absolute ADF test-statistic 1.103260 lower than the absolute critical tau values (3.857386, 3.040391, and 2.660551) at 1%, 5% and 10% significance level respectively. So we accept the null hypothesis. This implies that the R&D series has a unit root and it is non-stationary.

The problem of unit root can be removed by generating the first difference series of R&D i.e. "DR_D". We can reject the null hypothesis as P value is also less than 5 %(Table 6.4). Applying the ADF test on the differenced series, the result in the table below indicates that the computed ADF test statistic absolute value is 3.578659 which are greater than the absolute critical tau values (3.098896, 2.690439) at 5% and 10% significance level respectively. This implies that the first differenced R&D series has no unit root and it is stationary.

Table 6.5 Unrestricted Cointegration Rank Test Results.

	Statistic	0.05 Critical Value (p value)
Unrestricted Cointegration Rank Test (Trace)	24.97749	15.49471 (0.0014)
Unrestricted Cointegration Rank Test (Maximal Eigenvalue)	17.07011	14.26460 (0.0175)

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level. Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level

We have applied Johansen cointegration test that begins with an unrestricted VAR involving non-stationary variables, allows dealing with models with several endogenous variables. Cointegration test formulated on the Maximum Likelihood method of Johansen suggests two tests (the trace test and the maximum eigenvalues test) statistics to verify the cointegration. Taking linear deterministic trend, a lag interval in first differences up to 2 and the MacKinnon-Haug-Michelis (1999) p-values, we see that the null hypothesis of no cointegrating relationship can be rejected at the five percent level (trace statistic = 24.97749> critical value = 15.49471 (p-value: 0.0014); and maximal Eigenvalue statistic= 17.07011 > critical value = 14.26 (p-value: 0.0175)), thereby suggesting that there is cointegration among the variables (Table 6.5).

We have adopted the VECM Granger Causality/Block Exogeneity Wald Tests to check the causal relationship among FDI and R&D. We applied the chi-square (Wald) statistics to examine the combined significance of every other lagged endogenous variables in every equation of the model & also for combined significance of all other lagged endogenous variables in every equation of the model. Results are reported in Table 6.6.

Table 6.6 VECM Granger Causality/Block Exogeneity Wald Test Results

Dependent Variable: D(FDI)			
Excluded	Chi-sq	df	Prob.
D(R_D)	2.251017	2	0.3245
All	2.251017	2	0.3245
Dependent variable: D(R_D)			
Excluded	Chi-sq	df	Prob.
D(FDI)	0.032872	2	0.9837
All	0.032872	2	0.9837

The test results for D(FDI) equation indicate that null hypothesis can be accepted. It implies that R&D in India does not granger cause FDI in India. Similarly, test results for D(R_d) equation however also indicate that null hypothesis can be accepted which implies that FDI inflows in India does not cause R&D in India. It implies that there is independence between FDI inflows and R&D.

CONCLUDING REMARKS AND POLICY RECOMMENDATIONS

FDI has been treated as an instrument of economic growth for the host countries. Foreign firms invest and bring with them the package of valuable resources like technology, expertise, managerial skills, patents, processes, and information on international market, which are significant aspects for improving global market share. It provides advantageous status in respect to technology, administrative skills and way to foreign market; FDI inflow may hasten host country's R&D operations.

In this study, we investigated the association between FDI inflows and R&D in India. We found independence in both the variables even though there was a short term relationship between them. The findings of this study showed that FDI inflows has not significantly contributed to the R&D growth in India between 1996 and 2014 and the R&D growth has also not attracted greater inflows of FDI into India.

The results draw important implications that rise in FDI inflows in India is not because of increase in R&D operations in the nation but because of the measures undertaken by the Indian government. Foreign capital is treated as a way of bridging gaps between local savings and investment. India attracted large foreign investments in the past due to its new economic policies since 1991. Recently, FDI in India has acknowledged a remarkable boost from the initiation of the Make in India initiative. Devised to renovate India into an international manufacturing hub, the Indian government has commenced the initiative on September 2014, which intends to encourage manufacturing and draw foreign investment in India.

There are many fiscal incentives and various support measures have been carried by the government of India expected at promoting R&D in industry and the utilization of domestically available R&D options for industrial development. A large R&D capability and science and technology (S&T) base have been designed in the nation with tremendous facilities for indigenous development of support and technology provided to support the transmission of technologies to industry. The Indian IT industry has also contributed to the progress of the R&D sector. India is also anticipated to observe strong growth in its pharmaceutical and agriculture sectors as the government is investing huge sums to establish committed research centres for R&D in these sectors.

The government of India can provide incentives to foreign investors to collaborate with domestic firms in upgrading technology. This would attract more FDI and further helps in building strong technological structure in the nation. Foreign firms through partnerships, collaborations, joint ventures with indigenous firms can undertake potential research projects and share the new invented technologies and processes which would help in improving efficiency and productivity of both the firms.

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APPENDIX

Table 6.1 Results of ADF Unit root test on inward FDI

Null Hypothesis: FDI has a unit root Exogenous: Constant Lag Length: 0 (Automatic - based on SIC, maxlag=3)			
		t-Statistic	**Prob.***
Augmented Dickey-Fuller test statistic		-1.826977	0.3564
Test critical values:	1% level	-3.857386	
	5% level	-3.040391	
	10% level	-2.660551	

Table 6.2 Results of ADF Unit root test on first differenced inward FDI series

Null Hypothesis: D(FDI) has a unit root Exogenous: Constant Lag Length: 0 (Automatic - based on SIC, maxlag=3)			
		t-Statistic	**Prob.***
Augmented Dickey-Fuller test statistic		-4.766480	0.0018
Test critical values:	1% level	-3.886751	
	5% level	-3.052169	
	10% level	-2.666593	

Table 6.3 Results of ADF Unit root test on R&D series

Null Hypothesis: R_D has a unit root Exogenous: Constant Lag Length: 0 (Automatic - based on SIC, maxlag=3)			
		t-Statistic	**Prob.***
Augmented Dickey-Fuller test statistic		-1.103260	0.6906
Test critical values:	1% level	-3.857386	
	5% level	-3.040391	
	10% level	-2.660551	

Table 6.4 Results of ADF Unit root test on first differenced R&D series

Null Hypothesis: D(R_D) has a unit root Exogenous: Constant Lag Length: 3 (Automatic - based on SIC, maxlag=3)			
		t-Statistic	**Prob.***
Augmented Dickey-Fuller test statistic		-3.578659	0.0215
Test critical values:	1% level	-4.004425	
	5% level	-3.098896	
	10% level	-2.690439	