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FDI Inflows and Environment in India

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Abstract *This paper tries to find out whether there has been greater inflow of FDI in high pollution intensive manufacturing industries in India as compared to less pollution intensive industries. To analyze the impact of FDI inflow on the environment we have taken sectoral data on FDI inflows in the manufacturing sector from 1996 to 2013. Pollution data was regressed on FDI data to find out both long term and short term affect of FDI inflows on environment. Regression results of both long term and short term model showed that FDI inflows has positive impact on industrial pollution levels in India.*

Key words FDI, liberalization, environment, pollution haven hypothesis

JEL Codes: Q53, Q56

1. Introduction

Foreign Direct Investment (FDI) has become an important contributory factor in economic growth and development of many developing and less developing countries (LDCs) around the world. The positive benefits associated with FDI include transfer of capital, skill, technology, resources among others. However there are some costs also like impact on industries and employment in the host nation. There are numerous studies to support both positive and negative impact of FDI. Some studies observe a positive impact of FDI on economic growth, others detect a negative relationship between these two variables like that of Aitkin and Harrison (1999), Djankov and Hoekman (2000), Castellani and Zanfei (2002a, 2002b), and Zukowska-Gagemann (2002). Survey by OECD (2002) on studies regarding FDI and economic growth reveals that majority of the studies found that FDI contributes positively in enhancing economic growth. India too after decades of being cautious about the foreign capital opened its door to FDI in late 1980s. However, the main surge in FDI came after the introduction of economic reforms. Inflow of FDI is an important phenomenon associated with the liberalization measures introduced in 1991. This is facilitated by opening of various new sectors to FDI and increasing the cap on FDI in various industries to 51 percent and even more than that in some. Beginning 2000, the government allowed foreign investment through automatic route in all industries and this led to significant increase in FDI. Inbound investments in India during 2000-01 increased under automatic route. The total FDI inflows in India rose, from 193 billion rupees in 2000 to 1475 billion rupees in 2013(RBI). Though FDI has witnessed dramatic rise in the services sector, it has also increased significantly in the manufacturing. Moreover, the FDI stock and output in the manufacturing sector in India through the 1990s was found to be mutually reinforcing (Chakraborty and Nunnenkamp, 2008).

Most of the studies talks about the impact of foreign investment in economic growth. However, there is one more concern associated with FDI inflow is its impact on environment of the host country. The environmental concerns regarding liberalization and consequent inflow of foreign investment finds its voice in the Pollution Haven Hypothesis (PHH) which states that there will be more capital inflow in the developing and LDCs which usually have lax environmental regulations in compared to their developed counterparts. Relatively low environmental standards in the developing countries led the industries of industrialized countries to shift their manufacturing centers to these countries in the disguise of increasing foreign investment. If this PHH is true than that means increasing FDI will lead to degradation of environment in the developing countries which have opened up their economies to the foreign investment. Inflow of FDI in dirty industries will augment the pollution levels in the country. As in the case of environmental impact of liberalization, FDI also have both scale and composition effect. Scale effect means that increase in the level of pollution because of increase in the level of production from dirty industries where there are greater FDI inflows. Composition effect emerges from the change in the composition of industrial sector in favour the pollution intensive industries. In this background the following study tries to find out whether there has been greater inflow of FDI in dirty or high pollution intensive manufacturing industries as compared to less pollution intensive industries. To analyze the impact of FDI inflow on the environment we have taken sectoral data on FDI inflows in the manufacturing sector from 1996 to 2013. This has been done to know whether the FDI inflow was more in polluting industries or not. To know this pollution data was regressed on FDI data to find out both long term and short term affect of FDI inflows on environment. This paper is divided into seven parts where first is introductory in nature.

1.1. Objectives

(1) To find out the magnitude of FDI inflows in high polluting industries as compared to less polluting industries in the post reform period; (2) To estimate the impact of FDI inflows on the level of industrial pollution in India in post reform period.

1.2. Hypotheses

(1) There has been greater inflow of foreign investment into polluting industries relative to less polluting industries during post reform period; (2) FDI inflows do have a positive relation with the level of industrial pollution.

2. Methodology of research

FDI data was collected from Ministry of Commerce & Industry, Department of Industrial Policy and Promotion and Indiastats.com. Pollution load has been calculated using Industrial Pollution Projection System (IPPS) of World Bank since in India year wise estimates on pollution level at industries level is not available even now. The IPPS is a modelling system which merges the US data on pollution emissions and on industrial activity at the plant level to calculate pollution intensity of industrial sectors. Pollution intensity is defined as the level of pollution discharge/emissions per unit of manufacturing activity. How applicable are US-based estimates to other economies? It is clear that many country-specific factors will affect the accuracy of prototype IPPS projections outside the US. For particular sectors such as wood pulping, average pollution intensity is likely to be higher in developing countries. However, the pattern of sectoral intensity rankings may be similar. For example, wood pulping will be more water pollution-intensive than apparel manufacture in every country. The present version of IPPS can therefore be useful as a guide to probable pollution problems, even if exact estimates are not possible.

Since pollution load is given in US dollars, it is converted into Indian rupees using purchasing power parity of dollar for rupee in 1987-88. This is done because pollution intensity is given in 1987-88 prices. Splicing is used for converting all the variables on 1987-88 prices. Data on sector wise inflow is from 1996-97 to 2013-14. Since this is a time series data we have we have conducted ADF test for presence of unit root. CUSUMSQ shows data does not have structural break as it is under the 5 percent significance range so we have not used dummy variable in regression. Relationship between FDI and pollution is estimated as follows two models:

$$lnpollution = \alpha + \beta_1 lnfdi + ut \quad (1)$$

$$\Delta lnpollution_t = \alpha + \beta_1 \Delta FDI_t + \beta_2 ECT_{t-1} + u_t \quad (2)$$

Where: lnfdi is the log value of FDI whereas lnpollution is log values of pollution from different mediums and types namely air, water, toxic and metal.

3. Literature review

Shanti Gamper-Rabindran and Shreyasi (2004) used industry level data to evaluate the impact of trade liberalization measures on environment in India. They have also analyzed the magnitude of inflow of FDI in pollution intensive industries in the period concerned. This study reveals that exports and foreign investment flows has increased in more air and water polluting industries vis-à-vis cleaner industries in the post liberalization period. Acharya (2009) in his paper has examined two important issues of FDI inflows relating to India. One is its impact on GDP and other is on environment. To gauge the impact of FDI inflows on environment he has used the data on carbon dioxide emissions and foreign investment inflows from 1980 to 2003. Using co-integration analysis, it was found that FDI inflows have large impact on carbon dioxide emissions. Jaffe (1995) has studied have the links between environmental regulations and international competitiveness. The common view in this regard is that countries which have effective and strict environmental standards experience shift in their high pollution intensive industries to other countries which relatively have low environmental standard. There are very few studies pointing out the environmental impact of FDI inflows especially in context of Indian economy. The present study takes into account latest data on the variables involved to find out whether India is the case of PHH or not. Further, this is the first study in connection with Indian economy to study the impact of FDI inflows on pollution from different mediums that too using econometric analysis.

4. FDI inflow and environment in India

In order to analyze whether the inflow of FDI has shifted towards polluting industries over the period of time, data on aggregate FDI inflows in manufacturing, polluting and less polluting industries along with total FDI inflow is shown in table 1 and figure 1. Industries declared pollution intensive by CPCB are petroleum refineries; chemicals and chemical products; drugs and soaps; leather and leather products; ceramic and cement; fermentation; paper and pulp; and sugar. These industries also come under top polluting industries in IPPS criterion. Since, yearly sector wise data on FDI is available since 1996 with cumulative FDI inflow figures during 1991-95, we have taken data from 1996 to 2013. FDI inflows in manufacturing nearly doubled between 1996 and 1997 after which it shows a declining trend. After depicting fluctuations and declining trend FDI inflows bounced back from 2004 onwards and increased continuously till 2008 where after a year of trough due to global financial crisis it again showed a positive growth in 2011-12. In spite of the fact that government has undertook major FDI reforms such as opening up multi-brand retail up to 51 percent, allowing foreign airlines to pick up 49 percent stake in domestic airlines, bringing clarity to FDI in power trading exchanges etc., FDI inflows again took a dive in 2012-13. It revived the very next year showing that reforms will require some time to yields expected results and one would have to wait longer to assess a trend.

Table 1. FDI inflow in India (in billion rupees)

	Polluting industries	Less polluting industries	Manufacturing total	Total FDI
1996-97	17	24	42	104
1997-98	30	42	72	164
1998-99	21	31	52	133
1999-00	15	29	44	169
2000-01	20	31	50	193
2001-02	34	45	79	193
2002-03	45	75	119	213
2003-04	17	37	54	116
2004-05	43	60	103	173
2005-06	49	79	128	193
2006-07	61	128	188	504
2007-08	186	131	317	987
2008-09	208	132	341	1229
2009-10	139	173	312	1231
2010-11	200	145	346	885
2011-12	641	232	873	1651
2012-13	290	436	726	1295
2013-14	313	434	747	1475
CAGR 1996-2013	19	18	19	17
Coefficient of variation	124.7	100.8	104.5	92.1

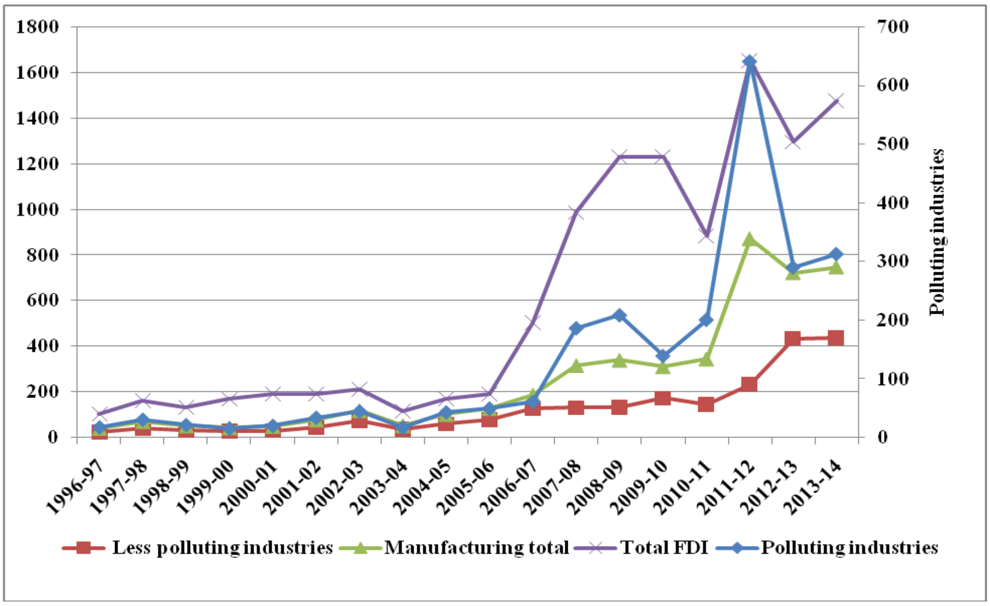

Figure1. FDI inflow in India (Rs. billion)

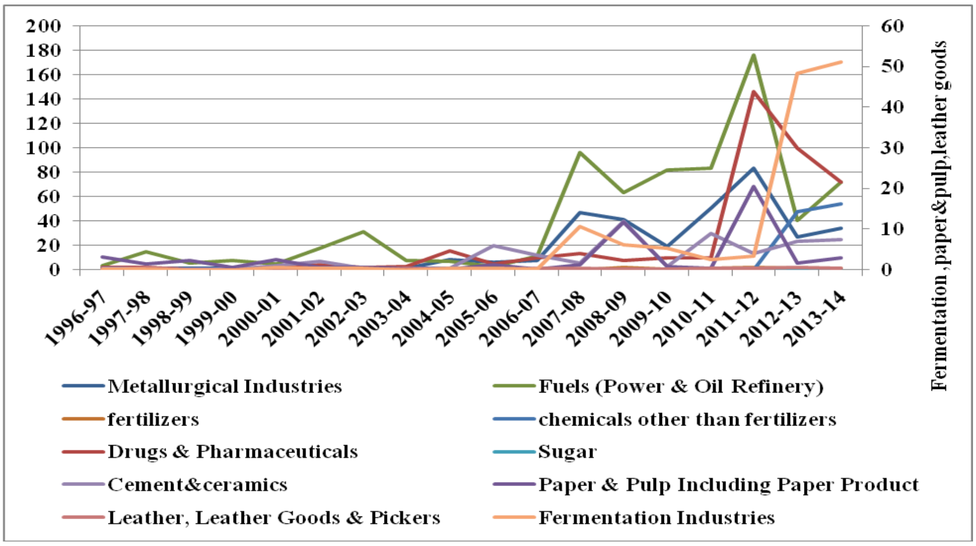

Figure 2. Inflow of FDI in polluting industries in India (Rs. billion)

Table 2. FDI inflows in polluting industries (in billion Rs.)

	Fuels (Power & Oil Refinery)	Chemicals other than fertilizers	Metallurgical Industries	Drugs & Pharmaceuticals	Paper, Pulp, Paper Product
1996-97	3	6	1	2	3
1997-98	15	9	1	2	1
1998-99	6	11	1	1	2
1999-00	7	5	2	1	1
2000-01	5	5	1	2	3
2001-02	17	3	2	4	1
2002-03	31	6	2	3	1
2003-04	7	3	1	3	0
2004-05	7	9	9	16	0
2005-06	3	13	6	5	1
2006-07	11	18	8	10	0
2007-08	96	12	47	13	1
2008-09	63	35	42	8	12
2009-10	82	18	19	10	1
2010-11	83	23	51	10	0
2011-12	176	195	83	146	21
2012-13	41	47	27	100	2
2013-14	72	54	34	72	3
CAGR	18	13	20	21	0
Average FDI	37	25	19	28	3
C.V	127.5	177.5	124.5	146.4	172.8
	Leather & its products	**Cement & ceramics**	**Sugar**	**Fermentation Industries**	**Fertilizers**
1996-97	0	1	0	0	0
1997-98	0	1	0	0	0
1998-99	0	0	0	0	0
1999-00	0	0	0	0	0
2000-01	0	3	0	1	0
2001-02	0	6	0	0	0
2002-03	0	1	0	0	1
2003-04	0	1	0	0	1
2004-05	0	1	0	0	1
2005-06	0	20	0	0	0
2006-07	1	12	1	0	0

2007-08	0	5	0	11	0
2008-09	0	40	0	6	2
2009-10	0	2	0	5	0
2010-11	0	30	0	3	1
2011-12	0	13	0	3	2
2012-12	1	23	0	42	1
2013-14	0	25	0	51	1
CAGR	0	22	36	40	29
Average FDI	0	10	0	10	0
C.V	115.7	121.1	138.3	160.0	116.7

Overall FDI inflows (including manufacturing, services & construction) exhibited an almost similar pattern with decline and slower growth in FDI in initial years of 2000s because of the aftermaths of the Asian crisis (Baer and Sirohi 2013), but increased after 2004 due to simplified procedures for approvals and increase in private equity (Rao and Dhar 2011). Another major policy change in the manufacturing sector (except drugs) came in the year 2006 when foreign equity in high priority industries increased from 51 percent to 100 percent through automatic route. Polluting sectors within the manufacturing have attracted higher FDI inflows as compared to less polluting sectors and overall manufacturing. The compound annual growth rate (CAGR) of FDI inflows in polluting sector is 19 percent in the period concerned against 18 percent and 19 percent in less polluting sectors and manufacturing, respectively. This increase in FDI inflows in pollution-intensive industries is driven by spikes in investments in drugs from Japan (Rs. 161 billion), and in metallurgical from Mauritius (Rs. 17.4 billion) and the US (Rs.15.5 billion). Average FDI inflows among polluting sectors comes out to 129 billion rupees (1996-2013) while that in less polluting is 125 billion rupees. However, volatility is very high in FDI inflows in polluting industries.

Value of coefficient of variation (C.V) is 124 percent in polluting industries which is 33 percentage points higher than the C.V of total FDI inflows. The main cause of this instability is erratic inflows in chemicals, fermentation and paper & pulp industries. Last two industries started receiving large FDI inflows only in the last few years, causing high variability in FDI inflows in polluting industries Among polluting industries share of fuels is highest in average FDI inflows during 1996 -2013 (table 2 and figure 2). Other industries are chemicals (25 million), metallurgy (19 million) and drugs (28 million). Inbound investment has mainly increased after 2004 in metallurgical from USA; petroleum refineries from Singapore; fermentation, ceramic and cement from Netherland. Chemical and chemical products consistently attract significant FDI inflows from US, Japan, Germany and UK in the last decade (2000-10). Drugs and Soaps have been attracting consistent FDI inflows from US, Netherland, Germany and Singapore. Investments from Mauritius dominate in each of the dirty industries. So, we can see that inflow of FDI has shifted towards polluting industries in recent times, especially since 2007 (Rastogi and Sawhney 2013). However, without having proper empirical analysis, we cannot say that FDI has caused damage to the environment. This requires finding relationship between sectoral emissions data from different industries and FDI inflows in these sectors.

5. Model specification

Data on sectoral emissions is taken from IPPS, whereas data on FDI from 1996 to 2013 is taken from reports of RBI. Since pollution data is on 1987-88 prices, FDI data is deflated into 1987-88 prices and converted to log form. Data on sector wise inflow of FDI is available only since 1996 so we have taken only 18 years data in our analysis. Pollution data is taken only for those manufacturing industries whose FDI data we have included in the study. To check stationarity of FDI data, we have conducted ADF test for presence of unit root. Table 3 shows results of ADF unit root test for FDI for levels and the first differences of the natural log values.

Table 3. Result of Augmented Dickey-Fuller Test for unit root

Variables	**Level**		**First difference**	
	Intercept	**Intercept and trend**	**Intercept**	**Intercept and trend**
LnFDI	-0.1	-3.1	-5.2	-5.0

Critical MacKinnon value at 1% is -4.7, at 5% is -3.8 and at 10% is -3.3.*denote significance at 5 per cent level. The lag length in the ADF tests was chosen based on Schwarz Info Criterion (SBC) with maximum lag set at 3.

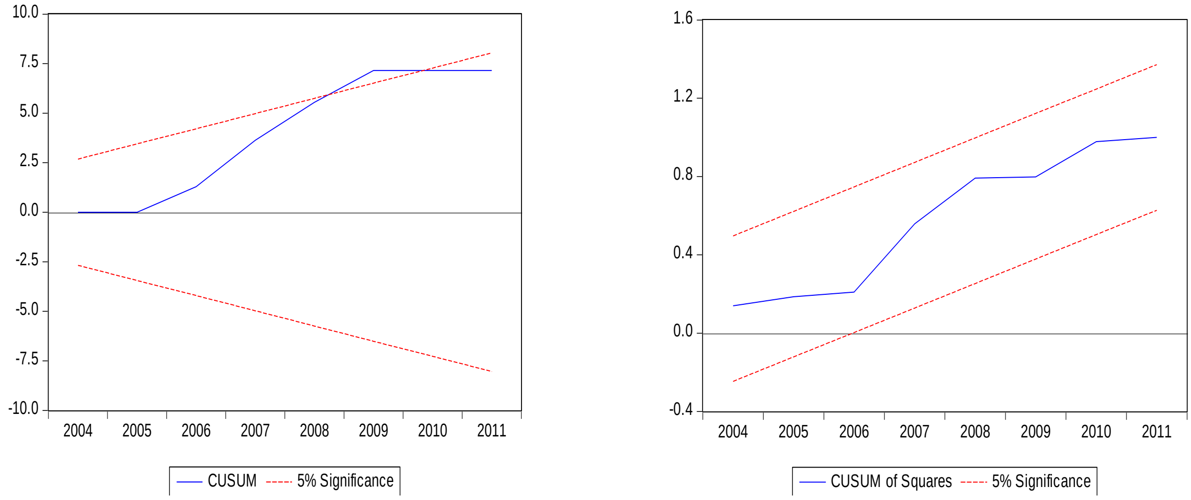

Figure 3. CUSUM and CUSUMSQ: FDI

Log FDI is non-stationary at levels and becomes stationary when it is first differenced. CUSUMSQ (fig 3) shows data does not have structural break as it is under the 5 percent significance range. This may be due to the fact that period undertaken for study here is not very long to take into account any sudden change in variables due to any policy change or external shock. Secondly, as data is nearly five years after the introduction of liberalization period so its impact has already been settled in. As both log pollution and log FDI are stationary at first difference there is every possibility that these two variables are co-integrated. We have used Engle and Granger two step method for testing cointegration. First unit root analysis of error terms was done (table 4) and it was found that they are stationary at level. Tau values are lower than Engle-Granger asymptotic values at 5%. So, we can say that variables are co-integrated and regression of pollution on FDI would not be spurious.

Table 4. Augmented Engle-Granger unit root test of residuals

Regressor= LnFDI	**Level**	
	Intercept	**Intercept and trend**
LnAir pollution	-4.7	-5.56
LnWater pollution	-6.0	-5.8
LnToxic pollution	-4.2	-4.94
LnMetal pollution	-4.48	-4.87

Note: Engle-Granger asymptotic values at 5%-3.05 and 10%-2.66

As we don't have any structural break in data and due to the lack of pre reform data on manufacturing FDI we cannot do a comparative analysis of pre and post reform period. So, we have tried to find out the impact of FDI on pollution. Co-integration test revealed that variables are co-integrated, so we can use regression in our analysis. This also means that there is a long term relationship between FDI and level of pollution. Evidently there may be discrepancy in the short run and we can treat this using Error correction mechanism (ECM). So, there will be two models:

$$\text{lnpollution} = \alpha_0 + \alpha_1 \text{lnfdi} + ut \qquad (3)$$

as u_t is stationary we will find short run relation using second type of model:

$$\Delta \text{lnpollution}_t = \beta_0 + \beta_1 \Delta \text{lFDI}_t + \beta_2 \text{ECT}_{t-1} + u_t \qquad (4)$$

In both the equations α_0 and β_0 is a constant term and α_1 and β_1 is the coefficient of independent variable FDI. In equ.1 α_1 captures long term elasticity of FDI with respect to pollution. Second equation shows values in the differenced form. In this equation, β_1 measures short-term impact of FDI on pollution whereas ECT measures the rate by which deviations in current period is corrected in the next period.

6. Results

Table 5 and 6 shows the long term elasticity of pollution from different mediums with respect to the level of FDI. Explanatory power of long term model is very high as the value of R^2 is more than 0.8. It does not suffer from problem of autocorrelation as value of Durban Watson statistics (D-W) is more than around 2.

Table 5. Long term impact of FDI on pollution (Log form)

Dependent variable		Coefficient	t value	R^2	F statistics	DW statistics
Ln air pollution	constant	7.25	26.79	0.85	94.26	2.2
	LnFDI	0.67	10.01			
Ln Water pollution	constant	8.33	26.6	0.81	69.3	2.01
	LnFDI	0.64	8.32			
Ln Toxic pollution	constant	7.09	25.9	0.84	85.2	2.14
	LnFDI	0.62	9.23			
Ln Metal pollution	constant	5.01	15.4	0.83	83.6	2.22
	LnFDI	0.73	9.14			

Table 6. Long run: regression equations

Dependent Variables	$= \alpha_o+\alpha_1 FDI_t+u_t$
Ln Air pollution	$=7.25+0.67FDI+u_t$
Ln Water pollution	$=8.33+0.64FDI+u_t$
Ln Toxic pollution	$=7.09+0.62FDI+u_t$
Ln Metal pollution	$=5.01+0.73FDI+u_t$

Since R^2 is less than D-W statistic, this model is free of spurious regression (Granger and New bold, 1974). Further, we can see that it satisfies the basic statistical diagnostics as indicated by value of F-statistics. Value of t statistics is higher than 1.96 at 5 percent significance level and its associated p-value is lower than 0.05 in all the regression results indicating that FDI is statistically significant in explaining changes in pollution level. Regression results indicate that for every 1 percent increase in FDI inflow in India, air, water and toxic pollution rises by more than 0.6 percent. Similarly, FDI increases metal pollution by 0.7 percent, respectively. Air pollution increase is mainly because fuels including oil refineries have the highest share in average FDI inflows over the years. Metallurgy sector along with industrial and other chemicals which are one of the main sources of water pollution has a combined share of more than 50 percent in average FDI inflows. Toxic pollution and metal pollution is the byproduct of metallurgy and industrial chemical sectors. Both of these sectors have a share of 37 percent in incoming FDI in India. So, result confirms our hypotheses that FDI inflow has a positive long run impact on the levels of industrial pollution in India. FDI led growth elasticity of industrial pollution is strong as all the regression coefficients have the values between 0.6 and 0.7 and they are significant. In face of the fact that pollution intensive industries are attracting large share of FDI inflows we need to include some strict pollution control standards in our policy regarding foreign investment. Government has taken measures regarding industrial pollution control but increase in industrial pollution due to FDI inflows is still an unattended issue.

In the light of the above analysis regarding long term impact of FDI inflows on the level of industrial pollution we have also constructed an error correction model to reconcile short run behaviour of pollution with its long run value. Results are given in tables 7 and 8. Error correction term is negative which again ascertain the fact that there is long run association between the dependent and explanatory variables.

Table 7. Short run impact of FDI on pollution (first difference)

Dependent variable		Coefficient	T value*	F Statistics*	R^2	DW
∆Ln air pollution	constant	0.09	4.88	3.54	0.35	2.3
	∆LnFDI	0.12	2.62			
	Err(-1)	-0.20	-1.8			
∆Ln Water pollution	constant	0.08	2.74	1.8	0.30	2.13
	∆LnFDI	0.13	1.8			
	Err(-1)	-0.22	-1.2			
∆Ln Toxic pollution	constant	0.07	4.18	5.20	0.44	2.4
	∆LnFDI	0.13	3.15			
	Err(-1)	-0.27	-2.7			
∆Ln Metal pollution	constant	0.10	3.18	3.14	0.32	1.8
	∆LnFDI	0.19	2.4			
	Err(-1)	-0.35	-2.20			

Note: *significance at 5%

Table 8. Short run: Regression equations

Dependent Variables	$=\beta_0+\beta_1\Delta FDI_t + \beta_2 ECT_{t-1}+u_t$
ΔLn Air pollution	$= 0.09+0.12\Delta FDI_t+ -0.20ECT_{t-1}+u_t$
ΔLn Water pollution	$= 0.08+0.13\Delta FDI_t+ -0.20ECT_{t-1}+u_t$
ΔLn Toxic pollution	$= 0.07+0.13\Delta FDI_t+ -0.27ECT_{t-1}+u_t$
ΔLn Metal pollution	$= 0.1+0.19\Delta FDI_t+ -0.35ECT_{t-1}+u_t$

Statistically, all the error terms are significant at 5% critical value, suggesting that pollution level adjusts to FDI with a lag. Discrepancy in the case of air and water pollution is only adjusted by 20 percent whereas it was 35 percent for metal pollution. This shows that adjustment is not very high. Coefficients of different forms of pollution are positive and are consistent with their long run behaviour. However, the value of the coefficients is low in comparison to the long run. This is due to the fact that FDI inflows does not immediately contributes to the pollution as production from a plant requires some gestation period. This is also reflected in the value of R^2 which is less than 50 percent in the short run. Barring this, model passes the test of autocorrelation and is statistically significant as all both t and F values are significant at 5% significance level.

7. Conclusions

As inflow of FDI was an important aspect of industrial liberalization measures, sectoral data on FDI inflows in manufacturing sector from 1996 to 2013 was taken into account to know whether FDI inflow is more in polluting industries or not. Comparative analysis of FDI inflows in polluting and less polluting sectors shows that polluting sectors within the manufacturing has attracted higher inflows as compared to less polluting sectors and overall manufacturing. Regression results also depicts that FDI inflows have positive impact on industrial pollution levels in India. Long term FDI led growth elasticity of industrial pollution was strong as all the regression coefficients have the values between 0.6 and 0.7. Short term model also depicted the same results. However, the value of the coefficients was low in comparison to the long run. This is due to the fact that FDI inflows does not immediately contributes to the pollution as production from a plant requires some gestation period. This shows that there has been greater inflow of foreign investment into polluting industries relative to less polluting industries.

Though FDI has important benefits for developing countries in terms of accelerating growth and assisting in development programmes but it also has costs in terms of environmental degradation. It is neither feasible nor desirable for developing economies like India to reduce the inflow of foreign capital as we face paucity of domestic financial resources. So what we need is to bring changes in industrial investment policy and link environmental concerns with it. FDI inflows especially in extractive and natural resource based industries intensify the level of environmental degradation. The rent arising for the use of natural resources is further used for importing raw materials. In order for the benefits of FDI to be realized in the long-run, rents must be reinvested in efficient enterprises and in long-term productive capital (Mabey and McNalley, 1998). There is a need to carefully monitor the industry wise inflow of FDI. It is important to ensure that FDI is beneficial to the host country by bringing in clean technology and know-how, which improves the environmental standards.

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