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Environmental Impact of Industrial Liberalisation in India

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Abstract: This study has done a systematic analysis of shifts in production pattern of industries to understand environmental connotation associated with liberalisation. Pollution data is regressed on output data. Post liberalisation period (1991-2013) data is compared to that of pre liberalisation (1973-1991). We have found that there has been slight increase in the level of industrial air and water pollution load in post reform period whereas increase has been higher in case of toxic and metal pollution load. This shows that in post reform period, India has become more specialized in the production from polluting industries relative to less polluting industries.

Keywords: environment, industrial pollution projection system, liberalisation, pollution, polluting industries.

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I. INTRODUCTION

Most of the developing countries of today have followed their developed counterparts and adopted industrialization as a strategy for economic growth and development. Faced with a severe balance of payments crisis in 1991, India embarked on an economic liberalisation program that encompassed industrial and trade policy, financial sector reforms and privatization. Industrial sector is one of the key areas which has been most affected by economic reforms. The focus of the 1991 industrial policy was on unshackling the bureaucratic controls and other restrictions. The reforms opened up industrial sector by liberalizing compulsory licensing, diluting the scope of public sector and permitting flow of foreign capital. In spite of the adoption of structural adjustment programme there has been stagnancy in the share of industrial sector in GDP and decline in its contribution to employment. There is also a lot of volatility in the growth of industrial production in the post reform period. Easy licensing norms have promoted the growth of industries, but in a haphazard manner. Not much change has been witnessed in the regional dispersal of industries in the post reform period as compared to the pre-reform period. Changes in industrial structure due to liberalisation could also have important inference for environmental pollution. Seen in case of various developing countries, that greater openness of economy brings more dirty industries to these countries which have lax environmental regulations from developed countries where these industries face stringent environmental rules. As India also witnessed liberalisation in 1991, this gave rise to this study as there is a need to have an in depth analysis on the environmental problems associated with pattern of industrial development since 1991. Level of industrial pollution depends on the pollution intensity of industries so we have only analyzed the compositional impact of liberalisation on domestic production. In order to test our hypotheses, we have assembled industry-level economic and environmental data at the all India level for the manufacturing sector. Level of industrial activity is estimated through value of output and pollution is calculated from Industrial Pollution Projection System (IPPS) of World Bank. Data on post liberalisation period (1991-2013) is compared to that of pre liberalisation period (1973-1991) using regression analysis. This has helped us to analyze whether pollution from industries has increased in the post liberalisation period in contrast to pre liberalisation. To comprehend the composition effect of liberalisation, we present the relative contribution of the main pollutant industries in total industrial emissions from 1973 to 2013. It could only be on the basis of a sound study that we can conclude the magnitude of the dangers posed to environment from industrialization in the aftermath of economic reforms. This paper is divided into seven parts where first is introductory in nature. After objectives, hypotheses, database and methodology; brief review of literature is given in section five. Section six is the main analytical part and last is conclusion and recommendations.

II. OBJECTIVES

- To examine the general relationship between liberalisation and the environment
- To evaluate the impact of industrial liberalisation on industrial pollution in India due to changes in composition of production

III. HYPOTHESES

- Industrial liberalisation policy has impact on environmental degradation.
- Since 1991, India has become more specialized in the production from polluting industries relative to less polluting industries

IV. DATABASE AND METHODOLOGY

Data for this paper has been collected from Annual Survey of Industries and various other databases on industrial indicators. 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.

Regression analysis is used to know whether pollution has increased in post reform period as compared to pre reform period. Time series data from 1973-74 to 2013-14 is utilized for this purpose. The entire time period is divided into two sub periods: pre reform (1973-74 to 1991-92) and post reform (1991-92 to 2013-14). 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 and then applied to deflated data of value of output of manufacturing sector given in ASI. Splicing is used for converting all the variables on 1987-88 prices.

$$\textbf{Pollution load}_{it}\textbf{=pollution intensity}_{i}\textbf{*value of output}_{it}$$

(Where i is industry and t is year)

Before going in for regression analysis to know the effect of output on pollution from various mediums on the level of pollution stationarity test is done on the variables. Further since time series data is usually for a long period of time there are very much chances that there may be structural break in data. To check this stability tests like CUSUM and CUSUMSQ tests are done along with Quandt-Andrews Unknown Breakpoint Test Chow Test for Structural Breaks.

V. BRIEF REVIEW OF LITERATURE

Various attempts have been made to study the impact of liberalisation on environment. Study by Low and Yeats (1992) depicts that developing countries show high revealed comparative advantages for polluting industries. Copeland (1994) and Copeland and Taylor (1994, 1995) have shown that, under a wide variety of assumptions, pollution intensity industries tend to migrate to countries with weaker pollution regulations. Loi Nguyen Duy (2012) studied the impact of trade liberalisation on environment in six newly industrializing Asian countries (China, Indonesia, Malaysia, Philippines, Thailand and Vietnam). This study indicates the existence of the pollution haven hypothesis and shows that trade liberalisation has proved detrimental for environment in developing countries. Mani and Jha (2006) analyzed the possible effects of trade liberalisation and globalization in Vietnam on its environment during the time frame spanning between 1997 and 2002 and found that production and exports has increased from the water and toxic pollution intensive sectors in this period. Jha S. and Rabindran S.G. (2004); also analyzed the effects of trade liberalisation for India 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 liberalisation period. Conversely, we also have studies which show that liberalisation has a positive effect on the environment. Grossman and Krueger (1991, 1993), Birdsall and Wheeler (1992), Antweiler et al. (1998) and Tsai (1999) are of the view that trade liberalisation could improve environmental conditions and quality. Based on these evidences one cannot generalize whether liberalisation will harm the environment or improve its quality. Impact of liberalisation on environment is very complex and depends on various country-culture specific conditions and types of reforms undertaken.

Very few studies have tried to analyze the impact of liberalisation on industrial pollution and only handful of them analyzes it with respect to Indian economy. None of the study is based on a robust time series data and in particular recent data. This study makes an attempt to analyze the impact of industrial liberalisation

on environment by analyzing whether the production has increased from the dirty or polluting industries in the aftermath of economic reforms using the most recent data available.

VI. LIBERALISATION AND ENVIRONMENT DEBATE

Liberalisation measures introduced in various countries during eighties and nineties were aimed at improving the availability and mobility of financial and human inputs. However, there is no mention about the possible impact of these reforms on natural resources. Economic reforms bring about changes in taxes, tariffs, exchange rates, licensing and investment. It has impact on environment as it influences economic activities of production, consumption and trade. There is a division of opinion about the possible impact of liberalisation and globalization policies on environment.

a) Advocates of globalization viewed that it brings about improvement in economic growth and development of the country which induces people to demand clean environment. Inflow of environment efficient technology from developed countries can help producer to oblige to the general demand to shift towards cleaner production techniques.
b) Others viewed that since domestic production and trade depends on natural resources, liberalisation can cause environmental degradation due to increased use of environmental resources. Post liberalisation phase can also depict the case of "pollution haven hypothesis". Since there are differences in environmental standards between developed and developing countries, removal of tariffs and other restrictions may enable the developed world to escape environmental restrictions in home countries by shifting their production to developing countries or so called pollution havens. In this case liberalisation is not beneficial for developing countries.

Liberalisation may affect environment through following impacts on the economy as pointed out by Grossman and Krueger (1991):

a) Composition effect: as consequence of opening up of trade and removal of various licensing restrictions country will try to expand its production and exports in the goods in which has more comparative advantage. The extent of the composition effect on environment depends on the fact whether country has comparative advantage in the production of more polluting or less polluting industries.

b) Scale effect: reduction in tariffs along with easing of norms for starting industries will augment production activities in the economy. However, increased scale of economic activity can also have negative environmental effects. Most economic activity damages the environment, whether in extracting raw materials, harvesting renewable resources, or in creating waste and pollution. Unless regulations are in place, an increasing scale of economic activity increases the level of environmental damage (UNEP 2005)

c) Technical effect: increase in income due to scale effect will enable people to demand cleaner environment. Inflow of less pollution intensive or clean technology of production from developed countries will help in reducing pollution content of production activities

What is significant for the environment is the net result of the composition, scale and technique effects, not the individual components. The impact of liberalisation on the environment is positive if the composition and technique effects exceed the scale effect, and negative if the opposite holds.

6.1 Liberalisation and environment in India:

India's liberalisation reforms have emphasized on removing various barriers and restrictions to allow unrestricted access to new firms, exports, imports and foreign capital for better utilization of available resources. All this has been done firstly, to reduce the role of state in industrial sector due to various inefficiencies so as to make way for private sector to get advantages of public-private partnerships and improving efficiency. Secondly, for making India an export oriented globalized economy through active engagement in trade, investment, technology with rest of the world. Major overhauling reforms were taken in the area of industry which includes- abolition of industrial licensing as an instrument of control over private investment, abolition of the restriction on investment by large industrial groups and opening the economy to FDI. Of the various reforms undertaken industrial sector reforms have the largest potential impact on the pattern and structure of industrial production.

We start therefore by analyzing the degree to which the composition of India's manufacturing output has shifted towards clean or dirty sectors. Table 1 show top ten polluting industries based on pollution intensity

Table 1: Top ten polluting industries

Air pollution	Water pollution	Toxic/Metals	Overall
Iron & steel	Iron & steel	Non ferrous metals	Iron & steel
Non ferrous metals	Non ferrous metals	Iron & steel	Non ferrous metals
Non-ferrous minerals	Pulp & paper	Industrial	Industrial chemicals

		chemicals	
Petro coal products	Misc. minerals	Leather products	Petroleum refineries
Pulp & paper	Industrial chemicals	Pottery	Non ferrous metals
Petroleum refineries	Other chemicals	Metal products	Pulp & paper
Industrial chemicals	Beverages	Rubber products	Other chemicals
Other chemicals	Food products	Electrical products	Rubber products
Wood products	Rubber products	Machinery	Leather products
Glass products	Petro products	Non-met machinery	Metal products

Source: Mani and Wheeler (1998)

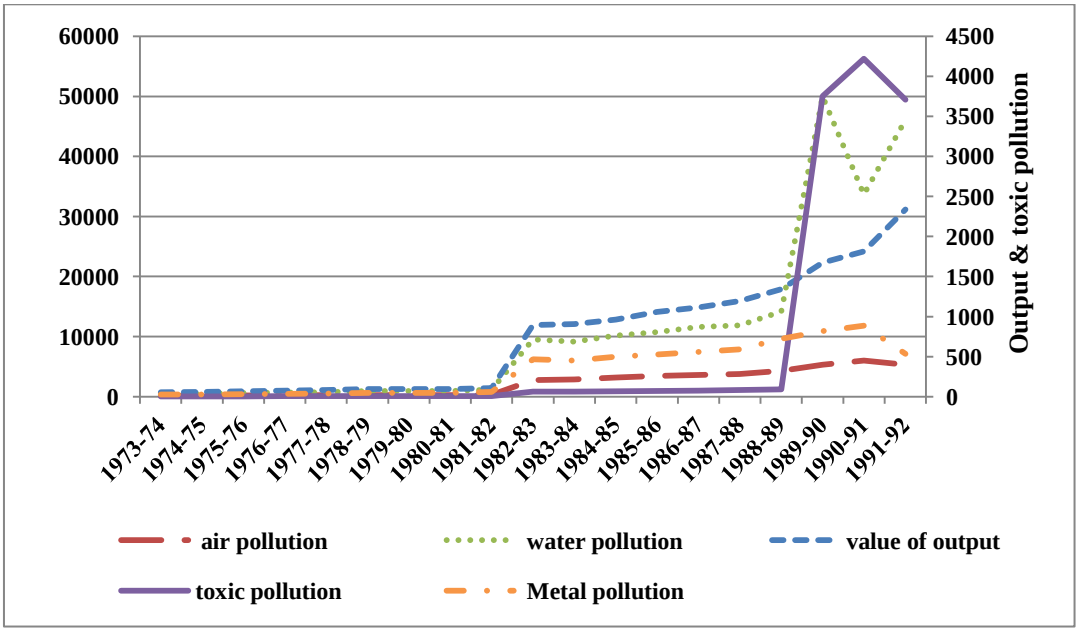

Fig.1 Value of manufacturing output and pollution intensity in India in pre-reform period, 1973-1991 (in billion rupees) at constant 1987-88 price
(Source: IPPS & ASI, various issues)

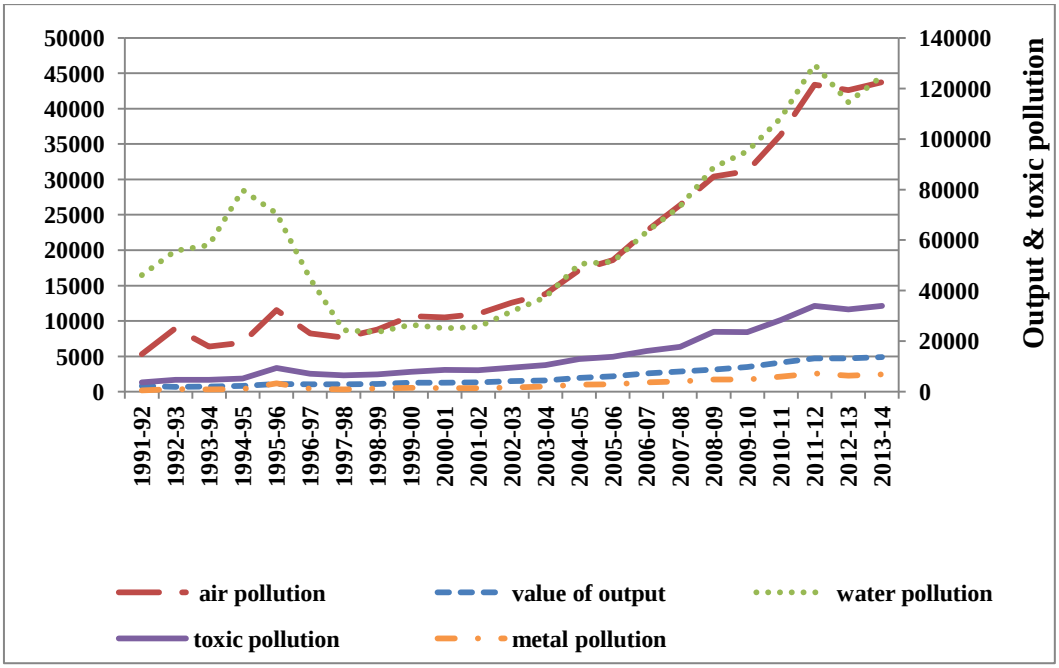

Fig. 2 Value of manufacturing output and pollution intensity in India in post-reform period 1991-2013 (in billion rupees) at constant 1987-88 prices
(Source: same as Fig 1)

India's output and pollution intensity in pre and post reform period is given in figures 1&2. It can be seen that there has been a continuous increase in pollution from all the mediums in post reform period as compared to pre reform period especially since 2001-02. Water pollution shows a very sporadic and volatile trend as compared to pollution from other mediums. On the other hand, output shows a slow and steady growth.

6.2 Compositional impact of liberalisation on domestic production:

In order to analyze whether pollution has increased in the aftermath of liberalisation or not, we have regressed different mediums of pollution on output. Pre liberalisation period is from 1973-74 to 1991-92 and post liberalisation is from 1991-92 to 2013-14. To employ the time series correctly, we must first check time series properties of data. Since there is variation in data, all the values are converted into log form as shown in figures.

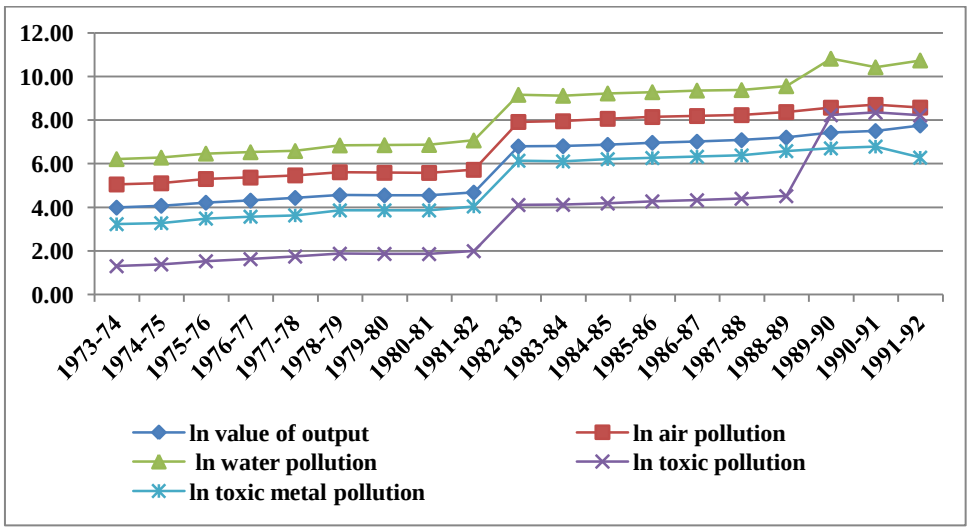

Fig. 3 Log Values of manufacturing output and pollution intensity in India in pre-reform period 1973-1991 (Source: same as Fig 1)

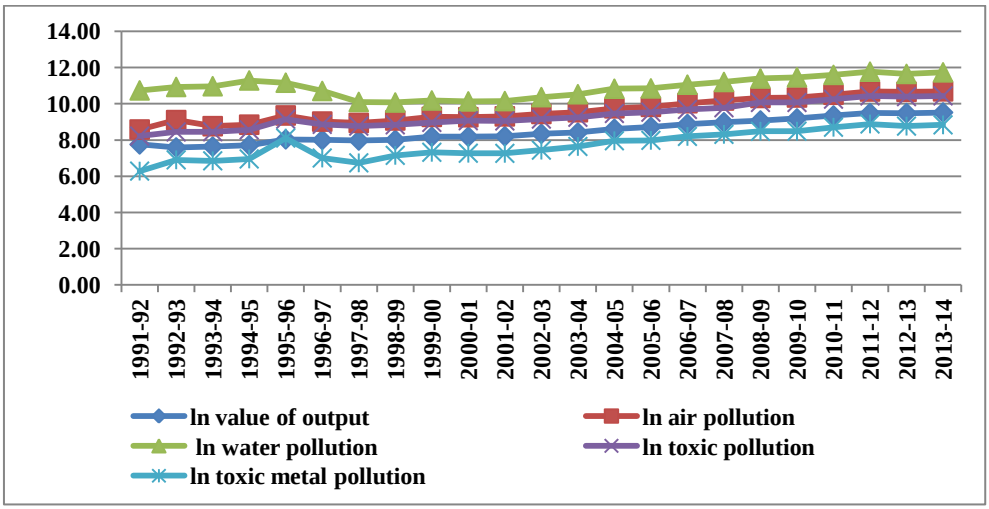

Fig. 4 Log Values of manufacturing output and pollution intensity in India in post-reform period 1991-2013 (Source: same as Fig 1)

Table 2: Result of ADF & Perron's Test for unit root

Variables	Level			First difference		
	ADF		ADF with breaks (Perron's)	ADF		ADF with breaks (Perron's)
	Intercept	Intercept & trend	Intercept	Intercept	Intercept & trend	Intercept
Ln Output	-1.24	-2.55	-1.34	-7.89*	-5.22***	-6.26
Ln Air pollution	-1.09	-1.62	-1.31	-5.56*	-5.56***	-6.18

LnWater pollution	-1.61	-1.63	-1.59	-6.27*	-6.37***	-7.08
LnToxic pollution	-1.23	-1.56	-2.14	-6.38*	-6.41***	-6.54
LnMetal pollution	-1.41	-2.51	-2.66	-7.41*	-7.43***	-6.85

Note: Critical MacKinnon value at 1% is -4.21, at 5% is -3.53 and at 10% is -3.20.*denote significance at 1 per cent level. The lag length in the ADF tests was chosen based on Schwarz Bayesian Criterion (SBC) with maximum lag set at 9. ADF with breaks is tested by Perron and Vogelsang (1993) critical values at1% -4.50, at 5% -3.94, at 10 % -3.65 Sources: fig 4 & 5.

Time series properties of data are checked through Augmented Dickey Fuller test (ADF). Table 2 shows the results of ADF unit root test for all five variables for levels and the first differences of the natural log values. Data is non stationary at the level but become stationary at the first difference as tau-values given by ADF test is more than critical MacKinnon value at 1 percent level of significance.

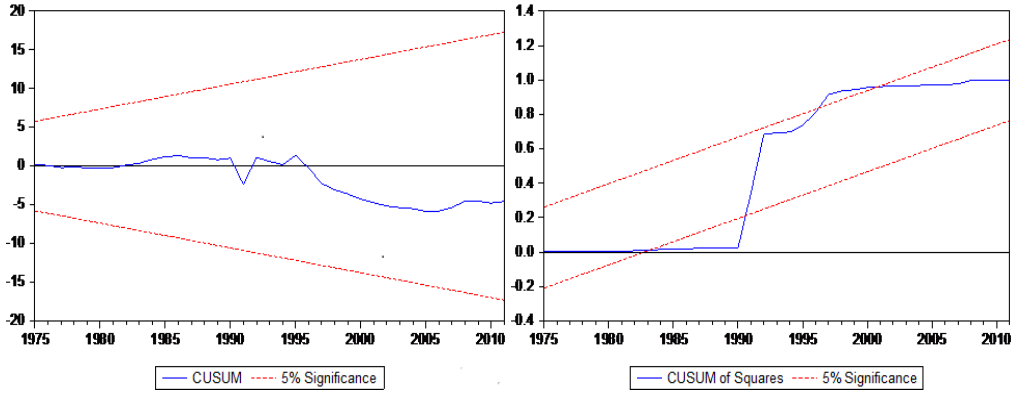

Fig. 5 (a) CUSUM & CUSUMSQ: Air pollution
(Sources: fig 4 & 5)

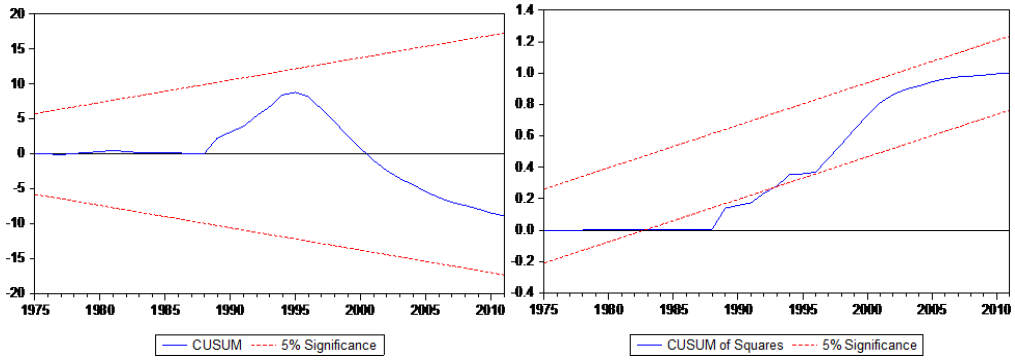

Fig. 5(b) CUSUM & CUSUMSQ: Water pollution
(Sources: same as fig.5.a)

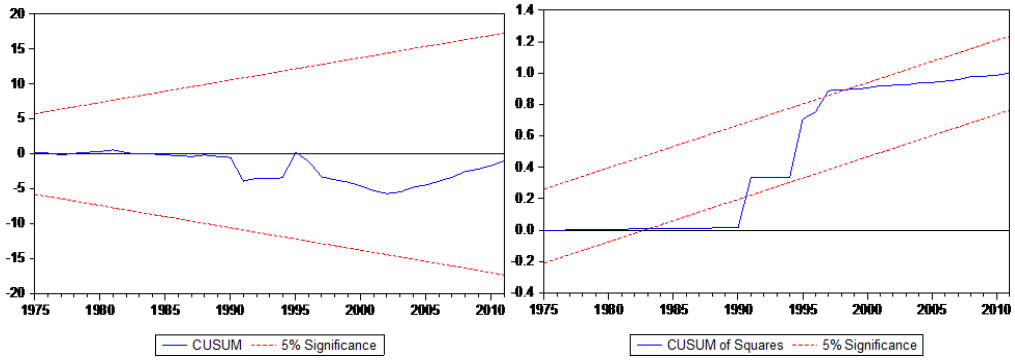

Fig. 5(c) CUSUM & CUSUMSQ: Metal pollution
(Sources: same as fig.5.a)

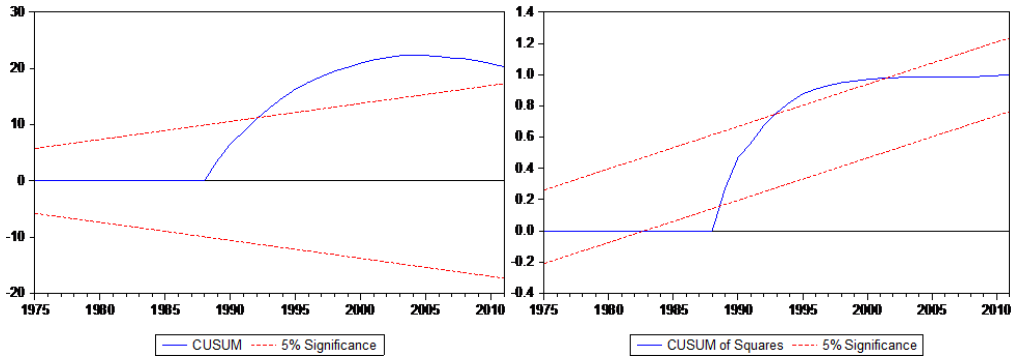

Fig. 5(d) CUSUM & CUSUMSQ: Toxic pollution
(Sources: same as fig.5.a)

Since our data is for a long period of time there may exist some structural breaks in data. CUSUM and Cusum Squares (CUSUMSQ) tests are done in order to know the stability of variables and Fig 5 shows the results of these tests.

In CUSUM test the test statistic is not outside the corridor except for toxic pollution. However, it shows large scale diversion from the mid line. On the contrary, the statistic test of CUSUMSQ is outside the corridor for all the variables. To confirm the results we have also done recursive residual tests and the results are same as it is for CUSUMSQ. We concluded that there is structural break in data. To determine the structural breakpoint, we have performed, Quandt-Andrews Unknown Breakpoint Test and Chow Test for Structural Breaks (Slettvold & Fjermestad 2010). Year column against Quandt Andrews test (table 3), shows year in entire time series with the highest estimated Wald Statistic, i.e. where the structural break is most probable. The appropriate asymptotic p-values are significant at a 5% significance level. For this matter, we allowed for a symmetric "trimming" of 10%. Structural break for all pollution levels except toxicity occurs in 1996 and 1997 which is quite natural as India has experienced a shift of regime in its industrial and trade reforms during that period. Structural break in case of toxic pollution occurred in 1989 which may due to the effect of the limited liberalisation programme started in late 1980's. We confirm the results from the Quandt-Andrews test with a simple Chow test. In this test we have to specify the exact year of structural break. Here the null hypothesis is that there is no structural break in the data, now if p value of F statistics is below 5 percent then we can reject null hypothesis and declare that there is structural break in the data. Results of Chow test confirm that there is structural break in data at a specified breakpoint. To account for the structural break, dummy variable has been introduced in the model.

Table 3: Result of Structural break tests

Variables	**Breakpoint year**	**Quandt-Andrews**		**Chow test**	
		Max Wald statistics value	**Probability**	**F-statistic value**	**Probability**
LnAir pollution	1996	9.18	0.0000**	4.59	0.0166**
LnWater pollution	1997	61.77	0.0000**	30.89	0.0000**
LnToxic pollution	1989	5697.99	0.0000**	2848.95	0.0000**
LnMetal pollution	1996	9.96	0.1206**	4.83	0.0136**

Table 4: Results of Johansen's H*l*(*r*) Cointegration test

Output (regressor)	**Hypothesized No. of CE(s)**	**Trace statistic**		**Outcome**
		10% Critical Value	**5% Critical value**	
	None *	**34.39**	**37.34**	
	At most 1	**16.76**	**18.90**	
		H*l*(*r*) value		
LnAir pollution	**None ***	38.95		Reject
	At most 1	1.93		Do not reject
Lnwater pollution	**None ***	38.60		Reject
	At most 1	1.41		Do not reject

Lntoxic pollutin	**None ***	39.45	Reject
	At most 1	1.86	Do not reject
Lnmetal pollution	**None ***	38.43	Reject
	At most 1	1.02	Do not reject

Now, as our data contains structural break we have also used Perron's (1989) test for unit root analysis. The critical values of Perron's test were corrected by Perron and Vogelsang in 1993. This test searches for the existence of unit roots in the presence of a structural break. We will compare the resulting tau values of ADF test with Perron's asymptotic critical values (corrected ones) and not with the critical MacKinnon in this modified ADF. The result given in table 3 confirms the presence of unit root in data as tau-values at level are greater than Perron's critical values at 1% significance level.

As data becomes stationary at the first difference, this induces the possibility for the time series to be co-integrated. To check whether the variables are co-integrated or not, we have done Johansen cointegration test. Since we have structural break in data we have used a modified form of Johansen test provided in Johansen et.al (2000) and called as the H*l*(*r*) test. The results of this test are given in table 4.

The asymptotic distribution of the test is different from what it would usually be for the trace test. The asymptotic critical values depend on the proportion of the way through the sample that the break occurs ($\lambda = 0.6$ in our case); and on (p - r), where p is the number of variables under test $p = 2$, here, and r is the cointegrating rank being tested. So, for us r=0, 1. H*l*(*r*) test indicates that in all the series the value of trace statistics exceeds its critical value (5 % & 10%); when null hypothesis is that there is no co-integration. Cointegration is tested separately for each type of pollution. So, on the basis of Johansen test we can conclude that at least one cointegrating vector is present. The cointegrating equation (normalized on the log of pollution from different mediums) is reported below in table 5 and it shows that the long- run estimates for the log of output are positive, (signs are reversed because of the normalization process). T-ratios are significant at 5% for all the variables and indicate that there has been an increase in output from industrial sector that accentuates the level of pollution. The presence of one cointegrating equation from which residuals (EC terms) can be obtained also makes it possible to investigate whether there is a short-run adjustment back to the long-term relationship using the Engle-Granger two-step procedure.

Table 5: Normalized Cointegration coefficients

Dependent variables→ Value(1.0000)	**Ln Air pollution**	**Ln water pollution**	**Ln toxic pollution**	**Ln metal pollution**
Cointegrating Coefficients with output	-1.02	-1.83	-1.84	-1.01
t-ratios	-133.18	-55.92	-81.23	-50.91

6.3 Model specification:

Error Correction Model

Given that there is a stable long-run relationship among the relevant variables even in the presence of a structural break, it is possible to estimate an error correction (EC) model that captures both the short-and long-run behavior of the relationship between pollution from different mediums and level of output (Engle and Granger, 1987). The changes in the relevant variables represent short-run elasticities, while the coefficient on the EC term represents the speed of adjustment back to the long-run relationship among the variables. Treating the percentage change in pollution inflows as the "dependent" variable, we have estimated EC model separately for each type of pollution in terms of first difference of the variables.

$$\Delta \text{lnpollution}_t = \alpha + \beta_1 \Delta \text{lnoutput}_t + \beta_2 (D_t * \Delta \text{lnoutput}_t) + \beta_3 ECT_{t-1} + u_t$$

6.3.1 Results:

The short run estimates of output shows that the increase in air, water and metal pollution due to 1 percent increase in the output in pre-reform period is in the range of 1.01 to 1.04 percent. To know the level of pollution in post reform period we have to add the value of dummy variable to the output coefficient for each type of pollution. Results indicate that level of industrial pollution has increased in the post reform period as compared to pre reform period. This shows that production has increased from pollution intensive industries which ultimately have led to an increase in air and water pollution, though not much. Iron and steel, cement industry and petroleum refineries are the top emitters of air pollution. Apart from iron and steel water pollution is mainly caused by non-ferrous metal and paper industries. One of the causes of the increase in pollution is rise in demand for infrastructure in the post liberalisation period, which has caused an increase in production from

these industries. Level of toxic pollution, which is mainly emitted by industrial chemicals, petroleum and iron& steel industries, has shown an increase of 1.53 percent in post reform period corresponding to 1 percent increase in output.

In post reform period the highest jump is witnessed in metal pollution. 1 percent increase in output leads to 1.82 percent increase in metal pollution in post reform period in contrast to a corresponding increase of 1.01 percent in pre 1996 period. Major contributor to metallic pollution are iron & steel, non-ferrous metals and industrial chemicals.

All the four models have good explanatory power with value of R^2 is in the range of 0.5 to 0.9 and does not suffer from problem of autocorrelation as Durban Watson statistics (DW) is close to 2 which suggests that there is no first-order autocorrelation in the model. Though value of R^2 is high but this model does not suffer from problem of spurious regression as R^2 is less than D-W statistic (Granger and New bold, 1974). To ensure that the model does not suffer from higher order serial correlation, an AR (4) specification was fitted and a Breusch-Godfrey test was performed. Again, the results indicate that there is no serial correlation in all the models. Further we can see that it satisfies the basic statistical diagnostics as indicated by value of F-statistics which shows that output significantly impacts the dependent variables as p values are less than 0.05. Value of t is large, and its associated p-value is lower than 0.05 in all the regression results indicating that output is statistically significant in explaining changes in pollution level.

This shows that pollution has increased in post reform period as compared to pre reform period from all the types of pollutants. Now we have to see what industries are generating most of the pollution depending on the nature of pollutant. This will helps us to know the cause of increase in pollution load in post reform period.

Table 6: Regression results

Dependent Variables			**Coefficient**	**t value***	**R^2**	**DW**	**F Statistic***
ΔLn Air pollution	**Pre-reform**	constant	0.96	24	0.94	2.01	216.04
		ΔLn output	1.02	3.5			
	Post-reform= ($Dum96*\Delta output_t + \Delta lnoutput_t$)	ΔLn output	1.09	13.3			
	Err(-1)		-1.44	-6.8			
ΔLn Water pollution	**Pre-reform**	constant	1.02	25.5	0.71	1.96	270.94
		ΔLn output	1.04	10.3			
	Post-reform= ($Dum97*\Delta output_t + \Delta lnoutput_t$)	ΔLn output	1.52	8			
	Err(-1)		-0.34	-2.3			
ΔLn Toxic pollution	**Pre-reform**	constant	0.07	7.2	0.51	2.05	55.66
		ΔLn output	1.02	3.2			
	Post-reform= ($Dum89*\Delta output_t + \Delta lnoutput_t$)	ΔLn output	1.53	4.6			
	Err(-1)		-0.5	5.3			
ΔLn Metal pollution	**Pre-reform**	constant	-0.04	-1.03	0.79	1.99	45.23
		ΔLn output	1.01	10.6			
	Post-reform= ($Dum89*\Delta output_t + \Delta lnoutput_t$)	ΔLn output	1.82	12.6			
	Err(-1)		-1.02	-6.1			

*significant at 5% critical value

Table 7: Regression equations

Dependent Variables	$=\alpha+\beta_1\Delta\text{lnoutput}_t+\beta_2(D_t*\Delta\text{lnoutput}_t)+\beta_3 ECT_{t-1}+u_t$
ΔLn Air pollution	$0.96+1.02\Delta\text{lnoutput}_t+0.07D_{96}*\Delta\text{lnoutput}_{t\,t}-1.44_{\,t-1}+u_t$
ΔLn Water pollution	$1.02+1.04\ \Delta\text{lnoutput}_t+0.48D_{97}*\Delta\text{lnoutput}_t-0.34_{\,t-1}+u_t$
ΔLn Toxic pollution	$0.07+1.02\ \Delta\text{lnoutput}_t+0.51D_{89}*\Delta\text{lnoutput}_t-0.5_{\,t-1}+u_t$

6.4 Sectoral emissions analysis:

In order to comprehend the composition effect that took place in the Indian industry after 1991, it is necessary to undertake a sectoral emission's analysis. Calculation of pollution load of different industries is explained in the methodology section. On its basis we have ranked the industries according to their contribution in total pollution load in a particular year and medium.

Table 8: Industrial air pollution: Top 10 most polluting industries in India in pre-reform period (percent share)

Industries	**1973-74**	**1974-75**	**1975-76**	**1976-77**	**1977-78**	**1978-79**	**1979-80**	**1980-81**	**1981-82**	**1982-83**
Iron & steel	31.5	31.7	31.6	31.6	29.9	34.1	35.4	36.1	38.8	35.1
Cement, lime	21.2	19.2	22.4	22.9	22.4	20.5	19.6	18.6	18.1	25.1
Oils & fats	10.8	10.3	8.7	8.6	9.5	7.9	8.0	7.6	6.5	6.4
Petroleum refineries	6.1	7.4	5.8	5.2	5.5	5.2	5.9	5.8	5.8	4.5
Pulp & paper	5.8	6.4	6.3	6.4	7.2	6.9	6.5	6.3	6.1	5.4
Sugar factories	4.5	4.1	4.4	3.6	3.8	3.9	3.0	2.6	3.5	3.9
Non ferrous metals	4.2	3.8	4.2	4.6	4.6	4.4	4.1	4.0	3.8	3.5
Industrial chemical except fertilizers	2.9	3.0	3.4	3.1	3.0	3.1	3.1	3.2	3.2	3.1
Chemical products	1.8	2.2	2.4	2.5	2.5	2.3	2.3	3.8	2.5	2.5
Structural clay products	1.5	1.4	1.4	1.4	1.4	1.4	1.5	1.6	1.5	1.4
		1983-84	**1984-85**	**1985-86**	**1986-87**	**1987-88**	**1988-89**	**1989-90**	**1990-91**	**1991-92**
Iron & steel		32.3	32.0	31.3	32.2	31.3	32.5	27.8	27.7	12.1
Cement, lime		28.3	30.9	32.5	31.3	29.7	29.6	27.2	28.8	37.2
Oils & fats		6.2	5.4	5.0	5.0	6.2	5.2	4.9	4.5	6.0
Petroleum refineries		5.0	5.5	4.9	5.4	5.2	4.8	8.4	9.3	6.3
Pulp & paper		5.6	5.2	5.2	5.3	5.7	5.3	4.9	4.8	5.5
Sugar factories		3.5	2.4	2.3	2.6	2.9	3.1	2.6	2.5	2.9
Non ferrous metals		3.5	3.5	3.2	3.1	3.8	4.5	4.9	4.0	5.0
Industrial chemical except fertilizers		3.0	2.9	2.7	2.9	2.8	2.6	2.9	3.3	4.0

Chemical products		2.3	2.2	2.8	2.2	2.3	2.0	2.9	2.5	3.3
Structural clay products		1.5	1.4	1.4	1.4	1.5	1.5	1.1	1.1	1.5

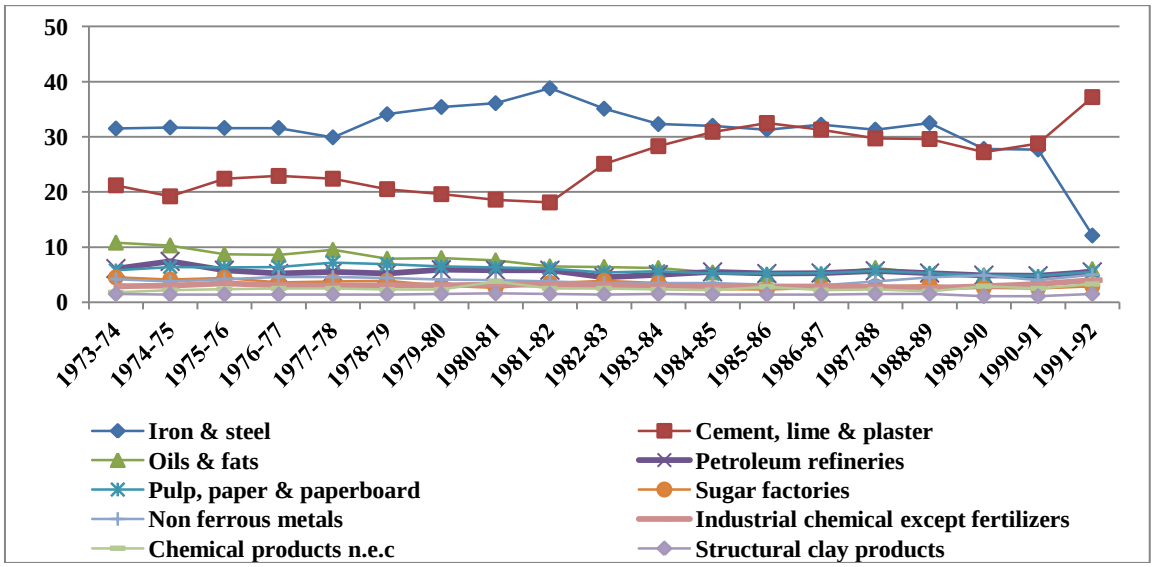

Fig.6 Percentage Share of top ten air polluting industries in pre reform period
Source: (Table 8)

Table 9: Industrial air pollution: Top ten most polluting industries in post-reform period (percent share)

Industries	**1992-93**	**1993-94**	**1994-95**	**1995-96**	**1996-97**	**1997-98**	**1998-99**	**1999-00**
Iron & steel	20.3	27.5	26.9	19.2	22.7	12.2	24.7	22.2
Cement, lime & plaster	21.1	27.6	27.9	20.7	31.3	33.6	27.4	31.5
Oils & fats	3.4	4.8	4.6	3.3	4.8	5.1	6.3	4.4
Petroleum refineries	4.8	7.2	7.4	5.0	7.6	8.2	8.0	8.1
Pulp & paper	3.2	4.6	4.8	3.4	4.8	4.4	3.9	3.7
Sugar factories	1.7	2.6	2.8	1.4	2.7	2.4	2.5	2.2
Non ferrous metals	3.4	4.0	4.7	3.9	4.0	5.6	5.0	5.9
Industrial chemical	2.4	3.4	3.7	2.1	3.7	5.2	3.6	3.1
Chemical products	2.0	3.3	2.9	2.6	2.9	4.4	3.1	3.7
Synthetic resins, plastic materials	1.8	2.6	2.6	1.7	3.0	4.8	4.4	4.1
	2000-01	**2001-02**	**2002-03**	**2003-04**	**2004-05**	**2005-06**	**2006-07**	
Iron & steel	21.3	20.6	23.4	25.1	27.9	25.8	26.2	
Cement, lime & plaster	28.0	28.7	23.5	22.6	21.7	21.4	24.0	
Oils & fats	4.1	4.1	5.6	4.6	3.9	3.3	3.6	
Petroleum refineries	11.1	13.8	16.9	17.6	17.6	19.9	19.7	
Pulp & paper	4.6	4.2	4.4	3.7	2.9	3.1	2.5	
Sugar factories	2.7	2.3	2.0	1.5	1.2	1.6	1.5	
Non ferrous metals	5.3	5.0	4.6	6.0	7.0	6.6	7.0	
Industrial chemical	4.5	4.1	3.1	2.9	2.8	2.7	2.3	
Chemical products	2.7	3.2	3.1	2.7	2.5	3.1	1.9	
Synthetic resins, plastic materials	4.7	3.7	3.8	3.7	3.2	3.0	2.6	
	2007-08	**2008-09**	**2009-10**	**2010-11**	**2011-12**	**2012-13**	**2013-14**	

Iron & steel	26.5	28.6	29.3	28.9	28.8	23.5	22.2	
Cement, lime & plaster	26.0	25.6	24.9	21.7	21.9	25.5	27.5	
Oils & fats	3.8	4.1	3.3	3.8	4.1	3.3	3.0	
Petroleum refineries	18.8	16.8	18.2	18.6	19.2	21.7	21.9	
Pulp & paper	2.7	1.6	1.8	2.0	1.5	1.6	2.0	
Sugar factories	1.2	0.9	1.3	1.4	1.2	1.3	1.1	
Non ferrous metals	6.2	5.2	4.5	6.1	6.3	5.7	5.6	
Industrial chemical	2.1	5.3	4.5	4.6	4.8	4.6	4.6	
Chemical products	2.0	2.2	2.1	2.5	2.1	2.6	2.0	
Synthetic resins, plastic materials	2.4	5.2	5.0	4.8	4.9	1.9	2.2	

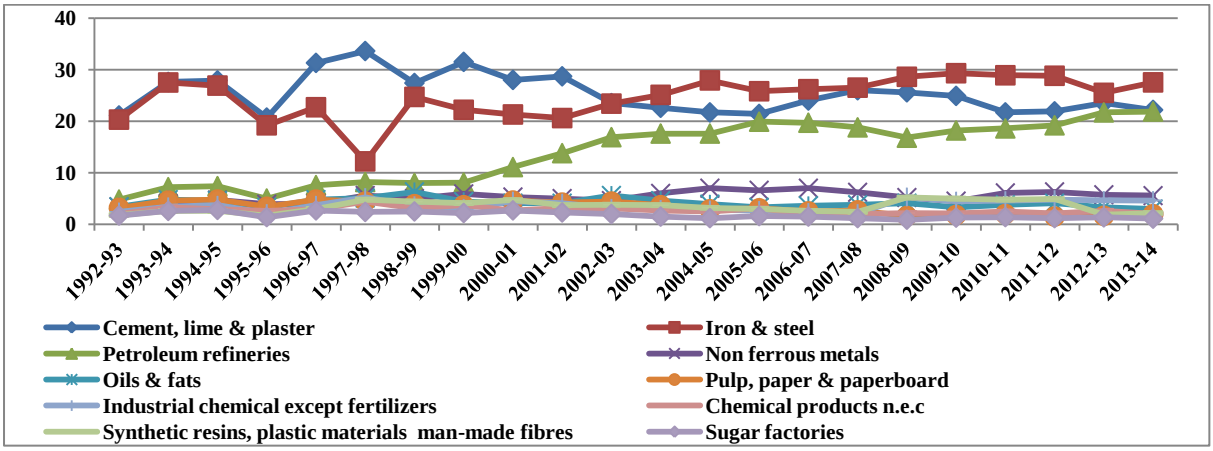

Fig.7 Percentage Share of top ten air polluting industries in post reform period (Source: Table 9)

Table 10: Industrial water pollution: Top ten most polluting industries in India in pre reform period (percent share)

Industries	**1973-74**	**1974-75**	**1975-76**	**1976-77**	**1977-78**	**1978-79**	**1979-80**	**1980-81**	**1981-82**	**1982-83**
Iron & steel	89.0	88.0	89.0	89.1	88.2	89.9	90.1	90.6	91.2	91.4
Pulp & paper	4.2	5.3	4.2	3.8	4.2	3.5	3.8	3.7	3.5	3.0
Non ferrous metals	2.8	2.6	2.9	3.2	3.3	2.8	2.5	2.4	2.2	2.2
Sugar factories	1.0	0.9	1.0	0.8	0.9	0.8	0.6	0.5	0.7	0.8
Industrial chemical	0.8	0.8	0.9	0.8	0.8	0.8	0.7	0.7	0.7	0.8
Dairy products	0.5	0.6	0.6	0.6	0.7	0.6	0.5	0.4	0.4	0.4
Drugs & medicines	0.4	0.4	0.4	0.5	0.5	0.3	0.4	0.5	0.4	0.4
Petroleum refineries	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1
Rubber products	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1
Cement, lime & plaster	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.1	0.1	0.2
	1983-84	**1984-85**	**1985-86**	**1986-87**	**1987-88**	**1988-89**	**1989-90**	**1990-91**	**1991-92**	
Iron & steel	90.3	90.0	90.2	90.3	89.5	89.6	85.84	87.05	70.63	
Pulp & paper	3.6	4.0	3.6	3.9	3.8	3.4	3.84	3.85	8.22	
Non ferrous metals	2.4	2.4	2.3	2.1	2.6	3.0	3.69	3.03	7.14	
Sugar factories	0.8	0.6	0.5	0.6	0.7	0.7	0.65	0.63	1.35	
Industrial chemical	0.8	0.8	0.7	0.8	0.7	0.7	0.84	0.96	2.21	
Dairy products	0.5	0.6	0.6	0.7	0.6	0.5	0.63	0.47	1.08	

Drugs & medicines	0.5	0.5	0.6	0.6	0.7	0.8	1.48	1.39	3.33	
Petroleum refineries	0.1	0.1	0.1	0.1	0.2	0.1	0.25	0.28	0.35	
Rubber products	0.2	0.2	0.2	0.2	0.2	0.2	0.06	0.05	0.11	
Cement, lime & plaster	0.2	0.2	0.2	0.2	0.2	0.2	0.20	0.21	0.51	

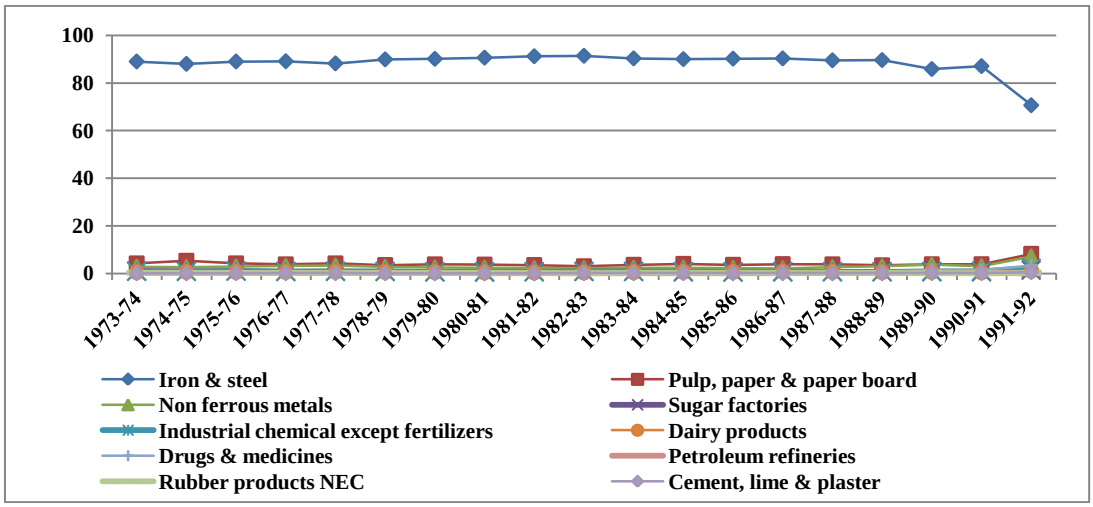

Fig. 8 Top ten water polluting industries in India in pre reform period
(Source: Table 10)

Table 11: Industrial water pollution: Top ten most polluting industries in post-reform period
(Percent share)

Industries	**1992-93**	**1993-94**	**1994-95**	**1995-96**	**1996-97**	**1997-98**	**1998-99**	**1999-00**
Iron & Steel	86.2	85.9	84.7	65.7	82.8	68.8	82.6	80.6
Pulp,& paper	3.5	3.7	3.9	3.1	4.5	6.3	3.4	3.4
Non ferrous metals	3.5	3	3.5	25.3	3.5	7.7	4.02	5.2
Drugs & medicines	1.7	2	1.9	1.4	2.3	4.2	2.7	2.6
Fertilizers	1.4	1.3	1.4	1.1	1.6	2.9	1.7	2.02
Industrial chemical	0.9	1	1.08	0.7	1.3	2.8	1.1	1.07
Sugar factories	0.6	0.6	0.7	0.5	0.8	1.09	0.7	0.6
Dairy products	0.6	0.6	0.6	0.5	0.7	1.4	0.8	0.8
Jewellery & related articles	0.39	0.57	0.5	0.42	0.6	1.32	1.01	1.48
Cement, lime & plaster	0.21	0.2	0.21	0.18	0.27	0.45	0.22	0.27
	2000-01	**2001-02**	**2002-03**	**2003-04**	**2004-05**	**2005-06**	**2006-07**	
Iron & Steel	79.9	79.8	83.1	83.5	85.4	83.8	84.5	
Pulp & paper	4.4	4.2	4.04	3.1	2.3	2.5	2.03	
Non ferrous metals	4.9	4.6	0.6	0.4	0.3	0.3	0.4	
Drugs & medicines	2.7	2.6	2.3	2.2	1.7	1.9	1.9	
Fertilizers	1.9	1.7	3.9	4.9	5.2	5.2	5.5	
Industrial chemical	1.6	1.5	1.3	1.2	1.0	1.1	1.0	
Sugar factories	0.8	0.7	1.0	0.9	0.8	0.8	0.7	
Dairy products	0.9	0.9	0.7	0.7	0.5	0.6	0.5	
Jewellery & related articles	0.85	1.75	1.1	1.4	1.4	1.9	1.8	
Cement, lime & plaster	0.25	0.26	0.2	0.2	0.2	0.2	0.2	

	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	
Iron & Steel	85.7	88.1	86.2	87.0	86.8	85.4	86.8	
Pulp& paper	2.2	1.2	1.3	1.5	1.2	1.4	1.6	
Non ferrous metals	0.3	0.2	0.3	0.3	0.3	4.7	4.3	
Drugs & medicines	1.6	1.7	1.7	1.8	1.8	2.1	1.0	
Fertilizers	4.8	3.9	3.2	4.5	4.6	0.2	0.2	
Industrial chemical	0.8	0.2	0.2	0.2	0.2	1.5	1.4	
Sugar factories	0.7	1.5	1.3	1.3	1.4	0.4	0.3	
Dairy products	0.5	0.2	0.5	0.5	0.5	0.5	0.6	
Jewellery & related articles	1.7	1.6	3.8	1.5	1.7	2.4	2.2	
Cement, lime & plaster	0.2	0.2	0.2	0.2	0.2	0.2	0.2	

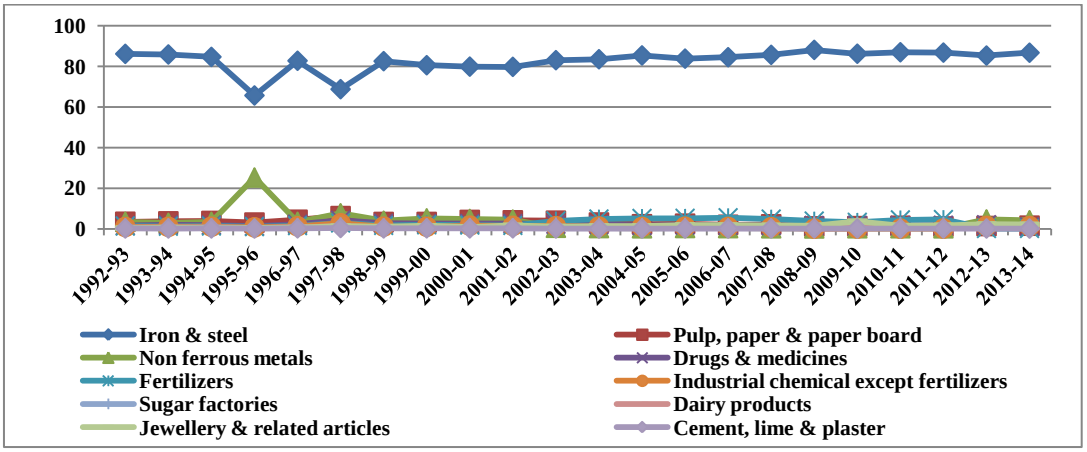

Fig.9 Top ten water polluting industries in India in post reform period
(Source: Table 11)

Table 12: Industrial toxic pollution: Top ten most polluting industries in pre-reform period (percent share)

Industries	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79	1979-80	1980-81	1981-82	1982-83
Iron & steel	12.2	12.0	12.6	12.2	11.3	13.1	13.4	13.7	14.8	14.5
Oils & fats	8.6	8.0	7.1	6.9	7.4	6.2	6.2	5.9	5.1	5.5
Sugar factories	5.3	4.7	5.3	4.2	4.3	4.5	3.4	3.0	4.0	4.9
Petroleum refineries	4.6	4.7	4.8	4.8	5.3	5.1	4.7	4.6	4.5	4.3
Grain milling	4.2	4.1	3.9	3.8	4.0	4.3	4.1	3.6	3.5	3.6
Motor vehicles	4.1	3.9	3.8	3.8	3.4	3.7	3.8	4.0	4.3	4.2
Food processing	3.6	3.8	3.7	3.8	4.1	3.5	3.2	3.0	2.6	2.2
Spinning, Weaving, & finishing textiles	3.6	3.5	3.6	3.3	3.7	3.6	3.7	3.7	4.0	3.9
Electrical industrial machinery	3.5	3.2	3.5	3.4	3.3	3.1	3.1	3.2	2.9	2.9
Soap, cleaning preps., perfume	2.4	5.1	5.4	5.8	6.6	6.1	6.7	7.8	8.9	10.3
	1983-84	**1984-85**	**1985-86**	**1986-87**	**1987-88**	**1988-89**	**1989-90**	**1990-91**	**1991-92**	
Iron & steel	13.6	14.1	13.7	14.0	13.2	14.1	25.3	25.5	11.2	
Oils & fats	5.4	4.9	4.5	4.5	5.4	4.6	1.5	1.4	1.9	
Sugar factories	4.5	3.3	3.1	3.5	3.7	4.1	0.3	0.3	0.4	
Petroleum refineries	4.6	4.5	4.4	4.4	4.7	4.4	6.9	7.7	5.2	
Grain milling	3.7	3.6	3.6	3.8	3.9	3.9	0.0	0.0	0.0	
Motor vehicles	3.8	3.6	4.0	4.2	3.9	4.2	0.8	0.8	0.7	
Food processing	2.9	3.2	3.0	2.7	2.6	2.4	0.1	0.1	0.1	
Spinning, weaving, textiles	4.1	4.1	4.1	3.9	4.4	3.6	2.5	2.5	2.8	

Electrical industrial machinery	2.6	2.8	2.3	2.3	2.8	2.6	0.4	0.4	0.5	
Soap, cleaning preps., perfumes	9.0	8.9	10.6	9.9	8.9	8.1	0.5	0.4	0.4	

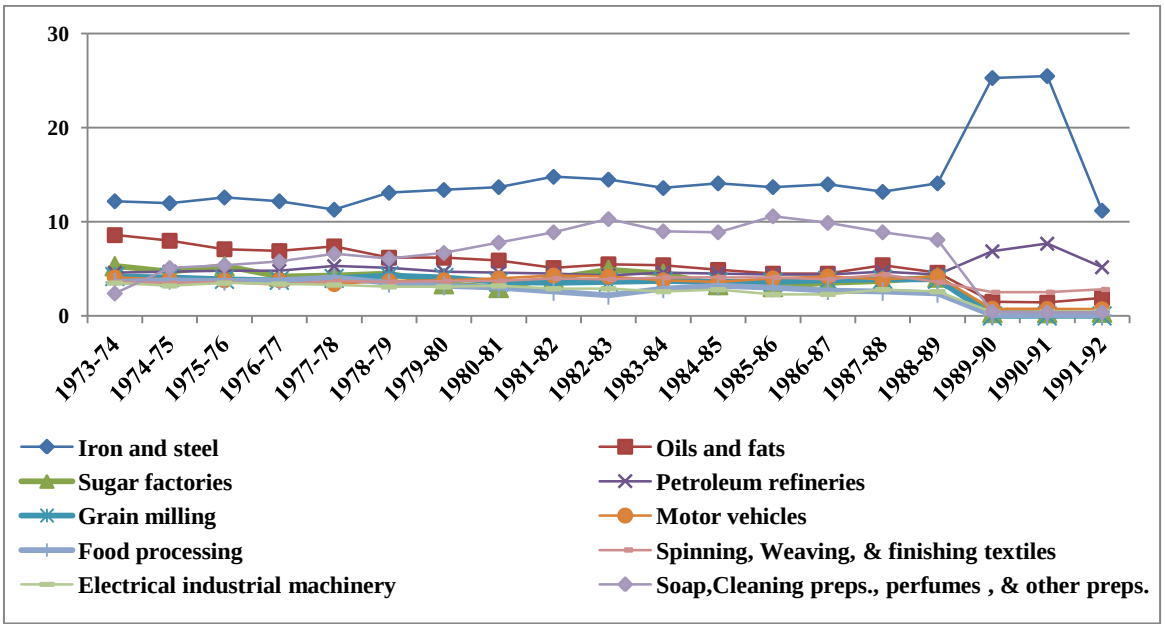

Fig.10 Top ten toxic polluting industries in India in pre reform period
(Source: Table 12)

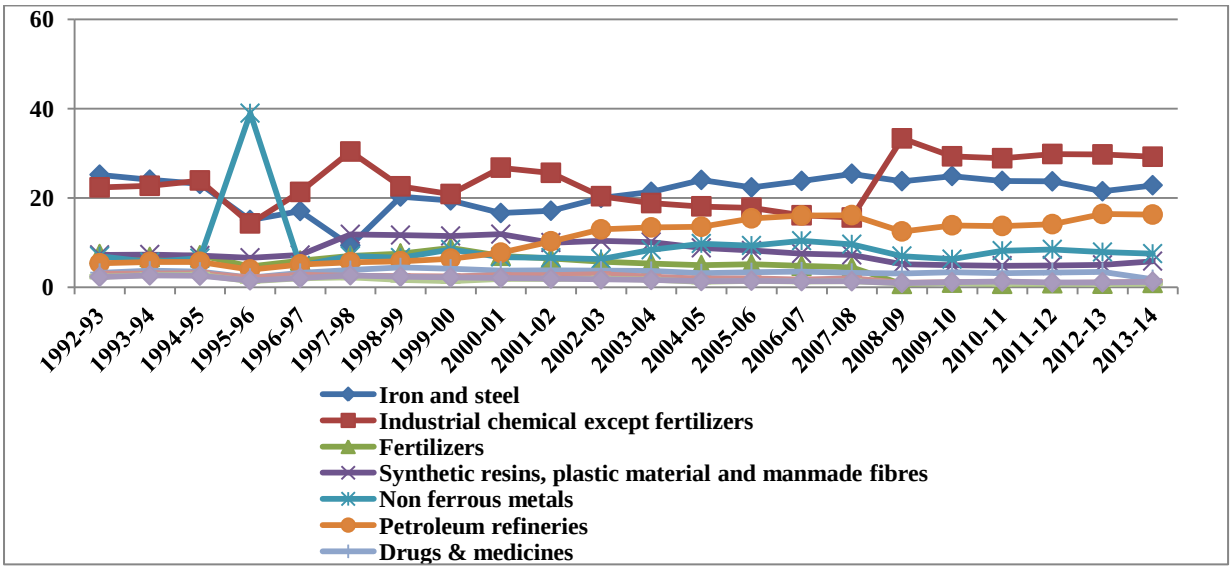

Fig.11 Top ten toxic polluting industries in India in post reform period
Source: Table 13

Table 13: Industrial toxic pollution: Top ten most polluting industries in post-reform period (percent share)

Industries	**1992-93**	**1993-94**	**1994-95**	**1995-96**	**1996-97**	**1997-98**	**1998-99**	**1999-00**
Iron & steel	25.2	24.1	23.1	15.1	17.1	9.4	20.3	19.4
Industrial chemical except fertilizers	22.4	22.7	23.9	14.3	21.3	30.4	22.6	20.9
Fertilizers	7.4	6.8	7.2	4.6	6.0	7.0	7.6	8.8
Synthetic resins, plastic	7.3	7.3	7.1	6.6	7.2	11.9	11.7	11.5

material and manmade fibres								
Non ferrous metals	7.0	5.7	6.5	39.0	4.9	7.0	6.6	8.5
Petroleum refineries	5.4	5.7	5.7	4.0	5.1	5.6	5.8	6.4
Drugs & medicines	3.2	3.7	3.5	2.1	3.2	3.9	4.5	4.2
Pulp and paper	3.1	3.1	3.2	2.2	2.8	2.6	2.5	2.5
Tanneries & leather finishing	2.4	2.7	2.8	1.4	2.0	2.2	1.6	1.4
Spinning, Weaving, & finishing textiles	2.3	2.7	2.6	1.6	2.1	2.7	2.4	2.2
	2000-01	**2001-02**	**2002-03**	**2003-04**	**2004-05**	**2005-06**	**2006-07**	
Iron & steel	16.6	17.1	20.0	21.4	24.0	22.4	23.8	
Industrial chemical except fertilizers	26.8	25.6	20.4	18.8	18.1	17.8	16.1	
Fertilizers	7.0	6.5	5.7	5.3	5.0	5.1	4.8	
Synthetic resins, plastic material and manmade fibres	11.9	10.0	10.4	10.1	8.8	8.2	7.6	
Non ferrous metals	6.8	6.6	6.4	8.4	9.8	9.4	10.4	
Petroleum refineries	7.7	10.3	13.0	13.4	13.6	15.4	16.1	
Drugs & medicines	3.7	3.8	3.7	3.7	3.1	3.4	3.6	
Pulp & paper	2.8	2.7	2.9	2.4	1.9	2.0	1.7	
Tanneries & leather finishing	1.9	1.9	1.9	1.7	1.3	1.4	1.3	
Spinning, Weaving, & finishing textiles	2.1	1.9	1.8	1.6	1.4	1.5	1.4	
	2007-08	**2008-09**	**2009-10**	**2010-11**	**2011-12**	**2012-13**	**2013-14**	
Iron & steel	25.4	23.8	24.9	23.8	23.7	21.5	22.8	
Industrial chemical except fertilizers	15.6	33.3	29.3	28.9	29.8	29.7	29.2	
Fertilizers	4.5	0.7	1.0	0.8	0.9	0.8	1.0	
Synthetic resins, plastic material and manmade fibres	7.2	5.2	5.0	4.8	4.9	5.0	5.8	
Non ferrous metals	9.6	7.0	6.3	8.2	8.5	7.9	7.5	
Petroleum refineries	16.2	12.5	13.9	13.7	14.1	16.4	16.3	
Drugs & medicines	3.3	3.1	3.4	3.2	3.3	3.5	1.8	
Pulp and paper	2.0	1.0	1.2	1.3	1.0	1.1	1.2	
Tanneries &leather finishing	1.4	0.9	1.0	0.8	0.8	0.7	0.9	
Spinning, Weaving, & finishing textiles	1.3	1.0	1.1	1.3	1.1	1.1	1.3	

Table 14: Industrial metal pollution: Top ten most polluting industries in pre-reform period (in percent)

Industries	**1973-74**	**1974-75**	**1975-76**	**1976-77**	**1977-78**	**1978-79**	**1979-80**	**1980-81**	**1981-82**	**1982-83**
Iron &steel	70.6	71.6	70.3	68.8	67.8	71.1	72.2	73.3	75.4	75.2
Non ferrous metals	17.3	16.1	17.5	18.8	19.6	17.0	15.5	15.0	13.6	13.9
Industrial chemical except fertilizers	2.9	3.1	3.4	3.0	3.1	2.9	2.8	2.9	2.8	3.0
Electrical apparatus & supplies	1.5	1.3	1.4	1.5	1.5	1.4	1.5	1.6	1.4	1.2
Tanneries &leather finishing	1.1	1.0	0.9	1.3	1.1	1.3	1.5	1.0	0.8	0.7
Rubber	0.8	0.9	0.8	0.9	0.8	0.8	0.9	0.7	0.7	0.5
Tires & tubes	0.7	0.8	0.7	0.7	0.7	0.7	0.7	0.8	0.7	0.7

Petroleum refineries	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3
Fabricated metal products	0.3	0.3	0.4	0.4	0.5	0.3	0.4	0.4	0.3	0.4
Machinery & equipments	0.3	0.3	0.3	0.4	0.4	0.3	0.3	0.4	0.3	0.3
	1983-84	**1984-85**	**1985-86**	**1986-87**	**1987-88**	**1988-89**	**1989-90**	**1990-91**	**1991-92**	
Iron &steel	73.9	73.9	74.4	75.5	72.1	70.8	65.3	68.2	43.5	
Non ferrous metals	14.8	15	14.3	13.3	16.2	18.4	21.5	18.2	33.7	
Industrial chemical except fertilizers	3.1	3.1	2.9	3	2.9	2.6	3.07	3.6	6.6	
Electrical apparatus and supplies	1.2	1.1	1.2	1.1	1.3	1.3	1.12	1.14	1.7	
Tanneries &leather finishing	0.7	0.8	0.8	0.8	0.9	0.8	0.8	0.7	1.1	
Rubber	0.7	0.7	0.8	0.7	0.8	0.7	0.2	0.2	0.3	
Tires & tubes	0.7	0.8	0.8	0.9	0.8	0.8	0.4	0.4	0.6	
Petroleum refineries	0.3	0.3	0.3	0.3	0.3	0.3	0.51	0.6	0.6	
Fabricated metal products	0.4	0.3	0.4	0.3	0.6	0.6	1.03	0.9	1.6	
Machinery & equipments	0.3	0.3	0.4	0.4	0.4	0.3	0.3	0.30	0.5	

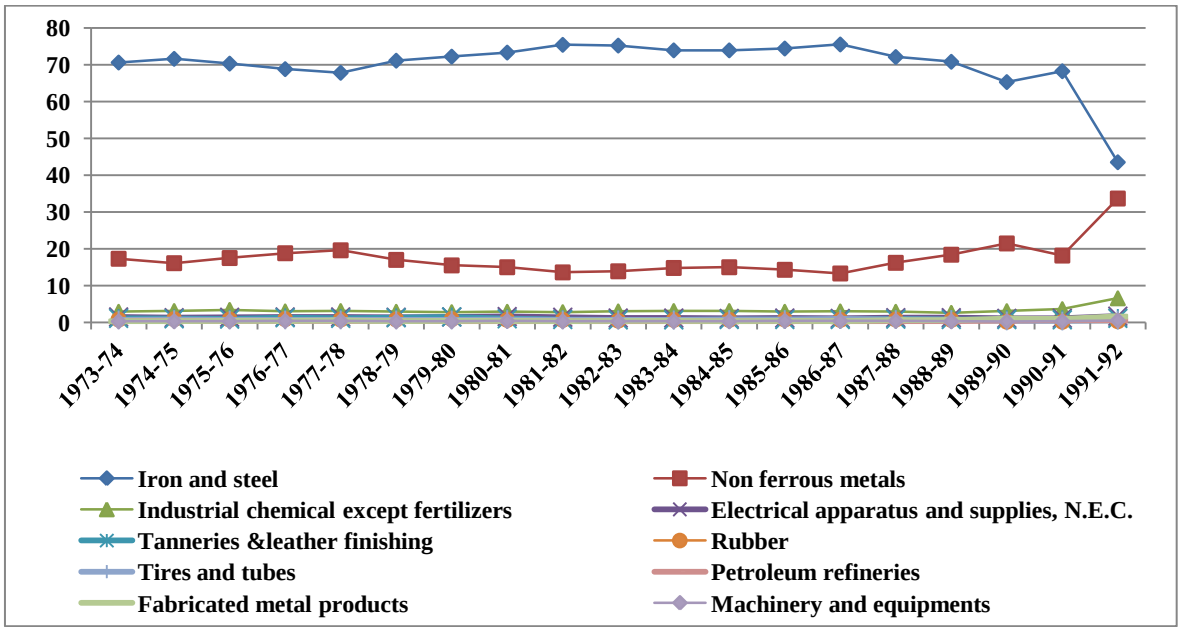

Fig.12 Top ten metal pollution intensive industries in India in pre reform period
(Source: Table 14)

Table 15: Industrial metal pollution: Top ten most polluting industries in post-reform period (percent share)

Industries	**1992-93**	**1993-94**	**1994-95**	**1995-96**	**1996-97**	**1997-98**	**1998-99**	**1999-00**
Iron &steel	66.1	67.3	64.7	23.9	61.3	40.0	61.5	56.9
Non ferrous metals	20.8	18.1	20.8	70.6	20.0	34.2	22.9	28.2
Industrial chemical except fertilizers	3.5	3.8	4.0	1.4	4.6	7.7	4.1	3.6
Fertilizers	1.7	1.7	1.8	0.7	1.9	2.7	2.0	2.3
Electrical apparatus & supplies, N.E.C.	1.0	1.1	1.1	0.4	1.1	1.5	1.5	1.3
Fabricated metal products	0.8	1.1	1.0	0.4	1.3	1.8	0.9	0.8
Spinning, Weaving, & finishing textiles	0.8	1.0	0.9	0.3	1.0	1.5	0.9	0.8
Synthetic resins, plastic material and manmade fibres	0.8	0.9	0.8	0.4	1.1	2.1	1.5	1.4
Tires and tubes	0.4	0.5	0.4	0.2	0.5	0.7	0.4	0.4
Petroleum refineries	0.4	0.5	0.5	0.2	0.5	0.7	0.5	0.5
	2000-01	**2001-02**	**2002-03**	**2003-04**	**2004-05**	**2005-06**	**2006-07**	
Iron &steel	56.4	57.6	62.5	60.3	60.8	59.5	59.3	
Non ferrous metals	26.2	25.4	22.6	26.9	28.2	28.4	29.6	
Industrial chemical except fertilizers	5.4	5.1	3.8	3.2	2.7	2.8	2.4	
Fertilizers	2.1	1.9	1.6	1.3	1.1	1.2	1.1	
Electrical apparatus & supplies	1.3	1.3	1.1	0.9	0.7	1.0	1.0	
Fabricated metal products	1.0	0.9	0.9	0.9	0.8	0.9	0.8	
Spinning, Weaving, & finishing textiles	0.9	0.8	0.7	0.6	0.5	0.5	0.4	
Synthetic resins, plastic material and manmade fibres	1.7	1.4	1.4	1.2	0.9	0.9	0.8	
Tires and tubes	0.4	0.4	0.3	0.3	0.2	0.3	0.2	
Petroleum refineries	0.8	1.0	1.2	1.1	1.0	1.2	1.2	
	2007-08	**2008-09**	**2009-10**	**2010-11**	**2011-12**	**2012-13**	**2013-14**	
Iron &steel	62.2	65.4	68.1	63.0	62.8	61.4	63.5	
Non ferrous metals	26.9	22.0	19.6	24.7	25.6	25.7	23.8	
Industrial chemical except fertilizers	2.3	5.5	4.8	4.6	4.7	5.1	4.8	
Fertilizers	1.0	0.2	0.2	0.2	0.2	0.2	0.2	
Electrical apparatus & supplies	1.0	1.0	0.9	1.1	0.9	1.0	1.2	
Fabricated metal products	0.9	0.7	0.7	1.0	0.7	0.8	0.9	
Spinning, Weaving, & finishing textiles	0.4	0.3	0.4	0.4	0.4	0.4	0.4	
Synthetic resins, plastic material and manmade fibres	0.7	0.6	0.6	0.5	0.5	0.6	0.7	
Tires and tubes	0.2	0.3	0.3	0.3	0.2	0.3	0.3	
Petroleum refineries	1.2	1.0	1.1	1.1	1.1	1.4	1.3	

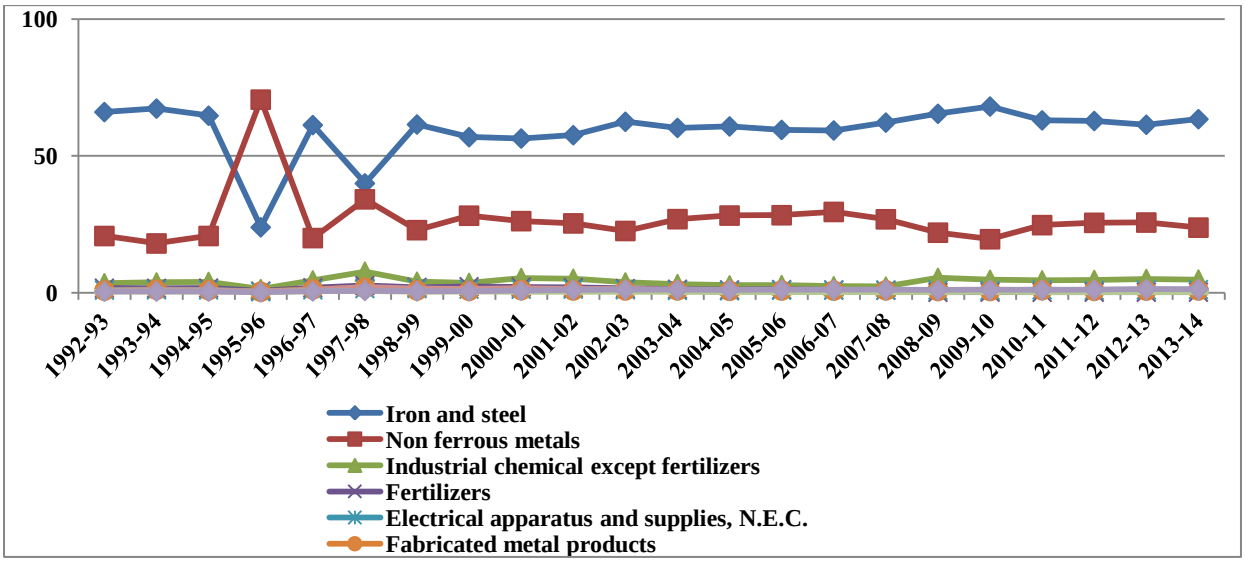

Fig.13 Top ten metal pollution intensive industries in India in post reform period
(Source: Table 15)

Iron & steel and cement industries remained the largest contributor to air pollution in India in both the periods under consideration. Share of iron & steel in total air pollution load was 31.5 percent in 1973-74 while that of cement, lime and plaster was 21 percent. However, production has shifted towards other air polluting industries like cement, petroleum refineries. Iron and steel industry is responsible for more than 80 percent of water pollution. Share of toxic pollution mainly increased due to rapid increase in share of Industrial chemicals except fertilizers which is nowhere in the top ten industries in pre reform period becomes the highest contributor in 1996 till 2002 and again from 2008 onwards. Metal pollution in India is mainly caused by iron& steel and non ferrous metals industries in both periods. However, Fertilizers, Synthetic resins industries have entered into top ten metal polluting industries in post 1991 period

Overall Iron & Steel emerged as the most polluting sector followed by non ferrous metals, industrial chemicals except fertilizers, petroleum refineries, fertilizers and others. Though the share of traditional polluting sectors like Iron & steel, cement industry, sugar factories has dipped but there has been increase in the share of other polluting sectors like petroleum refineries, industrial chemicals except fertilizers, non ferrous metals showing increasing interest towards polluting sectors in post reform period.

VII. CONCLUSION AND RECOMMENDATIONS:

Results of the study proved both of our hypotheses that liberalisation has impact on environment via composition of production and since 1991 India has become more specialized from in production from dirty industries. This indicates that there is a trade-off between the economic gains from liberalisation and the environmental consequences from a liberalisation episode that has not been accompanied by a simultaneous strengthening of environmental policies. The government should make an informed decision about how to balance the trade-off between the economic gains from liberalisation and the environmental costs. This study highlights the need to consider strengthening environmental policies at the time when industrial liberalisation is being contemplated. This study is conducted by using IPPS of World Bank as there is no systematic database on pollution from industrial activities in India. To get an actual estimation, an indigenous database on industrial pollution for India is required. This will help us to assess what changes are required to make at the industry level to make manufacturing process cleaner.

Further, as we can see that there are only five-six industries which are responsible for more than 90 percent of pollution and as we do not have enough trained man-power and resources to evaluate the pollution contribution of all the industries it is necessary that we put in place special environmental protection and pollution control policy for these industries only for now. This not only helps to control pollution but can also save lots of financial resources.

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