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ENVIRONMENTAL IMPACT OF INDIA'S TRADE LIBERALIZATION

Shreyasi Jha
UNC- Chapel Hill
sjha@email.unc.edu

Shanti Gamper-Rabindran
UNC- Chapel Hill
shanti@email.unc.edu

India's liberalization program of 1991 reduced trade barriers and removed investment restrictions across industries. Using a unique industry level dataset aggregated at the all-India level for all manufacturing industries, we compare the pre and post-liberalization periods to examine if India's domestic production and exports showed a greater increase in dirty industries relative to cleaner ones. We also examine whether there has been a greater inflow of FDI into pollution intensive sectors in the post-liberalization period. Our findings indicate that exports and FDI grew in the more polluting sectors relative to the less polluting sectors in the post-liberalization period.

JEL Classification: F14, F18, F21, O53, O24, Q56

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1. INTRODUCTION

Increasing trade liberalization in countries with weak environmental policies has raised concerns about the adverse environmental consequences of freer trade[1]. As a result of weak environmental policies, trade liberalization in developing countries may result in shifts in the composition of production, exports and FDI to more pollution-intensive manufacturing industries. However, there is little empirical evidence on the environmental consequences of trade liberalization in developing countries.

This paper contributes to the literature on the environmental consequences of trade liberalization episodes in developing countries by analyzing the composition (pollution intensive versus less pollution intensive) of manufacturing export, domestic production and foreign investment inflows around the period of India's trade liberalization program of 1991. Faced with a severe balance of payment crisis in 1991, the Indian government embarked on an economic reform program that included industrial and trade policy and financial sector reforms as well as privatization. In this paper we focus on India's trade liberalization policies. India has a weaker environmental enforcement regime relative to its main trading partners[2], therefore there is concern that trade liberalization could potentially encourage the use of India as a production base for more pollution intensive production.

We have assembled industry-level economic and environmental data aggregated at the all India level for the manufacturing sector. Using this unique dataset, we test three hypotheses. First, we examine the composition of domestic production at the all India level pre and post-liberalization. We ask whether India's domestic production is larger in the 'dirtier' industries within the manufacturing sector and whether production has shown a greater increase in the dirtier industries between the pre and post-liberalization periods. Second, we analyze the composition of manufacturing export to determine whether India is specializing in pollution intensive exports in the post-liberalization period compared to the pre-liberalization period. Finally, we examine whether foreign direct investment (FDI) has shown greater increase in the pollution intensive industries in the post-trade liberalization period relative to FDI into less polluting industries.

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[1] For a discussion of these concerns, see for instance, "World Development Report: The Environment and Development", World Bank, 1992; A Fair Trade Bill of Rights" at the Sierra Club website (www.sierraclub.org/trade/ftaa/rights.asp) and Bhagwati and Srinivasan (1995).

[2] India's main trading partners are the United States, Japan and the European Union.

Due to a lack of reliable data there are very few empirical studies that examine the environmental impact of trade liberalization episodes in developing countries. Using India's time-specific trade liberalization episode as a policy shock, we are able to identify the effect of the liberalization episode on the environment. We are therefore able to avoid the identification problem that plagues other industry-level studies that regress trade or FDI variables on environmental indicators[3]. The identification problem faced by previous studies is that while trade liberalization episodes may influence the composition of dirty versus clean production, the composition of production may in turn influence trade policy.

In the case of India's trade liberalization of 1991, studies suggest that the Indian regulators' choice of which industries to liberalize was driven purely by economic considerations, ignoring environmental criteria[4]. Indeed, we do not find any positive correlation between the industry-wise rate of decline of the effective rate of protection and industry-wise pollution intensity (Table 3). Moreover, at the time of India's liberalization, no major environmental policy changes took place that could explain changes in the pollution intensity of production and exports. Therefore, by examining changes in the pollution intensity of exports, production and FDI between the pre and post-liberalization periods, we are able to measure the possible environmental impact of India's liberalization episode. Like India, many other developing countries have weak environmental policies and previous trade barriers that favored capital intensive production. While the environmental impact of liberalization episodes in these developing countries will depend on their specific endowments and liberalization programs, this analysis of India's liberalization provides an informative case study.

The results from this study show that there has been a moderate increase in air and water pollution intensive exports in the post liberalization period compared to the pre-liberalization period. The results also provide support for the hypothesis that there has been a marginal increase in FDI inflows into sectors with higher air and water pollution intensity, after we address the sample selection issue in the dataset. Overall, these results provide some evidence in support of the concerns about the negative environmental consequences of India's trade liberalization and call for public policy responses.

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[3] For comprehensive literature review, see Jaffe, et. al. (1995) and Copeland and Taylor (2002).
[4] See for instance, Ahluwalia and Little (1998) and Gupta (2000).

2. TRADE REFORMS AND ENVIRONMENTAL REGIME IN INDIA

A. Trade Reforms

Faced with a severe balance of payments crisis in 1991, India embarked on an economic liberalization program that encompassed industrial and trade policy, financial sector reforms and privatization[5]. Prior to the 1991 reforms, the Indian government controlled trade through various forms of restrictions such as import licensing requirements and tariffs. Trade reforms broadly covered four areas - reduction of tariff rates, easing exchange control regulations, liberalizing import licensing requirements and the rationalization of export subsidies. (A brief account of these policies is given in Appendix 1.)

Import licensing was an important mode of protection used by the Indian government before 1991. Prior to 1991, all imports, unless specifically exempt, required a license or a customs clearance permit. All imports classified under one of four main licensing types, namely, restricted items, banned items, limited permissible, or open general license (OGL). In practice, although goods classified to open general license were exempt from licensing requirements, many OGL imports required government approval or were subject to "actual user" conditions[6]. Following trade liberalization of 1991, the different forms of import licenses were replaced by consolidated 'Negative List of Imports'. Goods not on the negative list were freely importable. Another, important aspect of India's trading system prior to liberalization was canalization, which granted sole privileges of import and export of certain designated commodities to state trading agencies. Of the trade measures that directly affected exports, export licensing was liberalized significantly. Export subsidies were not an important aspect of India's trading system, although the government does give incentives to exporters through tax concessions and duty exemption schemes.

For our analysis, prior to 1991, all manufacturing imports or exports were subject to some form of protection either through import licensing or through export licensing or canalization at the 3-digit NIC level. Post-1991, only twenty five percent of all 3-digit NIC manufacturing categories are subject to either import or export licensing requirements or canalization. In addition to liberalization of the licensing system, the average tariff also declined to 40 percent in

[5] Although the economic reforms began in 1991, the need for openness was felt for quite some time. However, the magnitude of trade and investment reform was negligible during the 1980s. The changes brought about during the 80s were not systematic and were never integrated into an overall framework.

[6] Actual user condition requires that the approved importer of the goods also be the actual user of the product.

1999 from one hundred and twenty eight percent in 1990 (Table 1). As a result of these changes, the average effective rate of protection (ERP) decline from 70 percent in 1989 to 47 percent in 1993 (Table 2 shows the pre-post-1991 effective rate of protection for some selected sectors). For our statistical analysis, the important point to note is that the effective rate of protection declined across all manufacturing sectors. The rate of decline was different across sectors (Mehta, 1999) and there is no correlation between the rate of decline of ERP and pollution intensity at the 2 digit industrial classification (see Table 3). This enables us to treat the trade liberalization in 1991 as an exogenous policy shock.

In the area of industrial policy, before 1991, compulsory industrial licensing was required to set up any new plant, either for capacity expansion or as a new business enterprise. The new industrial policy of 1991 abolished industrial licensing in all, but nine sectors of strategic concern[7]. As a result, post-1991, only nine (of a total of one hundred and eighty six 3-digit NIC[8]) manufacturing industrial categories are now closed to private investments or restricted through industrial licenses (Appendix 2).

Prior to 1991, FDI was only permitted in a small number of sectors. There were several bureaucratic hurdles, such as compulsory approval from various government ministries, local content and technology transfer requirements that effectively blocked foreign investors from investing in India. Post-1991, the policy with regard to FDI was liberalized by creating an automatic approval process. Thirty out of the total one hundred and eighty six 3-digit NIC industrial categories were placed on the list for automatic approval by the government. Subsequently, this list was expanded to include more industrial categories. The new FDI policy has resulted in a substantial jump in FDI from 1991 – 2001. The largest sources of FDI have been the United States, Mauritius, the United Kingdom and Japan (Table 4). (Appendix 2 gives an account of the changes in industrial policy relating to FDI.)

B. Environmental Regime in India

The two main pollution control statutes in India are the Water Control Act of 1974 and the Air (Prevention and Control of Pollution) Act of 1981. Although the scope of these legislations is broad, environmental regulations have not been very effective in controlling pollution and

[7] Such as defense, railways, and nuclear energy.
[8] The Indian equivalent of ISIC is the National Industrial Classification (NIC) and NIC 1987 (used for classification in this study) is identical to ISIC Rev. 2. See http://mospi.nic.in/stat_act_t3.htm.

preventing environmental damage.[9] One of the main reasons for this poor implementation is that there is basic division of power between the center and the state in India, reflecting the federal nature of the constitution. While the Central Pollution Control Board (CPCB) is responsible for setting environmental standards for plants and ambient air pollution levels, the implementation of environmental standards and their enforcement are decentralized and are the responsibility of the SPCB (State Pollution Control Board). For the purpose of our statistical analysis, the important point to note is that no major changes occurred in environmental policy during the period of our analysis.

3. LITERATURE REVIEW

Previous studies on the relationship between trade and the environment have found varying results**.** Low and Yates (1992) examined trade shares of polluting and non-polluting industries to developing countries and found that the export share of polluting goods from industrialized countries tended to decrease over time. Levinson and Taylor (2001) used a 2SLS (Two-Stage Least Squares) procedure with instruments to measure stringency of environmental regulations across states in the US, to capture the endogenous nature of the trade-environment relationship. Using this method they found that tighter environmental regulations are associated with larger net imports. Dean (2002) uses provincial level data on water pollution from China and found support for the idea that trade liberalization has both a direct and an indirect effect on emission growth and these could be opposite in sign.

In contrast, Grossman and Krueger (1993) examined the environmental impacts of NAFTA and found no evidence that a comparative advantage is being created by lax environmental regulations in Mexico. Using data across different countries from 1960-1995, Mani and Wheeler (1999) found that 'pollution haven effects' are insignificant in developing countries because production is mainly for domestic consumption, not for export. Tobey (1990) tested whether domestic environmental regulations have an impact on international trade pattern in five pollution intensive industries for 23 countries. He found no statistical significance of his environmental regulation measures on the net exports of these industries. Eskeland and Harrison (1997) examined industry level FDI in four developing countries (Mexico, Cote d`Ivoire, Venezuela and Morocco) and found no significant positive correlation between industry level FDI and measures of air and water emissions.

[9] Sudarshan (1998).

Studies on the relationship between FDI inflow and pollution characteristics of industries or countries have also found varying results. Levinson and Keller (2001) estimated the effect of changing environmental standards on patterns of international investment by examining FDI to the US and differences in pollution abatement cost across US states and found evidence that raising pollution costs has a moderate deterrent effect on foreign investment. Xing and Kolstad (1997) examined the FDI of several US industries (polluting and non-polluting) to test the effect of lax environmental regulations on FDI and found that laxity of environmental regulations in a host country is a significant determinant of FDI for polluting industries. Smarzynska and Wei (2001) used firm-level data on investment projects in 24 transition economies and found some support for the pollution haven hypothesis. In contrast, Mani, Pargal and Haq (1996) was one of the first studies to examine the effect of state-level environmental stringency as a determinant of investment location in a developing country. They found that the stringency of environmental enforcement at the state-level in India did not have a negative effect on proposed new plants.

Existing studies on the environmental aspects of India's liberalization have typically been descriptive studies of a small subset of manufacturing industries (for instance Gupta, 2000; Tewari, 2001). For instance, Tewari (2000) examined how the automobile and leather industries in the state of Tamil Nadu in India were coping with new environmental challenges in the post liberalization period. Gupta (2000) also examined the impact of India's trade and investment liberalization on the environment using the case study of the automobile sector. We have assembled industry-level economic and environmental data aggregated at the all India level for the manufacturing sector from various Indian government agencies. Our study takes advantage of this unique database to examine environmental effect of trade liberalization for the entire manufacturing sector across India.

4. HYPOTHESES AND ESTIMATION MODELS

A. Hypotheses

A priori, the effect on the composition of production within India in response to liberalization is unclear. The composition of production will depend on how the supply costs of the producers in more polluting industries changes relative to those in less polluting industries as a result of trade liberalization. Based on 'traditional' factor endowments such as capital and labor, India's comparative advantage is in labor-intensive production. If less strict environmental policies do influence production decisions, 'environment' can be considered a non-traditional factor of production, and India may have an advantage in pollution-intensive production. However, prior to

liberalization, investment restrictions in some manufacturing industries and trade restrictions, such as import tariffs and export taxes, may have skewed the relative supply costs of producers and led producers to allocate resources into industries other than those dictated by traditional and non-traditional factor endowments.

During the liberalization process, effective rates of protection (ERP) declined across all manufacturing industries (Table 2 shows the ERP for selected industries pre and post-1991). Prior to liberalization, domestic investors could invest only in a subset of industries (refer to discussion in section 2 about industrial policy). Post liberalization, domestic investors could invest in all but nine categories of manufacturing industries. Prior to liberalization, foreign investors were effectively shut out of all industries. Post-liberalization, foreign investors were allowed to enter into a subset of industries.

This opening up of the economy through a reduction in trade restrictions and the selective removal of investment restrictions during the liberalization episode would influence the supply costs of producers leading to possible change in the composition of production and export. With regard to FDI inflows, prior to 1991 there was negligible FDI inflow because of the number of bureaucratic hurdles in place. Therefore, we restrict our analysis to post-1991 composition of FDI inflows. The three hypotheses tested using industry-level economic and environmental data for India, pre and post-1991 are:

1. As a result of the trade liberalization of 1991, India has become more specialized in the production from dirty industries relative to clean industries (the composition effect on domestic production).
2. As a result of the trade liberalization of 1991, India has become more specialized in exports from dirty industries relative to clean industries (composition effect on trade flows).
3. Post-1991, there has been greater inflow of foreign direct investment into dirty industries relative to clean industries.

B. Estimation Models

To test hypothesis 1, we measure whether domestic production has shown greater increase in dirty industries relative to clean industries between pre-1991 and post-1991 years. Domestic production is a function of labor productivity (L), capital productivity (K), and pollution intensity (P). We use 3-digit NIC level data for manufacturing industries to compare

pre-trade liberalization years (1988-1990) with those immediately following trade liberalization (1992-1994). A second set compares the pre-1991 years with the period after trade liberalization occurred (1995-1997). This second period is examined because the effect of trade liberalization may occur after a time lag while firms set up production and trade ties. The regression model is:

$$Y_{it} = \alpha + \beta_1 K_{it} + \beta_2 L_{it} + \beta_3 P_i + \beta_4 (P_i * T_t) + \mu_i + \varepsilon_{it}$$

----------(1)

where, Y is the total output as a fraction of value added in manufacturing industry i for time period t measured at the 3-digit NIC level (there are total 186 3-digit NIC manufacturing industries); T is the liberalization dummy that takes the value 1 for post-1991 years and 0 otherwise; P is industry-wise pollution intensity and μ is industry fixed effects. Labor productivity is calculated by dividing man-days per worker by the value added. Capital productivity is calculated by dividing the total stock of fixed capital by the net value added. The variables of interest are the interaction variables that capture the increase in production of dirty industries relative to clean industries during the liberalization period. If domestic production does not show an increase in the dirty industries relative to cleaner industries, we would find that β_4 =0.

Second, we measure whether exports have increased in the dirty industries relative to clean industries between pre-1991 and post-1991 years. Based on Grossman and Krueger (1993), we estimate exports from India as a function of labor intensity (L), capital intensity (K), and pollution intensity (P). Similar to equation 1, we use 3-digit NIC level data for manufacturing industries to compare pre-trade liberalisation years (1988-1990) with those immediately following trade liberalization (1992-1994). A second set compares the pre-1991 years with a period several years after trade liberalization (1995-1997). This second period is examined because the effect of trade liberalization may occur after a time lag because firms may need to set up production and trade ties. The regression model is:

$$X_{it} = \delta + \gamma_1 X_{it-1} + \gamma_2 L_{it} + \gamma_3 K_{it} + \gamma_4 IIT_{it} + \gamma_5 P_i + \gamma_6 (P_i * T_t) + \eta_i + \omega_{it}$$

----------(2)

where, X is the export from industry i as a fraction of Indian value of shipment for time period t measured at the 3-digit NIC level (there are total 186 3-digit NIC manufacturing industries); T is the liberalization dummy that takes the value 1 for post-1991 years and 0 otherwise; P is industry-wise pollution intensity and η is industry fixed effects and ω is the error term. Labor intensity is calculated by dividing total payroll expenses in an industry by the value added. Capital intensity is calculated by dividing the value of fixed capital by the net value added. The variables of interest are the interaction variables that capture the increase in exports from dirty industries relative to clean industries during the liberalization period. If exports do not show an increase in dirty industries relative to cleaner industries, we would find that γ_6 =0.

Finally, we measure if there was a greater inflow of FDI into the dirty industries relative to the clean industries in the post-1991 years. In our discussion in section 2, we mentioned that pre-1991 FDI was effectively blocked from India due to bureaucratic hurdles. Post-1991, thirty out of a total of one hundred and eighty six manufacturing industries were selected for automatic approval for FDI. As a result, there may be selection bias if we were to restrict our analysis to only examining the FDI inflows into the thirty categories. However, for the remaining one hundred and fifty six categories FDI was zero. In order to determine if there was any bias in selecting the thirty industries, we compared the pollution intensity of the thirty industries to the entire sample of one hundred and eighty six industries (Table 5). We find that the air and water pollution intensity of the thirty industries where FDI was permitted was much higher than the average pollution intensity of the entire sample.

In addition, we also ran a probit regression to determine whether there were some significant factors that explain why some industries were selected for automatic approval of FDI (Table 6). We find that infrastructure industries, capital-intensive industries and pollution intensive industries are more likely to be selected for automatic approval for FDI. Therefore, any analysis of FDI which does not address the sample selection will yield biased results. We used Heckman's two-step selection model in our estimation. Heckman (1979) turned the selection bias problem into an omitted variables problem and proposed a method for estimating the omitted variable and inserting it into the second equation. From the theory of truncated normal distributions, we get an expression for the inverse Mills ratio. The inverse Mills ratio is the ratio of the probability to the cumulative density functions evaluated at the point at which the distribution is truncated. As the probability of being in the sample (i.e., being opened to FDI in

our sample) increases, the cumulative density function approaches one and the probability density function approaches zero, so the inverse Mills ratio approaches zero.

Therefore, in the first step we estimate a probit equation explaining whether or not an industry makes it to our sample, i.e., whether or not it is opened to FDI. If the probit includes the same set of variables as in the second equation, the model is identified by the non-linearity of the inverse Mills ratio. Some argue that additional variables should be added to the selection equation to identify the model. The additional variables that we have included in the second equation are industry characteristics such as wages and industrial productivity. The identifying variables in our first level are whether or not an industry is an infrastructure industry and the capital and labor intensity of an industry. These factors determine whether an industry in opened to FDI but may not affect the amount of FDI that flows in the second stage. Amount of FDI inflows is estimated as a function of pollution intensity, industrial productivity and labor costs. The unobserved variable in our estimation model is the decision to decision to open an industry to FDI. The regression model is:

$$Z_i = \beta_1 P_i + \beta_2 L_i + \beta_3 K_i + \beta_4 Y_i + \varepsilon_i \quad \text{----------(3.1)}$$

$$FDI_{it} = \gamma_1 I_{it} + \gamma_2 FDI_{it-1} + \gamma_3 P_i + \mu_i \quad \text{----------(3.2)}$$

Equation 3.1 estimates whether an industry is opened to FDI or not. In equation 3.1, Z is a binary variable that takes value 1 if an industry is opened to FDI and 0 if it is not opened to FDI; P is the pollution intensity of an industry; K measures capital intensity; L is labor intensity; Y measures whether it is an infrastructure industry; μ and ε are the error term.

Equation 3.2 estimates the amount of FDI inflow into manufacturing industry i in year t measured at the 3-digit NIC level. (I) is the set of other industry level characteristics that may affect FDI inflows such as labor cost differentials across sectors in an economy and industry wise productivity. Labor market conditions are measured by manufacturing wages paid in a given industry. Industry wise productivity is measured by net value-added. The variable of interest is P which is the industry-wise pollution intensity. If FDI does not show an increase in dirty industries, then γ_3 =0.

5. SAMPLE AND DATA

Table 7 provides a list of variables used in the industry-level analysis and their data sources. Data on industrial output, net value added, industrial wages, man-days and fixed capital come from the Annual Survey of Industries. This data is collected by the Central Statistical Organization in India and is organized by industry according to the National Industrial Classification (NIC)[10]. Data on exports from India comes from the Directorate General of Commerce Intelligence and Statistics in India. This data is organized according to the international Harmonized Commodity and Coding System (HS). To calculate the value of export for three digit manufacturing industries in India, we first mapped the HS categories to NIC codes. Debroy and Santhanam (1993) have matched HS code with the appropriate three-digit NIC code, using 1987 NIC codes. We used this matching to obtain the value of exports for each three digit NIC code. Data on foreign direct investment was provided by the Ministry of Commerce in India.

To measure industrial pollution intensity we obtained data on two measures. The first measure is the pollution load of the 17 categories of 'highly polluting' industries, obtained from the CPCB in India. However, this measure is only available for one year (1999). Therefore, we use an alternate measure of pollution intensity. This measure is calculated using the Industrial Pollution Projection System (IPPS) developed by the World Bank. Numerous studies use the results from IPPS for studies on countries where data is insufficient[11]. We use the assumption that global technological constraints make some industries more polluting than others. Limitations to this assumption is discussed in Gamper-Rabindran (2001) and Laplante and Meisner (2001).

To calculate the pollution load for industries in India, we first mapped the NIC categories to ISIC codes. Using purchasing power parity between India and the US, we converted IPPS pollution intensities to Indian Rupees. We deflated the value-added data from the Annual Survey of Industries and the pollution loads from IPPS to 1987-88 Indian prices using WPI for the manufacturing sub group. We applied the deflated pollution load (in kg per thousand Indian Rupees) to value-added (per thousand Indian Rupees) to obtain the pollution intensity for each manufacturing sub group.

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[10] The Indian equivalent of ISIC is the National Industrial Classification (NIC) and NIC 1987 (used for classification in this study) is identical to ISIC Rev. 2. See http://mospi.nic.in/stat_act_t3.htm. ISIC – refers to the International Standard Industrial Classification. It has undergone many revisions from time to time and the latest version is Rev. 3 (1990) with ISIC Rev 3.1 in draft form. See http://esa.un.org/unsd/cr/registry/ for details.

11 See for instance Gamper-Rabindran (2001); Laplante and Meisner (2001).

To test whether the pollution loads estimated using the IPPS database is a reasonable way to measure actual pollution load of Indian industries, we examined the correlation between the measures obtained from the CPCB and the IPPS for 1999. We find a high degree of correlation (0.87) between the CPCB pollution intensity measures and IPPS pollution intensity measure for water pollution intensity and a moderate degree of correlation (0.46) between the air pollution intensity measures generated from the two sources. We do not have measures from CPCB on toxic pollution intensity.

6. REGRESSION RESULTS

A. Impact of Trade Liberalization on Composition of Production

Table 8 shows the descriptive statistics. Table 9 presents the results of the first regression which compares pre-liberalization period with the period immediately following trade liberalization, i.e., 1988-1990 and 1992-1994. As a benchmark with which to compare the fixed effect estimates, columns (1), (2) (3) and (4) contain pooled OLS regression of industry level output on post-liberalization air pollution intensity, water pollution intensity, toxic pollution intensity and all three, respectively. Controlling for capital and labor productivity, in column (4) we find that the coefficient on the interaction term between liberalization dummy and water pollution intensity is positive (0.36) and significant. The inference we can draw is that water pollution intensive sectors had higher output in the period immediately following liberalization. However, any inference based on results of columns (1), (2) (3) and (4) is likely to be erroneous because these estimates are likely to omit industry characteristics that are correlated with both output and pollution intensity.

Once we include industry fixed effects in column (5), (6), (7) and (8) we find in column (6) and (8), the interaction term between the water pollution intensity and liberalization dummy is also positive and significant. An increase in water pollution intensity of one percentage point leads to one percent increase in total output, in the post liberalization period.

The positive sign on water pollution intensity and liberalization dummy is robust to different specifications. In Table 10, we estimated the equation with only air and toxic pollution intensity in columns (1), (2) and (3); and with air and water pollution intensity terms in columns (4), (5) and (6). Across these specifications, we find that water pollution intensity and liberalization dummy are positive and significant. The interaction term between air pollution and

trade liberalization dummy is not significant. The increase in water pollution intensive production, on the other hand, can be attributed to the trade liberalization of 1991.

In Table 11, we compare the pre-liberalization period (1988-1990) with a few years following trade liberalization (1995-1997). Our specification remains the same as in Table 9 however our period of analysis is now 1988-1990 and 1995-1997. Columns (1), (2), (3) and (4) provide the pooled OLS estimates with which to compare fixed effect estimates in column (5), (6), (7) and (8). In column (1) - (3) and (4) - (6) we either use an interaction term between air pollution intensity and post-liberalization dummy, an interaction term between water pollution intensity and post-liberalization dummy or an interaction term between toxic pollution intensity and post-liberalization dummy. In column (4) and (8) we use all three interaction terms. In column (6) and (8) of table 11, we find that an increase of one percent point in water pollution leads to 0.11 percent and 0.06 percent increase in output respectively, post-liberalization. A comparison of Table 9 and 11 indicates that in both time periods there is an increase in water pollution intensive production in the post-liberalization period. The increase is slightly higher in the second period indicating that output may have increased after a time lag. The result on water pollution intensity is robust to different specification in Table 12. However, the pollution intensity of production for other measures of pollution intensity (air and toxic) does not show an increase in the post-liberalization period.

B. Impact of Trade Liberalization on Composition of Exports

Table 13 presents the results of the second regression which compares exports as a fraction of domestic output in the pre-liberalization period with the period immediately following trade liberalization, i.e., 1988-1990 and 1992-1994. The specifications for Table 13 are the same as in Table 9 and Table 11. As a benchmark against which to compare the fixed effect estimates, columns (1), (2) (3) and (4) present the pooled OLS estimates of industry level net exports on post-liberalization air pollution intensity, water pollution intensity, toxic pollution intensity and all three, respectively.

Once we include industry fixed effects in column (5), (6), (7) and (8) we find that the interaction term between the air pollution intensity and liberalization dummy and water pollution intensity and liberalization dummy is positive and significant in column (6) and (8). An increase in water pollution intensity of one percentage point leads to 0.03 percent increase in ratio of exports to total Indian exports, in the post liberalization period and an increase in air pollution

intensity of one percentage point leads to 0.07 percent increase in exports, in the post liberalization period.

The positive sign on water and air pollution intensity and liberalization dummy is robust to different specifications. In Table 14, we estimated the equation with only air and toxic pollution intensity in columns (1), (2) and (3); and with air and water pollution intensity terms in columns (4), (5) and (6). Across these specifications, we find that water and air pollution intensity and liberalization dummy are positive and significant. Given our results in Tables 9-12 these results are not surprising because we found there was an increase in both air and water intensive production from 1988-1994. Therefore, it is not surprising that air and water pollution intensive exports have increased in the post-liberalization period when the trade barriers were removed.

In Table 15, we compare exports in the pre-liberalization period (1988-1990) with a few years following trade liberalization (1995-1997). Our specification remains the same as in Table 13, 11 and 9. However the period of analysis in table 15 is 1988-1990 and 1995-1997. Columns (1), (2), (3) and (4) provide the pooled OLS estimates and columns (5), (6), (7) and (8) present the fixed effect estimates. In column (1) - (3) and (4) - (6) we either use an interaction term between air pollution intensity and post-liberalization dummy, an interaction term between water pollution intensity and post-liberalization dummy or an interaction term between toxic pollution intensity and post-liberalization dummy. In column (4) and (8) we use all three interaction terms. In column (6) and (8) of Table 15, we find that an increase of one percent point in water pollution intensity leads to a 0.21 percent and 0.14 percent increase in exports respectively, post-liberalization. In column (5) and (8) of Table 15, we find that an increase of one percent point in air pollution intensity leads to a 0.02 percent and 0.03 percent increase in export respectively, post-liberalization. A comparison of Table 13 and 15 indicates that in both time periods there is an increase in water and air pollution intensive exports in the post-liberalization period. These results are robust to different specification in Table 16. Overall, we can conclude that air and water pollution intensive exports have increased in the post-liberalization period, indicating the post-1991 India is becoming become more specialized in dirty exports.

C. Impact of Trade Liberalization on Composition of FDI Inflows

Finally, in Table 17 we present results from the pooled OLS estimation and Heckman two-step estimation. Columns (1), (2), (3) and (4) provide the pooled OLS estimates and column (5), (6) (7) and (8) show two-step estimates. Columns (1)-(3) and (5)-(7) use air pollution intensity, water

pollution intensity or toxic pollution intensity and columns (4) and (8) use all three, respectively. In addition, we also include several control variables for industry level FDI and a lagged FDI term to take into account the dynamic nature of the investment process.

The pooled OLS coefficient on water pollution intensity in column (4) are positive and significant indicating that there has been an increase in water pollution intensive FDI in the post liberalization period. However, because of the sample selection issue any inference based on pooled OLS estimates is likely to be biased because OLS estimation ignores those industries which are not selected for automatic FDI approval and for which the amount of FDI inflows was zero post-1991.

In column (5) – (8) we present the second equation estimates of the Heckman two-step sample selection model. We find that the air and water pollution intensity are positively related with post-liberalization FDI inflow and these coefficients are significant. One percent increase water pollution intensity leads to a one percent increase in FDI inflows and one percent increase in air pollution intensity leads to 8 percent increase in FDI inflows. This implies that post-liberalization when barriers to FDI entry were removed there was greater inflow of FDI into water and air pollution intensive sectors. We find that lagged FDI and industrial productivity are also significant determinants of FDI inflows implying that FDI to existing industries is a function of past foreign investments to those industries. The negative coefficient on wage indicates that higher wage in an industry are a deterrent to FDI inflows.

7. CONCLUSIONS

Trade liberalization in India systematically removed trade barriers and restrictions on FDI, post-1991. Our findings indicate that exports and FDI grew in the more polluting sectors relative to the less polluting sectors between the pre and post liberalization periods. This evidence provides some support for concerns raised about the environmental impact of trade liberalization in India. Specifically, we find that trade liberalization has resulted in an increase in exports from industries that are more water and air pollution intensive relative to less pollution-intensive ones. In addition, our analysis of the post-1991 FDI inflows suggests that foreign investments were higher in industries that are more intensive in air and water pollution. After controlling for potential intervening variables and correcting for sample selection bias, we find that the post-1991 coefficients on air and water pollution intensity are positive (0.01 and 0.08, respectively). These results on FDI and net exports are robust to different empirical specifications.

An important caveat worth mentioning is that in the absence of Indian pollution intensity data, we have used pollution measures from the US as proxies (as suggested by previous IPPS studies). Should pollution intensity data from India become available, it would be useful to re-examine the issue using Indian measures of pollution intensities. Second, because we are using time-invariant measures of pollution intensity rather than actual emission levels, we cannot make statements about changes in actual pollution emission levels. However, by observing changes in the composition of pollution intensive production, we are able to make inferences regarding in changes in pollution levels.

These findings suggest that while trade liberalization measures have been pursued to promote economic growth in India, they have led to some potentially adverse environmental consequences. These results suggest that there is a trade-off between the economic gains from liberalization and the environmental consequences from a liberalization 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 liberalization and the environmental costs. This case study highlights the need to consider strengthening environmental policies at the time when trade liberalization is being contemplated.

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TABLES

Table 1: Tariff Structure in India, 1990-99

Sector	90-91	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00
	Mean (in percent)								
Whole Economy	128	94	71	55	40.8	38.6	34.4	40.2	39.6
Consumer Goods	142	92	76	59	45.4	45.4	39.8	45.9	42.9
Intermediate Goods	133	104	77	59	43.7	38.8	34.7	40.7	41.2
Capital Goods	109	86	58	42	33.1	33.8	29.7	35.3	35.3

Source: WTO Trade Policy Review of India, 1993 and 1998
Note: The total customs duty is calculated as the sum of the basic customs duty, surcharge of 10% on basic customs duty, and the special additional duty. The special additional duty is levied on the value of imports as well as the basic duty value, the surcharge value, and the additional duty value.

Table 2: Pre-Post 1991 Effective Rates of Protection in Selected Sectors

Category	89-90	93-94
Petroleum	25.72	26.34
Cotton Textiles	137.54	64.23
Fertilizers	96.66	97.17
Drugs and Pharmaceuticals	43.17	32.46
Cement	151.08	101.41
Iron and Steel	73.02	42.38
Automobiles	84.87	70.84
Simple Average	77.63	54.47
Value added weighted average	70.25	47.15

Source: WTO Trade Policy Review of India 1998.

Table 3: Correlation between changes in Effective Rate of Protection and Pollution Intensity at the 2 digit NIC level

	Change in ERP between 1989 and 1993	Change in ERP between 1993 and 1995	Change in ERP between 1995 and 1989
Air Pollution Intensity	0.025	-0.224	-0.093
Water Pollution Intensity	0.001	-0.219	-0.200
Toxic Pollution Intensity	-0.106	-0.161	-0.200

Table 4: Share of Top Investing Countries in FDI Approvals in India (1991-2001 in US $ million)

Country	**1991 to 1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001***	**% of Total**
USA	15422	10056	13570	3562	3575	4195	3191	24.57
Mauritius	1986	2334	10428	3166	3803	7234	1565	14.22
UK	3798	1525	4491	3201	2963	411	3974	9.34
Japan	2835	1488	1906	1283	1595	828	359	4.72
S. Korea	495	3221	1956	368	3649	41	25	4.47
Germany	2212	1538	2156	854	1143	456	289	4.02
Netherlands	1648	1049	871	496	632	4	2383	3.25
Austria	2003	834	432	2638	649	62	35	3.05
France	688	1672	713	514	1449	202	502	2.63
Malaysia	1493	42	2105	1803	116	16	103	2.6

Note : * Figures for 2001 updated upto July, 2001.
Source : Secretariat for Industrial Assistance (SIA), Department of Industrial Policy & Promotion, Ministry of Commerce & Industry, Govt. of India.

Table 5: Comparison of average pollution intensity of sectors where FDI was permitted post-1991 and all sectors

	Mean	
	FDI allowed post-1991	**All sectors**
Air Pollution Intensity	0.83	0.57
Water Pollution Intensity	0.70	0.47
Toxic Pollution Intensity	0.06	0.06

Table 6: Probit Estimates of Factors that Determine the Decision to allow FDI into a Manufacturing sector

Dependent variable: decision to allow FDI	**Probit Estimates**	
	(1)	**(2)**
Infrastructure Industry	0.79**	0.73**
	(0.082)	(0.082)
Dirty/Clean dummy	0.44**	
	(0.091)	
Labor Intensive Industry	-0.31**	-0.34**
	(0.048)	(0.048)
Capital Intensive Industry	0.02*	0.02*
	(0.009)	(0.009)
Air Pollution Intensity		0.07*
		(0.028)
Water Pollution Intensity		0.02
		(-0.02)
Toxic Pollution Intensity		-0.12
		(-0.52)
Observations	1779	1779

Standard errors in parentheses. * significant at 10%; ** significant at 5%.

Table 7: Data Sources

Variable	**Source**
Man-days per worker / net value added (labor productivity)	Annual Survey of Industries (ASI), Central Statistical Organization (CSO), New Delhi, India
Fixed capital stock / net value added (capital productivity)	ASI, CSO
Pollution intensity	IPPS data.
Manufacturing Wage	ASI, CSO
Export Data	Director General, Commerce Intelligence and Statistics, Ministry of Commerce, India
Net value added	ASI, CSO
Foreign Direct Investment	Ministry of Commerce, Government of India

Table 8: Descriptive Statistics

	Mean	Std Dev
Industrial Production Regression Year: 1988-1990, 1992-1997		
Output/value added	7.43	19.31
Labor Productivity	0.69	2.47
Capital Productivity	1.99	6.87
Air Pollution Intensity (in Rs. Value added)	0.57	1.14
Water Pollution Intensity (in Rs. Value added)	0.47	2.12
Toxic Pollution Intensity (in Rs. Value added)	0.062	0.076
FDI Regression Years: 1991-2000		
FDI (in million Indian Rs)	527.34	1302.71
Industrial Productivity (in 10 ml Indian Rs)	14.36	44.56
Wages (in 10 mln Indian Rs)	9.73	20.77
Air Pollution Intensity (in Rs. Value added)	0.55	1.15
Water Pollution Intensity (in Rs. Value added)	0.46	2.11
Toxic Pollution Intensity (in Rs. Value added)	0.061	0.075
Export Regression Year: 1988-1990, 1992-1997		
Gross Exports (in million Indian Rs.)	0.95	1.85
Labor Intensity	0.69	2.47
Capital Intensity	1.99	6.87
Air Pollution Intensity (in Rs. Value added)	0.57	1.14
Water Pollution Intensity (in Rs. Value added)	0.47	2.12
Toxic Pollution Intensity (in Rs. Value added)	0.062	0.076

(Monetary values are in 1987 Indian Rupees.)

Table 9: Comparing Pollution Intensity of Industry Level Output between pre-liberalization (1988-1990) and post-liberalization (1992-1994)

Dependent variable: output/value added	**OLS**				**Industry Fixed Effects**			
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Capital Productivity	-0.002	-0.002	-0.002	-0.002	0.11**	0.13**	0.09**	0.06**
	(-0.003)	(-0.003)	(-0.003)	(-0.003)	(0.030)	(0.032)	(0.027)	(0.025)
Labor Productivity	0.02**	0.02**	0.02**	0.02**	0.26**	0.34**	0.21**	0.18**
	(0.008)	(0.008)	(0.008)	(0.008)	(0.067)	(0.072)	(0.060)	(0.056)
Trade Liberalization Dummy	9.78**	9.66**	10.02**	9.97**	0.21**	0.20**	0.21**	0.22**
	(0.309)	(0.306)	(0.322)	(0.319)	(0.043)	(0.039)	(0.049)	(0.053)
Air Pollution Intensity	3.43**			2.19**				
	(0.215)			(0.189)				
Air Pollution Intensity x	-3.32**			0.27	-0.02			-0.02
Liberalization Dummy	(0.319)			(0.215)	(-0.03)			(-0.03)
Water Pollution Intensity		1.15**		0.54**				
		(0.134)		(0.108)				
Water Pollution Intensity x		1.01**		0.36**		0.02**		0.01**
Liberalization Dummy		(0.192)		(0.153)		(0.007)		(-0.002)
Toxic Pollution Intensity			0.61**	0.50**				
			(0.025)	(0.025)				
Toxic Pollution Intensity x			-0.62**	-0.52**			0.00	0.00
Liberalization Dummy			(0.041)	(0.039)			(-0.01)	(-0.01)
Industry Fixed Effects					Included	Included	Included	Included
Observations	1125	1125	1125	1125	1125	1125	1125	1125
R-squared	0.02	0.05	0.01	0.06	0.02	0.07	0.03	0.08

Standard errors in parentheses. Monetary values are in 1987 Indian Rupees. * significant at 10%; ** significant at 5%.

Table 10: Comparing Pollution Intensity of Industry Level Output between pre-liberalization (1988-1990) and post-liberalization (1992-1994) – different specifications

Dependent variable: output/value added	**Fixed Effects**					
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Capital Productivity	-0.002	-0.002	-0.002	0.001	0.001	0.001
	(-0.003)	(-0.003)	(-0.003)	(-0.003)	(-0.003)	(-0.003)
Labor Productivity	-0.02**	-0.02**	-0.02**	0.02**	0.02**	0.02**
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Trade Liberalization Dummy	0.21**	0.21**	0.22**	0.21**	0.20**	0.21**
	(0.043)	(0.049)	(0.052)	(0.043)	(0.039)	(0.044)
Air Pollution Intensity x Liberalization Dummy	-0.02		-0.02	-0.02		-0.02
	(-0.033)		(-0.033)	(-0.033)		(-0.033)
Water Pollution Intensity x Liberalization Dummy					0.01	0.02**
					(-0.018)	(-0.008)
Toxic Pollution Intensity x Liberalization Dummy		-0.002	-0.002			
		(-0.005)	(-0.005)			
Industry Fixed Effects	Included	Included	Included	Included	Included	Included
Observations	1125	1125	1125	1125	1125	1125
R-squared	0.02	0.02	0.03	0.02	0.05	0.06

Standard errors in parentheses.
** significant at 5%; ** significant at 1%

Table 11: Comparing Pollution Intensity of Industry Level Output between pre-liberalization (1988-1990) and post-liberalization (1995-1997)

Dependent variable: output/value added	**OLS**				**Industry Fixed Effects**			
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Capital Productivity	0.14**	0.19**	0.12**	0.09**	0.01**	0.01**	0.01**	0.01**
	(0.035)	(0.037)	(0.031)	(0.030)	(0.004)	(0.004)	(0.004)	(0.004)
Labor Productivity	0.10*	0.14**	0.08	0.07	0.03**	0.03**	0.03**	0.03**
	(0.058)	(0.062)	-0.052	-0.049	(0.008)	(0.008)	(0.008)	(0.008)
Trade Liberalization Dummy	10.02**	9.85**	10.27**	10.23**	0.50**	0.48**	0.45**	0.47**
	(0.316)	(0.314)	(0.327)	(0.324)	(0.047)	(0.043)	(0.054)	(0.057)
Air Pollution Intensity	3.45**			2.21**				
	(0.216)			(0.190)				
Air Pollution Intensity x	-3.36**			-2.09**	-0.03			-0.03
Liberalization Dummy	(0.321)			(0.276)	(-0.036)			(-0.036)
Water Pollution Intensity		1.15**		0.54**				
		(0.135)		(0.108)				
Water Pollution Intensity x		0.97**		0.34**		0.11**		0.06**
Liberalization Dummy		(0.194)		(0.154)		(-0.019)		(-0.02)
Toxic Pollution Intensity			0.61**	0.50				
			(0.025)	(0.025)**				
Toxic Pollution Intensity x			-0.63***	-0.52**			0.004	0.01
Liberalization Dummy			(0.041)	(0.039)			(-0.005)	(-0.005)
Industry Fixed Effects					Included	Included	Included	Included
Observations	1123	1123	1123	1123	1123	1123	1123	1123
R-squared	0.03	0.07	0.03	0.09	0.04	0.08	0.03	0.15

Standard errors in parentheses. Monetary values are in 1987 Indian Rupees. * significant at 10%; ** significant at 5%.

Table 12: Comparing Pollution Intensity of Industry Level Output between pre-liberalization (1988-1990) and post-liberalization (1995-1997) – different specifications

Dependent variable: output/value added	**Fixed Effects**			**Fixed Effects**		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Capital Productivity	-0.01**	-0.01**	-0.01**	0.01**	0.01**	0.01**
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Labor Productivity	-0.03**	-0.03**	-0.03**	0.03**	0.03**	0.03**
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Trade Liberalization Dummy	0.50**	0.45**	0.47**	0.50**	0.48**	0.50**
	(0.047)	(0.054)	(0.057)	(0.047)	(0.043)	(0.048)
Air Pollution Intensity x	-0.03		-0.03	-0.03		-0.03
Liberalization Dummy	(-0.036)		(-0.036)	(-0.036)		(-0.036)
Water Pollution Intensity x					0.09**	0.07**
Liberalization Dummy					(-0.019)	(-0.02)
Toxic Pollution Intensity x		0.01	0.01			
Liberalization Dummy		(-0.01)	(-0.01)			
Industry Fixed Effects	Included	Included	Included	Included	Included	Included
Observations	1123	1123	1123	1123	1123	1123
R-squared	0.04	0.03	0.09	0.04	0.07	0.15

Standard errors in parentheses. Monetary values are in 1987 Indian Rupees. * significant at 10%; ** significant at 5%.

Table 13: Comparing Pollution Intensity of Exports between pre-liberalization (1988-1990) and post-liberalization (1992-1994)

Dependent Variable - exports as a fraction of Value of Output	**Pooled OLS**				**Industry Fixed Effects**			
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Capital Intensity	0.05**	0.15**	0.15**	0.03**	0.02**	0.12**	0.12**	0.02**
	(-0.009)	(0.052)	(0.051)	(0.007)	(0.004)	(0.052)	(0.051)	(0.004)
Labor Intensity	0.162**	0.11	0.14	0.12**	0.08**	0.08	0.08	0.08**
	(-0.016)	(-0.111)	(-0.109)	(0.012)	(0.007)	(-0.111)	(-0.109)	(0.007)
Trade Liberalization	1.982**	1.46*	1.61**	1.71**	0.24**	0.96	0.19	0.07
Dummy	(-0.083)	(0.792)	(0.486)	(0.107)	(0.043)	(-1.105)	(-0.674)	(-0.074)
Air Pollution Intensity	-0.56**			0.03				
	(0.036)			(-0.041)				
Air Pollution Intensity x	0.66**			0.14**	0.04			0.07**
Liberalization Dummy	(0.058)			(0.057)	(-0.024)			(0.028)
Water Pollution Intensity		-0.23**		-0.19**				
		(0.062)		(0.013)				
Water Pollution Intensity		0.19*		0.13*		0.19*		0.03**
x Liberalization Dummy		(-0.117)		(0.021)		(-0.121)		(0.012)
Toxic Pollution Intensity			0.66**	0.30**				
			(0.208)	(0.032)				
Toxic Pollution Intensity			0.61*	0.24**			-0.03	0.02
x Liberalization Dummy			(0.331)	(0.048)			(-0.361)	(-0.025)
Lagged Export	0.62**	0.49**	0.48**	0.61**	0.02	0.51**	0.51**	0.01
	(0.029)	(0.042)	(0.041)	(0.029)	(-0.034)	(0.043)	(0.042)	(-0.034)
Industry Fixed Effects					Included	Included	Included	Included
Observations	749	907	932	748	749	907	932	748
R-squared	0.49	0.14	0.14	0.51	0.50	0.15	0.17	0.53

Standard errors in parentheses. Monetary values are in 1987 Indian Rupees. * significant at 10%; ** significant at 5%.

Table 14: Comparing Pollution Intensity of Exports between pre-liberalization (1988-1990) and post-liberalization (1992-1994) – different specifications

Dependent Variable - exports as a fraction of Value of Output	**Industry Fixed Effects**			**Industry Fixed Effects**		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Capital Intensity	0.02**	0.12**	0.02**	0.02**	0.12**	0.02**
	(0.004)	(0.051)	(0.004)	(0.004)	(0.052)	(0.004)
Labor Intensity	0.08**	0.08	0.08**	0.08**	0.08	0.08**
	(0.007)	(-0.109)	(0.007)	(0.007)	(-0.111)	(0.007)
Trade Liberalization	0.24**	-0.19	0.20**	0.24**	0.36**	0.10*
Dummy	(0.043)	(-0.674)	(0.057)	(0.043)	(-0.055)	(-0.066)
Air Pollution Intensity x	0.04**		0.03**	0.04**		0.08**
Liberalization Dummy	(-0.024)		(-0.015)	(-0.024)		(0.028)
Water Pollution Intensity					0.17	0.03**
x Liberalization Dummy					(-0.121)	(0.012)
Toxic Pollution Intensity		-0.03	0.03			
x Liberalization Dummy		(-0.361)	(-0.025)			
Lagged Exports	0.62**	0.48**	0.62**	0.63**	0.49**	0.61**
	(0.029)	(0.041)	(0.029)	(0.029)	(0.042)	(0.029)
Industry Fixed Effects	Included	Included	Included	Included	Included	Included
Observations	749	932	749	749	907	748
R-squared	0.50	0.17	0.52	0.50	0.15	0.61

Standard errors in parentheses. Monetary values are in 1987 Indian Rupees. * significant at 10%; ** significant at 5%.

Table 15: Comparing Pollution Intensity of Exports between pre-liberalization (1988-1990) and post-liberalization (1995-1997)

Dependent Variable - exports as a fraction of Value of Output	**Pooled OLS**				**Industry Fixed Effects**			
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Capital Intensity	0.82**	0.45**	0.36**	0.93**	0.05**	0.14**	0.18**	0.05**
	(0.025)	(0.030)	(0.031)	(0.024)	(0.014)	(0.029)	(0.028)	(0.014)
Labor Intensity	-0.01	0.05**	0.01	0.01	0.01**	0.07**	0.07**	0.01**
	(-0.011)	(0.020)	(-0.021)	(-0.01)	(0.006)	(0.019)	(0.018)	(0.006)
Trade Liberalization	-0.87**	-1.53**	-1.36**	-1.17**	0.15**	0.34*	0.26**	0.15**
Dummy	(0.068)	(0.166)	(0.109)	(0.097)	(0.040)	(-0.207)	(0.121)	(0.066)
Air Pollution Intensity	0.40**			0.15**				
	(0.029)			(0.039)				
Air Pollution Intensity x	-0.36**			-0.05	0.02**			0.03*
Liberalization Dummy	(0.046)			(-0.056)	(-0.013)			(-0.018)
Water Pollution Intensity		0.23**		0.09**				
		(0.013)		(0.013)				
Water Pollution Intensity		0.23**		0.14**		0.21**		0.14**
x Liberalization Dummy		(0.029)		(0.021)		(-0.022)		(-0.011)
Toxic Pollution Intensity			0.09**	-0.03**				
			(0.008)	(0.006)				
Toxic Pollution Intensity			0.09**	0.03**			-0.007	-0.001
x Liberalization Dummy			(0.013)	(0.008)			(-0.012)	(-0.004)
Lagged Exports	0.01*	0.05**	0.05**	0.008	0.005	0.05**	0.05**	0.005
	(0.007)	(0.014)	(0.014)	(-0.008)	(-0.004)	(0.014)	(0.014)	(-0.004)
Industry Fixed Effects					Included	Included	Included	Included
Observations	742	895	958	741	742	895	958	741
R-squared	0.92	0.93	0.93	0.96	0.92	0.95	0.94	0.97

Standard errors in parentheses. Monetary values are in 1987 Indian Rupees. * significant at 10%; ** significant at 5%.

Table 16: Comparing Pollution Intensity of Exports between pre-liberalization (1988-1990) and post-liberalization (1995-1997) – different specifications

Dependent Variable - exports as a fraction of Value of Output	Industry Fixed Effects			Industry Fixed Effects		
	(1)	(2)	(3)	(4)	(5)	(6)
Capital Intensity	3.05**	3.54**	3.05**	3.05**	3.54**	3.05**
	(0.014)	(0.028)	(0.014)	(0.014)	(0.029)	(0.014)
Labor Intensity	0.01**	0.07**	0.01**	0.01**	0.07**	0.01**
	(0.006)	(0.018)	(0.006)	(0.006)	(0.019)	(0.006)
Trade Liberalization	0.15**	0.26**	0.16**	0.15**	0.31*	0.15**
Dummy	(0.040)	(0.121)	(0.052)	(0.040)	(-0.18)	(0.062)
Air Pollution Intensity x	0.01		0.01	0.02		0.03**
Liberalization Dummy	(-0.023)		(-0.023)	(-0.013)		(-0.013)
Water Pollution Intensity					0.02*	0.02*
x Liberalization Dummy					(-0.012)	-0.011
Toxic Pollution Intensity		-0.007	-0.001			
x Liberalization Dummy		(-0.012)	(-0.004)			
Lagged Exports	0.005	0.05**	0.005	0.005	0.05**	0.005
	(-0.004)	(0.014)	(-0.004)	(-0.004)	(0.014)	(-0.004)
Industry Fixed Effects	Included	Included	Included	Included	Included	Included
Observations	742	958	742	742	895	741
R-squared	0.92	0.94	0.96	0.92	0.95	0.97

Standard errors in parentheses. Monetary values are in 1987 Indian Rupees.
* significant at 10%; ** significant at 5%.

Table 17: Pollution Intensity of FDI Inflows Post-trade liberalization, 1991-2000

Dependent Variable – ln (FDI)	Pooled OLS Estimates				Heckman Selection Model			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lagged FDI	0.61**	0.61**	0.60**	0.61**	0.60**	0.60**	0.59**	0.60**
	(0.055)	(0.055)	(0.055)	(0.055)	(0.055)	(0.055)	(0.055)	(0.055)
Ln (Industrial	0.08	0.09	0.09	0.09	0.29*	0.30*	0.30*	0.30*
Productivity)	(-0.082)	(-0.081)	(-0.081)	(-0.082)	(0.157)	(0.156)	(0.157)	(0.156)
Ln (wages)	0.01	-0.01	0.02	-0.01	-0.01**	-0.01**	-0.02**	-0.01*
	(-0.004)	(-0.005)	(-0.004)	(-0.005)	(-0.004)	(-0.005)	(-0.004)	(0.005)
Air Pollution	0.01			0.01	0.03**			0.01*
Intensity	(-0.053)			(-0.053)	(-0.009)			(-0.006)
Water Pollution		0.06		0.07*		0.07**		0.08*
Intensity		(-0.045)		(-0.046)		(-0.035)		(0.046)
Toxic Pollution			-1.41	-1.86			-1.40	-1.84
Intensity			(1.34)	(1.36)			(-1.315)	(-1.336)
Inverse Mills Ratio					0.56	0.66	0.40	0.67
					(0.422)	(0.413)	(0.412)	(0.46)
Observations	213	213	213	213	1720	1720	1720	1720
R-squared	0.39	0.4	0.4	0.4				

Standard errors in parentheses. Monetary values are in 1987 Indian Rupees.
* significant at 10%; ** significant at 5%.

APPENDIX 1: Trade and Exchange Policy Reforms

- The Rupee was adjusted downwards by about 22 percent in July 1991 and is now determined by market forces.

- LERMS (Liberalized Exchanged Rate Management System) introduced in March 1992. Under LERMS, virtually all capital goods and raw material are made freely importable subject to tariff protection as long as foreign exchange to pay for imports is obtained through the market.

- The maximum tariff was lowered from 250% in 1991 to 65% in 1994, 50% in 1995 and 40% in 1996-97.

- India signed the MIGA (Multilateral Investment Guarantee Agency) protocol for the protection of foreign investments in April, 1992.

- The duty on capital goods was reduced from 25 % to 20%.

- A number of export subsidies such as cash compensatory support for exports, have been abolished.

- A number of measures to strengthen the development of Export Houses and Trading Houses as an instrument of promoting exports were announced.

- The Export Processing Zones (EPZ) scheme and the 100% Export Oriented Unit (EOU) scheme were liberalized to include agriculture, horticulture, aquaculture, poultry, and animal husbandry.

- Abolition of industrial approval requirement for import of OGL (open general license) capital goods, raw material and consumable and spares.

- Quantitative restrictions (QRs) being removed on a phased basis. A number of items were removed from restricted to OGL list and can therefore be imported freely.

Source: **Economic Survey of India** (various issues); Gupta, 1999; Bajpai and Sachs, 2000

APPENDIX 2: Reforms in Industrial Policy including policies related to FDI

- Abolition of industrial licensing for all new projects regardless of size, except in 9 designated industries and for projects within 25 kms radius of 23 cities with population of over one million. Licenses are not required within this radius if industries are designated as non-polluting or where they are located in designated industrial areas.

- Automatic clearance of capital goods imports for delicensed projects if foreign exchange requirements are made available from foreign equity investments or if the requirement is less than 25 percent of the total value of plant and equipment.

- Automatic approval for projects involving foreign equity investments up to 51 percent in 34 specified high priority capital intensive, industries provided the foreign exchange for imported capital goods is met from foreign equity and repatriation of profits is covered by export earnings over a period of 7 years from the commencement of production.

- The list of industries eligible for foreign equity investment under automatic approval route by RBI was expanded in 1997-98. Equity investments up to 100 per cent by NRIs/OCB (Overseas Corporate Bodies) has been permitted in high priority industries. These include 9 high priority industries in metallurgical and infrastructure sector and 13 other priority industries.

- Foreign equity investments in mining (3 categories of industries) has also been allowed up to 100 per cent.

- The ceiling of 24 per cent for aggregate portfolio investment limit for NRI/OCB/FII has been raised to 30 per cent of issued and paid up capital.

- Abolition of all pre-entry clearance requirements in the MRTP Act, which is applied to large or dominant firms. The Act is restricted to focus on policing of monopolistic, restrictive or unfair trade practices as well as consumer protection.

- Phased manufacturing programs (PMP) which allow for enforcement of strict local content requirements were abolished

- Mandatory convertibility allowing financial institutions to convert part of their loan to equity if felt necessary by their management is waived.

- Power sector has been opened to both domestic and foreign private investments

- Abolition of industrial capacity licensing allowing firms to freely manufacture any article in response to market demand (except those subject to compulsory licensing).

- The Disinvestment Commission has been set up to identify public sector enterprises for equity disinvestment and work out disinvesment modalities.

- 15 items reserved for manufacture in the small scale have been dereserved.

Source: **Economic Survey of India** (various issues); Gupta, 1999; Bajpai and Sachs, 2000.