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Dirtier Trade for India? The story of globalization

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Abstract

With the opening up of trade a country can enjoy consumption benefits from a good without incurring the costs imposed on the local environment by the production process. Thus an explicit trade flow has an implicit pollution content. The direction of pollution flow depends on the volume and the composition of the trade matrix and the deeper root of the problem lies in the state of technological knowledge. Given the technological alternatives a developing country is more likely to specialize in environmentally intensive production processes compared to the developed countries. This propensity can be explained in terms of weaker environmental regulations. So, trade may create some apparent comparative advantage for less developed countries in pollution-intensive goods. This surmise, if correct, would encourage

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dirty industries to migrate from 'North' to 'South'. So, trade encourages specialization in and migration of industries, which may eventually make the trade induced growth path of "South"unsustainable.

In this paper we have tried to estimate the pollution content of India's trade over the phase of liberalization and globalization. It has been observed that the pollution content of India's trade has definitely increased between 1985 and 2000, indicating a tendency towards specializing in relatively dirty industries, though no conclusive evidence regarding "migration" of dirty industries is observed.

1 Introduction

A lot of debate is going on, on the question of the effect of trade liberalization on the environment. Generally, the developing world is facing weaker environmental regulations. This regulatory failure may lead to apparent comparative advantage in environmentally intensive product. The alternative positions in this regard are stated in terms of "pollution haven hypothesis" and "factor endowment hypothesis"[2].

[2]The pollution haven hypothesis predicts that in the post liberalization period pollution will increase in the developing countries, as dirty industries will migrate from the developed to the developing countries. The alternative to the pollution haven hypothesis, the factor endowment hypothesis on the other hand, predict that the capital intensive industries will migrate to the developed countries from the developing countries. The factor endowment hypothesis argues that since the capital intensive heavy industrial sectors are subjected to protection in the developing economies, removal of trade barriers will encourage these sectors to expand in the developed regions. Thus the factor endowment hypothesis predicts a decrease in pollution intensity of output of the developing countries in the post liberalization period.

With trade liberalization, the differences in environmental standards between the developed and developing countries might induce "environmental load displacement". Trade enables a country to consume a good without incurring the pollution externality created during its production. So, a country importing a good effectively displaces the implicit pollution load to the exporting country. Trade liberalization might encourage less developed countries which have weaker environmental standards to specialize in pollution intensive product, resulting in a net displacement of pollution load from the developed to the developing countries. Since trade liberalization imposes environmental costs on developing economies, trade liberalization may not be always welfare improving for these countries. Hence benefits of trade liberalization must be weighed against the cost of additional environmental degradation. A number of studies have tried to measure the effect of trade liberalization on the environment (Robison (1988), Tobey(1990), Low and Yeats (1992), Lucas, Wheeler and Hettige (1992), Mani and Wheeler (1999), Muradian *et al.* (2002), Cole (2004) etc.).

The standard approach in the literature analyzing the effect of trade liberalization on the environment is to divide the effect of trade liberalization on the environment into three parts: scale effect, composition effect and technique effect (Copeland and Taylor (1994 and 1995), Cole (2000) and Antweiler et al (2001)). Trade liberalization raises the level of economic activity in the economy which in turn leads to an increase in the level of pollution. This is known as scale effect. With trade liberalization there is increased production of goods in which the country has comparative advantage. This is referred to as the "composition effect". Thus for a developing country with apparent comparative advantage in pollution intensive goods composition effect is likely to lead to an increase in production of pollution intensive goods.

Trade liberalization leads to an increase in the level of income in the economy which subsequently leads to the adoption of cleaner techniques. This technique effect has beneficial effect on the environment.

Indian economy is following the path of gradual liberalization since the beginning of the Rajiv Gandhi era in 1985. Before that time we had a fairly restricted economy where under the banner of self reliance a number of protectionist policies had been active. In July 1991 the liberalization and globalization policy was formally announced and since then we are trying to achieve higher and higher targets in terms of the rate of growth by increasing our degree of openness. An analysis of India's export performance over the period 1991-92 to 1999-2000 reveals that Cotton Yarn, Drugs and Pharmaceuticals and Metal Manufactures have increased their share in total exports (CMIE, July 2000). All these commodity groups are classified as dirty by Central Pollution Control Board (CPCB). At this juncture we thought it would be interesting to check whether our success in the international market is coming at the cost of higher domestic pollution or not. If trade liberalization has encouraged our country to specialize in pollution intensive industries then the benefits brought about by trade liberalization should be weighed against the cost of additional environmental degradation. Hence increased specialization in pollution intensive industries would suggest the need for efficient use of economic instruments to deal with these environmental externalities. The successful combination of trade and environment policies will not only lead to growth, but also make the process of growth sustainable in the long run.

In this paper attempt has been made to analyze the effect of trade liberalization on our trade vector. Attempt has also been made to subdivide the total effect of trade liberalization into scale, composition and technique effect. To find out whether in the post globalization era specialization in dirty goods has increased two alternative methodologies have been adopted. In the first part of the paper the Revealed Comparative Advantage (RCA) Indices for all categories of exports for the years 1985, 1992, 1996 and 2000 have been computed. Revealed Comparative Advantage Index of a country in a particular industry is defined as the share of that industry in the total export of the country relative to the share of that industry in total world export. If the RCA index is greater than one then the country is said to have a revealed comparative advantage in that industry. A comparison of the RCA indices in the pre and post liberalization era should help us to identify the groups of commodities towards which our comparative advantage has shifted in the post liberalization era. This should give us an idea about the "composition effect" of trade liberalization. If in the post liberalization period our comparative advantage has shifted towards dirty goods then the RCA indices of these goods should show improvements in the post liberalization period.

The second method adopted runs in terms of the estimation of total pollution content of India's trade. Any change in the structure of our exports should be reflected in the "pollution content" of our trade vector. The total pollution content of exports and imports can be defined in terms of direct and indirect abatement cost of the exportables vis-a-vis that of the importables. An explicit trade flow has implicit pollution content. When a country imports a commodity it enjoys consumption benefits from that commodity without incurring the pollution cost generated in its production process. Thus by importing a commodity a country effectively exports or displaces the pollution load that would have been generated if the importing country had to produce the commodity itself. Similarly, when a country exports a commodity it effectively imports the pollution it had to incur to produce the commodity. In a typical developing country, according to Prebisch-Singer hypothesis the major exports are related to primary sector whereas the major imports are related to the secondary sector. If along with trade liberalization the economy grows, then it will gradually be more industrialized and the relative importance of the secondary sector activities in the export sector will go up. So, compared with the initial condition the pollution content of export would go up relative to that of imports.

When a developing country exports primary products which have very small pollution content, and imports secondary products which have very high pollution content then the economy is a net exporter of pollution. In this paper two different definitions of pollution content of trade has been introduced. The first is the total pollution content of trade. Total pollution content of trade is defined as the ratio between the total pollution content of exports to that of the total pollution content of imports. The second is referred to as the relative pollution content of trade. This is defined as the ratio of pollution content per rupee of exports to the pollution content per rupee of imports. The pollution content of India's trade matrix has been calculated for four years, viz., 1985, 1992, 1996 and 2000. The year 1985 is chosen as the benchmark. The year 1992 is the year immediately following the official announcement of liberalization whereas the years 1996 and 2000 chosen at four year intervals would show the state of pollution trading at a matured stage of globalization.

Rest of the paper will be organized as follows. Section 2 will discuss the methodology of this exercise whereas section 3 will report the major findings. The concluding section (section 4) will indicate the direction of future research.

2 Methodology

2.1 Revealed Comparative Advantage Index

Following Low (1992) Revealed Comparative Advantage Index for commodity i for country j has been defined as:

$$RCA_{ij} = \frac{x_{ij}/X_j}{x_{iw}/X_w} \tag{1}$$

where x_{ij} = India's total export in the i^{th} commodity, X_j = India's total export, x_{iw} = World export of commodity i, X_w = Total world exports. RCA > 1 indicates a revealed comparative advantage. To compute the revealed comparative advantage indices we have used trade data in SITC categories at the 3- digit level. The data has been obtained from then UN Trade Statistics Yearbooks.

2.2 The Pollution Content of Trade

This exercise aims at finding the ratio of pollution content of India's exports to that of India's imports at four different points in time: 1985, 1992, 1996 and 2000. The pollution content of the export or the import bundle is defined as the total abatement cost implicit in the export or import bundle. When an exportable is produced direct pollution is generated by the process of production. Moreover, the used inputs, when produced, have also generated pollution externalities. So, the total pollution content (direct plus indirect) of a commodity can be estimated in terms of the total abatement cost involved in the entire process. Following Dean (1992) we refer to this externality as "abatement content" of the relevant product.

Abatement content of any commodity can be broken into two parts: (a) direct abatement content (b) indirect abatement content. Direct/explicit abatement content gives a measure of the amount of pollution generated while producing the commodity itself. If $E = (E_1,\ E_2,\ \ldots\ E_n)'$ is the export bundle and the corresponding unit abatement cost vector is $C = (C_1,\ C_2\ \ldots\ C_n)$ then $CE = (E_1C_1 + E_2C_2 + \ldots + E_nC_n)$ will simply give a measure of the explicit/direct abatement content of the export bundle. Direct abatement content misses out a significant portion of the abatement cost implicit in the production process of the inputs used in the production of commodities in the export bundle. Hence, to find the pollution content of the export or import bundle one must also find out the abatement content of the inputs used in producing the commodities contained in the export or import bundle. The abatement content of the inputs used in producing the export or import bundle is referred to as the indirect/implicit abatement content of the export or the import bundle. The sum of the explicit and implicit abatement content of any commodity bundle may be referred to as the total abatement content of that commodity bundle.

This concept of total pollution content can be best captured in the context of Leontief Static Open Model (LSOM) where the underlying economy is characterized by intersectoral dependence. If there are n sectors in the economy and E is the final export vector that the system wants to support, then

$$X = AX + E, \text{ or, } X = (I - A)^{-1}E \tag{2}$$

where X is $(n \times 1)$ output vector needed to support E and A is the $(n \times n)$ input-output matrix.

So the total pollution content of E will be equal to $\theta = CX$ i.e. $C(I - A)^{-1}E$ [C is the abatement cost vector representing the abatement costs as percentage of output of the different I-O sectors] and for import (M) would be $\delta = C(I - A)^{-1}M$ i.e., the pollution content of trade can now be expressed as:

$$\text{Total pollution Content of trade (TPC)} \;=\; \frac{\theta}{\delta} \tag{3}$$

and

$$\text{Relative pollution content of trade (RPC)} = \frac{(\theta/E)}{(\delta/M).} \tag{4}$$

2.2.1 Data Description

The aim of this exercise is to find out the pollution content of trade for India at four points of time 1985, 1992, 1996 and 2000. As is evident from the discussion above, data on the values of export and imports for each of these years, I-O tables for each of these years and the abatement costs of the I-O sectors are required for this purpose.

Annual export import data are reported by the UN Trade Statistics Yearbooks, in SITC category up to 5 digit level classification. Export import data has been collected for the years 1985, 1992, 1996 and 2000 at 3-digit level. For 2- digit level, the industry classification would be overly aggregative, whereas at the 4 or the 5 digit levels there exists severe missing observation problem due to small magnitude of the relevant transaction figures. For any particular category, transaction data is reported provided the figure exceeds some critical level. So, as a compromise the 3-digit level has been chosen. Input output tables have been taken from the input output transactions tables published by the Central Statistical Organization (CSO) at an interval of 5 years. For finding the pollution content of trade in 1985 the commodity $\times$ commodity I-O table for 1983-84 has been used. For 1992 the 1989-90 I-O tables have been used. The only I-O table available after 1989-90 is that of 1993-94. Tables for more recent year have not yet been published by the CSO. Hence, the 1993-94 tables have been used for both 1996 and 2000.

Abatement cost data for the Indian industries has been obtained from Annual Survey of Industries (ASI) 1997-98, the Central Statistical Organization (CSO). The Annual Survey of Industries 1997-98 reports both running expenses and gross value of plant and machinery for pollution control for all NIC-87 categories. The ASI 97-98 also reports the gross output of all the NIC-87 categories. For the calculations, per unit abatement cost figures have been obtained by taking the ratios of the running pollution control expenses to the corresponding outputs[3].

The rows and the columns of the CSO's I-O (commodity $\times$ commodity) tables represent the groups of commodities which are the principal products of the I-O sectors to which they belong. For e.g., the first commodity group is Food Crops. Similarly the second commodity group is Cash crops.

The available I-O tables report the rupee value of the inter industry transactions in lakhs of rupees. i.e., if i and j are any two commodity groups in the commodity $\times$ commodity I-O table then the I-O table records the total value in lakhs of rupees of the amount of inputs of commodity group i that is used in the production of commodity group j and vice versa.

The discussion in the Section 2.2 reveals that calculating the abatement cost of the export/import bundle an input output coefficient matrix is needed i.e., the a_{ij} coefficient matrix is required. The available I-O transactions

[3]One problem behind using constant abatement cost ratios is that in this case the per unit abatement cost is taken as fixed even though increasing average or marginal abatement cost is the usual assumption in economics. The implicit assumption behind constant unit abatement cost is that environmental standard is imposed at the unit level of production. Increase in the volume of production calls for increased abatement effort at the extensive scale but does not necessarily imply an increase in the intensity of abatement activity. Since we assume that the intensity of abatement activity is constant, per unit abatement cost is fixed.

tables however record the intersectoral transactions at the aggregate level i.e., the $X_{ij}s$. To find the coefficient matrix from the transactions table, entry in each cell is divided by the gross output of the corresponding commodity group i.e., $a_{ij} = X_{ij}/X_j$. For example the value of transactions from sector 1 to sector 1 in the input output transactions table for 1983-84 was Rs. 328390 lakhs. While the gross value of output of sector 1 is Rs. 3492584. Hence $a_{11} = 328390/3492584 = 0.094$. Transactions from sector 2 to sector 1 is Rs. 1364 lakhs. Hence $a_{21} = 1364/\ 3492584 = 0.0004$. Since both the numerator and the denominator of the expression represent rupees in lakhs, hence, the $a_{ij}s$ are pure numbers indicating the value of i^{th} commodity required for producing a rupee worth of the j^{th} commodity.

The I-O table for 1983-84 is available at the 60 sector classification. The 1989-90 and 1993-94 table is available at the 115 sector classification. Hence the 1989-90 and 1993-94 tables have been aggregated to 60 sectors following the sector descriptions provided by the CSO in their appendix IV of the I-O transactions tables for 1989-90 and 1993-94.

At the next stage of the exercise the SITC trade statistics have to be matched with the production I-O data and then these I-O figures must be matched with the NIC abatement cost data.

2.2.2 Data Matching

The first task is to find the export (E_i) and import (M_i) figures belonging to the different I-O categories. To do this we will have to match the different SITC categories to the I-O categories. This has been done following the CSO's sector description enclosed in the appendix III and IV of the CSO's transactions tables for 1983-84, 1989-90 and 1993-94. These tables record the different industries which are included under each I-O category. Each

SITC category has been matched to the I-O sector, which includes the industry which manufactures the commodity/ commodities belonging to the SITC category. Take for example SITC categories 121 (Tobacco Unmanufactured Refuse) and 122 (Tobacco Manufactured). Products of these categories were exported by India in 1985. Both these categories have been included under the I-O commodity group 15 (Tobacco Products) in the Abatement Cost Table for 1985. According to CSO's sector description I-O category 15 (Tobacco Products) includes tobacco stemming, redrying, grading etc. and manufacture of bidi, cigars, cigarette etc. Detailed description regarding the matching of the SITC categories with the I-O categories is recorded in the abatement cost tables for the different years.

Generally each SITC category could be matched to a single I-O category. Problem arises with SITC 724 (textile, leather machinery) and SITC 728 (Other Machi. for Special Industry). SITC 724 category can be included under both I-O 39(Industrial Machinery for Food and Textiles) and 40(Other machinery). It is also not clear from CSO's sector description whether 728 should be included in I-O 39 or 40. To remove these problems sectors 39 and 40 of CSO's input output transactions table has been aggregated, so that our sector 40 includes Machinery for Food and Textiles as well as other machinery. So, ultimately we are considering a 59×59 input output transactions matrix[4].

The next step of the exercise would be to find out the abatement cost of the I-O sectors i.e., the C_js. The abatement cost data is available in NIC categories. The trade data is available in the SITC categories. The SITC categories have been matched to the NIC categories. Take for example SITC

[4]It may be noted that the aggregation of sectors 39 and 40 is not expected to affect the results as the same scheme of aggregation has been followed for all the years under consideration.

category 011(Meat Fresh Chilled). This has been matched to NIC category 200 (Slaughtering, Preparation and Preservation of meat). For most of the SITC categories this matching is possible but this scheme failed for the SITC categories belonging to I-O sectors 9 and 10[5]. For the SITC categories belonging to sectors 9 and 10 the abatement costs could not be accurately determined due to the non availability of the abatement cost data for the corresponding NIC categories. For example consider Crude Petroleum (333), included in I-O sector 9. Abatement cost data for the NIC category which corresponds exactly to this SITC category is not available. So, SITC category 333 has been matched to the NIC category, Mfg. Of refined petroleum Products (314), with abatement cost 0.0007 as 314 is the closest NIC category for which abatement cost data is available. The abatement cost of any I-O sector will obviously depend on the different commodities which are included in the I-O sector. Each I-O category contains SITC categories with different levels of abatement costs. So, to find out the abatement cost of any I-O category first we have to find out the abatement costs of all the SITC categories contained in the I-O category and then a weighted average of the abatement costs of the relevant categories have to be taken. In this exercise the shares of the different SITC categories in the total value of trade in each I-O cate-

[5]It may be noted that the abatement costs of the sectors 9 and 10 have remained constant over the period of our analysis. Constancy of the abatement cost figures indicates that the constituent SITC categories and their quantitative importance (i.e. the share of the constituent SITC categories in the total value of trade of the respective I-O sectors) have remained constant over the period of our analysis. So, the abatement cost figures assigned to these sectors have not affected the direction in which the pollution content ratios have moved. Of course, the magnitude of the ratios might have been affected. Thus, the direction of change would be preserved though the exact magnitude might change with more accurate data.

gory has been noted. Then to find the abatement cost of each I-O category the weighted average of the abatement cost of SITC categories included in the I-O category has been taken. The weights are the shares of the different SITC categories in the total value of trade of each I-O category. Though the abatement cost per SITC category is unchanged, as the constituent commodities and their quantitative importance are changing over the years, the I-O category wise abatement cost is also varying over time.

Table 2.1: Abatement Cost Table 1985 (An Illustrative excerpt)

1	2	3	4	5	6	7	8	9
I-O Category	SITC Category	Description of SITC Category	Value of Export (1985)(in Rs '000)	Value of Import(1985) (in Rs '000)	Total Value of trade (1985) (in Rs '000)	NIC Category	per unit abatement cost of NIC category	Calculation of a.c. for I-O category
	011	Meat frsh, chilld frozen	58628		58628	Slautering, Preparation and Preservation of meat (200)	0.0004	0.000003
	023	Butter		21035	21035	Mfg of dairy Prod (201)	0.0001	0.000013
	036	Shell fish frsh frozen	307215		307215	Processing, canning and reserving of Fish ecct. (203)	0.0000	0.000001
	048	Cereal etc. prep		22857	22857	Grain Milling (204)	0.0000	0.000004
	054	Veg. Etc. frsh, smply prsvd	55677	156386	212063	Canning and Pres. of fruits and Veg (202)	0.0003	0.000003
	057	Fruit nuts, frsh dried	222109	51483	273592	Canning and Pres. of fruits and Veg (202)	0.0003	0.000003
	058	Fruits Pres. Preparations	44114		44114	Canning and Pres. of fruits and Veg (202)	0.0003	0.000003
	071	Coffee and Subs.	225577		225577	Coffee curing, Roasting, Grinding etc. (214)	0.0000	0.000000
	074	Tea and Mate	516711		516711	Processing and Blending of Tea (213)	0.0001	0.000006
	423	Fixed Veg Oil Soft		332626	332626	Mfg. of veg. oils and fat other than hyrogenated (211)	0.0000	0.000009
	424	Fixed Veg Oil Nonsoft	35496	285651	321147	Mfg. of veg. oils and fat other than hydrogenated (211)	0.0000	0.000009
13			1821597	870038	2691635			0.000065

The methodology for finding the abatement cost of individual I-O categories can be illustrated with the abatement cost calculations for I-O 13 (Food Products excluding Sugar) for 1985. I-O category 13 is "Food Products excluding Sugar". It contains 13 SITC categories like meat Fresh, chilled Frozen (011), Butter (023), Shell Fish Fresh Frozen (036), Cereal etc Preparations, Veg. etc Fresh Simply Preserved (054), Fruit Nuts, Fresh Dried (057), Fruit Preserved, Preparations (058), Coffee and Substitutes (071), Tea and Mate (074), Spices (075), Feeding Stuff For Animal (081), Fixed Veg. Oil Soft (423), Fixed Veg. Oil Non Soft (424). For each of these 13 categories we know the abatement cost from the corresponding NIC categories. Now, to find out the overall abatement cost for the I-O category, the weighted average of the abatement costs of these SITC categories has been taken, with the relative trade share in value terms as relevant weights (see column 9 of table 2.1). The calculations for abatement costs for I-O 13 are shown in the Table 2.1.

Abatement cost ratio for I-O category 13 has been found to be equal to 0.000065 or 0. 0001(approx.), i.e. the abatement cost of category 13 is 0.01% of the total value of output. For all other I-O sectors which include multiple SITC categories this process is repeated. Some I-O categories include a single SITC category or multiple SITC categories all of which has been matched to a single NIC category. For these I-O categories there is only one abatement cost that is relevant. For e.g., in 2000 the only SITC category included under I-O category 21 was SITC 821(Furniture and parts thereof). This SITC category has been matched to NIC Category 276 (Manu. of Wooden Furniture and Fixtures) with abatement cost 0.00. I-O 21 has been assigned abatement cost 0.00 in the abatement cost table for 2000. In the abatement cost table for 2000 I-O 29 includes SITC categories 511 (Hydrocarbons, nes and derivatives), 512(Alcohols, phenols etc and their derivatives), 513(Carboxylic acid and their derivatives), 514(Nitrogen-function compounds), 515(Organo-inorganic and heterocyclic compounds) and 516(Other organic chemicals). All these SITC categories have been matched to a single NIC category Organic and Inorganic Chemicals with abatement cost 0.0017. There are some I-O sectors whose products are not included in the export import list. For these I-O sectors the abatement cost of the NIC category, which corresponds to the I-O category in question, has been used. For example take I-O 33 (Cement). Products of I-O 33 were not exported or imported in 1985, 1992, 1996 or 2000. This sector has been matched to the NIC category Mfg of cement Lime and plaster (324) with abatement cost 0.0007 to capture the linkage effect.

So, the following information has been extracted from the data: (i) the input-output coefficient matrices, (ii) The export and import figures corresponding to the different I-O sector i.e. the export/import vectors for the four years under consideration and (iii) the abatement cost vector. Now the method described in section 2.2 can be used to obtain the pollution content of trade for the four years.

2.2.3 Methodological Algorithm

Before leaving this section, for the sake of better comprehension let us repeat the steps involved in calculating the pollution content of exports and imports.
Step 1: Start with an n $\times$ n I-O matrix.
Step 2: Match the trade data (SITC categories) with I-O categories.
Step 3: Match the abatement cost data (NIC categories) with SITC categories and then using Step 2 to I-O categories.
Step 4: Find the vector representing the direct and indirect commodity requirement for producing the export (import) vector.

Step 5: Find the abatement content of the exportables (importables) by multiplying the vector found in step 4 by the abatement cost vector.
Step 6: Find out the pollution content of trade following the formulae given in section 2.2.

Following these six steps in the next section an attempt is made to estimate the pollution content of India's trade for four specific years: 1985, 1992 and 1996 and 2000.

3 Results and Interpretations

3.1 Results

The RCA indices were computed for all categories of exports for all the years under consideration. 1985 has been taken as the base year and the RCA indices of the other three years were compared to those in 1985. It has been found that for all three years, among the categories whose RCAs showed improvement with respect to the base year, more than 60% were dirty. Between 1985 and 1992, 62% of the export categories, which showed improvement in their RCAs were dirty. Between 85 and 96, 67.9% were dirty. Between 85 and 2000 the corresponding figure was 67.2%. The commodities identified as dirty in our study are those that have been classified as orange or red category dirty industries by the Central Pollution Control Board (CPCB) and the Central Statistical Organization (CSO) of India. Table 3.1 reports RCA indices of a few selected SITC categories. A number of categories identified as dirty by CPCB and belonging to SITC categories 51 (Organic Chemicals), 53 (Dyeing, tanning and colouring materials), 59 (Chemical materials and products nes), 67 (Iron and Steel) and 69 (Manufactures of metal nes) have shown significant increase in RCAs over the period of analysis. Thus our analysis in terms of the RCA indices suggests that there has been a shift towards specialization in dirty industries.

Table 3.1: India's Revealed Comparative Advantage Indices (a few selected industries)

SITC Category	1985	1992	1996	2000
511(Hydrocarbons nes and derivatives)	–*	–	0.99	1.05
513 (Carboxylic Acid and their derivatives)	–	0.48	1.19	2.16
516 (Other Organic Chemicals)	–	1.92	3.90	5.99
531 (Synt. Dye, Nat Indigo Lakes)	2.21	6.31	7.23	8.25
591 (Pesticides, disinfectants)	1.13	1.83	3.34	3.90
671 (Pig and Sponge iron . . .)	0.08	4.09	3.28	2.35
695 (Tools for use in the hand or machines)	1.02	1.40	1.28	1.48
697 (Household Equip. of base metal, nes)	0	1.97	0	5.26
699 (Manufactures of base metal, nes)	0.72	–	0.95	1.580

* stands for 'insignificant transaction' for calculation of RCA Index

Table 3.2: Pollution Content of India's Trade (in Rs '000)

		1985	1992	1996	2000
(A)	Pollution Content of Exports	13196218	63585419	120099178.5	246533726.2
(B)	Pollution content of Imports	27484349	65004807	156264425.1	219352036.2
(A/B)	Total Pollution content Ratio	0.480	0.978	0.769	1.12
(A/E)/(B/M)	Relative Pollution content Ratio	0.835	1.13	0.948	1.38

It is interesting to note that compared to the pre-liberalization phase, in the post liberalization era the pollution content of India's trade has gone up. Impact of trade liberalization on pollution content can further be subdivided into three effects: scale effect, composition effect and technique effect. Scale effect refers to the increase in pollution content due to the increase in the export import ratio. The composition effect refers to the increase in pollution content due to a shift in the composition of the export bundle towards more polluting goods. Trade liberalization increases the level of income in the economy, which in turn results in increased demand for cleaner environment, and subsequent adoption of cleaner techniques. This is called the technique effect. Technique effect is likely to reduce the pollution content. The change in the pollution content ratios between the pre and post globalization period is likely to reflect the combined influence of all these three effects. The total pollution content ratios reflect all three effects. The relative pollution content ratios measures the pollution content of a rupee worth of exports relative to the pollution content of a rupee worth of imports. Hence, the relative pollution content ratios reflect only the composition and the technique effects. The increase in the relative pollution content ratio in the post liberalization period suggest that the composition of our export bundle has shifted towards more pollution intensive goods and this composition effect has outweighed the technique effect. Between 1992 and 1996 there has been a slight decrease in the pollution content ratios. Both total and relative ratios have declined. The decline is more pronounced in case of the total pollution content ratio. This suggests that one factor behind the decline in the total pollution content ratio is the scale effect. The relative pollution content ratio has also decreased between 1992 and 1996. This indicates that between 1992 and 1996 the technique effect might have outweighed the composition effect. Since the I-O table for 1993-94 has been used for the calculation of pollution content of trade for both 1996 and 2000, this approximation would outright reject the possibility of quantifying the magnitude of the technique effect between 1996 and 2000. So, here we may comment only on the extent of the scale and the composition effects. The increase in the relative pollution content ratio between 1996 and 2000 suggests that there has been increased specialization towards dirty industries between 1996 and 2000.

4 Concluding Observations

4.1 Summing Up

The major findings of our study can be summarized as follows:

- Most of the commodity groups whose RCA indices have shown improvements in the post liberalization period are dirty.

- After liberalization, the pollution content of India's trade has increased significantly[6]:

  the total pollution content ratio has increased from 0.480 in 1985 to 1.12 in 2000.The relative pollution content ratio has increased from 0.835 in 1985 to 1.38 in 2000. Thus, from a net exporter of pollution India has become a net importer of pollution.

From the foregoing discussion it is apparent that in a globalized, liberalized set up, a less developed country can gain from trade only at the cost of specializing in environmentally intensive products. It is interesting to note that for a developed country like the US the pollution content ratio is always very close to one, though the magnitude of the ratio is falling over time (Robison 1988). Robison (1988) found that the US is a net exporter of pollution and the degree of this export is going up over time. For a developing

[6]This kind of study conducted for four isolated years may sometimes give wrong idea about the actual trend. Hence policy conclusions cannot be drawn solely on the basis of this result. But the increase in pollution content and the magnitude of increase (133.3% increase in the total pollution content and 65.27% increase in relative pollution content ratio between 1985 and 2000) that our results suggest, point towards the necessity of conducting further studies on the trade off between trade and environment in the context of India.

country like India, the ratio is expected to be lower than unity indicating country status of net exporter of pollution. For India this ratio was less than one in the pre liberalization period but it has increased gradually since then and at present the ratio is greater than one. Thus from a net exporter of pollution India has become a net importer of pollution. In fact, the speed of increase for India in the post liberalization phase is a matter of serious concern. If this tendency cannot be reversed in near future the liberalization growth path may not be sustainable in the long run.

4.2 Agenda for Future Research

On the basis of our data set distinction could not be made between the specialization effects and migration effects. It would be interesting to study separately the effect of liberalization on pollution trading due to specialization in environmentally intensive products and due to migration of dirty industries to the South.

Antweiler, Copeland and Taylor (2001) suggested an integrated framework to consider more comprehensive hypotheses related to the pollution haven effect and factor endowment effect simultaneously. I intend to extend my framework in future to test Antweiler -Copeland -Taylor type comprehensive hypotheses.

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