Pollution Haven and Factor Endowment Hypotheses Revisited: Evidence from India

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Abstract

The relationship between trade expansion and environmental protection has been characterised by two extreme viewpoints – promoting trade worsens environmental conditions and higher environmental standards impose an economic cost. Two conflicting hypothesis emerge from the debate. One manifestation of the above-described trade off is the hypothesis that increasing trade may encourage developing countries with weaker environmental protection to specialise in industries that create more pollution. This claim is referred to as the pollution haven hypothesis; the first competing hypothesis.

The second hypothesis, the factor endowment hypothesis (FEH), predicts that trade liberalisation will result in trade patterns consistent with the Heckscher-Ohlin-Samuelson (HOS) theory of comparative advantage based on factor endowment differentials. Rich countries are typically well endowed with physical capital. Since capital-intensive goods are often also pollution-intensive, factor-endowment theories of international trade predict that rich countries specialize in polluting goods. However, rich countries might have a higher willingness to pay for environmental quality and thus set higher environmental standards. From the general premise that pollution intensive goods are relatively capital intensive (Antweiler et al 2001 and Cole and Elliott 2001), it is assumed that pollution-intensive industries will relocate production from countries in the relatively labour abundant South to those in the relatively capital abundant North. The manifestation of the PHH, in direct conflict with the FEH, is that dirty industries may relocate from the North to the South, or simply that, dirty industries from the developed world become displaced from the world market by similar industries from developing countries.

The present paper aims at contributing to test both the hypotheses (PHH and FEH) for India during 1990s. In addition the paper also tests the same hypotheses for the case of India and EU (15). The input-output method is used and suitably modified to test both the hypotheses. It is clear from the results that import related pollution is much larger than the export related pollution for India. The findings of the present work challenge the pollution haven hypothesis (PHH) arguing that liberalization of trade policy in India has not been associated with pollution intensive industrial development. On the other hand the study supports the factor endowment hypothesis thus confirming that the export oriented labour requirements are much more in weight than its import counterpart. Hence India gains in terms of emission from trade in both the cases.

Keywords: International trade, carbon emission, Pollution haven hypothesis, Factor Endowment Hypothesis, Input-output analysis

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Introduction

A policy of trade liberalization is often suggested as a means of stimulating economic growth in developing countries. Trade liberalization consists of policies aimed at opening up the economy to foreign investment and lowering trade barriers in the form of tariff reduction. However, while trade may stimulate growth it may simultaneously lead to more pollution either as a result of relocation of polluting industries from countries with strict environmental policy or due to increased production in dirty industries. Given the potential benefits of trade liberalization policies, it is important to examine whether such policies are in fact in conflict with the environment as they expand production and accelerate economic growth.

Thus what happens to the environment when international trade is liberalized is a matter of debate. It is commonly assumed by economists and environmentalists alike that greater economic openness will lead to increase pollution in developing countries, as free trade will increase environmental degradation in developing countries. Among environmentalists, one common concern is that liberalized trade regimes and market driven exchange rates, by increasing the incentive for export, will lead to greater exploitation of natural resources (e.g. native forests). Secondly, free trade will increase industrial pollution in developing countries, through displacement of dirty industries from developed countries with stricter environmental regulation, and through competitive pressure on developing countries to reduce further their environmental standards.

The relationship between trade expansion and environmental protection has been characterised by two extreme viewpoints – promoting trade worsens environmental conditions and higher environmental standards impose an economic cost. Two conflicting hypotheses emerge from the debate. The first competing hypothesis, known as the pollution haven hypothesis (PHH), is derived from changes in environmental legislation that in turn can distort existing patterns of comparative advantage. In the developed world the costs of complying with environmental regulations appear to be increasing steadily. Since the stringency of environmental regulations increases with income and economic development (for example Dasgupta et al. 1995) the PHH assumes that developing countries possess a comparative advantage in pollution-intensive production. Thus "pollution havens" arise. The second hypothesis, the factor endowment hypothesis (FEH), predicts that trade liberalisation will result in trade patterns consistent with the Heckscher-Ohlin-Samuelson (HOS) theory of comparative advantage based on factor endowment differentials. Rich countries are typically well endowed with physical capital. Since capital-intensive goods are often also pollution-intensive, factor-endowment theories of international trade predict that rich countries specialize in polluting goods. However, rich countries might have a higher willingness to pay for environmental quality and thus set higher environmental standards. From the general premise that pollution intensive goods are relatively capital intensive (Antweiler et al 2001 and Cole and Elliott 2001), it is assumed that pollution-intensive (hereafter “dirty”) industries will relocate production from countries in the relatively labour abundant South to those in the relatively capital abundant North. The manifestation of the PHH, in direct conflict with the FEH, is that dirty industries may relocate from the North to the South, or simply that, dirty industries from the developed world become displaced from the world market by similar industries from developing countries. Both the hypotheses are simultaneously tested for India.

The trade policy components of the Indian reform process undertaken since July 1991 have been motivated by a full recognition of the important role that trade can play in promoting sustained economic growth in the context of sustainable development. The expanded scope for specializing in areas of comparative advantage is manifest in the improved growth performance of the economy. Furthermore, while exports have responded to the removal of the anti-export bias of a protectionist environment, domestic industry appears to have been stimulated by the expanded availability of imports and capital goods, and the challenge of competing in the international market place. The positive response of Indian industry to deregulation is amply demonstrated by the capital goods sector. The capital goods industry, which witnessed a negative growth of 12.8% in 1991-92, registered an average growth of about 23% during 1994-96.

The growth rate has been much higher for both exports and imports after liberalization. India’s share in world exports continued to increase from 0.52% in 1990 to 0.67% in 2000. This increase was higher than in the previous decade because of the gradual lifting of the quantitative restrictions and reduction in tariff. The effect of liberalisation is highly visible in external trade indices: post liberalisation growth has been much higher in exports and imports both, and external trade now accounts for 20% of India’s GDP, significantly higher than 13% level in 19990-91. The annual average growth rate of exports increased from 7.6% during 1980/81-1991/92 to 10% during 1992/93-1999/2000 and that of imports has increased from 8.5% to 13.4% for the same period. The reason for such export increment goes to buoyancy in world demand and revival of world trade reflecting East Asian recovery bottoming out of some global commodity prices, coupled with trade policy initiatives taken by the government. On the other hand, the share of imported manufacturing goods rose by 35.8% in 1980-81 to 48% in 1990's and sharply rose to 78% in 1999-2000. India's imports are characterised by a large share of raw materials and fuels (above 25% of total and very dependent on world prices), as well as chemicals and other intermediate goods (about 30% of the total imports), accompanied by fairly even breakdown for between equipment and consumer goods (respectively 16%, including transportation, and 21% of total). With regards to export, three broad categories of product are dominant: food and agricultural products diversified manufactured goods, mostly for consumer markets and industrial products and semi processed goods for almost 40% of total exports. The responsible sectors in this respect are electronic goods, leather goods, textile yarn, and fabrics and made ups, machinery iron and steel, primary steel and chemicals and professional instruments. Most of these sectors are energy intensive.

The European Union and the USA are by far the most important markets for Indian exports, absorbing each about 20% to 25% of total exports. Asian countries excluding Japan also account for about 20% to 25% of exports (with Hong Kong and China being the largest importer of Indian goods in Asia, followed by Bangladesh Sri Lanka and Singapore). Japan is still a small market, with about 5% of total Indian exports. Within Europe, Germany and the UK are the largest importers (around USD 2.1 bn each, in 1998), with France, Belgium and Italy being significant (above USD 1 bn each). Altogether after trade liberalisation, OECD countries account for 54% of the trade with India. The European Union is currently India's largest trading partner, accounting for nearly a quarter of the total two-way trade. In terms of imports, Asian countries (excluding Japan) and the European Union supply almost 50% of India's total imports. Within Asia South Korea Malaysia and Singapore are the most important partners; while in Europe, the UK, Germany and Belgium are the largest suppliers. The Middle East countries are the major supplier of India's oil imports and the region accounts for a very large 16% of total imports.

Economic liberalisation in India has led to an impressive growth in the two-way trade, which has increased by about 156 percent between 1991 and 2001- while imports were up 171.53 percent; exports grew by 141.61 percent. Indo-EU trade has increased - specifically from 12.6 billion Euros in 1993 to over 25.7 billion Euro in 2000. With liberalization Indian exports have diversified and expanded. There is a significant change in the composition and range of Indian exports that now enter the European market. The share of Indian exports in the EU's overall imports is only 1.3%; its impact on India's overall economy is much greater.

Indian exports are mainly dominated by textiles & clothing, (32.15), agricultural & marine products (8.57%), gems & jewellery (12.24%), and leather and leather goods (11.03%), which together account for more than 60 percent of the total exports. Of late, exports of engineering, electronics (9.20%) and chemical products (7.93%), have registered a significant growth, although their overall size still remains small in 2000. Indian imports from EU are dominated by Gems and Jewellery (37.90%), Engineering goods (29.73%), Chemical and allied products (8.55%), Metal and Metal products (5.84%) and Transport equipment (3.74%) in 2000.

During1999, India-EU trade constituted 5.3% of the EU-Asia trade. The figures of India’s trade with the European Union for the period 1994-1999 may be seen in the graph below.

Figure 1 here

EU has been enjoying a favourable balance of trade with India since 1990 as shown by the following Table 1.1

Table 1.1 here

India-EU bilateral trade touched for the first time ECU 20.3bn in 1999. India’s exports registered ECU 10.002 bn and imports ECU 10.3446bn and the balance of ECU 320 million remained in EU’s favour. India's strength lies in its traditional exports like textiles, agricultural and marine products, gems and jewelry, leather, and engineering and electronics products. In 2001 trade was again in favour of India.

What has been the impact of such changed performance of trade on the environment in India? The present research concentrates on this question and aims at contributing to the environmental trade debate by evaluating the impacts of liberalized trade with other countries and also explores its exclusive effect with European Union on the environment in the Indian economy since the 1990s.

Trade liberalization efforts in India are afoot to increase the volume of tradable commodities (especially the export) expecting that both Europe and India would gain. Environmental impacts of trade openness needs to be researched in this context. Several questions may come up. Whether this openness is increasing industrial pollution in India, whether the increasing incentive to export in the liberalized period will lead to a greater exploitation of natural resources, whether free trade with Europe is generating more industrial pollution than before through the displacement of dirty industries from Europe with stricter environmental regulation and through competitive pressure on India to reduce further its environmental standards, are all examples of environmental issues that needs to be researched. These problems have long run implications for sustainable development. Studies are needed to examine the pollution intensity of tradable goods of India and rest of the world and also exclusively Europe and to throw light on the above mentioned issues, especially whether India is gaining from an environmental point of view or not, due to the reformed trade.

Thus, the objective of the present work to study the impact of India’s trade with rest of the world on CO_2 emissions from fossil fuel combustion during 1990s and to estimate the pollution terms of trade that will measure India's environmental gains or losses from trade with other countries by testing the pollution haven hypothesis. The present study also attempts to test the factor endowment hypothesis (FEH). In addition the paper tests these two conflicting hypotheses for India and EU (15) simultaneously.

The plan of the paper is as follows

Section 1 will review the selected literature on trade and environment. Section 2 will develop the methodology. Section 3 will discuss the data. Results and discussions are presented in Section 4 and Section 5 will conclude the paper.

Section 1

Survey of Selected literature

With revitalization of trade liberalization policies there has been a growing literature on the effects of international trade on the environment. This section will briefly review some of these literatures. Grossman & Krueger, 1992; Lucas et.al, 1992; Birdsall & Wheeler 1993; Nordsdorm & Vahugan, 1999; Khrushch 1996; Wheeler & Martin, 1992; Schaeffer, and SÁ, 1996;Gallagher & Ackerman , 2000 have made a significant contribution on this issue. The methodologies employed to test this relationships are widely varied, as are the results (Gallagher and Ackerman, 2000). Antweiler et al. (2001) set out a theory of how openness to international goods markets affects pollution concentrations. They develop a theoretical model to divide trade's impact on pollution into scale, technique and composition effects and then examine this theory using data on sulfur dioxide concentrations from the Global Environment Monitoring Project. They found that international trade creates relatively small changes in pollution concentrations when it alters the composition, and hence the pollution intensity, of national output. Their estimate of the associated technique and scale effects created by trade imply a net reduction in pollution from these sources. Combining their estimates of scale, composition and technique effects yields a somewhat surprising conclusion: freer trade appears to be good for the environment. Very recently Eskeland and Harrison (2003) have examined the pollution haven hypotheses using data on US foreign direct investments- whether multinationals tend to flock to pollution havens in developing countries.

The role of international trade in determining the environmental damage has been addressed by specialists using Input-Output techniques (Wright, 1974; Fieleke, 1975; Antweiler, 1996; Lange, 1998; Proops et al., 1999; Munksgaard and Pedersen 2001; Lenzen 2001;Machado et al. 2001). Recently studies by Hann (2002), Gerihall et al (2002), Lange(2002), Wadeskog (2002), Lange and Hassan(2002), Przybylinski (2002), Hayami and Nakamura(2002) and Ahmed (2002) have also addressed the issues on trade and environment using I-O techniques. The main concern of these international trade oriented studies has been to evaluate how foreign trade affects environment locally and globally.

Through goods and services traded in a globally interdependent world, the consumption in each region is linked to green house gas emissions in other regions. Most studies dealing with energy and greenhouse gases in a closed and open input-output model employ single region models. These single region studies are based on the assumptions that commodities imported from foreign countries are produced using domestic production technology and energy inputs. However, this assumption is not necessarily valid. Recently, Lenzen and Mungsgaard (2002) have made an extension of the existing single region model as described by Munksgaard and Pedersen (2001) and Lenzen (2001) by introducing a multi-regional input-output model to calculate the amount of energy and green house gases embodied in a value unit of commodities produced for Danish final consumption.

Some specialists have been particularly concerned with the impacts that international trade might have on the effectiveness of climate change agreements. Among them work of Wyckoff and Roop (1994) can be mentioned. According to them global warming policies based on reducing domestic greenhouse gas emissions ignore the carbon embodied in international trade flows, which could be important if emission reduction schemes include only a subset of emitting countries. This analysis shows, and discusses implications of the finding, that a significant amount (about 13%) of the total carbon emissions of the six largest OECD countries is embodied in manufactured imports.

Machado et al. (2001) applies I-O techniques to the Brazilian economy to evaluate the total impacts of international trade on its energy use and CO2 emissions. Results show that in 1995 in Brazil carbon embodied in the exports of non-energy goods are larger than the relevant amounts embodied in the imports of non-energy goods. Hann (2002) has derived environmental balance of trade by analysing the trade relationships for a number of trade patterns of the Netherlands. These bilateral environmental balances of trade are further analysed by tracking down differences in the absolute levels of export and import and eco-efficiencies (pollution or natural resource requirements per money unit of product).

The cross country studies like Gerilla et al. (2002) for China and Japan, Przybylinski (2002 for Poland and Germany, Hayami and Nakamura (2002) for Japan and Canada Ahmed (2002) selected OECD countries are worth mentioning in this respect.

Regarding environmental regulation and foreign direct investment the studies have been made by Xing and Kolstad (1997), Low &Yates (1992) deserve mention. They submitted that the dirty industries relocate to countries with lax environmental regulation. . Using industry level trade data from the US, Levinson and Taylor, 2001 showed that imports of dirty goods to the US increased over the last 3 decades. In recent years some studies have used firm level or plant level data. Smarzynska and Wei, 2001, used firm-level data on investment projects in 24 transition economies and found some support for the pollution haven hypothesis.

Cole et al. (2001) examine the evidence for pollution haven Hypothesis (PHH) and factor endowment Hypothesis (FEH). They test a monopolistic competition model of inter- industry and intra- industry trade to examine the North South trade patterns whether consistent with either PHH or FEH. They submitted that both the hypotheses are at work and may, due to their temporary nature, often cancel each other out. In summary, the role played by foreign trade seems to be highly significant in affecting the use of natural resources (energy included) and in generating environmental damage in countries in particular, as well as in the world as a whole.

Copeland and Taylor (2003) set out the two leading theories (pollution haven hypothesis and factor endowment hypothesis) linking international trade to environmental outcomes, developing the empirical implications, and examining their validity using data on measured sulfur dioxide concentrations from over 100 cities worldwide during the period 1971 to 1986. The empirical results are provocative. For an average country in the sample, free trade is good for the environment. There is little evidence that developing countries will specialize in pollution-intensive products with further trade. In fact, the results suggest just the opposite: free trade will shift pollution-intensive goods production from poor countries with lax regulation to rich countries with tight regulation, thereby lowering world pollution. The results also suggest that pollution declines amid economic growth fueled by economy-wide technological progress but rises when growth is fueled by capital accumulation alone.

Unfortunately very little work has been done in India, in particular using I-O techniques. The present work aims at this and attempts to contribute to the environment and trade debate by evaluating the impacts of international trade with the rest of the world and also exclusive contribution with European Union on emissions of carbon dioxide (CO_2) in the Indian economy during 1990s using input-output techniques.

The question we address is simple: in the countries like India, has greater openness defined in terms of trade regimes been associated with the so called pollution havens or supporting factor endowments?

Section 2
Methodology

The methodology of the present research is based on Leontief's Input-Output framework (1951). The structure of the input-output model can be framed as:

$$\mathbf{X = Ax + Y} \qquad \text{………. (1)}$$

Here X is a vector (nx1) of industrial output. Y is a (nx1) vector of final demand vector of industries and A is a technical coefficient matrix (nxn) describing interdependencies among output of industries. The solution of (1) gives

$$\mathbf{X = (I - A)^{-1} Y} \qquad \text{………. (2)}$$

Where $(I - A)^{-1}$ is the matrix of total input requirements. I is an identity matrix (nxn).

Now we have introduced domestic and import matrix in our model. Actually we have separated the total flow matrix into two parts (domestic and import) because we know that the total flow of intermediaries (production process of industries) contain the domestic output as well as the imported.

First, we define:

X^d_{ij} = element (i,j) of the matrix of intermediate deliveries supplied by domestic production

M^d_{ij} = element (i,j) of the matrix of intermediate imports by origin

so that

$X_{ij} = X^d_{ij} + M^d_{ij}$ = element (i,j) of the matrix of intermediate deliveries

Then, we define:

D^d_i = element i of the vector of domestic final demand supplied by domestic production

D^m_i = element i of the vector of imported domestic final demand

so that

$D_i = D^d_i + D^m_i$ = element i of the vector of domestic final demand

Next, we define

E_i = element i of the vector of exports

Then we have the input-output accounting identities

$X_i = X^d_{ij} + D^d_i + E_i$ …………(A)

where X_i denotes the i element of vector of gross output supplied by domestic production

Finally we define

$A^d = D_{ij}/ X_j$ the matrix of domestic input-output coefficient

$R^d = [I- A^d]^{-1}$ = the Leontief domestic inverse matrix

A^m = matrix of imported intermediate input coefficients with $a^m_{ij} = M_{ij} / X_j$ as element (i,j), and

$A = A^d + A^m$, i.e. the matrix of total (domestic plus imported) input-output coefficients

Then in equation, in obvious notation reads: $X^d = A^d X^d + Y$ from which it easily follows that

$$\mathbf{X_d = (I - A_d)^{-1} Y} \qquad \textbf{………. (2a)}$$

Equation (2a) defines exclusively the domestic output. Now the emission model can be elaborated through (2a).

I) Emission model

Total amount of an emission from fossil fuel combustion can be calculated as a function of output of industries. To estimate the carbon emission the model will be

$$\mathbf{F_{pd} = CL1X_d = C\ L1\ (I - A_d)^{-1}\ Y} \qquad \text{-------- } \mathbf{(3)}$$

Here F_p is a scalar giving the total quantity of an emission from fossil fuels combustion in India. Emissions under this study are CO_2 meaning carbon dioxide, which is defined as pollution type p. C is a vector of dimension m (1xm), of coefficients for the industrial emission intensity per unit of fossil fuel burnt. L1 is a matrix (mxn) of the industrial consumption in energy units of m types of fuel per unit of total output of n industries. In equation (3) CL1 carries only direct requirement of pollution intensities from industries and C L1 $(I - A)^{-1}$ gives the direct as well as indirect requirement of pollution intensity from industries.

Let CL1 = S and $(I - A)^{-1} = R$. Then equation (3) will be

$$\mathbf{F_{pd} = SR_d\ Y} \qquad \text{----------------------- } \mathbf{(3a)}$$

To establish a link between trade and environment we need to develop the trade model by extending the equation (3a).

Trade model

By separating the final demand vector as domestic (Yd) and net exports we get

$$Y = Yd + Yx - Ym \qquad \text{------------------ (4)}$$

Where Yx (nx1) is defined as the vector content of export only and Ym(nx1) as vector content of imports. Here we assume identical technology (Heckscher-Ohlin) to find out the pollution content of imports for the rest of the world. So the pollution content of export and import can be defined as in (5) and (6).

$\mathbf{F_{pd}}$ **exports** = SR_d Yx -------- (5)

$\mathbf{F_{pd}}$ **imports** = S R_d Ym -------- (6)

Equation (5) and (6) are scalar giving total carbon content of export and import. The sectoral contribution of the carbon content of export and import is estimated by putting diagonal matrix of export and import vectors which will become *Yx*(nxn) and *Ym* (nxn*)*. Then (5) and (6) will be

F_{pd} exports = SR_d *Yx* -------- *(5*)*

F_{pd} imports = S R_d *Ym* -------- *(6*)*

Now, a measure of **pollution terms of trade (PTOT)** will be

$\mathbf{PTOT_d = F_{pd}\ exports / F_{pd}\ imports = [SR_d\ Yx] / [SR_d\ Ym]}$--------- **(7)**

Equation (7) derives PTOT for India with the rest of the World.

In this paper we have also tried to capture the European Union's export and import contribution with India separately. The major equations are calibrated below.

The pollution content of exports to European Union

$\mathbf{F_{pd}\ exports_{eu}} = SR_d Yx_{eu}$ -------- (8)

Again the pollution content of imports from European Union

$\mathbf{F_{pd}\ imports_{eu}} = S\ R_d Ym_{eu}$ -------- (9)

The sectoral contribution of carbon traded also derived in the same manner like (5*) and (6*)

$\boldsymbol{F_{pd}\ exports_{eu}} = SR_d\ Yx_{eu}$ -------- *(8*)*

$\boldsymbol{F_{pd}\ imports_{eu}} = S\ R_d\ Ym_{eu}$ -------- *(9*)*

Now, a measure of **pollution terms of trade (PTOT)** will be derived as

$\mathbf{PTOT_{deu} = F_{pd}exports_{eu} / F_{pd}imports_{eu} = [SR_dYx_{eu}] / [SR_dYm_{eu}]}$ --------- **(10)**

Equation (10) derives the PTOT of India whether exists with European Union by testing the **pollution haven hypothesis**. This measure is the ratio of the pollution content of 1 unit of exports relative to the pollution content of 1 unit of imports. A country gains environmentally from trade in relative terms whenever its imported goods have higher pollution content than its exported goods. When the pollution terms of trade are greater (smaller) than 100, that particular country's exports contain more (less) pollution than it is receiving through imports. The expressions of (10) will provide the compositional effect.

The PHH explanation will be stronger if we discuss factor endowment hypothesis in this context, which offers another view on the impact of international trade on the allocation of environmental burdens across countries. This hypothesis maintains that pollution intensities of production are highly correlated with capital intensities (see e.g. Copeland and Taylor, 2003). In that case, capital-abundant countries (i.e. typically rich, developed countries) have a comparative advantage in pollution intensive goods, which they will export according to the Hecksher-Ohlin theory.

The expansion of global trade receives so much attention largely because it has important influences on the factor markets of the countries involved. This also explains why, after decades, the Heckscher-Ohlin-Vanek (HOV) model is still a mainstay of international economics. The HOV model, which focuses on the relationship between production factors and trade, predicts that a country will export services of the factors that are relatively abundant in the country and will import services of the factors that are relatively scarce in the country. Consequently, theories about factor prices and about welfare of different production factors were developed based on this model.

For testing the factor endowment hypothesis we have modified our previous equations by introducing labour and capital coefficients.

Recollecting equation (2a) and multiplying by the labour and capital coefficients we get

$$\mathbf{LX_d = L(I - A_d)^{-1} Y} \qquad \text{……….} \quad \mathbf{(11)}$$

$(I - A_d)^{-1} = R$

or $\mathbf{LX_d = LR_d\, Y}$

$$\mathbf{KX_d = K(I - A_d)^{-1} Y} \qquad \text{………… .}\mathbf{(12)}$$

$\mathbf{KX_d = K\, R_d\, Y}$

Where L and K symbol are treated as labour and capital coefficients of all sectors in the study and LR_d and KR_d provide the sector wise labour and capital requirements.

To estimate the labour requirements and capital requirements in exportable and importable further equation (11) will be multiplied by export and import vector which are presented below:

$$\mathbf{L_{exp} = LR_d}\, Yx \qquad \text{……….} \quad \mathbf{(13)}$$

$$\mathbf{K_{exp} = KR_d}\, Yx \qquad \text{………….}\mathbf{(14)}$$

The labour and capital requirements of importable can also be classified similarly in equation (15) and (16).

$$\mathbf{L_{exp} = LR_d}\, Ym \qquad \text{……….} \quad \mathbf{(15)}$$

$$\mathbf{K_{exp} = KR_d}\, Ym \qquad \text{…………. } \mathbf{(16)}$$

Equations (13) to (16) classified here derive the total labour and capital requirements in case of export and import.

Now we attempt to compute the requirements of labour and capital exclusively for trading with European Union.

$$\mathbf{L^{eu}_{exp} = LR_d}Yx_{eu} \qquad \text{……….} \quad \mathbf{(17)}$$

$$\mathbf{K^{eu}_{exp} = KR_d}Yx_{eu} \qquad \text{…………. } \mathbf{(18)}$$

$\mathbf{L^{eu}_{imp} = LR_d}Ym_{eu}$ ………. **(19)**

$\mathbf{K^{eu}_{imp} = KR_d}Ym_{eu}$ ……… **(20)**

As we know that the factor endowment hypothesis briefs that labour rich country will export labour intensive goods which are environment friendly and imports capital intensive goods. The ratio of labour import and export will be less than 1. Similarly the capital abundant country will export capital intensive goods and imports labour intensive goods and the ratio of capital import and export will be greater than 1, which are mostly pollution intensive. Here the hypothesis supports.

Section 3
Data

To implement the model and to calculate the pollution terms of trade we require Input - Output data, and energy flow data and price indices, CO_2 data, trade related data and labour and capital coefficients for the year 1991-92 and 1996-97 respectively. In this present study we consider EU 15 as European Union.

Input-Output Data

This study requires two Input-Output tables of the Indian economy for the years 1991-92, 1996-97 prepared by Government of India, Planning Commission (1995, 2000).

Input-Output tables are Commodity by Commodity tables consisting of 60 x 60 sectors. These have been aggregated to 33 sectors on the basis of the nature of commodities and trade and energy intensiveness.

Here we have considered three energy sectors coal, crude oil & natural gas and electricity separately and other 57 non energy sectors have been aggregated to 30 non-energy sectors by considering export and import share. Thus, aggregated Input-Output tables of this study consist of 33x33 sectors.

Price Indices

The Input-Output tables of 1996-97 are available at 1991-92 prices.

Data on energy

C.M.I.E (Centre for Monitoring Indian Economy) will provide the energy flow data for the two years, 1991-92 and 1996-97, respectively at physical unit i.e. million tons of oil equivalents (mtoe).

Data on emissions of pollutants

The CO_2 emissions from fossil fuel combustion have been estimated by IPCC (Inter governmental panel on climate change) guideline. For estimation of CO_2 emission we need to extend the above conventional input-output framework in one important respect i.e. we have to compute the amount of CO_2 emission that takes place in the production of various activity level. It gives the total quantity of CO_2 emitted owing to burning of fossil fuel (coal, oil) inputs used by various production industries.

Trade related data

India's trade with European Union for commodities for the year 1991-92 and 1996-97 is available from Foreign Trade by Commodities published by Statistics Directorate, Vol 5, OECD, Paris 1998. The classification of the commodities available in this volume does not follow exactly the classification of commodities in I-O tables of India. We have to make the necessary correspondence between the two classifications and make necessary aggregation. Secondly the OECD data are available at current prices but the I-O data are at constant prices (1991-92 prices). So we have to formulate different price indices for export and import items. In this regard the UN publication entitled "International Trade Statistics Yearbook" for different years has been of great use.

Exchange rate

We have to convert the trade data in million dollars available from OECD publications to Indian currency, million Rs. For that we have used the exchange rate available from International Financial Statistics, IMF Publication.

Labour and capital data

To estimate the sectoral labour and capital coefficients we have used the labour stock data i.e. persons engaged in each sector and capital stock data from Annual Survey of Industries (ASI), Agricultural Statistics of India , Forest Statistics of India, National Accounts Statistics published by Central Statistical Organization (C.S.O).

Section 4
Results and Discussion

4.*1: Evidence on Pollution Haven Hypothesis from India's Trade with the Rest of the World*

In this section we basically are dealing with the pollution terms of trade, as developed in Section 2 which measures an empirical assessment of it by using an index.

We have computed the pollution terms of trade of India with rest of the world for CO_2 emission in 1991-92 and 1996-97. Results are presented in Table 4.1.

Table 4.1 here

The value obtained is 49.76 % for CO_2 in 1991-92 and rose to 52.64% in 1996-97. The value of the indices of Pollution Terms of Trade (PTOT) of the pollutant has increased marginally by 3% within the span of five years in India during the reform period. However, the value of PTOT index is below 100. This indicates that India exports goods that are produced more environment friendly than goods it imports. Thus the pollution haven hypothesis is not supported by the results.

The reasons behind the low value of PTOT (less than 100) will be clear if we analyse the composition of exports and imports of India for the two years, 1991-92 and 1996-97 (Table 4.2 in Appendix).

A look at the composition of exports and imports in India (Table 4.2) indicate several features. One of the most important feature of the composition of Indian Exports are primarily dominated by primary products (other crops, fishing, other food and beverages) having a share of 13.4 % in 1991-92 and 10.08% in 1996-97. Textile products have a share of 17.50% in 1991-92 and 16.99% in 1996-97. A significant change in the composition of export has been observed in manufacturing sector. The share of the manufacturing products (agricultural machinery, electrical machinery, communication equipment, electronic equipment transport equipment and other manufacturing) has increased from 17% in 1991-92 to 22% in 1996-97. On the other hand crude petroleum & natural gas and petroleum products (15% in 1991-92 and 16% in 1996-97 respectively), non-metallic product (13.82% in 1996-97 and 9.67 in 1991-92), iron and steel (3% in both the year), machinery goods (shares 34% in both the years) and transport services (8.60 % in 1991-92 and 10.31% in 1996-97) are major items in the import basket. These products are the sources of CO_2 emission while the exportable generate less pollution (table 4.2).

Table 4.2 here

It is evident from this table (4.2) that the textile products which are export items though generate higher levels of pollution are, however, outweighed by the pollution generated by import items like petroleum product, iron and steel, non electrical machinery sector. The picture will be crystal clear if we analyse the carbon content of export and import of India with the rest of the world during 1991-92 and 1996-97 (table 4.3).

Table 4.3 here

The most important point about the exportable and importable is intra-industry trade. Among the export sectors the remarkable contribution of CO2 achieved by textiles, rail and other transport equipment, construction sectors, petroleum products, chemicals and leather and leather products. The sectors like petroleum products, other chemicals, fertiliser, metals and non-metallic minerals, agriculture and other machinery and construction sectors are under the import category, which secure a significant position. Apparently the carbon content of export share is less than import derives that export intensive goods are less pollution bearers. The analyses of the type of commodities also support the fact. The composition of the carbon content of export and import presents a similar trend in both the years but the total contribution in actual is alarming. Carbon content of exportable for the above mentioned sectors are quite high in 1996-97 than 1991-92. Importable also provides a similar scenario. As we have considered the H-O assumptions in our study so it is rather difficult for us to say exactly the import related energy intensity and technological coefficients role. Overall we can put some general observation that during the first phase of 90s energy consumption has increased by 5.8% p.a. due to trade liberalization and more openness forced the economy to use more energy technology in all aspects that caused the changes in trade composition.

The foreign factor (in our case emissions) content of the Indian imports simply is not involved in our analysis. In examining the pollution haven hypothesis, we were interested in the Indian emission content of the domestically produced commodities that are substituted by imported goods, because this substitution reduces production and therefore pollution in India. We have thus not used this Indian emission content to estimate the foreign emission content, which would have required the assumption of identical technologies.

Next we have attempted to measure the same for EU15.

4.2:: Evidence on Pollution Haven Hypothesis from India's Trade with Europe

After analysing the impact of India's trade with world let us now concentrate on India's trade with Europe and impacts on CO_2 emissions. Table 4.4 records the values of PTOT of India with Europe and its impact of CO_2 for the year 1991-92 and 1996-97.

Table 4.4 here

The result shows that the values of pollution terms of trade are less than 100 though there has been a marginal rise in the value of 71.20 to 73.85 in 1996-97.

Let us take a look at the composition of trade of India with European Union. European Union is a developed region and it is a major trading partner of India. It follows from the trade debate that due to trade liberalisation the dirty industries migrate to less developed region. As we observe the above results (Table 4.4) do not support the hypothesis. It will be more evident from Table 4.5, which presents the share of exports and imports of India with European Union in 1991-92 and 1996-97 respectively.

Table 4.5 here

The commodity composition of trade presented in Table 4.5 bears an interesting picture. The export basket of India's trade with Europe is predominated by agriculture and related products like tea, coffee, fish food and beverages etc sharing 11.48% in 1991-92, 14.53% in 1996-97, textiles (more than 20% in both the years). Machineries (electrical, non-electrical, communication, electronics, transport equipments and various other manufacturing goods) account for 38.11% of total export in 1991-92 and 43.51% in 1996-97. This shows that as a result of trade liberalisation the share of manufacturing goods in the total has gone up.

The share of import from Europe reveals that other minerals account for approximately 8% and Iron and steel 7.65% and 5.78% in both the years respectively. There has been a significant rise in the share of imports of manufacturing goods to Europe. It has gone up from 50.65% in 1991-92 to 66.54% in 1996-97. Thus India imports more manufacturing goods than does export to Europe. The manufacturing goods are more capital intensive and generate more CO_2. India does not import oil and crude petroleum from Europe. But a large inflow of CO_2 embodied in trade with Europe is due to high share of manufacturing goods in the import baskets of India with Europe (table 4.6).

Table 4.6 here

The above results indicate that Indian exports are cleaner than the goods replaced by imports. Trade liberalisation in India has led to a further increase of gains with the rest of the world (excluding Europe).

From these results we observe that the values of PTOT indices are less than 100 for all cases. This indicates that the India export goods to Europe that are produced more environment friendly than the goods it imports. Pollution haven hypothesis is not supported by the results based on our study. Thus our observation contradicts.

India is among the countries, which are in the vanguard of environmental protection. India has environmental standards for products and processes, has environmental impact assessment and has introduced environmental audit as well as an eco-labelling scheme. Recent India's strategy is that environmentally harmful processes should be stopped and that over-exploitation of non-renewable resources should be controlled.

It should be noted that exports must often meet the product standard and to the extent that clean products require clean processes. The Government of India is also concerned with environmental problems and has set up Central Pollution Control Board .The different state governments have also set up State Pollution Control Board. These bodies are actively engaged to maintain the environmental standards. Moreover, wide ranges of instruments are used including legislation and regulation, fiscal incentives voluntary agreements and educational programmes. Several policy declarations and laws have contributed to the minimisation of GHG emission in India. These include the Forest Act (1980), the Air Pollution Act (1981, amended in 1987), the National Conservation Strategy (1992) and a Policy Statement on Abatement of Pollution (1992). More direct contributions to limiting growth in CO2 emission are brought about by the government's energy efficiency and conservation programmes and renewable energy programmes.

Policies for improving the energy efficiency and conservation have been introduced during the Eighth Five Year Plan. A comprehensive "National Energy Efficiency Programme" was launched during this period to coordinate and organise existing and new efforts on energy conservation in various sectors of the economy for achieving a targeted energy savings of about 5000mw in the electricity sector and 6 million tonnes of oil in the petroleum sector during the plan period. Various measures have been taken by the different industries in India to ensure quality and clean products for access to the markets of industrial countries for exportable. It should be noted that the dominance of fossil fuels in the import basket is the major cause of high pollution content.

To strengthen the above discussion on pollution haven hypotheses, we introduced one additional motivation for trade in our model. Since dirty industries are often capital intensive, we allowed countries to differ in relative factor endowments. That is, we investigated the implication of the factor endowments hypothesis as a competing theory of trade in dirty goods.

4.3 Evidence on factor endowment hypothesis from India's Trade with the Rest of the World

In this section we are discussing whether the factor haven hypothesis at all support Indian case while trading with European Union exclusively and rest of the world.

Two factors labour and capital are considered. We have estimated the capital and labour requirements to produce one million Rupees worth of typical exportable and importable in 1991-92 and 1996-97 respectively (table 4.7).

Table 4.7 here

Results show that India seems to have been endowed with less capital per worker than any other country in the world in 1991-92 and 1996-97 respectively because it is a labour surplus economy. Thus HO theory predicts that Indian exports would have required more labour (less capital per worker) than imports. We observe that Indian imports were 59% and 63% more capital intensive than Indian exports in 1991-92 and 1996-97. These results are more likely as India is a labour surplus economy. Its population size was 840 million 1991-92 and also the total labour force is estimated to be 500 million. However the total number of economically active population was around 280 million. It is a well known fact that India is not a capital rich country. The data shows that capital requirements in export and import have increased to 73.43% and 67% respectively during 1991-92 and 1996-97 (after liberalisation effect). But the labour requirement share in import has increased more in percentage i.e. 67% but its export counterpart has increased only 15.67%. the number of workers employed in manufacturing rose from 34.03 million in 1983 to 42.50 million in 199394 and further to 48 million in 99-00. In absolute term this look quite impressive. However in percentage terms, the importance of manufacturing as a provider of employment has not changed significantly. In fact, there was no improvement over the ten year period 1983-93 as in both the years manufacturing accounted for 11.3% of the employed workers. Thereafter, there is a marginal improvement, as the percentage of employed workers in manufacturing rose to 12.1% in 99-00. In case of mining and quarrying, electricity gas and water supply remained .6% and .3% respectively in 1997-98. Transport, storage and communications are important segments of the infrastructure but their employment potential is rather limited. Over the period in absolute terms employment in this sector has rapidly grown. The number of employed workers increased from 1.7 million in 1983 to 5.05 in 1999-00. But the fact remains that even now in absolute terms the total employment in this sector is not much. This shows that its employment potential is rather limited.

Overall this finding is not in the tune of Leontief findings on US. Leontief observes that US imports were 30% more capital intensive than US exports for the year 1947. This is known as Leontief paradox as it contradicts the HO theory which predicts that the US exports would have required more capital per worker than US imports. This finding generated debate in the trade theory which has not yet been dissolved (Treflar, 1995). Our factor endowments findings have important implications for the recent trade environment debate.

4.4:: Evidence on factor endowment hypothesis from India's Trade with the European Union

Here we have also tested the factor endowment hypothesis exclusively for Europe is elaborated in table 4.8.

Table 4.8 here

We observe that Indian imports from EU were 128% and 114% more capital intensive than Indian exports to EU in 1991-92 and 1996-97. These results are obvious as India is a labour surplus economy. From these results it seems that Indian case supports the factor endowment hypothesis which is obvious by taking into account the pollution haven hypothesis. The trend remains the same of labour and capital requirements but the share dominates more when India's trade exclusively with European Union. The basic reasons are the composition of trade; type of commodities traded and share of capital and labour requirements exactly to follow up trade.

Regarding the share of labour requirement compared to capital is declining. Various reasons can be accounted for that. Interestingly, despite economic reforms growth rate of employment in the organised sector has shown a tendency to decline. After the liberalisation the share of public sector is fading but on the other hand private sectors are gaining. It is now well established that the profit maximising business corporates would never generate the amount of employment that the public sector generated in the past. Overall the pattern of growth over the 1990s did not generate much employment in urban areas. The govt policy systematically worked against the interest of most small producers who employed the most labour intensive forms of urban production and accounted for the dominant part of urban manufacturing employment.

Above all most important theoretical weakness should be addressed here. As we have mentioned that factors (labour and capital) so far we have estimated from Europe's segment to India as Europe's export to India is basically from the point of view of India's factor requirements in producing each unit of output's. The same logic has also been applied in case of the rest of the world also. This is as it is said in HOV model or in Hecksher-Ohlin- Samuleson.

As we observed in this section that the factor endowment hypothesis maintains that pollution intensities of production are highly correlated with capital intensities (see e.g. Copeland and Taylor, 2003). In that case, capital-abundant countries (i.e. typically rich, developed countries) have a comparative advantage in pollution intensive goods, which they will export according to the HO theory theoretically known as factor haven hypothesis (FHH).The world wide debate concerning the issue of pollution haven and factor endowments parallely due to several factors. But the interaction of these two conflicting hypothesis rests on the fact of labour and capital requirements per unit of emission generation. The integration of these two hypotheses is estimated in table 4.9.

Table 4.9 here

Where P belongs to the emission generation (CO_2) from fossil fuel combustion, L_X and L_X^{eu} are labour requirements in total exports and exports to EU respectively. Similar interpretation has also been applied for capital.

Table 4.9 integrates the two conflicting hypotheses in a single concept. This is done by establishing the relationship between emission generation and its corresponding capital and labour's contribution. The above table (4.9) highlights the fact that one unit of labour's contribution per unit of emission generation is less than its capital counterpart in case of both exports and imports. Moreover the significant contribution occurred in emission generation per unit of Capital in importable (P/K_m) than its labour counterpart (P/L_m) [i.e.(P/K_m) > (P/L_m)]. The same hypothesis is observed in EU case also. Over period changes are also significant. The common reason against the fact reflects that Indian economy is moving towards more capital intensive than labour. Contribution of Emission will also depend on this fact which might be responsible for changing the results of the factor endowment hypothesis in future.

As our study deals with the period of 1991-92 and 1996-97, the first half of 90s, altogether supports the factor endowment hypothesis by challenging the pollution haven. The study also challenges the famous paradox of Leontief.

Since comparative advantage is determined jointly by differences in pollution policy and differences in factor endowments, most of the predictions of pollution haven model can be reversed in a world where factor endowments matter, and hence our simple model can provide a potential resolution to the puzzle we began with. Dirty good production can remain in high-income countries despite much tighter regulation if these cost disadvantages are offset by other factors.

The work has shown the impact of trade liberalisation on environment in India. The most important conclusion from the results (Tables 4.1, 4.4) that India cannot be characterized as a pollution haven. The idea was that an increase of trade implies extra pollution because exports increase but less pollution because imports increase (which are no longer produced at home any more). To have pollution haven the first effect exceeds the second effect, thus leading to increase in the net effect in pollution. Pollution haven exports dirty products and imports relatively clean products. It is clear from the results of the present study that import related pollution is much larger than the export related pollution. Hence India gains in terms of emission from trade. It should be noted that for a country to be characterized as pollution haven it is necessary that a country losses from trade, while its trading partner (here Europe or the rest of the world excluding Europe) gains. The pollution haven hypothesis can thus be accepted only if both conditions are fulfilled. If one of the two conditions is not satisfied (as is the case for India) the hypothesis is rejected. But the other hypothesis supports as reflected in table (4.7 and 4.8)

The development overtime does not change the conclusion. But it provides a significant observation. In case of Europe the results reveal that values of PTOT though less than 100 have increased during the liberalised period. This indicates that India's trade with Europe during the liberalisation period has moved India towards pollution haven even in the early 90s. Recalling table 1.1, this reflects that India's, trade was favourable in 2001. More specifically, the export growth rate was more than import growth. It ensures that the value of PTOT could be more than 100 and composition of export related carbon emission forces continues to be dominant in 2001. Moreover, the labour content in export and import so also capital may react oppositely thus affecting factor endowment hypothesis results. Due to I-O data constraint the study could not apply the present methodology on 2001. ***It calls for further exploration.***

Section 5
Conclusion

The complex interrelationships between trade, environmental regulations and the composition of the global economy have become a focal point for international policy makers. With this in mind, this paper has examined trade patterns to ascertain whether comparative advantage in pollution intensive production is driven by environmental regulation differentials (the PHH) and/or factor endowment differentials (the FEH).

More specifically the present paper attempts to contribute on recent controversial debate on trade and environment by testing the two contradictory hypotheses i.e. pollution haven and factor endowments for India and rest of the world and also for EU exclusively. The environmental indicator for this study concentrates only on CO_2 emissions from fossil fuel combustion during 1990s. Overall the study measures India's environmental gains or losses from trade with other countries.

Results reveals that Indian evidence do not suffering from pollution heaven in both the cases by achieving the pollution terms of trade below 100 but it do support the factor endowments by exporting more labour intensive goods which are environment friendly as it is estimated in table 4.9.

Trade may lead to both a cleaner environment in poor countries and a reduction in global pollution. Poorly regulated Southern countries will necessarily gain from trade, while more stringently regulated Northern countries will gain as well. Our results also point out that differences in pollution policy alone need not imply that trade liberalization will force dirty industries to migrate to less regulated countries.

The factor endowments hypothesis turned out to be extremely important. Almost all of the predictions of the pollution haven hypothesis are reversed when factor abundance motives for trade are sufficiently strong. The factor endowments hypothesis also allows us to distinguish between situations where differences in regulation matter to trade in dirty goods- the pollution haven effect- from where they are the most crucial determinant of trade patterns- the pollution haven hypothesis. Without another motive for trade, these two results blur into one, and this has led to much confusion in the literature.

For example, our analysis indicates that inconsistency of pollution haven effect which is mainly dominated by pollution regulation differences(low pollution terms of trade, less than 100), but at the same time for factor endowment differences to be a much stronger determinant of trade patterns than pollution regulation differences (that is, the strong form of the pollution haven hypothesis fails).

The findings of the present work challenge the pollution haven hypotheses arguing that liberalization of trade policy in India has not been associated with pollution intensive industrial development. Our findings are in conformity with those of Birdsall and Wheeler (1993) on Latin America specially Chile. From case studies and econometric evidence they conclude that protected economies are more likely to favour pollution intensive industries while openness actually encourages cleaner industries through the importation of developed country pollution standards. However, the work of Machado et al. (2001) on Brazil does not corroborate our findings.

Other evidence suggests that trade flows which are primarily determined by factor endowments do not imply that pollution regulation differences are irrelevant; and it also suggests that trade flows which are affected by differences in pollution policy, after controlling for all other determinants of trade, does not imply that countries with relatively strict environmental regulation will export dirty goods (Copeland Taylor, 2003).

Studies from other countries reflect that (Copeland Taylor, 2003) factor endowment effects can reinforce pollution policy effects. Polluting industries that are intensive in unskilled labor or in natural resources that are abundant in low-income countries will be attracted to those low-income countries by both factor abundance and less stringent policy. We would therefore expect to see heterogeneity across industries as well as countries in how policy differences and factor endowments interact to determine trade patterns.

Some cases (Copeland Taylor, 2003) it has also seen that, even if rich countries do turn out to have a comparative advantage in dirty industries because of factor endowment effects, this does not mean that pollution policy is irrelevant for trade patterns. As our analysis indicates, for given levels of capital abundance, increases in the stringency of pollution policy erode a country's comparative advantage in dirty goods and tend to reduce dirty good exports.

The most interesting results reflect from the study by Cole et al. (2001). The trading partners selected for there study are: UK-Asia, USA-Asia, USA-Latin America, and Japan-Asia. In terms of support for the

PHH and/or the FEH, the testing of the two models provides mixed results. In the HOV model they found no evidence to suggest that environmental regulations are determining net exports, whilst they have seen some evidence to suggest that a country's capital endowment is a positive determinant of net exports. In their imperfect competition model, relative environmental regulation similarities determine intra-industry trade (indirectly indicative of a pollution haven effect), whilst an increase in capital-labour differentials actually increases intra-industry trade (contrary to the predictions of the FEH). Overall their evidence suggests that differences in environmental regulations and factor endowments are, to some extent, influencing global trade patterns. This raises the possibility of conflicting forces in operation which may cancel each other out during certain periods (1969-96). These discoveries are only made through an examination of North-South trade pairs, through an examination of sub-periods within their large time series, through an analysis of the individual components of trade and through the testing of a monopolistic competition trade theory.

Since the pollution haven and factor endowments hypotheses offer such different predictions, we have designed our empirical work to facilitate a weighing of their relative strength. Our results in this regard are surely provocative. Our empirical findings suggest that factor abundance motives for trade in dirty goods are more important than pollution haven motives. Since poor developing countries are capital-scarce, this implies that freer international trade will encourage dirty industry to migrate northward and not southward. This will make poor developing countries cleaner and not dirtier. In our case India being a developing and labour rich country gains from trade in terms of CO_2 emission.

Summarized, given that the pollution haven hypothesis can be viewed as a result of the HO theory, and given that the hypothesis was rejected for India, it seems that this gives rise to a green Leontief paradox. Further empirical studies for other (developing) countries should indicate whether India is an exception or whether the Indian results hint at a general phenomenon. Our empirical finding supports the FHH based on theoretical consideration. Being a developing labour abundant country it exports labour intensive goods, which are clean in nature.

The present study covers only the early years of the liberalisation and its impact on environment. Much has changed in recent years and also going to change in days to come. So a detailed investigation of the impact of liberalisation of trade on environment using different environmental indicators will be a future agenda for research.Further priority work under the Committee and the United Nations Conference on Trade and Development (UNCTAD) should include elaborate studies for better understanding of the relationship between trade and environment, particularly for sustainable development in developing countries.

References

1. **Ahmed,N (2002)** Environmental Spillovers - Energy Use and Carbon Leakages in the OECD, Paper presented at the 14th International conference on Input-Output Techniques held at UQAM, Montreal, Canada 10-15th October
2. **Annual Survey of Industries(1991-92)** Government of India
3. **Annual Survey of Industries(1996-97)** Government of India
4. **Annual Report (2000)** EU – India Trade 1999, Mission of India to the European Union, Brussels
5. **Antweiler, W (1996)** The Pollution Terms of Trade , Economic Systems Research, Vol. 8(4) , 361-5
6. **Antweiler, W. B.R. Copeland and M.S. Taylor (2001**) Is Free Trade Good for the Environment? *American Economic Review*
7. **Birdsall, N & D. Wheeler (1993)** Trade Policy and Industrial Pollution in Latin America: Where are the Pollution Havens? *Journal of Environment and Development*, 2(1), (winter).
8. **Central Statistical Organization (2002)** National Accounts Statistics, Govt of India
9. **Cole M. A, Robert J. R. Elliott and Abdul K. Azhar(2001)** The Determinants of Trade in Pollution Intensive Industries: North-South Evidence, Working Paper, Department of Economics, University of Birmingham
10. **Copeland B. R. and M.S Taylor (2003)** Trade and the Environment: Theory and Evidence, Princeton: Princeton University Press
11. **Dasgupta S., A. Mody, S. Roy and D. Wheeler (1995)** Environmental Regulation and Development: A Cross-Country Empirical Analysis. World Bank, Policy Research Department, Working Paper No. 1448.
12. **Daly,H (1993)** Problems with free trade : neoclassical and steady state perspectives in : Zaelke ,D.,Orbuch,P, Housman ,R (eds) .Trade and Environment : Law ,Economics and Policy. Island Press, Washington, DC,: 147-57
13. **Eskeland,G.S. & A.E.Harrison (2003)** Moving to greener pastures? Multinationals and pollution haven hypothesis, *Journal of Development Economics*,70,: 1-23
14. **Fieleke,N.S (1975**) The energy content of US export and imports, Working paper no.51, Div.Int.Finance, Board of Governers, Federal Reserve System.
15. **Gallagher ,K & F. Ackerman (2000)** Trade Liberalization and Pollution Intensive Industry in Developing Countries: A Partial Equilibrium Approach, Global Development and environment Institute, Working Paper 00-03,October

16. **Gerilla, G. P, S. Kagawa & H. Inamura(2002)** International Trade and Carbon Emissions: A Case of China and Japan, Paper presented at the 14th International conference on Input-Output Techniques held at UQAM, Montreal, Canada 10-15th October
17. Gr**ossman G & A. B. Krueger(1992)** "Environmental Impacts of a North American Free Trade Agreement," CEPR Discussion Papers 644.
18. **Haan M.D (2002)** Extending the Scope of Environmental Indicators by Taking into Account International Trade Dependencies, Paper presented at the 14th International conference on Input-Output Techniques held at UQAM, Montreal, Canada 10-15th October
19. **Hayami ,H & M. Nakamura (2002)** CO2 Emission of Alternative Technologies and Bilateral Trade between Japan and Canada: Technology Option and Implication for Joint Implementation, Paper presented at the 14th International conference on Input-Output Techniques held at UQAM, Montreal, Canada 10-15th October
20. **Jones,T (1998)** Economic globalisation and the environment : an overview of the linkages in :OECD .Globalisation and the Environment : perspectives from OECD and dynamic non member economies, Paris, OECD(proceedings) :17-28.
21. **Khrushch, M (1996)** Carbon emissions embodied in manufacturing trade and international freight of the eleven OECD countries. Berkeley: University of California, Berkeley (MSC.'s Thesis).
22. **Lange, G-M. (1998)** "Applying an integrated natural resource accounts and input-output model to development planning in Indonesia", Economic Systems Research, 10 (2): 113-34.
23. **Lange G-M & R. Hassan (2002)**Trade and the Environment in Southern Africa: The Impact of the 'User Pays' Principle for Water on Exports of Botswana, Namibia, and South Africa, Paper presented at the 14th International conference on Input-Output Techniques held at UQAM, Montreal, Canada 10-15th October
24. **Lenzen M. (2001)** A generalized input-output multiplier calculus for Australia, *Economic Systems Research* 13 (1), 65-92.
25. **Lenzen ,M & J. Munksgaard (2002)** Energy and Greenhouse Gas Emissions Embodied in Trade, Paper presented at the 14th International conference on Input-Output Techniques held at UQAM, Montreal, Canada 10-15th October
26. **Leontief, W (1951)** The Structure of American Economy ,1919-39, Second Edition, New York, Oxford University Press
27. **Low,D and A.Yates (1992)** Do dirty industries migrate, International trade and environment, World Bank Discussion paper 159
28. **Lucas, R.E.B., D. Wheeler & H. Hettige (1992)** Economic Development, Environmental Regulation and the International Migration of Toxic Industrial Pollution: 1960-88. in Low, P. (ed.) International Trade and the Environment. World Bank Discussion Paper No. 159.
29. **Machado,G,R.Schaeffer&E.Worrell(2001**)Energy and carbon embodied inthe international trade of Brazil: an input-output approach, *Ecological Economics* , 39(3): 409-424

30. **Munksgaard, J. & K.A. Pedersen (2001)** CO_2 Accounts for Open Economies: Producer or Consumer Responsibility*?* Energy Policy, 29(4): 327-35.
31. **Norsdorm,H & S, Vahugan (1999)** Trade and environment ,Special studies ,WTO, Geneva
32. **OECD(1997)** Economic globalisation and the environment, OECD Paris
33. **OECD(1998)** Statistics Directorate, Vol 5, OECD, Paris.
34. **Pearce,D & J, Warford (1993)** World Without End : Economics ,Environment and Sustainable Development .The World Bank, Washington, DC, OUP, New York
35. **Planning Commission (1995)** A Technical Note to the Eighth Plan of India, Input-Output Transaction Table for 1991-92, New Delhi, Govt. of India
36. **Planning Commission (2000)** Input-Output Transaction Table For 1996-97,New Delhi, Govt. of India
37. **Proops, J.L., G.Atkinson, B.F.V .Schlotheim & S, Simon (1999)** International trade and the sustainability footprint: a practical criterion for its assessment , Ecological Economics 28:75-97
38. **Przybylinski.M (2002)** Bilateral “Pollution Flows” between Poland and Germany, Paper presented at the 14th International conference on Input-Output Techniques held at UQAM, Montreal, Canada 10-15th October
39. **Schaeffer, R & SÁ, André Leal de (1996)** “The embodiment of carbon associated with Brazilian imports and exports”, Energy Conversion and Management, 37 (6-8): 955-60.
40. **UNFCC (1992)** United Nations Convention on Climate Change, UN, New York
41. **Wheeler, D and P. Martin (1992)** "Prices, Policies, and the International Diffusion of Clean Technology: The Case of Wood Pulp Production," in P. Low (ed.), International Trade and the Environment, (Washington: World Bank}
42. **Wright, D.J (1974)** Goods and services: an input -output analysis, *Energy Policy*, 2(4): 307-15
43. **Wadeskog, A (2002)** Trade and the Environment in Input-Output Based Environmentally Accounts Analysis, Paper presented at the 14th International conference on Input-Output Techniques held at UQAM, Montreal, Canada 10-15th October
44. **Wyckoff, A.W., & J.M. Roop (1994)** The embodiment of carbon in imports of manufactured products: Implications for international agreements on greenhouse gas emissions, Energy Policy, 22(3): 187-94
45. **Xing,Y and C. Kolstad(2002)** Do lax environmental regulations attract foreign investment? Environmental and Resource Economics, 21:1-22.

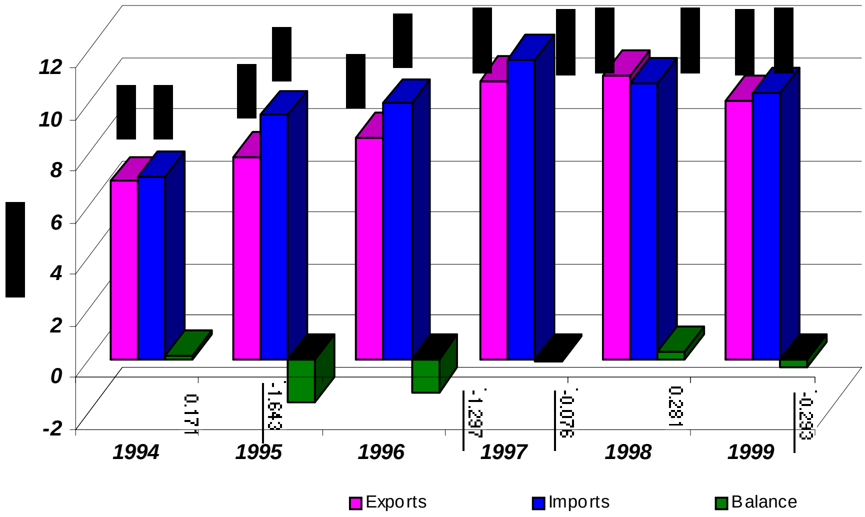

Figure 1: India's trade with the European Union

Source: India-EU Annual Report, 1999, Brussels

Table 1.1
India-EU Trade (1991-2001) (in Euro Million)

Year	Export	Import	Total
1991	4756	5219	9975
1992	4878	5246	10124
1993	5880	6294	12174
1994	6912	7053	13965
1995	7794	9442	17236
1996	8588	9895	18483
1997	9465	10208	19673
1998	9790	9539	19329
1999	10020	10344	20364
2000	12341	13303	25644
2001	12941	12610	25524

Source: India-EU Annual Report, 1999,Brussels

Table 4.1

Pollution terms of trade of India with rest of the world for CO_2 emission in 1991-92 and 1996-97

CO_2 emission	**1991-92**	**1996-97**
Pollution embodied in exports	107.77	199.02
Pollution embodied in imports	215.55	378.75
Pollution terms of trade	.4976	.5264
Pollution terms of trade*100	49.76	52.64

Table 4.2: Share of exports and imports of India in 1991-92 and 1996-97(percentage)

	Export 1991-92	*Import 1991-92*	*Export 1996-97*	*Import1996-97*
Coal &lignite.	0.035716	0.537832	0.019455	0.153541
Crude petroleum. &natural gas	0	7.961783	0	3.895727
Electricity	0.016153	0	0.008701	0.044389
Cereals and pulses	0.873887	0.725895	0.791691	0.594064
Sugarcane	0	0	0	0
Jute	0	0.015237	0	0.013654
Cotton	1.469759	0.228421	0.962875	0.20117
Tea and coffee	0.818607	0	0.270219	0
Rubber	0	0.012354	0	0.007999
Other crops	4.422739	0.387245	4.147393	0.290569
Animal husbandry	0.313192	0.630491	0.217612	0.627373
Forestry &logging	0	0.853009	0	0.828623
Fishing	2.191268	0.005491	1.760784	0.007351
Other minerals	1.340893	9.678097	1.138214	13.82845
Sugar	0.075023	0.014276	0.082122	0.044389
Hydrogenated oil	0	0.022101	0	0.020224
Other food & beverages	2.877598	0.892269	1.854295	1.087134
Cotton textiles	4.803236	0.09609	4.820633	0.095587
Other textiles	12.87444	0.919723	14.17897	0.916886
Wood &wood products	0.040383	0.073029	0.028058	0.07602
Paper &paper products	0.071074	1.541154	0.049468	1.661711
Leather &leather products	6.049005	0.092796	6.627209	0.114736
Rubber products	1.942868	0.130683	1.35002	0.12689
Plastic products	0.418726	0.144685	0.291043	0.094832
Petroleum products	1.965662	6.78289	1.072273	8.925863
Fertilizer	0.005205	2.552301	0.004595	2.414714
Pesticides	0.214658	0.192318	0.261811	0.18432
Other chemicals.	5.101711	10.72123	6.224227	6.833873
Cement	0	0.005491	0.053086	0.044291
Other non metallic mineral products	0.705355	0.340572	0.384309	0.226986
Iron &steel	0.601257	3.363167	0.433191	3.290211
Non ferrous metals	0.260066	1.781792	0.207161	1.472003
Agricultural machinery and other non electrical mach.	3.108768	17.87256	2.802496	18.05541
Electrical machinery	1.285613	2.874616	1.080387	3.499167
Communication equipments	0.044511	0.893642	0.029525	0.762093
Electronic equipments	0.8554	3.552877	3.253089	5.339126
Rail and other transport equipments	1.786003	4.799445	1.54457	4.257336
Other manufacturing.	9.999533	4.88675	13.5874	2.659651
Construction	0	0	0	0
Rail and other transport services	6.87192	8.595294	5.610368	10.31389
Communication	0.20353	0.347985	0.110473	0.41737
Trade	10.89496	0	16.91254	0
Other services	15.46128	5.474412	7.829703	6.572397
Total	100	100	100	100

Table 4.3:Carbon content of exportable and importable in India

	Sectors	Carbon content of import in India 1991-92	Carbon content of export from India 1991-92	Carbon content of import in India 1996-97	Carbon content of export from India 1996-97
1.	Coal and Lignite	0.854392	0.043396	0.341298	0.039271
2	Crude petroleum and Natural Gas	6.05621	0	6.347519	0
3	Electricity	0	0.074478	0.365945	0.065134
4	Cereals and Pulses	1.042725591	0.960103904	1.25997068	1.524783693
5	Sugarcane	0	0	0	0
6	Jute	0.00388033	0	0.00532638	0
7	Cotton	0.365551986	1.798981499	0.472830063	2.055120603
8	Tea and Coffee	0	0.238294905	0	0.181556095
9	Rubber	0.009673114	0	0.009053426	0
10	Other Crops	0.224407131	1.96024123	0.261679437	3.391726884
11	Animal Husbandry	0.365847418	0.138994937	0.603709682	0.190156419
12	Forestry and Logging	0.271736881	0	0.432419789	0
13	Fishing	0.003046041	0.929727822	0.017459384	3.797753491
14	Metals and Non-metallic Minerals	12.89704231	1.366662456	36.518247	2.729516546
15	Sugar	0.019868813	0.079857345	0.097122598	0.163165964
16	Hydrogenated Oil	0.050512203	0	0.081928691	0
17	Other Food and Beverages	1.228441349	3.03009233	2.725994165	4.22226791
18	Cotton Textiles	0.209278203	8.00100467	0.335245926	15.35306153
19	Other Textiles	1.474932275	15.79102118	2.553715405	35.86140515
20	Wood and Wood Products	0.039553104	0.016728286	0.063065732	0.021137294
21	Paper and Paper Products	4.242951697	0.149657867	6.335397677	0.1712663
22	Leather and Leather Products	0.095708496	4.771691469	0.177186419	9.293649788
23	Rubber products	0.162199372	1.844336351	0.209929678	2.028208856
24	Plastic Products	0.117283255	0.259603258	0.143687215	0.400446396
25	Petroleum Products	55.05551	12.20286	99.98702	10.98747
26	Fertilizers	12.74885144	0.019884725	14.7460234	0.025480636
27	Pesticides	0.250542218	0.213881865	0.373696038	0.482014252
28	Other Chemicals	20.12990462	7.326221337	21.98155503	18.18034728
29	Cement	0.019750317	0	0.204556332	0.22263798
30	Other Non-metallic Mineral Products	0.948630886	1.502668029	0.982225532	1.510141022
31	Iron and Steel	11.54686556	1.578857128	23.72335674	2.838222149
32	Nonferrous Metals	6.497375078	0.725323304	9.350073767	1.19492463
33	Agricultural and Other	32.64222958	4.342586358	74.69983914	10.52888973
34	Non-electrical Machinery	4.591403047	1.570518123	5.971409515	1.674236878
35	Electrical Machinery	0.839626371	0.031985767	1.343653846	0.047270419
36	Communication Equipment	4.305863856	0.792896497	9.669877923	5.350224689
37	Electronic Equipment	6.055448449	1.723472457	11.78638221	3.883070882
38	Rail and Other Transport Equipment	7.797485559	12.20340769	5.147283247	23.87894362
39	Other Manufacturing	0	0	0	0
40	Construction	19.90643312	12.17244289	35.03897998	17.31782666
41	Rail and Other Transport Services	0.16227791	0.072592958	0.308930386	0.074254214
42	Communication	0	4.962597113	0	15.02736729
43	Trade and other services	2.257079692	4.875529841	4.06085705	4.393033294
	Total	**215.4905**	**107.7727**	**378.7545**	**199.0241**

Table 4.4: Pollution terms of trade of India with EU for CO_2 in 1991-92 and 1996-97

CO_2 emission	1991-92	1996-97
Pollution embodied in exports	25.63	69.91
Pollution embodied in imports	36.19	94.66
Pollution terms of trade	.7120	.7385
Pollution terms of trade*100	71.20	73.85

Table 4.5: Share of exports and imports of India with European Union (percentage)

Sectors	*1991-92*		*1996-97*	
	Exports	**Imports**	**Export**	**Imports**
Coal &lignite.	0	0.022714	0.0017088	0.01209
Crude petroleum .& natural gas	0	0	0	0
Electricity	0	0	0	0
Cereals and pulses	0.690814	0.017256	1.01608534	0.011838
Sugarcane	0	0	0	0
Jute	0	0	0	0
Cotton	0	0	0	0
Tea and coffee	2.620986	0	2.33024988	0.00326
Rubber	0	0.015644	0	0.002626
Other crops	2.375676	0.479483	7.19683537	0.54423
Animal husbandry	0.295023	0.218128	0.10039138	0.408336
Forestry &logging	0	0	0	0
Fishing	3.174387	0.001378	4.1502137	0.017618
Other minerals	1.67288	8.036976	0.36708791	7.444788
Sugar	0.322546	0.01747	0.14202081	0.016426
Hydrogenated oil	0	0.024447	0	0.003951
Other food & beverages	2.003014	2.13981	1.60277039	0.178149
Cotton textiles	1.686175	0.395711	1.8358247	0.285899
Other textiles	22.81052	0.404712	24.4893961	1.723771
Wood &wood products	0.155566	3.042173	0.03276484	0.008713
Paper &paper products	0.04291	2.876014	0.01566729	1.818858
Leather &leather products	7.905565	0.298419	9.25276401	0.149358
Rubber products	0.127373	0.276002	0.44664456	0.376421
Plastic products	0.195761	0.40526	0.26636043	0.072921
Petroleum products	1.873967	2.647747	0.86364018	0.898392
Fertilizer	0.006541	3.027376	0.00026541	0.348061
Pesticides	0	0	0	0
Other chemicals.	7.706026	10.44507	6.41670022	10.472814
Cement	0	0	0	0
Other non metallic mineral products	3.288972	1.340056	0.29936757	0.689558
Iron &steel	1.74486	7.657268	0.20883678	5.782082
Non ferrous metals	1.072541	4.42042	0.38180929	1.154052
Agricultural machinery and other non electrical mach.	0.800101	18.44497	1.47208338	19.45944
Electrical machinery	1.463655	11.56353	1.89167129	30.19409
Communication equipments	0.206243	1.514105	0.02997354	1.548354
Electronic equipments	0	0	0	0
Rail and other transport equipments	1.045134	6.488738	2.1518333	2.998618
Other manufacturing.	34.60447	12.646156	32.971721	12.3459
Construction	0	0	0	0
Rail and other transport services	0	0	0	0
Communication	0.108257	1.133016	0.0653018	1.029364
Trade	0	0	0	0
Other services	0	0	0	0
Total	100	100	100	100

Table 4.6:Carbon content of exportable and importable of India and EU(mt of CO_2)

Sectors		Carbon content of export to EU 1991-92	Carbon content of Import to EU 1991-92	Carbon content of export to EU 1996-97	Carbon content of Import to EU 1996-97
1.	Coal and Lignite	0	2.199101	0.41743	3.304063
2	Crude petroleum and Natural Gas	0	0	0	0
3	Electricity	0	0	0	0
4	Cereals and Pulses	0.150523	0.003928	0.588999	0.007677
5	Sugarcane	0	0	0	0
6	Jute	0	0	0	0
7	Cotton	0	0	0	0
8	Tea and Coffee	0.151314774	0	0.06678354	0.000737499
9	Rubber	0	0.001940904	0	0.000908705
10	Other Crops	0.208825054	0.044028073	1.771410157	0.149856603
11	Animal Husbandry	0.025966962	0.020055685	0.026403149	0.120141448
12	Forestry and Logging	0	0	0	0
13	Fishing	0.267114496	0.000121092	2.694157745	0.012794632
14	Metals and Non-metallic Minerals	0.338149913	1.697063217	0.264949764	6.011204729
15	Sugar	0.068091317	0.003852662	0.084929044	0.010988728
16	Hydrogenated Oil	0	0.008853754	0	0.004894321
17	Other Food and Beverages	0.418299062	0.466808916	1.098424303	0.136583785
18	Cotton Textiles	0.557045351	0.136561041	1.759762162	0.306584813
19	Other Textiles	5.548739894	0.10284102	16.35830828	1.467945154
20	Wood and Wood Products	0.012780404	0.003619301	0.007428986	0.002210008
21	Paper and Paper Products	0.017919519	1.254637351	0.0163256	2.120263298
22	Leather and Leather Products	1.236797431	0.048770049	3.905340803	0.070523356
23	Rubber products	0.02398016	0.054280935	0.201960514	0.190412072
24	Plastic Products	0.024070437	0.052053754	0.110303485	0.033782375
25	Petroleum Products	2.307236792	3.40539654	2.644133281	3.077034249
26	Fertilizers	0.004956	2.396132	0.000443	0.649887
27	Pesticides	0	0	0	0
28	Other Chemicals	2.194683561	4.595070944	5.641054951	4.398910463
29	Cement	0	0	0	0
30	Other Non-metallic Mineral Products	1.38960877	0.150087068	0.354057004	0.912336966
31	Iron and Steel	0.908700144	4.165764206	0.411544173	12.74704296
32	Nonferrous Metals	0.593251937	1.976357796	0.662842004	2.241323404
33	Agricultural and Other	0.221657404	6.49557046	2.795326658	29.6758301
34	Non-electrical Machinery	0.354608057	2.926584944	1.348708886	22.01591208
35	Electrical Machinery	0.029393222	0.225415623	0.014443567	0.834684951
36	Communication Equipment	0	0	0	0
37	Electronic Equipment	0.200019062	1.297241097	1.628202108	2.538261187
38	Rail and Other Transport Equipment	8.375501828	2.186063158	19.02706226	1.388147811
39	Other Manufacturing	0	0	0	0
40	Construction	0	0	0	0
41	Rail and Other Transport Services	0.007657687	0.0837221110	0.013210576	0.232959951
42	Communication	0	0	0	0
43	Trade and other services	0	0	0	0
	Total	**25.6368**	**36.0019**	**63.9139**	**94.6639**

Table 4.7

Capital and labour requirements in exports and imports (India and rest of the world)				
	1991-92		**1996-97**	
	Capital requirements million rupees	**Labour requirements per million rupees of output**	**Capital requirements million rupees**	**Labour requirements per million rupees of output**
Exports	Akx=1306816	Alx=16797164	Akx=2266412	Alx=20547719
Imports	Akm=1422480	Alm=11498803	Akm =2374966	Alm= 13232407

1991-92

K_x = Akx/Alx = 77799.76

K_m =Akm/Alm = 123706.78

K_m = 1.59 K_x

1996-97

K_x = Akx/Alx = 110299.93

K_m =Akm/Alm = 179481.02

K_m = 1.63 K_x

Here Akx = capital requirements in exportable   Alm = labour requirements in importable

Alx = labour requirements in exportable   Akm = capital requirements in importable

K_x = ratio of capital and labour requirements in exportable

K_m = ratio of capital and labour requirements in importable

Table 4.8

Capital and labour requirements in exports and imports (India and EU)				
	1991-92		**1996-97**	
	Capital requirements million rupees	**Labour requirements per million rupees of output**	**Capital requirements million rupees**	**Labour requirements per million rupees of output**
Exports	Akx= 186479	Alx=2239341	Akx=611080	Alx=7678300
Imports	Akm=249473	Alm=1310710	Akm =864779	Alm= 5054458

1991-92

K_x = Akx/Alx = 83274

K_m =Akm/Alm =190334.24

K_m = 2.28K_x

1996-97

K_x = Akx/Alx = 79585.32

K_m =Akm/Alm = 171092.33

K_m = 2.14K_x

Table 4.9

Generation of CO_2 emission per unit of labour and capital

	1991-92	**1996-97**
India and rest of the world		
Emission generation per unit of Labour in exportable (P/L_X)	0.0000064118	0.0000096847
Emission generation per unit of Capital in exportable (P/K_X)	0.0000824141	0.000087804
Emission generation per unit of Labour in importable (P/L_m)	0.0000187454	0.0000286078
Emission generation per unit of Capital in importable (P/K_m)	0.000151531	0.000159392
India and EU		
Emission generation per unit of Labour in exportable $(P/L_X)^{eu}$	0.0000116106	0.0000091166
Emission generation per unit of Capital in exportable $(P/K_X)^{eu}$	0.000139426	0.000114551
Emission generation per unit of Labour in importable $(P/L_m)^{eu}$	0.000028229	0.0000187953
Emission generation per unit of Capital in importable $(P/K_m)^{eu}$	0.000148313	0.000109855