Environment and poverty in India: An Input-Output Approach*

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Abstract

In India, air pollution is restricted mostly to urban areas, where automobiles are the major contributors and to a few other areas with a concentration of industries and thermal power plants. The major pollutants are CO, SO2 and NOx. The major sources of air pollution in the country are industries (toxic gases), thermal power plants (fly ash and sulfur dioxide) and motor vehicles (carbon monoxide, lead, and particulate matter). Major polluting industries and automobiles emit tonnes of pollutant everyday thereby putting citizens to great health risks. Already Delhi has attained the dubious distinction of being the fourth most polluted city in the world. Among the 14 highly polluted cities in India Calcutta and Howrah scores the prominent position regarding annual concentration of SPM, SO_2 and NOx.

Incidence of poverty is high in India and about one third of the population is below poverty line that is largely affected by environmental hazards. How far the environmental hazards are caused by different income groups? Thus issue of environment and poverty is a matter of research.

However, very little work has been done on this problem in India. The present paper concerns with this.

The paper estimates the industrial emissions of CO_2 SO_2 and NO_X in India and sources of change is investigated. In addition, it also examines the sources of change of CO_2, SO_2 and NO_X in India generated by different income groups especially by the lower income groups.

To carry out the study the paper uses input-output structural decomposition analysis (SDA). Extension of the model incorporating different income groups is done. The study covers the period of 80s and 90s. Findings and policy options are presented in the paper.

Introduction

Environmental problems span a continuously growing range of pollutants hazards and ecosystem degradation over ever wider areas. Problems with energy supply and use are related not only to global warming, but also to such environmental concerns as air pollution, acid precipitation,, ozone depletion, forest destruction, and emission of radioactive substances. These issues must be taken into consideration simultaneously if humanity is to achieve a bright energy future with minimal environmental impacts. Much evidence exists, which suggests that the future will be negatively impacted if humans keep degrading the environment. The proposed study mainly estimates the pollutants emission (CO_2, SO_2 and NOx) by combustion of fossil fuels i.e. coal, crude oil and natural gas from industrial sector.

The environmental effects of these fuels are of growing concern owing to increasing consumption levels. Coal and oil are the two major sources of energy for industries and vehicles. The major sources of air pollution are the combustion of fuels for electricity generation, and transportation, industrial processes, heating and cooking. The pollutants SO_2 and NO_X produced by the combustion of fossil fuels, particularly for both stationary and mobile source such as smelters for non ferrous ores, industrial boilers and transportation vehicles. The emission of CO_2 occurs wherever fossil fuels are burnt. A part from that energy in the form of biomass, containing carbon fixed from the atmosphere, releases CO_2 into the atmosphere when burnt.

The combustion of these fuels in industries and vehicles in particular has been a major source of pollution posing health hazards. The adverse health effects of air pollution are now well recognized (Romieu, and Hernandez, 1999). The health effects of SPM, CO, SO_2 and NO_X include cardiovascular and respiratory diseases, chronic bronchitis, reduced visibility, increased morbidity etc. Certain environmental pollutants have reached levels that are well in excess of levels judged to be adequate to safeguards health.

The adverse effect of air pollution depends on the level of exposure, the population structure, the nutritional status and the lifestyle. It is observed that the effects are higher in developing nations than developed ones. Reports from the developing countries show a causal relationship between air pollution and health effects. The number of people living below poverty line is higher in developing countries. Poor people are often seen as compelled to exploit they’re surrounding for short-term survival, and are assumed to be the ones most exposed to natural resources degradation. Although the current fossil fuel use in developing countries is still half that of developed countries, it is expected to increase by 120% by the year 2010. If control measures are not implemented, it has been estimated that by the year 2020 more than 6.34 million deaths will occur in developing countries due to ambient concentrations of particulate air pollution (Romieu, and Hernandez, 1999).

Most evidence suggests that populations living in cities with high levels of air pollution in developing countries experience similar or greater adverse effects of air pollution (Romieu, and Hernandez,1999).A study by (Smith et al. 1999) also demonstrates that around 40 to 60 % of acute respiratory infections are due to environmental causes.

Indian scenario is also alarming. A recent survey by Central Pollution Control Board India (CPCB) has identified 23 Indian cities to be critically polluted. 12 major metropolitan cities in India produce 352 tonnes of oxides of nitrogen, 1916 tonnes of carbon mono oxides from vehicular emission and 672 tonnes of hydrocarbon. The CO_2 SO_2 and NO_X in the ambient air of India is above the WHO safe limit. It is needless to say that at this level, pollution of urban air is likely to have a serious impact on the health of the community. The patterns of disease and death exhibited in Indian health data are highly suggestive of the possible importance of environmental factors in today’s Indian health scene.

People who live in poverty are those exposed to the worst environmental and health risks. Overall, somewhere between 25% and 33% of the global burden of diseases can be attributed to environmental factors. This proportion is larger in conditions of poverty, where more environmental hazards are present in the nearby living and working environment, and people have less capacity to protect themselves against exposure and effects of harmful and unpleasant pollutants. The environmental threats facing poor people tend to be more directly hazardous to human health’s we know that pollution related health hazards is not uniform in all income groups. It affects the lower income groups’ more than upper income groups. Incidence of poverty is high in India and about one third of the population is below poverty line that is largely affected by environmental hazards.

The impacts on health associated with energy use are inevitable as development is linked with the energy consumption levels. However a comprehensive epidemiological assessment of the situation has not been made in India. The present study will address in a modest way the link between poverty and air pollution. More elaborately it explains the pollution generated by which groups exactly (lower income groups / higher income groups) and who will suffer. Whether the pollution generated group is different from the suffering group or it remains same. All basic questions may arise in this context. Normally we have seen from other studies that higher income groups are consumed mainly the fossil fuel based energy more than the middle or lower income groups. But in the present study which group facilitates exactly to generate more pollution is estimated here.

The objective of the present study is to estimate the industrial emissions of CO2, SO2 and NOX in India during 1983-84 to 1993-94. Changes in emissions and effects of various sources of change in industrial CO_2 SO_2 and NOX emissions have been investigated using input-output structural decomposition analysis (SDA) for the year 1983-84, 1989-90 and 1993-94. Further the study will estimate the pollution generated by each income groups i.e. how much shared by higher and how much by middle and lower.

The organization of the paper is as follows: Section 2 deals with the selected literature. Model formulation is explained in section 3. Data collection and processing is explained in section 4. Section 5 discusses the results and concluding remarks is outlined in section 6.

SECTION 2

Review of the Literature

In developing countries the price of rapid growth is all too often noxious airborne pollution, which annually contributes to a disturbing number of avoidable deaths. In recent decades, however, there has been considerable progress in the epidemiology of air pollution, significant changes in international air pollution guidelines, and the emergence of more systematic approaches to air pollution control. While many of these advances have originated in affluent countries, there have been major developments in other parts of the world.

There are several studies that have established the linkage between environmental pollution and health impact. More specifically the fact is empirically tested that air pollution affects health. Studies by Holgate et al (1999), Calthrop and Maddison (1996), Gerking and Stanley (1997), McCubin et al (1999) Evans and Smith (2002), Cifuentes and Lave (1993), Larson et al. (1999), Vazquez et al. (1999), Toma (2000), Alberini et al. (2000), Samet et al. (2000) capturing the health impact of air pollution. Cifuentes and Lave (1993) have estimated the marginal benefit of air pollution abatement due to health effects of most important pollutants (suspended particulate, SO_2, NO_2 and O_3) for US economy. Toma (2000) studied impact of outdoor air pollution on long-term public health in Austria, France and Switzerland. Results show that chronic bronchitis, bronchitis in children and person days of restricted activities are due to air pollution in these countries. Cost of illness and willingness to pay estimates of the damages from respiratory illness associated with air pollution are compensated using data in Taiwan in 1991-92 by Alberini et al. (2000). A contingent valuation survey was conducted to estimate WTP to avoid respiratory illness. Air Pollution and Mortality in 20 of the largest cities in the United States, from 1987-1994 have been developed by Samet et al. (2000). The analyses provide evidence that air pollution with particles is still adversely affecting the public health and strengthen the rationale for limiting concentrations of respirable particles in outdoor air.

Studies by Agarwal (1999), Gupta, Keswani and Malhotra (1997), Sikdar and Mondal (1999), Chitkara (1997), Sinha & Bandyopadhyay (1998), Romieu and Hernandez (2003), Saksena and Smith (2003) analyses the causal relation between air pollution and health hazards in India.

A World Bank study in 1995 (Agarwal, 1999) formulated a model establish the relationship between air pollution and human morbidity and mortality. The model was subsequently used to assess environmental and health condition in India. Using air quality data for 1991-92 provided by Central Pollution Control Board (CPCB) from 290 monitoring station in 92 Indian cities and towns and researchers found that air pollution results in 40351 premature deaths in India. Calcutta, Mumbai and Delhi accounted for 5726 (14%), 4477 (11%), and 7491 (19%), respectively. Substituting the CPCB air quality data for 1991-92 by the corresponding 1995 data, researchers at the Centre for Science and Environment (CSE) found that the figures for number of premature deaths increased to 51779 – a rise of 28%. Calcutta, Delhi, Mumbai, Kanpur and Ahmedabad accounted for 10,647,9859,3639,3006 premature deaths respectively (Brandon & Hommann (1991-92) and Anon (1997)). These cities account for 66% of the total premature deaths from air pollution in India. The total estimates of annual episodes of illness due to SPM in the air have increased from 19805388 in 1991-92 to 25645721 in 1995. about 51779 people were estimated to have died prematurely in 33 Indian cities due to air pollution in 1995 as against 40351 in 1991-92, a rise of 28% over the period. Thus the country is paying a heavy price as a result of deaths and incidences of illness due to ambient SPM.

Gupta, Keswani and Malhotra (1997) estimate GHG emissions for three reference years 1980-81, 1985-86 and 1987-88 using a simple spreadsheet model. Bose (1998) has constructed a transport simulation model to evaluate automotive energy use and control of emissions for four Indian metropolises during 1990-2011 (Calcutta, Bombay, Delhi, and Bangalore).

Sikdar and Mondal (1999) have conducted a study on air pollution (TSP, SO2, NOx, CO_2) in Calcutta. They have identified vehicular emission as a primary source of these pollutants. They have stated few regions as most polluted and also added that the pollutants are carried by northerly wind during the winter season from more polluted region to less polluted one. They suggested that an air quality management on reducing stationary source and mobile source emissions will help to mitigate the air pollution and improve the quality of life. A study by Sinha & Bandyopadhyay (1998) tried to capture the metallic constituents of aerosol present in biosphere, which have been identified as potential health hazards to human beings. A similar study made by Sharma et.al. (1999) concentrates on acute respiratory infections in urban slum area in India.

Chitkara (1997), on the other, hand presents a brief review on air pollutants and its related health hazards. According to her study air pollution depends on three factors i.e. 1) source of emissions e.g. industrial vehicular land use etc, 2) meterological conditions e.g. river valleys, coastal areas, mountains, etc. and 3) time. She also explains the factors affecting air pollution, emissions discharges and their source (vehicular emission, domestic emission, industrial emission, emission due to energy). TERI (1997) has carried out few estimates based on the effects of SO_2, particulate matter, carbon monooxide and carboxyhaemoglobin at various concentrations (ppm), exposure (time) and corresponding health effects.

Cropper et al. (1997) have examined the impact of particulate air pollution (SO_2, TSP) on daily mortality in Delhi. They have found a positive significant relationship between particulate pollution and daily non-traumatic deaths, as well as deaths from certain causes (respiratory and cardiovascular problems) and for certain age groups. Romieu and Hernandez (2003) stated that difference in relation to the level of exposure and co-exposure to the different pollutants mixtures, the population structure, the nutritional status and the lifestyle observed in developing nations suggests that the adverse effect of air pollution may be even greater than those observed in the developed nations. They reviewed the epidemiological studies that describe the health effects of various air pollutants (including particulate matter, sulphur dioxide, nitrogen dioxide, ozone, carbon monoxide and lead) for different cities of the developing world. Saksena and Smith (2003) examine the potential impact of indoor air pollution on health in developing countries, with a particular emphasis on exposure to particulates.

Chabra (1996) establishes air pollution as one of the major causative factor behind the 10-12% incidence of bronchial asthma in the age group of 5-16 years in India. And he also argues that it is increasing significantly due to rapid growth of transport sector. In Calcutta, SO_2 levels are getting dangerously high – in some residential areas SO_2 have touched 175 mg/cu.m during winters. Calcutta has the dubious distinction of being placed sixth among the 41 most polluted cities when it comes to SO_2 and SPM levels, according to Global Pollution and Health, a report published in 1996 by WHO and the United Nations Environmental Programme (UNEP), while acceptable annual average level of SPM by WHO standards is 60-90 mg/cu.m, Calcutta’s average was 344.3 mg/cu.m in 1995. This increases significantly in winters. A study (WRI, 1998-99) shows that China’s air pollution levels are among the worlds highest. This is because of the China’s growing consumption of coal. Other studies like Pearce (1996) Navrud (2001) Matthew J. Neidell (2003) deserve mention.

Mukhopadhyay & Forssell (2001) estimated emission of CO2, SO2 and NOx in India using input-output method. They also tried to capture the health impact of air pollution in India. They concluded that a great number of people are affected by respiratory infection especially lower respiratory infections. Further people in the age group 65+ are largely affected. To study the impact of pollution on health they have developed a very preliminary regression analysis here relating emission of pollution to deaths due to diseases like asthma, whooping cough, acute respiratory infections and they found positive correlation between air pollution and health problems. Their result seems to be consistent with the empirical fact. India being a developing country with rather high air pollution should address the problem seriously.

SECTION 3

Model Formulation

In this section we will describe the Input-Output Structural Decomposition approach used in estimation of the pollutants emission (CO_2, SO_2 and NOx) and factors responsible for changes in emission. It will also estimate the emission generated by different income groups.

- **Advantage of the framework**

The methodology for relating economic activity to the natural environment in an Input-Output framework is convenient and popular. In particular, when modeling the use of various fuels by an economy with Input-Output method, the distinction must be made between fuels used by industries, to allow the production of the total output of those industries, and fuels used directly by final consumers .It is well known that Input-Output analysis is a suitable tool for assessing resource or pollutant embodiments in goods and services. The second advantage lies on the part of assessing the role of different income groups through multiplier effect. So it is a unique technique to study the above problem in this regard.

- **Model 1**

The model starts with the basic concepts of the Input-Output framework of Leontief Mathematically, the structure of the input-output model can be expressed as:

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

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 .For an energy input-output model, the monetary flows in the energy rows in equation (2) are replaced with the physical flows of energy to construct the energy flows accounting identity, which conforms to the energy balance condition (Miller & Blair 1985). We apply a “hybrid method” based on Miller & Blair (1985), and it always conforms with energy conservation conditions.

For estimation of CO_2, SO_2 and NOx emission we have extended the above conventional input-output framework in one important respect i.e. we have to compute the amount of CO_2,

SO_2 and NOx emission that takes place in the production of various activity levels. We apply the fuel specific carbon, sulphur and nitrogen emission factors to the row vector of fossil fuel sector of the respective Input- Output table to estimate the total CO_2, SO_2 and NOx emitted by coal and oil sector. We use an emission factor of 0.55 (mt of CO_2)/mt for coal and 0.79(mt of CO_2)/mt for oil to arrive at carbon emissions by different sectors due to coal and oil separately. For sulpher emission factor we have taken .003 (mt of SO_2)/mt for coal and .015 (mt of SO_2)/mt for oil .For nitrogen emission .018(mt of NOx.)/mt for coal and .001 (mt of NOx)/ mt for oil .

Then we follow the normal convention of measurement, of carbon dioxide in carbon sulphur and nitrogen equivalent units. For conversion to CO_2, SO_2 and NOx units the carbon, sulphur and nitrogen emission figures are multiplied by 3.66, 2 and 3.28 respectively .It gives the total quantity of CO_2 , SO_2 and NOx emitted owing to burning of fossil fuel (coal ,oil) inputs used by various production sectors(industry).

On the basis of the above estimated figure we calculate the direct carbon dioxide sulphur dioxide and nitrogen oxide emission coefficient and total (direct and indirect) carbon dioxide sulphur dioxide and nitrogen oxide emission coefficient.

Let C = C(j) (**)

It is a vector of fossil fuel emission coefficients representing the volume of CO2, SO2 and NOx emissions per unit of output in different sectors. That is when the sectoral volume of CO2, SO2 and NOx emission is divided by sectoral output then it gives us the direct CO2, SO2 and NOx emission coefficient. The direct and indirect carbon sulphur and nitrogen emission coefficient of sector j can be defined as Cjrij, where rij is the (i,j)th element of the matrix (I-A)-1. The direct and indirect CO_2, SO_2 and NOx of a sector is defined as emission caused by the production vector needed to support final demand in that sector. This would depend not only on the direct and indirect emission coefficient of that sector but also on the level of sectoral final demand.

i) Emission model

Now in equation form of CO_2, SO_2 and NOx emissions from fossil fuel combustion can be calculated from industrial fuel data in the following manner.

$F = CtL1X = Ct\ L1\ (I - A)^{-1}\ Y$ -------- (3)

Here F as a vector, giving the total quantity of CO_2, SO_2 and NOx emissions from fossil fuel combustion only.

C as a vector of dimension m (mx1, of coefficients for CO_2, SO_2 and NOx emissions per unit of fossil fuel burnt.

L1 as a matrix (mxn) of the industrial consumption in energy units of m types of fuel per unit of total output of n industries.

Subscript t denotes the transpose of this vector.

In equation (3) CtL1= S carries only direct requirement of CO_2 , SO_2 and NOx intensities from industries and Ct $L1(I - A)^{-1}$ gives the direct as well as indirect requirement of CO_2,SO_2 and NOx intensities from industries .

So equation (3) explains the CO_2, SO_2 and NOx emissions due to fossil fuel combustion in India from production activities.

ii) Structural decomposition analysis

Next, we develop a Structural Decomposition Analysis [SDA] for this model. It is a technique to study over period changes. It has become a major tool for disentangling the growth in some variables over time, separating the changes in the variable into its constituent parts. SDA seeks to distinguish major sources of change in the structure of the economy broadly defined by means of a set of comparative static changes in key parameters of an Input-Output table.

The total industrial CO_2, SO_2 and NOx emissions (TE) can be expressed as:

$TE = \Delta F = SRY = S (I - A)^{-1} Y$ ------- (4)

Where $R= (I - A)^{-1}$

Here S represents the industrial CO_2, SO_2 and NOx intensity

According to the structural decomposition analysis method, the change in total CO_2 , SO_2 and NOx emissions between any two years i.e. year o and year t can be identified as :

$TE = \Delta F = S_t (I – A_t)^{-1} Y_t - S_o (I – A_o)^{-1} Y_o$ ----------- (5)

$= S_t R_t Y_t - S_o R_o Y_o$ ----------- (6)

$=S_t R_t Y_t - S_o R_t Y_t + S_o R_t Y_t - S_o R_o Y_o$ ----------- (7)

$= \Delta S R_t Y_t + S_o R_t Y_t - S_o R_o Y_o$ ----------- (8)

$= \Delta S\, R_t\, Y_t \;+ S_o\; R_t\, Y_t - \; S_o\; R_o\, Y_t + S_o\; R_o\, Y_t - \; S_o\; R_o\, Y_o$ ---------- (9)

$= \Delta S\, R_t\, Y_t \;+ S_o\, \Delta R Y_t + \; S_o\; R_o\, Y_t \; - \; S_o\; R_o\, Y_o$ ----------(10)

$=\Delta S\, R_t\, Y_t \;+ S_o\, \Delta R Y_t + \; S_o\; R_o\, \Delta Y$ ------------ (11)

The first term of equation (11) reflects the CO_2, SO_2 and NOx emission changes due to the changes of CO_2, SO_2 and NOx intensity of various industries.

The second term of Equation (11) defines the CO_2, SO_2 and NOx emission changes due to the changes in technical coefficient matrix.

And the third term of Equation (11) refers the CO_2, SO_2 and NOx emission changes due to the changes in the final demand of various industries.

Here t refers to the current period and o defines the previous period.

Only fuel NOx has been considered. Thermal NOx has not been taken into consideration.

Model 2

iii) Extension of the model incorporating different income groups

Now the final demand vector Y has been treated separately by breaking the total final demand as

Y = Y1 + Y2

Where Y1 = Cl + Cm + Ch -------- 12

Y2 = Y2 -------- 13

The term Cl carries the vector of household consumption belong to lower income groups.

The term Cm carries the vector of household consumption belong to middle income groups.

The term Ch carries the vector of household consumption belong to higher income groups.

The term Y2 signifies the vector of other final demand components like government consumption, change in stock, investment, export and import.

Now if we introduce equation 12 and 13 into equation 11 then it ultimately forms as

$=\Delta S\, R_t\; (Clt + Cmt + Cht + Y2t\,) + S_o\, \Delta R\; (Clt + Cmt + Cht + Y2t\,) + \; S_o\; R_o\, \Delta\, (Cl + Cm + Ch + Y2\,)$ ------------ (14)

So ultimately the first term of equation 14 gives

$=\Delta S\, R_t\, Clt + \Delta S\, R_t\, Cmt + \Delta S\, R_t\, Cht + \Delta S\, R_t\, Y2t$ -------- (14a)

Equation 14a reflects the changes in intensity of CO_2, SO_2 and NOx term by considering the different final demand groups.

Likewise the second term of equation 14

$= S_o \Delta R\ Clt + S_o \Delta R\ Cmt + S_o \Delta R\ Cht + S_o \Delta RY2t$ --------- (14b)

Equation 14b covers the changes in technical coefficient of CO_2, SO_2 and NOx term by considering the different final demand groups. Finally the third term of equation 14 reveals

$= S_o R_o \Delta Cl + S_o R_o \Delta Cm + S_o R_o \Delta Ch + S_o R_o \Delta\ Y2$ -------- (14c)

Equation 14c reflects the changes in final demand of CO_2, SO_2 and NOx term by considering the different final demand groups.

Each income group specific and rest of the final demands contribution for CO_2 emission can be figure out from equation (14a, 14b and 14c). By this categorisation we can estimate the degree of responsiveness of the responsible factors for CO_2, SO_2 and NOx emission in a special form.

$L = \Delta S\ R_t\ Clt + S_o \Delta R\ Clt + S_o R_o \Delta Cl$ ---------------- 15 (a)

$M = \Delta S\ R_t\ Cmt + S_o \Delta R\ Cmt + S_o R_o \Delta Cm$ ------------ 15 (b)

$H = \Delta S\ R_t\ Cht + S_o \Delta R\ Cht + S_o R_o \Delta Ch$ ------------------ 15 (c)

$Y2 = \Delta S\ R_t\ Y2t + S_o \Delta RY2t + S_o R_o \Delta\ Y2$ -------------- 15 (d)

The equations are presented in 15 a, b, c, d for lower, middle, higher income groups and rest of the final demand sectors respectively.

SECTION 4

Data source

To implement the model and to conduct the Structural Decomposition Analysis of energy consumption changes we have used Input - Output data, price indices, and energy flow data. Input-Output tables of the Indian economy for the years 1983-84, 1989-90, 1993-94 prepared by C.S.O (1985, 1992, 1999). For price deflator National Accounts Statistics and also for Energy data C.M.I.E (1991, 95, 98) report has been used.

Consumption Expenditure of different commodities for different expenditure class have been collected from the unpublished disaggregated data of National Sample Survey, 38^{th} ,45^{th} and 50^{th} round (NSSO, Govt of India).

Aggregation Scheme: Input-Output tables are Commodity by Commodity tables consisting of 115x115 sectors. These have been aggregated to 47 sectors on the basis of the nature of commodities and energy intensiveness. We have considered three energy sectors coal, crude oil &natural gas and electricity separated and other 112 non energy sectors have been aggregated to 44 sectors. To make the Input-Output tables of 1983-84, 1989-90 and 1993-94 comparable the three tables must be evaluated at some constant prices. We use 1983-84 as a base year and adjust 1989-90 and 1993-94 table to 1983-84 prices using price indices. We convert the monetary units of energy sectors into physical unit from the energy data published by C.M.I.E (1991, 1995 and 1998) report. Three energy sectors like coal as million tonnes, crude petroleum in million tonnes, natural gas in million cubic meter and electricity in T.W.H have been converted into one common unit which is million tonnes of oil equivalent.

NSSO

a) Data Specification: NSSO data for 38th Round (1983-84), 45th Round (1989-90) and 50th Round (1993-94) has been bought (from NSS Office, New Delhi) which were in the .dat format, and converted to required format using SPSS 10.0.

b) Conversion of NSS data in compatible form : NSS data is compatible to many data base and econometric software. But in our case the consumer expenditure dataset is huge. For e.g. 1993-94 data for food item consists of around 26 lacs rows for urban and 37 lacs for the rural data, for other items are in figure of 14 lacs and 13 lacs for rural and 10 and 11 lacs for urban respectively. Thus we have used SPSS 10.0 to read and analyze data in the required format.

c) Nature and components: Disaggregated raw data have been arranged in terms of several variables like item code, sector code, state code, household's no, total expenditure, and monthly per capita expenditure etc.

d) Data Analysis using SPSS 10: NSSO 38th, 45th and 50th Round data (for the year 1983-84, 1989-90 and 1993-94 respectively) have been arranged in terms of item code, expenditure on those items and then MPCE (item codes for different blocks and the required block levels for our purpose are extracted from the huge data set).

Data are arranged and sorted according to different expenditure class, which are further segregated in terms of different expenditure class like MPCE for lower income group

(LIG), middle-income group (MIG), higher income group (HIG). This classification has been made for the year 1983-84. Since due to changes in prices, the size of the income group will change for the year 1989-90 and 1993-94. However necessary deflator has been used to make all the income groups at the price 1983-84. Consumption expenditure for the year 1989-90 and 1993-94 are available at current prices so necessary price adjustments has been made. To change the consumption expenditure for different income groups for the year 1989-90 and 1993-94 has been changed to 1983-84 prices using price indices. So the income groups classifications are at 1983-84 prices are as follows:

Rs 0-6000 are classified as lower income groups; middle income groups leveled as Rs. 6000-12,000 and Rs. 12,000 and above belong to upper income groups.

But in 1989-90 NSSO data we have not got that general format of data as 1993-94. Thus we have computed per capita expenditure data from the available dataset and then we segregated the expenditure data according to the three income groups.

We aggregated item-wise consumer expenditure data of different income groups of NSSO data as the sectors in input-output data table for the respective years.

SECTION 5

Model Estimation and Analysis of Results

Results based on Model 1

Now let us check the emission level of CO_2, SO_2 and NOx according to our present model. Aggregated Hybrid Input –Output table for the year 1983-84, 1989-90 and 1993-94 are presented in appendix. These tables show energy sectors are in physical unit (mtoe) and rest are in million rupees. From these tables I-O coefficient matrix (A) and the Leontief Inverse matrices have also been presented in appendix.

These tables have been used to compute direct and total emission coefficient using the equation (**) in model section.

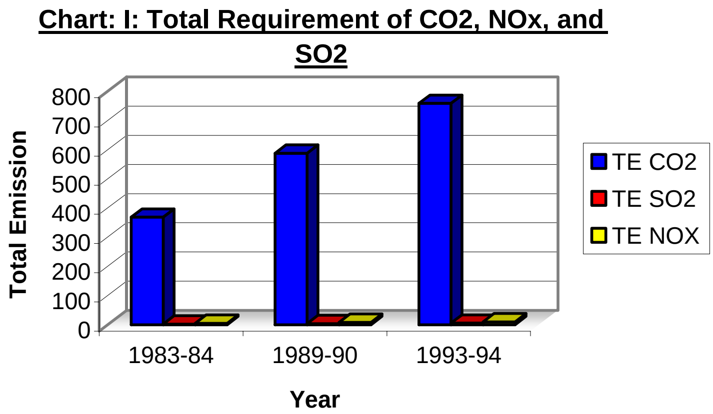
Total Emission:

The total industrial CO_2, SO_2 and NOx emissions (TE) have been calculated using the I-O data for the respective years. Total emission for the three air pollutants were computed as mentioned by the equation (4) in the above model.

Table: 1: The Trend of Total Emission of CO_2, SO_2 and NOx:

Sl. No.	Years	Total Requirement		
		CO_2	SO_2	NO_X
1.	1983-84	369.50	2.69	4.98
2.	1989-90	588.41	4.04	8.86
3.	1993-94	759.44	5.63	9.91

The trend of CO_2, SO_2 and NOx emissions (TE) as shown in the above table can be represented by the Bar diagram as shown below. It is evident from the diagram that there is an increasing emission trend of all these three pollutants over



the decade.

Sector-specific Intensity of CO_2, SO_2 and NOx during 1983-84, 1989-90 and 1993-94:

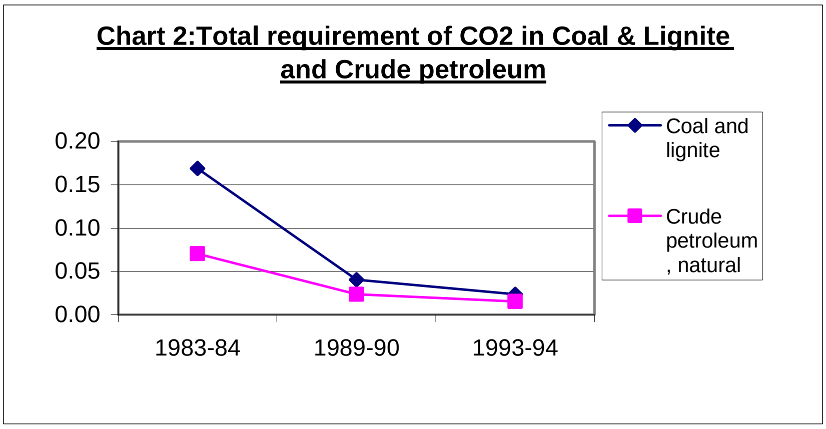
From the previous analysis it is clear that total emission of each and every pollutant shows increasing trend over time. Now we would concentrate on the sector specific intensity for the three major pollutants CO_2, SO_2 and NOx. The calculated sector-specific direct and total requirement of CO_2, SO_2 and NOx (for 1983-84, 1989-90 and 1993-94) are given in the following tables 2a, 2b, and 2c respectively.

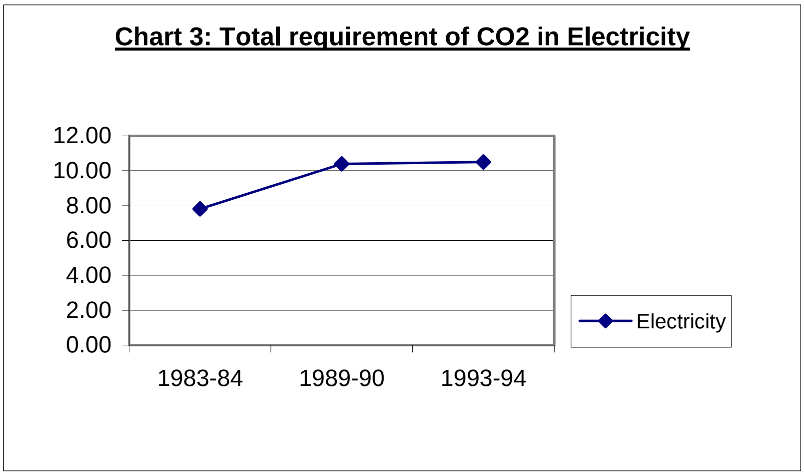
Following tables shows that the overall sector-specific direct and the total requirement of CO_2 SO_2 and NOx is very high for the ***energy sectors*** like ***coal and lignite, crude petroleum natural gas and the electricity*** than that of the non-energy sectors like misc. service, medical and health, misc. metal products and others. Within these three energy sectors electricity sector has got the highest total and direct intensity of CO_2 SO_2 and NOx and thus it contributes most in total emission of the pollutants. Again the direct requirement of CO_2, SO_2 and NOx contribute less than the total requirement. This is because the total requirement include both direct and indirect requirement of the pollutant.

If we look at the total and direct requirement figure for electricity over time, it is in increasing trend for all the three pollutants. If we compare two periods simultaneously then the contribution leads to higher in the first period and little bit stagnant in the second phase. Electricity sector mainly consumes coal. So if the grade of coal is better then definitely it will release less amount of CO2 and then the CO2intensity coefficient of that particular sector will be lower.

Again composition of energy sectors' contribution in total requirement of CO2 has undergone changes overtime. As shown in the following two charts there are sharp fall in contribution of crude oil petroleum and natural gas in the pre-reform period which becomes uniform during the reform (chart 2). This fall in contribution is due to the increase in the direct and intermediate use of electricity in the economy over the pre-reform period (chart 3).

The results reveal that electricity ranks the highest among all sectors throughout the period. For Crude oil sector the figure is little higher in 1983-84 but it was declining in the second phase. In case of coal sector changes due to the evolution of sectoral energy use composition i.e. from coal to gas or any other renewable energy with less CO_2 intensive. Out of the other sectors petroleum product contributes a little bit higher than the other sectors.





Through out the period the total coefficient of the transport sector fluctuates. The intensity of the cement sector gradually falls from .018 to .006. The performance regarding carbon intensities in cement sector has really improved. It occurs in conjunction with the installation of relatively expensive new technologies such as pre calcining facilities, high efficiency roller mills and variable speed motor. Actually high efficiency and improved technology lead to low intensity of carbon emission. The direct intensity of the construction sector is lowest among all sectors. This is because it does not take much of fossil fuel based energy to construct a building or a road, but the construction sector uses many energy intensive materials such as bricks, cement, iron & steel, aluminium glass and asbestos. So the indirect part achieves prominence in this respect leading to high value of total intensity. The above fact carries that the sectors like construction, textile, trade and agriculture, transport emit CO_2 fairly high due to indirect effect. Given the higher value of indirect coefficient and the larger volume of activity, the production of above sectors turn out to be the most responsible for CO_2 emission in India when they are viewed in terms of total (direct and indirect) emissions due to final demand in each sector. The direct SO_2 emission coefficients were higher generally for the sectors like petroleum products, electricity, chemical and chemical-products, basic metal, metal products and machinery and trade and other services but it varies between periods. The sectors like fertilizer also become prominent. If we consider average then the direct coefficients of SO2 drops in most of the sectors.

But when we are looking for the total emission coefficients of SO_2 then coal and crude oil and natural gas contribution should deserve mention. The other sectors like fertilizer, mining and quarrying, iron and steel, cement and transport record high emission coefficient.

In case of direct NOx emission coefficients (table 2c) of electricity contributes more .Except iron and steel most of the sectors drops a little bit. But for the total emission coefficients of NOx emission in case of electricity contributes very high growth than all other sectors. Coal and lignite sector and crude oil also rank after that. For total emission coefficients the sectors like iron and steel, petroleum products, basic metal & machinery transport, cement should also be mentioned due to high share. Now we are moving to concentrate on the empirical results of decomposition analysis for CO_2, SO_2 and NOx.

i) Formulation of SDA:

SDA is a unique technique to study sources of change in the structure of the economy broadly defined by means of a set of comparative static changes in key parameters of an Input-Output table. The total changes in estimated CO2, SO2 and NOx emission from 1983-84 to 1993-94 have been decomposed into effects caused by three components following the equation 11 given in Section 2.

Here we tried to consider the comparative static changes of total CO_2, SO_2 and NOx emissions for the three parameters: ***emission intensity (S), technical coefficient (R), and final demand (Y)***. According to the structural decomposition analysis, the change in total CO_2, SO_2 and NOx emissions between any two years i.e. year o and year t can be considered as 1983-84=o and 1989-90=t in first period and the year 1989-90=o and 1993-94=t for the second period .

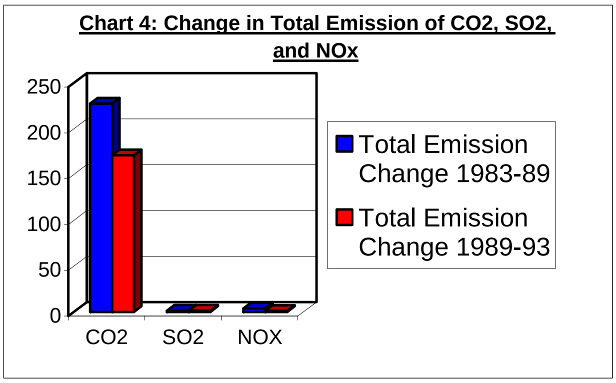
ii) SDA for 1983-1989 and 1989-1993 :

We consider change in total emission due to change in the three above mentioned parameters. The results of these SDA are shown in the following table. The total emission change is shown in chart 4.

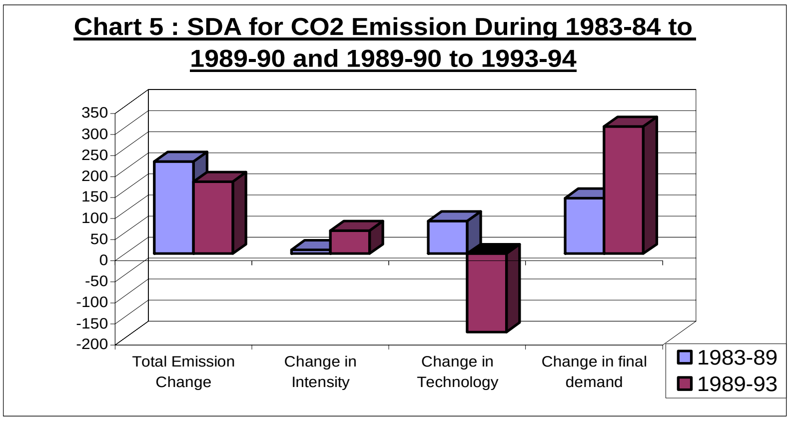
Table: 3: Structural Decomposition Analysis of the Emission of CO_2, SO_2, and NO_X during 1983-84 to 1993-94(mt of CO_2, SO_2, and NOx)

Year	Pollutants	Total Emission Change (ΔTE)	Comparative Static Change		
			Change in Intensity (ΔS)	Change in Technology (ΔR)	Change in final demand (ΔY)
1983-84 & 1989-90	CO_2	227.47	9.23	77.69	131.99
	SO_2	1.35	0.02	0.4	0.93
	NO_X	3.88	0.36	1.68	1.84
1989-90 & 1993-94	CO_2	171.03	54.99	-185.82	301.86
	SO_2	1.59	1.02	-1.39	1.96
	NO_X	1.05	-1.54	-2.15	4.74

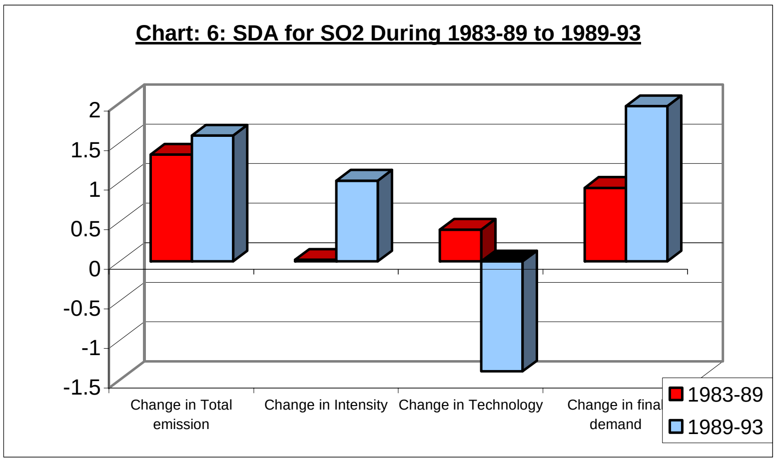
The total changes of CO_2 and NOx emissions drop sharply during 1st (1983-89) and 2nd (1989-93) period. A little bit upward trend has been observed in case of SO_2. The 1st term of the equation (11) i.e., $\mathbf{\Delta S\, R_t\, Y_t}$ reflects the CO_2 , SO_2 and NOx emission changes due to the changes of CO_2 , SO_2 and NOx intensity of various industries is represented by column (4) of the above table. The second term of Equation (11) $\mathbf{S_o\, \Delta R Y_t}$, defines the CO_2, SO_2 and NOx emission changes due to the changes in technical coefficient matrix shown in the column (5) of table 3. Similarly, the third term of Equation (11), $\mathbf{S_o\, Ro\, \Delta Y}$ refers the CO_2 , SO_2 and NOx emission changes due to the changes in the final demand of various industries and represented by column (6).



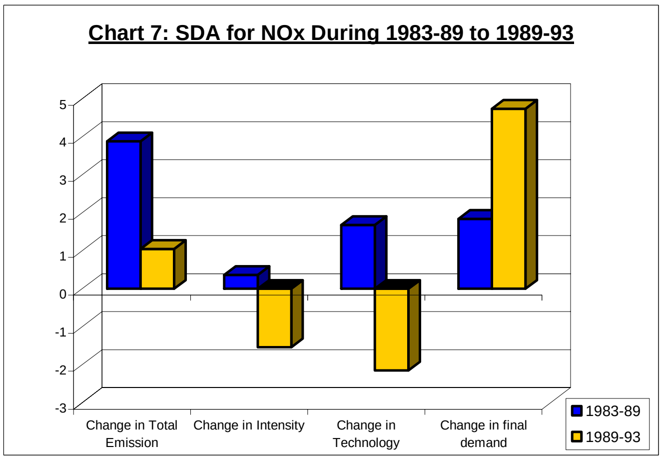
It is evident from the above table that change in total emission of CO_2 in pre-reform period (during 1983-84 to 1989-90) was mainly due to the change in final demand (around 60%) and then due to change in technological change (around 36%) and rest was due to the change in intensity level (around 4%). The scenario drastically changed during the phase, 1989-90 to 1993-94. In reform period, share of intensity change increases and affect positively the total emission of CO_2, while during this period change in technological factor affect total emission inversely. But the effect of change in final demand was consistent and rather more amplified to change the total emission level during economic reform which is clear from the following chart (chart5).



SDA table and the diagrammatic representation (chart 6) show that total emission of SO_2 has increased during 1983-84, 1989-90 to 1993-94. Most of this change in emission was due to increase in final demand and change in intensity and more specifically final demand and intensity during the period rises more than proportionately than the change in total emission. This is because of the negative impact of technological change on total emission change.



SDA of NOx represented by the above table and following chart (table 3 and chart7) show that the total emission of NOx falls during the period from 3.88 to 1.05 and this fall in NOx emission was due to more than proportionate fall in intensity and technology from 0.36 to -1.54 and 1.68 to -2.15 respectively. This is clear from the charts that during that period increase in final demand from 1.84 to 4.74, which were outweighed by the other two factors.



Now we are going to elaborate the CO2, SO2 and NOx ***intensity*** part which are shown in table 3. As we have seen that changes in intensity throughout the period (1983-84 to 1993-94) became positive for all sectors. It means that the industries are using energy intensive technology or are CO_2 intensive finally contribute to increase CO2 emission. From direct and total intensity results it reveals that electricity sector ranks the top among other sectors to increase CO_2 emission. It is due to the maximum amount low graded coal consumption and also for the inefficient process (Mukhopadhyay & Chakraborty, 1999).The similar performance is also observed in case of transport, iron and steel, and construction sectors. Those sectors increase the CO_2 emission significantly. The intensity of SO2 and NOx emission reveals quite a similar picture like CO2 except in the second period the intensity of NOx contributes negatively.

The ***rate of technical coefficient*** of CO_2, SO_2 and NOx has been displayed in table 3. The changes in the rate of technical coefficient regarding CO2 emission were positive up to 1989-90 but in the reform period it became negative. The results of SO2 and NOx also reveal the same pattern. The basic reason behind a negative share in the reform period is due to moderate coal and crude oil consumption i.e. 4.8%p.a and 5.6%p.a. respectively during 1991-96 (Mukhopadhyay, 2001). In case of oil sector the technical changes like minimization of the risks of exploration, optimal mix of exploration, energy conservation and interfuel substitution has took place. While in case of coal sector it is due to the efficient technology like exploration, exploitation, efficient utilization, new mining technology (Mukhopadhyay, 2001). As a matter of fact we can mention that the technological change has increased emission in the first period due to electricity sector. The responsible electricity sector was due to low thermal efficiency of power plants in India caused by the generally small size of its power plants. Besides the low capacity utilisation of thermal power plants also decreases overall energy efficiency. The average annual load factor of all thermal plants in India was 53.8% in 1990-91. This is largely attributed to inefficiency in the operation and maintenance of plants (Govt of India, Planning Commission, 1992).

These facts ultimately move towards high emission. Moreover moderate technical changes have taken place leading to reduce energy consumption which in turn generates low emission. But the contribution of the fuel sector in this respect goes to coal and oil. New mining technologies for coal have been introduced with a fair degree of success. The slight technical improvement in case of oil and natural gas sector has been possible due to the flaring of minimization of associated gas, the off take of natural gas, also the minimization of the risks

of exploration both by an optimal mix of exploration in different basins in India and vigorous measure for energy conservation and inter fuel substitution. Moreover creation of capacity and its utilisation for oil was very low in eighties but improved substantially, particularly in the early 90's. Due to technical improvement in capacity utilisation the growth rate of crude throughput also performed well at 58.6% in 1995-96 which was 4% higher than 1991-92.
Our next factor deals with the changes in the final demand for CO2, SO2 and NOx emissions.

This factor dominates among all other factors. Its contribution was just double in 1989-90 to 1993-94 compare to previous period for all pollutants. It actually happened due to high energy consumption by the final demand sector which has increased by 6.9% per year during 1989-90 to 1993-94. The share of individual sectors are 9% for coal, 5.47% for crude oil and natural gas and 7.85% for electricity in this respect. The demand for electricity in the household sector is expanding rapidly as the pressure of urbanisation continues to increase and the availability of consumer durables also continues to expand. Several of the relatively newer and faster growing industries such as jems and jewellery garments and electronics are more energy intensive. The rapid pace of urbanization and diverse urban growth pattern involve many basic structural changes in the economy, which have major implication for energy use and also CO_2 emission. Urbanisation brings changes in the way resources are collected distributed and used. The rising per capita income associated with urbanization increase demands for both end use energy and energy intensive products and services.

Results based on model 2

In this section we are trying to capture the responsible factor's contributions made by the lower, middle and higher income groups for CO_2, SO_2 and NOx emission. This section is an extension of the previous one. We have already discussed the responsible factors contribution. Here we are trying to capture all income groups share in each responsible factors for emissions. The overall observation regarding this follows that responsible factors contribution made by the lower income groups are lesser in amount and higher income groups dominate. If we consider the period wise performance in case of each responsible factor then picture will be comprehensible.

Changes in intensity made by the three groups are identified in table 4. The overall intensity effect sharply increased from first period (1983-84 -1989-90) to second period (1989-90-1993-94) but the contributions made by three groups sharply fallen. The adjustment of this intensity effect was made by the other final demand sectors like for e.g. exports, imports, govt.consumption expenditure. In the first sub period the other final demand sector acted negatively i.e. the contribution helped to reduce the intensity of carbon, sulphur etc. But during the course of the period the effect has become changed and moved in opposite directions. This follows that the other final demand sectors are becoming more pollution intensive. It might have been possible due to govt.final consumption expenditure or export.

Table 4
Contributions of lower, middle and higher income groups regarding Changes in intensity of CO_2, SO_2 and NOx emissions

Year	Pollutants	Change in Intensity (ΔS)	Comparative Static Change			
			Lower income groups	Middle income groups	Higher income groups	Other final demand sectors
1983-84 & 1989-90	CO_2	17.795753	12.03629	53.895736	100.50913	-148.645408
	SO_2	0.02	0.234	-1.335	1.03	0.0994
	NO_X	0.36	0.112	-0.564	0.815	1.154
1989-90 & 1993-94	CO_2	54.99	10.8892	26.59092	39.99682	-22.48013
	SO_2	1.02	0.025	-0.0342	1.005	0.029
	NO_X	-1.54	0.003	-1.234	0.607	-0.924

Table 5
Contributions of lower, middle and higher income groups regarding Changes in technology of CO_2, SO_2 and NOx emissions

Year	Pollutants	Change in Technology (ΔR)	Comparative Static Change			
			Lower income groups	Middle income groups	Higher income groups	Other final demand sectors
1983-84 & 1989-90	CO_2	77.69	5.330497	-7.20658	-13.1078	92.666916
	SO_2	0.4	0.097	-0.054	0.853	-0.407
	NO_X	1.68	0.004	-0.0756	1.012	0.756
1989-90 & 1993-94	CO_2	-185.82	-15.7614	-41.2958	-78.33717	-50.25967
	SO_2	-1.39	0.016	-0.97	0.0453	-0.496
	NO_X	-2.15	0.17	-1.97	0.153	-0.521

We have discussed that technological change has improved the situation during the course of the period. Here also the higher income groups dominate (table 5). Most striking features observed in case of other final demand sectors.

Table 6

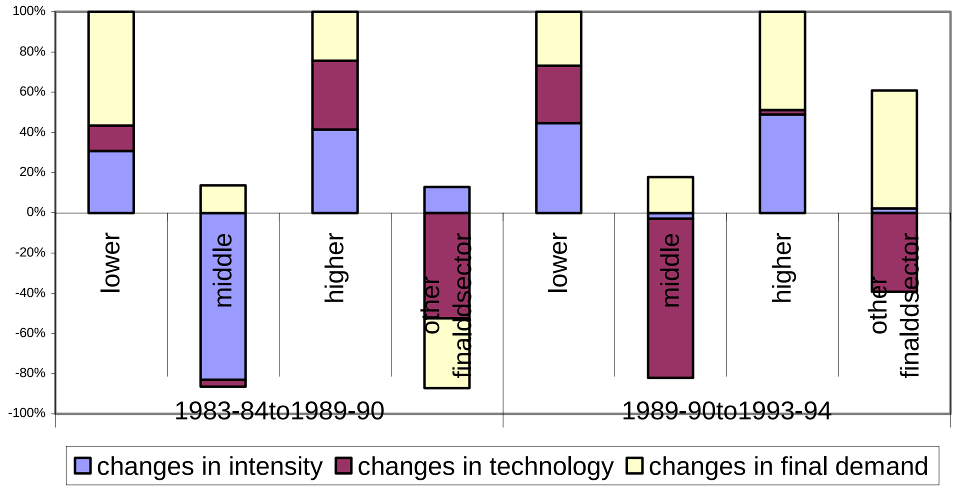
Contributions of lower, middle and higher income groups regarding Changes in the final demand of CO_2, SO_2 and NOx emissions

Year	Pollutants	Change in final demand (ΔY)	Comparative Static Change			
			Lower income groups	**Middle income groups**	**Higher income groups**	**Other final demand sectors**
1983-84 & 1989-90	CO_2	131.99	23.52	58.1967	81.99972	-31.79848
	SO_2	0.93	0.431	0.219	0.607	-0.268
	NO_X	1.84	0.006	0.007	0.765	1.066
1989-90 & 1993-94	CO_2	**301.86**	14.41695	65.01506	129.4478	92.727234
	SO_2	1.96	0.015	0.218	1.004	0.739
	NO_X	4.74	0.125	0.649	1.903	2.066

This factor's contribution is highest among all. Lower income group's contribution has been fallen in this respect but middle groups helped a little to increase the total contribution in the second phase. But the real additions are caused by the higher income group. If we compare the contributions made by the groups after combining all factors then the story is somewhat similar like individual contribution.

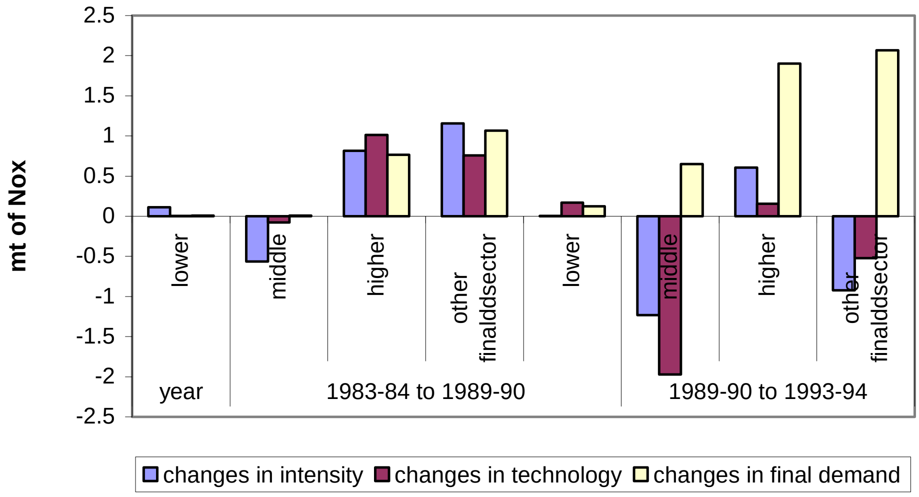
The trend regarding responsible factors contribution of the middle and higher income groups remains almost same for both the periods. The degree of shifting between factors for middle and higher is not enormous. Only the striking points to be noted in this respect are intensity effect which drops its shares between the study periods. But lower income groups' trend was quite different. Let us analyse factor by factor share for lower groups. It derives that changes in technology share was largely affected. Its contribution was positive in 1983-84 to 1989-90 but responded negatively in 1989-90 to 1993-94.

CHART 8:Distribution of factors among lower,middle and higher income groups for SO2 emission



In case of SO_2 emission, lower income group's contribution has fallen sharply during the period. Interchange of factors (changes in intensity and changes in technology) share has been observed in middle groups. A steady growth of factors had been observed for higher income groups except the technological change factors which was comparatively high in the first period than the later.

CHART 9:Income wise contribution of factors for NOX EMISSION



For NOx emission higher income groups dominate throughout. Middle income group's contribution was negative and not so significant in the first period but the same contribution has increased during the course of the period. For lower income groups contribution was negligible over the period. To get a comprehensible picture of three income groups below three figures will try to combine all factors together. Higher income group dominates for all emission cases. Middle group contributions can be counted as second. But lower income group contributions were negligible over the course of the period.

Chart 10

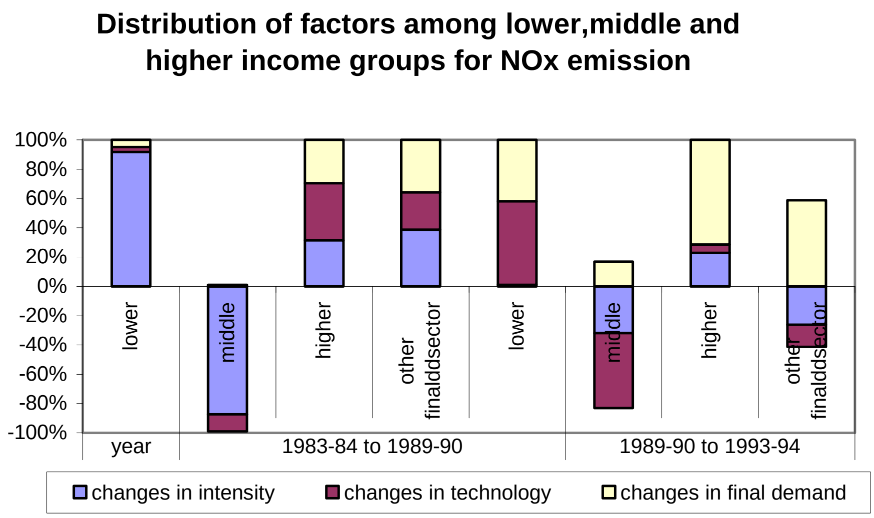


Chart 11

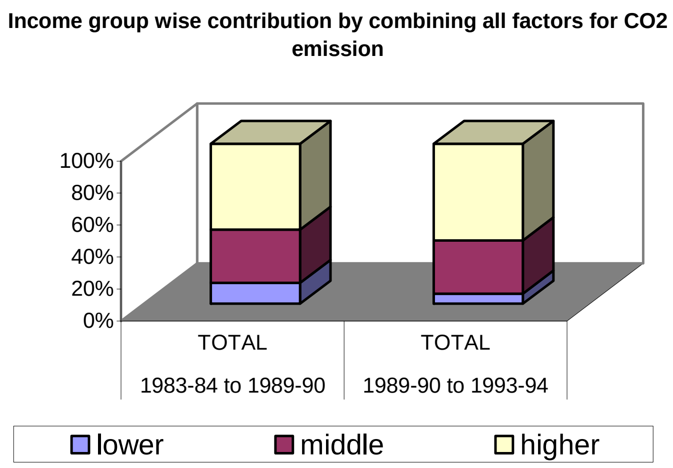


Chart 12 Income wise total factors distribution for SO2 emission

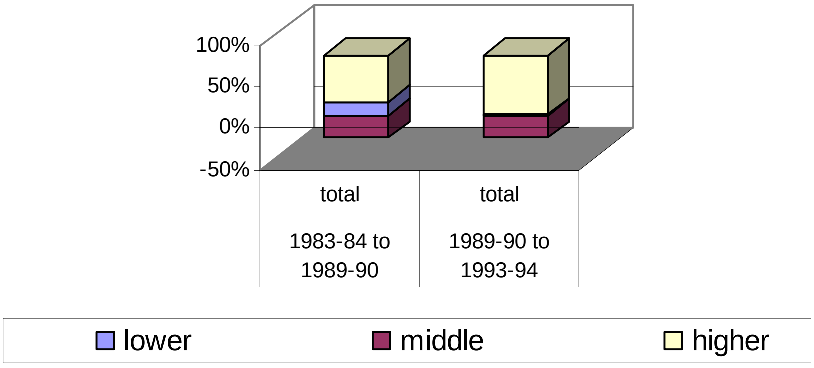
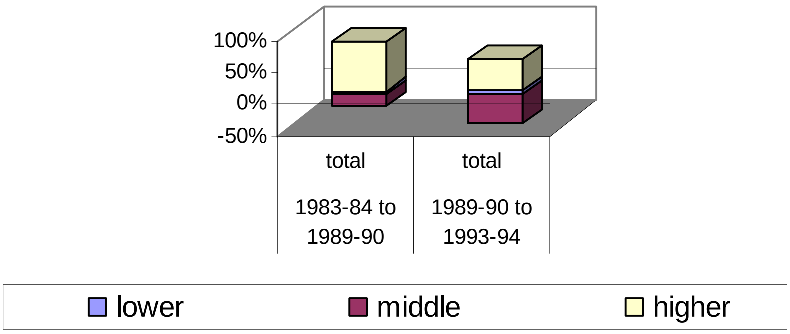


Chart 13: Income wise distribution of factors for NOx emission



The adverse effects of air pollution depend on the level of exposure, the population structure, the nutritional status and the lifestyle. It is observed that the effects are higher in developing nations than developed ones, because number of people living below poverty line is higher in developing countries. Poor people are often seen as compelled to exploit there surrounding for short-term survival, and are assumed to be the ones most exposed to natural resources degradation.

Section 6

Conclusion

The overall assessment from the figures as captured above reveals that the contribution made by the lower income group was not significant but the higher income groups dominate for all emissions and almost for all factors. It is well known that people who live in poverty are those exposed to the worst environmental and health risks. Overall, somewhere between 25% and 33% of the global burden of diseases can be attributed to environmental factors. This proportion is larger in conditions of poverty, where more environmental hazards are present in the nearby living and working environment, and people have less capacity to protect themselves against exposure and effects of harmful and unpleasant pollutants. The environmental threats facing poor people tend to be more directly hazardous to human health's we know that pollution related health hazards is not uniform in all income groups. It affects the lower income groups' more than upper income groups. Incidence of poverty is high in India and about one third of the population is below poverty line that is largely affected by environmental hazards. Our assessment follows that higher income groups are almost responsible for generating emissions more than 75% and 20-22% shared by middle income groups. But very negligible amount has been contributed by lower. Unfortunately the well known factor is that lower income groups are suffering seriously due to pollution (Ekbom & Bojo 1997, Doumani & Listorti, 2000).

The biggest task at present is to tackle the generation of emission by the higher income groups. Few policies can be prescribed in this context.

1) It is not possible to restrict the energy consumption of the higher and middle income groups but the possible solution is to introduce efficient energy technology and clean fuel in each sector. For implementation of clean fuel in each sector govt. should introduce sector specific policies.
2) Even more than 50 years after independence from almost two centuries of British rule, large scale poverty remains the most shameful blot on the face of India. India still has the world's largest number of poor people in a single country. The main causes of poverty are illiteracy, a population growth rate by far exceeding the economic growth rate for the better part of the past 50 years, protectionist policies pursued since 1947 to 1991 which prevented large amounts of foreign investment in the country. Poverty alleviation is expected to make better progress in the next 50 years than in the past, as a trickle-down effect of the growing middle class. Increasing stress on education, reservation of seats in government jobs and the increasing empowerment of women

and the economically weaker sections of society, are also expected to contribute to the alleviation of poverty.

3) In India, it is estimated that about 350-400 million are below the poverty line, 75 per cent of them in the rural areas. India has had a number of antipoverty programs since the early 1960s.The most important task is to provide subsidies to the lower income groups especially for the energy sector for betterment of life. Because poor people are mostly deprived from these sectors. Among all developing countries per capita energy consumption is too low in India.
4) Awareness among the lower income groups is also needed for proper care of health.

Now the question arises whether the lower income groups are suffering at all. From what type of diseases do they actually suffer? Are those diseases due to pollution? What will be the share of sufferers due to pollution specific diseases by higher and middle groups? These are all for further areas of research.

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Table 1a: Sector-wise private final consumption expenditure of lower middle and higher income groups for the year 1983-84 (% share)

	COMMODITY	lower	middle	higher
1	Coal and lignite	5	75	20
2	Crude petroleum and natural gas	0	0	0
3	Electricity	4.329078	35.765	59.9024
4	Agricultural crops	19.65265	23.17828	57.16907
5	Animal husbandry	31.57802	7.145539	61.27644
6	Forestry and logging	30.354	12.367	57.28
7	Fishing	30.354	12.367	57.28
8	Metallic and non-metallic minerals	0	0	0
9	Food and food products	6.234	36.786	56.98
10	Beverages	0.099046	36.49282	63.40813
11	Tobacco products	1.33035	57.47717	41.19248
12	Cotton textiles	4.666356	54.28526	41.04838
13	Wool, Silk & Synthetic fibre textiles	4.666356	41.04838	54.28526
14	Jute, hemp, mesta textiles	0	5.447466	94.55253
15	Miscellaneous textile products	4.186851	8.696608	87.11654
16	Wood and wood products including furniture	5.98	29.456	64.564
17	Paper, printing & publishing	12.69649	51.26965	36.03386
18	Leather and leather products	0	20.956	79.045
19	Rubber products	4.9875	34.956	60.0565
20	Plastic products	4.9875	31.654	63.3585
21	Petroleum products	2.367	38.7896	58.8434
22	Coal tar products	0	0	0
23	Inorganic heavy chemicals	0	0	0
24	Organic heavy chemicals	0	0	0
25	Fertilizers	0	0	0
26	Paints, varnishes and lacquers	0	0	100
27	Other chemicals	2.045	23.765	74.19
28	Cement	0	0	0
29	Clay and non-metallic mineral products	8.987	39.965	51.05
30	Iron and steel	0	0	0
31	Non-ferrous basic metals	0	0	100
32	Miscellaneous metal products	3.765	29.456	66.779
33	Tractors and agricultural machinery	0	0	0
34	Industrial machinery(F & T)	0	0	0
35	Other Machinery	0	20	80
36	Electrical and Electronic appliance	0	14.30841	85.69159
37	Rail equipments	0	0	0
38	Other transport equipments	8.965	34.1645	56.8705
39	Miscellaneous manufacturing	0	21.324	78.676
40	Construction	0	0	0
41	Gas and Water	4.329078	35.765	59.9024
42	Railway transport services	0	46.2963	53.7037

43	Other transport services	5.324	31.458	63.22
44	Storage and warehousing	0	0	0
45	Communication	0	30.567	69.453
46	Medical and health	5	30	65
47	Misc. Services	6.786	36.675	56.539

Table 1b: Sector-wise private final consumption expenditure of lower middle and higher income groups for the year 1989-90(% share)

	COMMODITY	**lower**	**middle**	**higher**
1	Coal and lignite	8.586941	68.66868	22.74438
2	Crude petroleum, natural gas	0	0	0
3	Electricity	6.534039	32.555	60.9112
4	Agricultural crops	23.9392	32.177	43.88381
5	Animal husbandry	24.7025	21.91682	53.38068
6	Forestry and logging	24.09049	24.52755	51.38246
7	Fishing	23.1255	25.677	51.198
8	Metallic and non-metallic minerals	0	0	0
9	Food and food products	9.4545	28.72	61.83
10	Beverages	10.47785	35.72201	53.80014
11	Tobacco products	5.193951	45.35653	49.44952
12	Cotton textiles	6.943158	39.67357	53.38328
13	Wool, Silk & Synthetic fibre textiles	2.333178	33.24717	64.41965
14	Jute, hemp, mesta textiles	2.517	11.34073	86.14627
15	Miscellaneous textile products	2.093425	16.2076	81.69897
16	Wood and wood products including furniture etc.	6.05	28.3345	65.61533
17	Paper, printing & publishing	9.911766	44.60503	45.48321
18	Leather and leather products	4.065	24.0845	72.85583
19	Rubber products	6.057269	36.4482	57.49453
20	Plastic products	6.057269	34.7972	59.14553
21	Petroleum products	8.567	37.7893	53.6437
22	Coal tar products	0	0	0
23	Inorganic heavy chemicals	0	0	0
24	Organic heavy chemicals	0	0	0
25	Fertilizers	0	0	0
26	Paints, varnishes and lacquers	0	0	0
27	Other chemicals	11.30569	28.3324	60.36191
28	Cement	0	0	0
29	Clay and non-metallic mineral products	15.2068	36.96129	47.8329
30	Iron and steel	0	0	0
31	Non-ferrous basic metals	0	0	50
32	Miscellaneous metal products	1.8825	20.28152	77.83598
33	Tractors and agricultural machinery	0	0	0
34	Industrial machinery(F & T)	0	0	0
35	Other Machinery	6.117	27.284	66.599
36	Electrical and Electronic appliance	1.716994	18.60083	79.68218
37	Rail equipments	0	0	0
38	Other transport equipments	11.1525	33.91975	54.92775
39	Miscellaneous manufacturing	9.330437	24.77837	65.89119
40	Construction	0	0	0

41	Gas and Water	6.181639	34.1645	59.6282
42	Railway transport services	8.158423	39.57675	52.26482
43	Other transport services	4.050288	18.26005	77.69066
44	Storage and warehousing	0	0	0
45	Communication	0	28.0085	72.0015
46	Medical and health	10.36567	31.23993	58.3944
47	Misc. Services	8.72806	32.90206	58.36988

Table 1c:Sector-wise private final consumption expenditure of lower middle and higher income groups for the year 1993-94(% share)

Sectors	COMMODITY	lower	middle	higher
1	Coal and lignite	12.17388	62.33735	25.488765
2	Crude petroleum, natural gas	5.034	17.234	77.74
3	Electricity	8.739	29.345	61.92
4	Agricultural Crops	28.22575	41.17571	30.598541
5	Animal husbandry	17.82699	36.68809	45.48492
6	Forestry and logging	17.82699	36.68809	45.48492
7	Fishing	15.897	38.987	45.116
8	Metallic & non-metallic minerals	0	0	0
9	Food and food products	12.675	20.654	66.68
10	Beverages	20.85666	34.9512	44.192144
11	Tobacco products	9.057552	33.23589	57.706556
12	Cotton textiles	9.219961	25.06187	65.71817
13	Wool, Silk and Synthetic fibre textiles	0	25.44596	74.554042
14	Jute, hemp, mesta textiles	5.034	17.234	77.74
15	Other textiles products	0	23.7186	76.281401
16	Wood and wood products including furniture	6.12	27.213	66.666667
17	Paper, printing and publishing	7.127038	37.94041	54.932555
18	Leather and leather products	8.13	27.213	66.666667
19	Rubber products	7.127038	37.94041	54.932555
20	Plastic products	7.127038	37.94041	54.932555
21	Petroleum products	14.767	36.789	48.444
22	Coal tar products	0	0	0
23	Inorganic heavy chemicals	0	0	0
24	Organic heavy chemicals	0	0	0
25	Fertilizers	0	0	0
26	Paints, varnishes and lacquers	0	0	0
27	Other chemicals	20.56638	32.89979	46.533829
28	Cement	0	0	0
29	Clay and non-metallic mineral products	21.4266	33.95759	44.615808
30	Iron and steel	0	0	0
31	Non-ferrous basic metals	0	0	0
32	Miscellaneous metal products	0	11.10704	88.892963
33	Tractors and agricultural implements	0	0	0
34	Industrial machinery(F & T)	0	0	0
35	Other machinery	12.234	34.568	53.198
36	Electrical and Electronic appliances	3.433987	22.89325	73.672764
37	Rail equipments	0	0	0
38	Other transport equipments	13.34	33.675	52.985
39	Miscellaneous manufacturing industries	18.66087	28.23275	53.106377
40	Construction	0	0	0
41	Gas and Water	8.0342	32.564	59.354

42	Railway transport services	16.31685	32.85721	50.825942
43	Other transport services	2.776576	5.062097	92.161327
44	Storage and warehousing	0	0	0
45	Communication	0.05	32.84	67.11
46	Medical and Health	15.73133	32.47986	51.788804
47	Misc. Services	10.67012	29.12913	60.200753