Impact of International Trade on Domestic Air Pollution of India

MS Received February 04, 2013; Reviewed August 30, 2013; Accepted November 18, 2013

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Abstract

Since trade liberalization, the contribution of total trade in goods and services to the GDP rose from 16% in 1990–91 to 47% in 2008–10. India has some vision to come under the category of developed nations by 2020. For attaining this goal, India is adopting every necessary measure; two of them are liberalized trade and environmental regulations. The study focused on finding whether there exists some correlation between the two and whether liberalized trade has an impact on domestic air pollution. Results show that with concentration of NO2 is decreasing at the rate of 47% while that of SO2 is increasing at a rate of about 73%.

Keywords: Economic reforms, environment kuznet curve, environmental pollution, trade liberalisation & trade balance

Introduction

The increasing economic development and a rapidly growing population that has taken the country from 300 million people in 1947 to more than one billion people today are putting a strain on the environment, infrastructure, and the country's natural resources. Industrial pollution, soil erosion, deforestation, rapid industrialization, urbanization, and land degradation are all worsening problems. India has been ranked as seventh most environmentally hazardous country in the world by a new ranking released recently. The study is based on evaluation of "absolute" environment impact of 179 countries, whose data was available and has been done by researchers in Harvard, Princeton, Adelaide University and University of Singapore on January 12, 2011. Brazil was found to be worst on environmental indicators, whereas Singapore was the best. United States was rated second worst and China was ranked third.

There are many types of environmental pollution such as Air pollution, Water pollution, Land pollution, Noise pollution etc. This study is basically confined to air pollution.

Statement of the problem

A central question is whether globalization helps or hurts in achieving the best tradeoff between environmental and economic goals. Do international trade and investment allow countries to achieve more economic growth for any given level of environmental quality? Do they damage environmental quality for any given rate of economic growth or they promote both economic growth and environmental quality?

Review of literature

Previous studies on the relationship between trade and the environment have found varying results. Some of the interesting findings are as below-

Chattopadhyay (2005) estimated the pollution content of India's trade. Weaker environmental regulations and poor technological knowledge encourage dirty industries to migrate from North to South which eventually induce growth path of South unsustainable. To find out whether in the post globalization era, specialization in dirty goods has increased or not, he adopted two methodologies i.e., Revealed comparative advantage (RCA) and estimation of total pollution content of India's trade. Results show that most of the commodities groups whose RCA indices have shown improvement in post liberalization period are pollution intensive. Total pollution content has increased from 0.480 in 1985 to 1.12 in 2000 making India a net importer of pollution.

Frankel (2009) found no detrimental effects of trade on some measures of environmental degradation such as local SO2 air pollution, controlling for income. Thus Trade and growth give countries the means to clean the air, provided they have effective institutions of governance in place at the national level. The evidence does suggest that trade and growth can exacerbate other measures of environmental degradation, however, particularly CO2 emissions. The difference can be explained by the observation that CO2 is a global externality, which cannot be addressed at the national level due to the free rider problem. Nowadays, people living in one country want to protect the air, water, forests, and animals not just in their own countries, but also in other countries as well.

Jha & Rabindran (2004) compared the pre and post-liberalization periods to examine if India's domestic production and exports showed a greater increase in dirty industries relative to cleaner ones. Using regression model on a unique industry level dataset aggregated at the all-India level for all manufacturing industries, they found that exports and FDI grew in the more polluting sectors relative to the less polluting sectors in the post-liberalization period.

Hassoun Nicole (2009) considered the case for free trade on the assumption that there is an obligation to mitigate environmental problems. Although there is not enough empirical evidence regarding free trade's environmental impact to conclude that free trade will generally be good or bad for the environment, but he suggested that there is reason to worry about unrestricted free trade's environmental effects.

Relationship between trade and environment

For the last ten years environmentalists and the trade policy community have engaged in a heated debate over the environmental consequences of liberalized trade. The debate was originally fueled by negotiations over the North American Free Trade Agreement and the Uruguay Round of GATT negotiations, both of which occurred in 1947 when concerns over global warming, species extinction, and industrial pollution were rising. Recently it has been intensified by the creation of the World Trade Organization (WTO) and proposals for future rounds of trade negotiations. The debate has often been unproductive because the parties differ greatly in their trust of market forces and typically value the environment differently. The purpose of this study is to set out what we currently know about the environmental consequences of international trade. The study critically reviews both theory and empirical work to answer this question. Much of the earlier literature was normative, with a focus on issues such as gains from trade and optimal trade or environmental policies. With the increased integration of the global economy, it has become difficult to ignore the negative impact of international consequences on domestic environment.

There exist various theories focusing on the relationship between international trade and domestic environment. Some environmental effects of international trade come via economic growth, and some arise even for a given level of income. In both cases, the effects can be either beneficial or detrimental. Effects of trade that do not operate via economic growth can be classified in three categories: that are adverse (race to the bottom), beneficial (gains from trade), and effects that vary across countries depending on local "comparative advantage." Major theories are as follows:

Environmental Kuznets Curve

A look at data across countries or across time allows some rough generalizations. For some important environmental measures (like SO2), an inverted U-shaped relationship appears. At relatively low levels of income per capita, growth leads to greater environmental damage, until it levels off at an intermediate level of income, after which further growth leads to improvements in the environment.

The idea behind the Environmental Kuznets Curve is that, although growth is bad for air and water pollution at the initial stages of industrialization, later on it reduces pollution as countries become rich enough to pay to clean up their environments. Only if pollution is largely confined within the home or within the firm does that panglossian view apply. Most pollution, such as SO2, NOx, etc., is external to the home or firm. For such externalities, higher income and a popular desire to clean up the environment are not enough. There must also be effective government regulation, which usually requires a democratic system to translate the popular will into action as well as the rule of law and reasonably intelligent mechanisms of regulation.

Another possible explanation for the pattern of the Environmental Kuznets Curve is that it works naturally via the composition of output. In theory, the pattern could result from the usual stages of economic development: the transition from an agrarian economy to manufacturing, and then from manufacturing to services. Services tend to generate less pollution than heavy manufacturing. This explanation is less likely than the conventional view to require the mechanism of effective government regulation. If the Kuznets curve in practice resulted solely from this composition effect, however, then high incomes should lead to a better environment even when externalities arise at the international level, which is not the case. Importantly, most past research has not found a Kuznets curve for carbon dioxide.

Race to the bottom hypothesis

This notion is perhaps the strongest basis for fearing that international trade and investment specifically (rather than industrialization generally) will put downward pressure on countries' environmental standards and thus damage the environment across the global system. Leaders of the industry, and of the unions whose members are employed in the industry, are always concerned about competition from abroad. When domestic regulation raises their production costs through abatement costs, they fear that they will lose competitiveness against firms in other countries. Thus, developing nations lax their environmental standards and allow their environment to deteriorate to keep their cost of production low.

Gains from trade hypothesis

Trade allows countries to attain more of what they want, which includes environmental goods in addition to market-measured output. A first possibility concerns technological and managerial innovation. Openness could encourage innovation beneficial to environmental improvement as well as economic progress. A second possibility is an international ratcheting up of environmental standards. When the largest state sets high standards for auto pollution control equipment, for example, the end result may be similar standards in other states as well. They tend to bring clean state-of-the-art production techniques from high-standard countries of origin, to host countries where they are not yet known.

Pollution Haven Hypothesis

Comparative advantage could be deliberately created by differences in environmental regulation itself. The motivation for varying levels of regulation could be differences in demand for environmental quality, arising from differences in income per capita or the motivation could be differences in the supply of environmental quality arising from differences income.

There is a little empirical evidence to support the hypothesis that countries that have a particularly high demand for environmental quality – the rich countries – currently specialize in products that can be produced cleanly, and let the poor countries produce and sell products that require pollution. Suri and Chapman (1998) find that middle-income countries' growth only leads to lower domestic pollution if they increase imports of manufactures. Muradian, O'Connor and Martinez-Alier (2001) find evidence that the imports of rich countries embody more air pollution than their exports. Antweiler, Copeland and Taylor (2001) found that rich countries have higher capital/labor ratios, capital-intensive industries are more polluting, and this factor-based pollution-haven effect dominates the income-based pollution-haven effect.

Porter Hypothesis, 1995

The hypothesis suggests that strict environmental regulation triggers the discovery and introduction of cleaner technologies and environmental improvements, the innovation effect, making production processes and products more efficient and commercially competitive. The cost savings that can be achieved are sufficient to overcompensate for both the compliance costs directly attributed to new regulations and the innovation costs.

In the first mover advantage, a company is able to exploit innovation by learning curve effects or patenting and attains a dominating competitive position compared to companies in countries where environmental regulations were enforced much later.

Singer–Prebisch Hypothesis

Singer and Prebisch examined data over a long period of time suggesting that the terms of trade for primary commodity exporters did have a tendency to decline. A common explanation for the phenomenon is the observation that the income elasticity of demand for manufactured goods is greater than that for primary products - especially food. Therefore, as incomes rise, the demand for manufactured goods increases more rapidly than demand for primary products. Thus, exporter nation shift to production and export of manufactured goods which are polluting in nature. In this way, it causes damage to the domestic environment of the producer nation.

The Impossible Trinity of global environmental regulation

The concerns of anti-globalizers can be understood by means of a trilemma of regulation, called the principle of the Impossible Trinity of Global Governance. In designing a system of global governance, three kinds of goals are desirable. First, globalization for the economic benefits of a nation. Second, regulation, when it comes to externalities like pollution, is not adequately addressed by the marketplace. Third, national sovereignty, because different countries have different needs or preferences, and also because nations take pride in their political independence. The principle of the Impossible Trinity points out that it is feasible to design a system with any two of these attributes, but not with all three.

The three attributes are represented as the sides of the triangle in the accompanying figure:

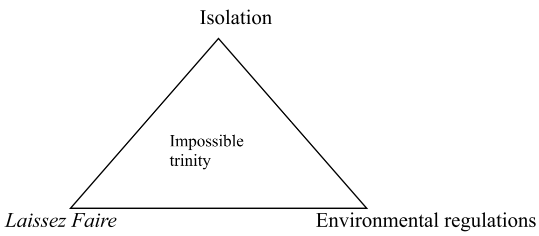

Figure 1: Impossible Trinity

The lower left corner represents a system of complete laissez faire. The private market is given responsibility for everything. With no government regulation, there is nothing to coordinate internationally and thus no loss to national sovereignty. The lower right corner represents multilateral regulation at the global level. While there are not many "world federalists" around today, a proposal to establish a powerful World Environment Organization would be a step in this direction. The top corner represents isolationism. Only if, countries cut themselves off from trade, investment, and other international interactions, can they preserve complete national sovereignty, while practicing whatever kind of regulation they wish.

The process of international economic integration has moved most countries toward the bottom side of the triangle. As a result, globalization is creating a growing conflict between the needs of environmental regulation and the demands of national sovereignty. The claim is that globalization has undermined the ability of sovereign governments to impose the level of environmental standards they would like.

Although the impossible trinity can be a useful way to think about the potential for globalization to undercut national environmental regulation, it can be very misleading in some contexts. There are two main reasons for this. First, even for environmental externalities that are largely confined within countries, such as local air pollution, there is little empirical evidence that the "race to the bottom" hypothesis, in fact holds. Indeed, international trade and activities of multinational corporations may sometimes put upward pressure on environmental standards. Second, and more importantly, some environmental issues spill over across national borders even in the absence of international trade and investment, making it difficult for individual countries to address them through independent regulation. Environmental protection requires international cooperation, and cooperation in turn requires some loss of "sovereignty."

Effects of Trade on Environment

Grossman and Krueger (1993) used the concepts of scale, composition and technique effects to link changes in the economy to environmental outcomes.

Scale effect: It measures the increase in pollution that would be generated if the economy were simply scaled up, holding constant the mix of goods produced and production techniques. As an example, if there were constant returns to scale and all of the endowments of the economy grew by 10 percent, and if there were no change in relative prices or emission intensities, then we should expect to see a 10 percent increase in pollution. Imports help in increasing resource endowments of a nation.

Composition effect as captured by the change in the share of the dirty good in national income. If we hold the scale of the economy and emissions intensities constant, then an economy that devotes more of its resources to producing the polluting good will pollute more. Composition of trade is changing as per demand of consumers. Trade via income helps in improving living standards which leads to increase in demand for luxurious, and energy intensive products.

Finally, technique effect: Holding all else constant, a reduction in the emissions intensity will reduce pollution. An eco-friendly technique of production produces low emissions. International trade help in transferring techniques from one nation to other and these techniques can be polluting or non-polluting.

Objectives

- To see the trend in trade balances of India before and after trade liberalization.
- To see the trend in environmental pollution after trade liberalization.
- To check whether there exists a correlation between trade balances and air pollution.
- To evaluate the impact of trade liberalization on air pollution.

Hypotheses

- There exists no correlation between trade and air pollution.
- Concentration of pollutants like SO2 and NO2 is independent of the trade balance of India.

Methodology

This study is limited to national boundary of India and based on secondary data. Secondary data on the trade balance is collected from indiastat.com between time periods 1970 to 2006. Data for concentration of pollutants is obtained from the website of Central Pollution Control Board in India and indiastat.com from 1990 to 2002. Pollutant concentration for India is calculated by summing up the values for major states of India. Depending on the specification for these estimates the study use pollutant concentration as a dependent variable on trade balances which is independent variable here. The study estimates the Second Degree Polynomial Regression Model on this time series data. SPSS software is used for curve estimation and regression analysis along with MS Excel.

Air Pollution

Air pollution is defined as the introduction of chemicals, particulate matter or biological materials that cause harm or discomfort to humans or other living organisms or cause damage to the natural or built environment into the atmosphere. Pollutants can be in the form of solid particles, liquid droplets or gases. In addition, they may be natural or man-made and primary or secondary.

Usually, primary pollutants are directly emitted from a process, such as ash from a volcanic eruption, the carbon monoxide gas from a motor vehicle exhaust or sulfur dioxide released from factories. Secondary pollutants are not emitted directly. Rather, they form in the air when primary pollutants react or interact. For example ground level ozone —that make up photochemical smog.

Table I: Sources and effects of pollutants

Pollutant	Sources	Health Effects	Environmental Effects
Ozone (O_3)	Secondary pollutant formed by chemical reaction of VOCs and NOx in the presence of sunlight.	Breathing problems, reduced lung function, asthma, irritates eyes, stuffy nose, reduces resistance to colds and infections, premature ageing of lung tissue.	Damages crops, forests, and other vegetation; damages rubber, fabric, and other materials; smog reduces visibility.
Nitrogen Oxides (NOx)	Emitted from high temperature combustion of gasoline, natural gas, coal and oil. Produced naturally during thunderstorms by electrical discharge.	Lung damage and respiratory illnesses	Ozone (smog) effects; precursor of acid rain which damages trees, lakes and soil; aerosols can reduce visibility. Acid rain also causes buildings, statues, and monuments to deteriorate.
Volatile Organic Compounds (VOCs)	Fuel combustion, solvents, paint. (Cars are a major source of VOCs.)	Ozone (smog) effects, cancer, and other serious health problems.	Ozone (smog) effects, vegetation damage.
Particulate Matter	Fine and tiny particles of solid or liquid suspended in a gas originating from volcanoes, dust storms, forest and grassland fires, living vegetation, and sea spray. Burning of fossil fuels in vehicles, power plants and various industrial processes also generate significant amounts of aerosols.	Eye, nose, and throat irritation; lung damage; bronchitis; cancer; early death.	Source of haze which reduces visibility. Ashes, smoke, soot, and dust can dirty and discolor structures and property, including clothes and furniture.
Sulfur Dioxide (SO_2)	SO_2 is produced by volcanoes and burning of coal and oil, especially high-sulfur coal; industrial processes	Respiratory illness, breathing problems, may cause permanent damage to lungs.	Precursor of acid rain, which can damage trees, lakes, and soil; aerosols can reduce visibility. Acid rain also causes buildings, statues, and monuments to deteriorate.
Lead	Combustion of fossil fuels and leaded gasoline; paint; smelters; battery manufacturing.	Brain and nervous system damage (esp. children), digestive and other problems. Some lead-containing chemicals cause cancer in animals.	Harm to wildlife and livestock.
Mercury	Fossil fuel combustion, waste disposal, industrial processes (incineration, smelting, chlor-alkali plants) and mining.	Liver, kidney, and brain damage; neurological and developmental damage.	Accumulates in the food chain.

Source: Computed

Vapi in Gujarat and Sukinda in Orrisa is among the world's top 10 most polluted places, according to the Blacksmith Institute, a New York-based nonprofit group. As many as 51 Indian cities have extremely high air pollution, Patna, Lucknow, Raipur, Faridabad and Ahmedabad topping the list. Bangalore holds the title of being the asthma capital of the country.

Table II: Air quality, trends over 1995-2008, averaged for India

Air quality indicator	India	India	Sweden
Year	1995	2008	2008
Pollutant, PM10 (micrograms per cubic meter)	109	59	11
Pollutant, CO_2 emissions (kg per 2005 PPP$ of GDP)	0.7	0.5	0.2
Pollutant, methane, Agriculture emissions (% total)	68.8	N.A.	28.1
Pollutant, nitrous oxide, Agriculture emissions (% total)	75.2	N.A.	60.2
Health, mortality rate (under 5, per 1000)	100	67	3

Source : Widipedia.com

As can be inferred from the table emissions and mortality rate is decreasing in India since 1995 but at a slow pace. India being a developing nation lags far behind the developed nation, Sweden in all its indicators.

Table III: Variation in concentration of pollutants (ug/m3) since 1990

Year	Conc. Of NO_2	Conc. of SO_2
1990	496.3	420
1991	582.7	507
1992	550.8	336
1993	852.9	544
1994	929.8	535
1995	1006	621.7
1996	651	546
1997	66	556
1998	669.2	437.8
1999	523.4	263105.7
2000	452.01	263105.7
2001	452.01	263105.7
2002	452.01	263105.7

Source:http://www.indiastat.com/environmentandpollution/11/airpollution/45/stats.aspx

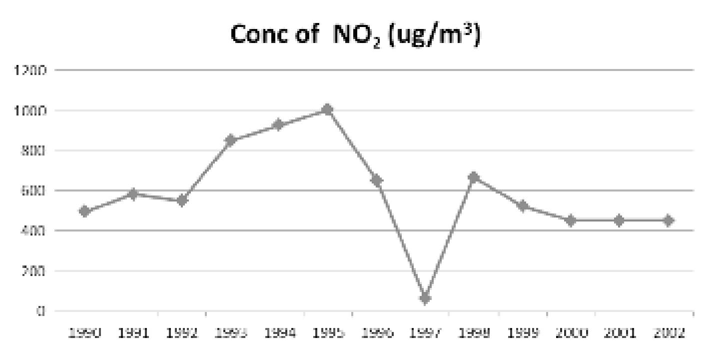

Figure 2: Variation in concentration of NO2

Above trend shows that the mean concentration of NOx increased rapidly after 1990s till 1995. Because of implementation of some environmental norms, it decreased after 1996 but later increased again with the process of urbanization and industrialization. After 1998 Asian crisis, it fall down, and now it is constant. Using NO2 data acquired from 1996 to 2006 by the Global Ozone Monitoring Experiment (GOME) instrument aboard ESA's ERS-2 satellite, researchers found that Nitrous oxide emissions over India is growing at an annual rate of 5.5 percent/year. The location of emission hot spots correlates well with the location of mega thermal power plants, mega cities, urban and industrial regions. With the weekly data collected and then averaged over the year, Central Pollution Control Board also reported that the average annual SOx and NOx emissions level and periodic violations in industrial areas of India were significantly and surprisingly lower than the emission and violations in residential areas of India from 1998 to 2008.

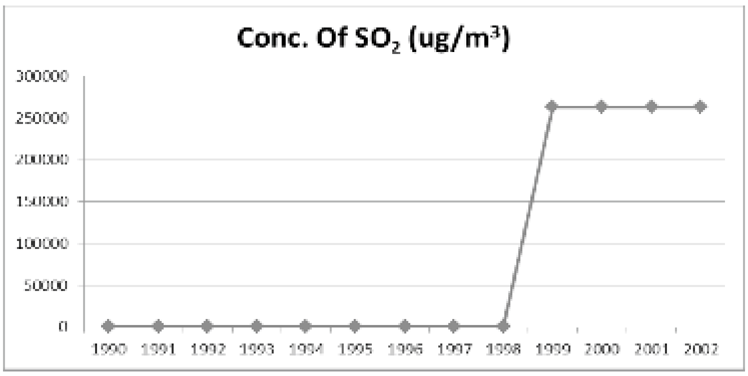

Figure 3: Variation in concentration of SO2

Emissions of SOx have increased in India over the past two decades. Rapid trade, industrialization, urbanization, and traffic growth are most likely responsible for the increase.

Scenario of International Trade in India

Till the early 1990s, India was a closed economy following import substitution and export pessimism. The Indian currency, the rupee was inconvertible, average tariffs exceeded 200 percent, quantitative restrictions on imports were extensive, and there were stringent restrictions on foreign investment. The state bureaucracy became known as the “License Raj” because its comprehensive scheme of licenses, required for all business activities, created fertile ground for widespread bribes, red tapism and political kickbacks. By the end of 1990, the government was close to default, its central bank had refused new credit and foreign exchange reserves had reduced to the point that India could barely finance three weeks' worth of imports. As a result, the government of P. V. Narasimha Rao and his Finance Minister Manmohan Singh started breakthrough reforms. Controls started to be dismantled, tariffs, duties and taxes progressively lowered, state monopolies broken, the economy was opened to trade and investment, private sector enterprise and competition were encouraged and globalization was slowly embraced.

India has come a long way toward opening its borders to trade – exports and imports grew at 19% and 30% in 2004 and 2005 respectively. Thus, India's trade to GDP ratio has increased from 15 percent to 35 percent of GDP between 1990 and 2005, and the economy is now among the fastest growing in the world. Its foreign investment inflows increased from 0.5% of GDP in 1991 to 4.1% in 2000. Although India has steadily opened up its economy, its tariffs continue to be high when compared with other countries, and its investment norms are still restrictive. This leads some to see India as a 'rapid globalize' while others still see it as a 'highly protectionist' economy.

Variation in Trade balance of India before and after economic reforms:

Trade balance is the difference between the monetary value of exports and imports in an economy over a certain period of time. A positive trade balance is known as a trade surplus and consists of exporting more than is imported; a negative trade balance is known as a trade deficit or trade gap.

Trade balance forms part of the current account, which also includes other transactions such as income from the international investment position as well as international aid. If the current account is in surplus, the country's net international asset position increases correspondingly. Equally deficit decreases the net international asset position.

Table IV: Year wise trade balance of India in crore Rs

Year	Trade Balance
1969-70	-99
1972-73	104
1975-76	-1229
1978-79	-1085
1981-82	-5802
1984-85	-5390
1987-88	-6570
1990-91	-10635
1993-94	-3350
1996-97	-20103
1999-00	-55675
2002-03	-42069

Source: http://www.indiastat.com/foreigntrade/12/foreigntrade/107/stats.aspx

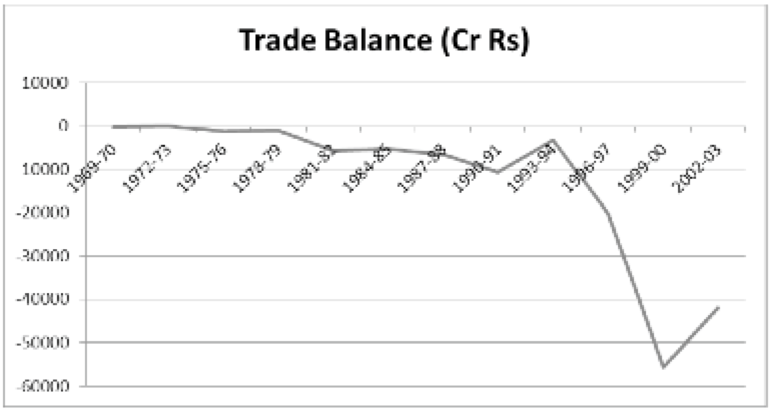

Figure 4: Variation in Trade Balance

During the first phase of international trade policy of India, the volume of Exports and Imports were less, due to the restrictive trade policy, but imports were more than exports. India's trade balance remains negative always because of higher volume of imports. It was only in 1972-73 and 1976-77 when trade balance was positive. The higher trade deficit could be attributed to a rise in petroleum, oil and lubricants (POL) as well as non-POL components in imports. Continued uptrend in prices in the international markets, and rise in the price of gold were the major contributors to trade deficit. First hike in oil prices occurred in 1973 and second in 1979-80. India being a net importer of oil, exogenous supply shock had a cascading effect on prices of imports and deteriorated Balance of payments. During 1970s – 1980s India's major imports were non food items and India was concentrating on domestic industrial production. Thus, share of manufactured goods in this decade increased from 50% to 57%. From 1970s to 1990s i.e., in the pre-reform period the growth rate of Indian exports and imports were 16.1% and 17.8% respectively which increased in the post reform period (1990-2000) to 19.5 and 20.1% respectively. But the growth rate of import is still high.

Currently, India's services exports are fast catching up with the country's merchandise exports to support exports.

Variation in net imports of some energy intensive products before and after economic reforms

Coal, crude oil and petroleum products are considered to be the most energy intensive and environmentally sensitive goods. A variation in their net imports depends on many factors like demand, supply, prices, tariffs, trade and environmental policies. These are considered both as raw materials as well as finished goods. Their use has a negative impact on the environmental quality of the user nation as well as on the ambient environment.

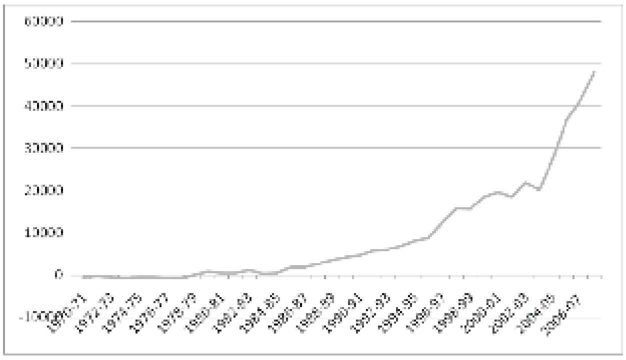

Figure 5: Variation in net imports of coal (thousand tonnes):

The figure shows that net imports of coal have increased gradually till 1985. After smooth increase of coal imports till 1995, it increased with fluctuations till 2003 and then a steep increase for a period of 2 years. Increasing globalization, urbanization and industrialization is the major cause for this.

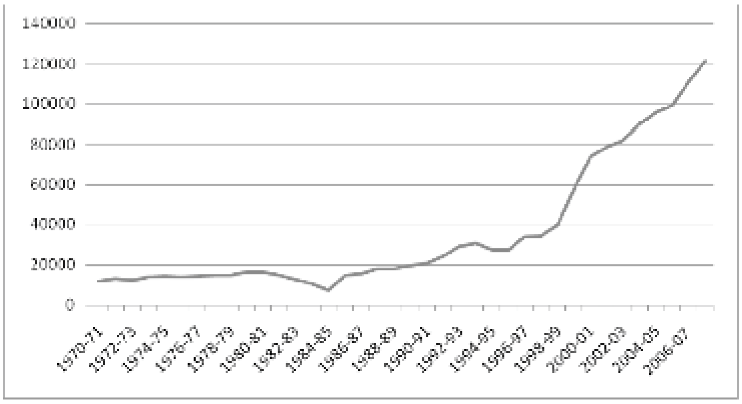

Figure 6: Variation in net imports of Oil (thousand tonnes):

Net imports of crude oil also show a trend exactly similar to that of coal. There has been two international oil price hikes in 1972 and 1979. After the second oil price hike in 1979, net imports of oil started falling because of unaffordable high prices but it revived in 1984 due to demand. The high dependency on this conventional non renewable and finite source of energy will have negative spillover effects on the environment as well as natural resources of a nation.

So, there is a need to develop non-conventional renewable energy sources like solar, tidal, biogas etc. for future progress of the nation and sustainable development.

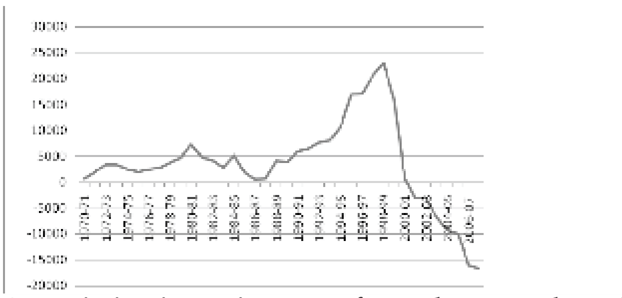

Figure 7: Variation in net imports of Petroleum products (thousand tonnes):

Net imports of petroleum products have shown a very fluctuating trend. It was increasing since 1970s but fell after the first oil shock it declined but revived later. After the second oil shock in 1979, net imports again started falling in 1980. It is only after trade liberalization that their imports have increased but that too till 1997. Afterwards net imports decreased due to Asian Financial crisis and that to such an extent that they reached below initial net imports in 1970s. The another reason for continuing fall in net imports is industrialization in India which has changed the trade composition. Before 1970s India was a major exporter of primary products but, efforts of Second Five Year Plan led to the development of many industries. Thus, India started producing manufactured goods and its dependence on imports of manufactured goods started declining.

Results and Findings

Relation between trade and environment

Table V: Correlation Coefficients:

	Trade balance (Rs crore)	Net imports of Coal ('000 tonnes) (1)	Net imports of Crude oil ('000 tonnes) (2)	Net imports of Petroleum products ('000 tonnes) (3)
NO_2	0.684	-0.751	-0.751	0.643
SO_2	0.028	0.621	0.501	-0.483

Source: Computed using SPSS

Statistically, measures of environmental quality are positively correlated with the level of trade balance. It is more significant in case of NO2 as compared to SO2. It means that as negative trade balance of India increases because of larger imports, concentration of pollutant in the local atmosphere rises significantly. Thus, the first null hypothesis is rejected against the alternative hypothesis which is accepted as their exists some correlation between trade and environmental quality. Correlation between concentration of NO2 and net imports of coal and oil is negative but it is positive with petroleum products.

Correlation between concentration of SO2 and net imports of coal and oil is positive but it is negative and low with petroleum products. But the correlation is not causality so regression analysis is done.

a.)Curve estimation

Trend analysis of the pollutant with time results into following figures-

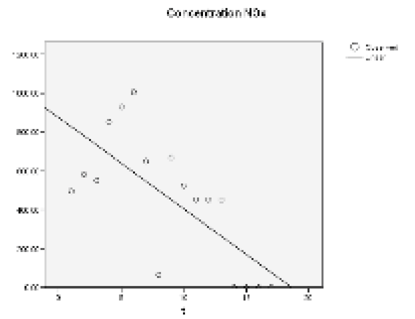

Figure 8: Trend analysis of NO2

Y1 = 874.043 - 46.892 t

Y1stands for concentration of NO2 and t stands for time. Results show that concentration of NO2 is negatively related with time. With change in time, concentration of NO2 decreases at a rate of about 47%. 874.043 is the positive intercept of slope.

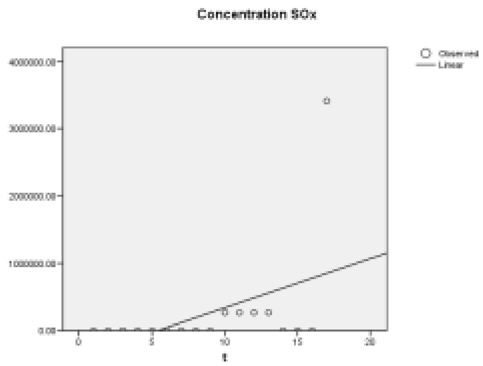

Figure 9: Trend analysis of SO2

Y2 = - 397288 + 73377.08 t where Y2 stands for concentration of SO2 and t stands for time. Results show that concentration of SO2 is positively related with time. With change in time, concentration of SO2 increases at a rate of about 73% which is very fast and harmful for environment. -397288 is the negative intercept of slope.

b.)Regression Results

Model applied: Second degree polynomial regression on time series data from 1990 to 2000

$Y_i = b_o + b_{1i}\ tb + b_{2i}\ tb^2 + u_i$

Where Y_i = Concentration of pollutant in ug/m^3

b_o = Intercept term

b_1 = Coefficient for trade balance

b_2 = Coefficient for the square of trade balance

u_i = error term

i = time period from 1990 to 2005

t_b = Trade Balance

Table VI: Estimates of the model

Dependent variable	b_0	b_1	b_2	R^2	Adjusted R^2	F statistic	Standard error of Estimate
NO_2	780.006* (7.378)	.010* (2.617)	3.11E-08 (1.609)	.557	.489	8.180*	230.928
SO_2	7585.883 (.145)	-3.023 (-1.572)	-1.66E-05 (-1.677)	.179	.052	1.412	114291.001

Source: Computed from SPSS

The above results show that the trade balance has a significant positive impact on concentration of NO2 in the atmosphere at 5% level. R square value is .557 which means 55.7% variation in the concentration of NO2 is explained by Trade balance and square of Trade balance. Value of coefficients reveal that with the increase in the trade balance rate of increase in concentration of NO2 is initially faster than at a later stage. This shows that after attaining some development in the Indian economy, trade will not have a devastating impact on Indian air pollution.

For concentration of SO2the values of the estimates are insignificant at 5% level. Value of R square is.179 which means only 17.9% variation in the concentration of SO2 is explained by Trade balance and square of Trade balance. Value of coefficients reveals that with a decrease in the trade balance rate of increase in concentration of SO2 is initially faster than at a later stage.

Hence, second null hypothesis is also rejected against the alternative hypothesis which says that there exists impact of trade balance on environmental quality.

Conclusion

The first conclusion is simply that there is now a great deal of evidence supporting the view that pollution is rising, and imports are far ahead than Indian exports. As revealed by trend analysis concentration of NO2 is decreasing while that of SO2 is increasing in Indian atmosphere. Graphs of trade balance show that Indian exports lag behind Imports and this negative trade balance is increasing fastly. International trade is correlated with environment quality positively. Though this correlation is low for concentration of SO2 as compared to the concentration of NO2. Regression analysis proved the fact that trade does affect air pollution significantly. The review of various theories suggests that increased trade relations cannot be simply associated with increased environmental damage. Beneficial changes in environmental policy will likely follow, and this leaves the net impact on the environment unclear.

Notes

1 Copeland & Taylor (2004)
2 Stern I. (2004)
3 Frankel J.A. (1999)
4 The trend analysis of both the pollutants matches with the reports of Centre for Science and Environment. (cseindia.org)
5 "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" – Brundtland Commission
6 Gujrati D. & Snageetha. (2007).
7 Curves of NO2 and SO2 represents a parabola which in mathematical terms are represented by a quadratic function as Y= bo + b1 X+ b2 X2 . This is called as second degree polynomial in variable X as the maximum power of X is 2 here. The Stochastic version is written as Y= bo + b1 X+ b2 X2 + ui. X2 is non-linear function of X. hence, the model does not violate the assumption of no multicollinearity.
8 Value of second degree coefficient (b1) is very less than first degree coefficient (b0). This mean the rate of change is slowing down.

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