Environmental Regulations and Industrial Trade Competitiveness: Evidence from South Asian Countries

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Submitted for Degree
Of
Doctor of Philosophy

Faculty of Management, Law and Social Sciences
UNIVERSITY OF BRADFORD
2020

Abstract

This thesis examines the impact of environmental regulations on trade competitiveness for South Asian countries. The study further investigates whether South Asian countries have become a pollutive haven of industrial exports to OECD countries during 1984-2004. The thesis also analyses whether tariff walls created by the governments to offsets stringent environmental regulations negatively affect pollutive industrial trade flows. This study has identified gaps in the literature after critically reviewing both competing trade theories and empirical literature surrounding the subject. Firstly, most of the empirical literature on the subject has focused on developed countries while ignoring less developed regions like South Asia. Second, several studies concluded trade competitiveness impact of environmental policy following a single estimation method when results are sensitive to the choice of the method used. Hence, for robust results, cross-methods analysis was imperative. Thirdly, the empirical literature on the subject focused on most pollutive industries and ignored the research on somewhat pollutive and least pollutive sectors as well as comparative analysis between those industries. This study has contributed to the literature by filling these gaps. Following the neo-classical theory, the central hypothesis of this thesis is that environmental regulations negatively affect different categories of pollutive industrial export competitiveness. By using the highest dis-aggregated ISIC level trade data and incorporating other socio-economic variables, this study has deployed comparative advantage trade models by Balassa (1965), competitiveness indicator by XU (1999), and bilateral RCA model by Grether and de Melo (2004). The study used the gravity model to control for un-observed effects over time on trade flows while capturing environmental regulations impact on pollutive industrial trade competitiveness. Accordingly, to avert endogeneity/data sensitivity issues and to ascertain robust estimates, the present research has among others computed Random Effect and Newey-West standard error models. The statistical modeling results show that while India gained trade competitiveness in most pollutive industrial trade, Pakistan and Bangladesh lost their trade competitiveness in the same category. The research finds evidence of most pollutive industries of South Asian countries increasing their bilateral RCAs and exports with OECD countries and reset of the world. A comparative analysis between most pollutive to less pollutive industries showed a lack of support for any systematic specialization patterns of trade for South Asia during 1984-2004. Nonetheless, this study findings based on gravity modeling clearly depicted a statistically significant negative impact of environmental regulations on total exports, most pollutive exports, and less pollutive industrial exports for South Asia and OECD countries. This study rejected the pollution haven hypothesis between South Asian pollutive industrial exports with OECD. It further concluded that tariff barriers created by countries to offsets environmental regulation costs would prove counterproductive to competitiveness. At the policy level, instead of lobbing for protectionism to balance out environmental regulatory costs, the governments in both developed and developing countries need to focus on forming better environmental policies fostering both competitiveness and environmental quality. Also, trade-offs between environmental regulations and competitiveness are challenging situations for South Asia and OECD countries. Therefore, sustainable production and trade policies combined with innovative and cost-effective environmental policies are needed to accomplish environmental gains and competitiveness.

Key words: Environmental Regulations, trade competitiveness, South Asia, OECD, Gravity Model, pollutive industrial exports, comparative advantage, pollution haven, tariff barriers.

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ACKNOWLEGEMENTS

I would like to express my profound gratitude to my supervisor Dr. Hossein Jalilian for his guidance, knowledge, patience, constructive feedback, and continuous support of my doctoral research program. My research journey went through a bumpy road due to my family circumstances that required my constant attention of care. Without Dr. Hossein patience and moral support, in addition to his highly valued academic guidance, I would not have been able to reach this stage of completing my Ph.D. research.

My sincere thanks are due to my research colleagues and academic staff for their valued feedback on my earlier presentations during the doctoral research seminar series. I would also like to extend my thanks to the Faculty of Management, Law and Social Sciences admin team for all their valued support during my research program.

My family deserves special thanks for their continued support. I want to express my massive thank to my late mother for her guidance, support, and prayers, who sadly died during my research pursuit. Finally, I wish to thank my highly supportive wife and two children for their continuous encouragement and selfless support towards my research endeavours.

Dedication

To my beloved late Parents

ACRONYMS

AHS	Effectively Applied Tariff Rate
APEC	Asia Pacific Economic Cooperation
ARIMA	Autoregression Integrated Moving Average
ASEAN	Association of Southeast Asian Nations
CEECS	Central and Eastern European Countries
CEPII	Centre d'Études Prospectives et d'Informations Internationales
CIA	Central Intelligence Agency
CIESIN	Center for International Earth Science Information Network
CPI	Consumer Price Index
DCs	Developed Countries
EEA	European Economic Area
EEC	European Economic Community
EKC	Environmental Kuznets Curve
EPA	Environmental Protection Agency
EPI	Environmental Performance Index
ERI	Environmental Regulations Index
ESG	Environmental Sensitive Goods
ESI	Environmental Sustainability Index
EU	European Union
FDI	Foreign Direct Investment
FEM	Fixed Effect Model
GATT	General Agreement on Tariffs and Trade
GDP	Gross Domestic Product
GMM	Generalized Method of Moments
HAC	Heteroskedasticity- and autocorrelation-consistent
H-O	Heckscher-Ohlin

H-O-S	Heckscher-Ohlin-Samuelson
H-O-V	Heckscher-Ohlin-Vanek
IIT	Intra Industry Trade
IMF	International Monetary Fund
ISIC	International Standard Industrial Classification
LDCs	Less Developed Countries
MNCs	Multinational Corporations
NAFTA	North American Free Trade Agreement
NGOs	Non-Governmental Organizations
OECD	Organization for Economic Cooperation and Development
OECDL	Overall Environmental Control Loadings
OLS	Ordinary Least Squares
PAOC	pollution abatement operating costs
PHH	Pollution Haven Hypothesis
PPMs	Process and Production Methods
RCA	Revealed Comparative Advantage
RCDA	Revealed Comparative Dis-advantage
REM	Random Effect Model
REW	Rest of World
RTA	Regional Trade Agreement
SAARC	South Asian Association for Regional Cooperation
SAPTA	SAARC Preferential Trade Agreement
SIC	Standard Industrial Classification
SITC	Standard International Trade Classification
STAN	STructural ANalysis Database
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNCTAD	United Nations Conference on Trade and Development

UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
VIF	Variance Inflation Factor
WITS	World Integrated Trade Solution
WPI	Wholesale Price Index
WTO	World Trade Organization
XRCA	Exports Revealed Comparative Advantage
XRCDA	Exports Revealed Comparative Dis-Advantage

Chapter 1

Introduction

1.1 Background

A crucial challenge identified in Agenda-21 during the Earth Smith (1992) was to ensure that trade and environmental objectives are mutually supportive to each other's that guided to encompass environmental concerns in trade agreements such as GATT, NAFTA, and WTO (Jayadevappa and Chhatre, 2000:176). At the same time, liberalization endeavors around the globe aimed at creating a competitive business environment in the 1990s have shifted focus from lowering tariff barriers to eliminating non-tariff barriers to trade. And series of multilateral environmental agreements (MEA's) covering the areas of public health standards, food safety requirements; emission limits; waste management and disposal rules; packaging and recycling regulations, and labeling policies all playing a vital role in, among others, shaping the domestic environmental policies and international trade flows (Esty, 2001). These outcomes have raised serious concerns for developing economies on compliance with environmental policies' impacts on manufacturing traded commodities competitiveness at domestic and international levels. At present, issues about the effects of environmental regulations on trade competitiveness are debatable across nations. One of the common concerns is that the differential in environmental standards between countries allows the polluting industries to relocate from those countries where environmental standards are high- generally advanced OECD countries- to the countries where environmental standards are relatively lower- generally developing countries. The latter group of countries tends to become a haven for most pollutive industrial exports (Caporale et al., 2010 in Jayawardane and Edirisingh, 2014; Cole and Elliott, 2003; Cole et al., 2005; Low and Yeats, 1992).

This study critically reviewed the theoretical debate between neo-classical trade theories whose central position premises on competitive market structure and new trade theorists who believed in market imperfection and economies of scale. The literature, especially in a neo-classical orthodoxy, advocates that environmental regulations can influence negatively to production costs, trade pattern, industry location, and gains from trade and thus competitiveness of the economy and relaxing one or few assumptions of model(s) produce quite complex results (Walter, 1975a; Grubel, 1976; Pethig, 1976; McGuire, 1982; Siebert, 1974 & 1980; Copland and Taylor, 1994 & 1995;

Merrifield, 1988; Chichilnisky,1994; Palmer, Oates and Portney, 1995). New trade theorists such as Porter and Van der Linde (1995) argued that there was no trade-off between environmental-related social benefits and private cost as properly designed environmental standards can trigger innovation that may partially or more than fully offset the costs of complying with them thus advocated win-win solution. Palmer, Oates and Portney (1995) argued that there was no free lunch in economics, and pollutive industries would bear some environmental costs. Hence this research is no exception and will follow mainly neo-classical orthodoxy. Furthermore, theory suggests that environmental costs can be offset through the benefits ascertained through the introduction of new technology. However, the difference of opinion is whether the environmental regulation costs can be fully or more than fully offset by the benefits gained after introducing new innovative environmental technology, which is an empirical question to investigate (XU, 2000).

Two key competing arguments are at work at theoretical, empirical as well as at policy development levels. Firstly, environmental regulations can affect the trade competitiveness of the industry and country. Secondly, since environmental stringency increase with state of development (Dasgupta et al., 1995), the differences in the degree of stringency in environmental regulations between stringent North and laxer South can allow countries in the South to develop a comparative advantage in pollution-intensive production and trade (Cole, 2004), later is termed as pollution haven hypothesis. This pollution haven hypothesis can manifest itself in the form of dirty industries relocating from developed to developing countries and or developed countries pollutive industries being displaced from the world market by similar industries from developing economies (Cole and Elliott, 2003). The theoretical rationale for the pollution haven hypothesis came from, among others, Baumol and Oates (1988). Assuming that the difference in transport costs, tariffs, and like are non-existed between two countries and that developing countries adopt lax environmental standards compared to the advanced countries, they argued that the developing countries would enjoy the comparative advantage in the production of pollution-intensive goods and would export the dirty products. Accordingly, they concluded that those countries that do not control pollution than others who control pollution emissions would voluntarily become the repository of the world's dirtiest industries (Baumol and Oates, 1988:265).

This study reviewed both direct and indirect methods on the subject to trace the measurable impact of environmental regulation policies on pollutive industrial trade and competitiveness. The research carried out in the 1970s and 1980s pre-dominantly chose an indirect method of estimation, and the focus of attention was on estimating environmental control costs in the US most pollutive industrial traded sectors. Most studies concluded that the impact of environmental regulatory costs on pollutive industries trade patterns was insignificant as environmental control costs on average remained around 2 percent in overall manufacturing costs. Nevertheless, other carefully assessed empirical findings showed that environmental control cost for pollution abatement in manufacturing sectors could leave considerable adverse effects for industrial trade flows and the country's balance of trade and payments.

The studied mainly from 1990 onwards, used the direct methods to assess the impact of environmental policy on industrial trade competitiveness and broadly deployed comparative advantage model developed by Balassa (1965), Heckscher-Ohlin-Vanek model (in Murrell, 1990), and gravity trade model pioneered by Tinbergen (1962) and Linnemann (1966). Empirical research conducted in the area, which mainly focused on the developed part of the world, has produced mixed results. Some researchers do not find the negative impact of environmental regulations on trade competitiveness, while others do. Similarly, some researchers have explored the possibilities of developing countries to become a haven for world pollutive exports others tends to reject this phenomenon, thus leaving the issue of environmental regulations impact on trade competitiveness unresolved (Walter, 1973; Evans, 1973; Mutti and Richardsion, 1977; Robison, 1988; Tobey, 1990; Low and Yeats, 1992; Kalt, 1988; Wilson, 2002; Cole and Elliott, 2003; Mani and Wheeler, 1998; Grether and de Melo, 2004; Caporale et al., 2010; Jayawardane and Edirisingh, 2014; Cantore and Cheng, 2018). The literature has drawn attention to the debated subject that import tariffs are either an artificial barrier to trade or new trade barriers that have emerged to offset costs associated with stringent environmental regulations. The results based on proxies on industrial tariffs data indicated the negative impact of tariffs barriers on most pollutive industries trade (XU, 2000).

After critically reviewing empirical literature, the present study has identified some gaps in the literature regarding the impact of environmental policies on trade competitiveness. Firstly, the empirical quests on the subject were primarily confined to the developed part of the world, and less attention was given to LDCs, including South Asian countries. Secondly, on the pollution haven hypothesis, earlier literature tended to be biased in countries' coverage choices. It concentrated only on developed world analysis with aggregated trade data (Sorsa, 1994) when the pollution haven hypothesis demands the investigation between developed and developing countries using the highest dis-aggregated trade data. Thirdly, the results in most of the empirical work this study reviewed are sensitive to the type of methodology chosen and country (s) / period selected, and the nature of pollutive industry/type of environmental regulations chosen. Some studies lacked a theoretical basis regarding the choice of model others failed to report or perform diagnostic tests/sensitivity analysis. Fourthly, the earlier empirical literature has focused on a too narrowed selection of most pollutive industry trade analysis like iron and steel only (Low and Yeats, 1992). However, those who have provided an in-depth analysis of the pollutive industries' trade specialization patterns relied on most pollutive industry trade data only (XU, 1999) and ignored a comparative analysis of trade specialization patterns between most with relatively less pollutive industries. Moreover, the author of this study could not find any comprehensive research on South Asian countries regarding the impact of environmental regulations on industrial trade competitiveness using the most pollutive to least pollutive industrial groups and bilateral trade flows of South Asia with OECD countries. This thesis contributes to the literature by filling these research gaps.

South Asia region, which is home to 22 percent world population (Kemal et al., 2000), has not received much attention to addressing environmental regulations and trade competitiveness. Also, there is a dearth of rigorous research to analyze the environmental policy consequences for various categories of pollutive industries using dis-aggregated level trade data. South Asia is one of the fastest-growing regions globally and depicted a rapid expansion of trade during liberalizations periods of the 1980s and 1990s. Still, intra-regional trade has been severely affected and has not kept pace with the global rate of the trade like other regions around the world. One of the critical factors of low inter-regional trade was the border tension with India, Pakistan and the geopolitical and legacy of mistrust that has had a visible mark left on intra-regional trade expansion efforts. Other vital factors responsible for low intra-regional trade between South Asian countries include identical comparative advantage on commodity trade, lack of trade complementarities, restrictive trade policies, lack of regional transport network and transit system, and political upheaval. The intra-regional trade in South Asia, which as a percentage of total trade volume stood at 2 percent in 1980, remained around 3 percent in 2004. Export from the South Asian region during the same period rose from US$17billion in 1980 to US$120 in 2004. The trade of SAARC regions with EU countries, including with most OECD countries which were to the tune of 62 percent in 1980, rose to 67 percent in 2000 and remained almost 67 percent in 2007. The intra-regional trade among SAARC countries wherein India, Pakistan and Bangladesh remained vital players in the group trade were 3.5 percent in 1980 and increased to 4.5 percent in 2000 and stood at 4.8 percent in 2007 and thus intra-regional trade remained considerably low in the South Asian region (Uddin and Nasir, 2004; UNCTAD,2008; Asian Foundation, 2019).

The above analysis clearly shows that the trade interests of South Asian regions are mainly with OECD countries, and the latter group is following the most stringent environmental regulations. Therefore, it is worth looking at environmental regulations consequences of South Asian trade with high-income OECD to examine trade competitiveness consequences for South Asian regions of environmental regulations. Also, the present research took inspiration from one of the recent works on the state of environmental performance for, among others on three selected South Asian countries viz. India, Pakistan, and Bangladesh, which shows that while India and Pakistan in terms of performance scoring are next to each other, Bangladesh is a bit behind in terms of environmental performance but not far behind[1]. Compared to the 1980s, South Asian economies have made progress during the 1990s and onwards in creating environmental institutions, strengthening environmental protection activities, and improving environmental governance through inter alias creating environmental ministries, environmental protection agencies and emergences of independent bodies such as NGOs. These efforts are focused on creating an environment of internalizing the environmental externalities using environmental regulatory tools and promoting and encouraging property rights that foster new institutions at the grass-root level for environmental management. South Asian economies are still relying on regulatory -command and control- mechanism for accomplishing environmental control objectives than those of market-based economic instruments. Nevertheless, these economies are gradually moving towards market-based instruments like assigning the proper pricing to the environmental resources such as water at industrial level (World Bank, 1992; UNIDO, 2000). The empirical research on industrial level trade indicates that export interests of South Asian countries also lie in mostly the similar primary resource-based commodities (Kemal et al., 2000; Pitigala, 2005).

[1] Dasgupta et al. (1995) mustered information from the individual 31 country reports compiled under the UNCED guidelines. Each report is based on identical survey questions and provided detailed information on the state of environmental policies, legislation, and enforcement within each country. Using this information Dasgupta et al. (1995) developed an index of the stringency for environmental regulations for 31 countries.

1.2 Main Study Objectives

Given this background, the present study, after highlighting the broad debated issues surrounding the linkage of environmental policy and key economic variables, will make a case for central debated issues which is the impact of environmental regulations on pollutive industrial trade competitiveness. The focus of research will be primarily on pollutive industries exports competitiveness in South Asian countries covering the period 1984 to 2004 and their bilateral trade flows with OECD countries. Given the gaps highlighted in the literature, the study focuses on four key research questions. Firstly, whether South Asian countries, due to both internal and external environmental regulations, lost trade competitiveness in most pollutive industrial trade, somewhat pollutive industrial trade and, relatively less pollutive industrial trade during 1984-2004. Secondly, the study examines whether, due to the difference in environmental regulations compliance between stringent OECD countries and lax South Asia if South Asian countries have become a haven for most pollutive manufacturing exports to OECD. Thirdly, which is linked with the first two research questions whether the impact of environmental regulations on relatively less pollutive industries groups trade competitiveness will be the same as literature predicts for most pollutive industrial trade or somewhat different results could be witnessed. Fourthly, the research examines whether tariff walls created by the countries against industries trade leave adverse effects on different groups of pollutive industrial trade competitiveness. Following a literature review on the theoretical association between environmental policy and trade competitiveness, especially in the light of neoclassical trade theory, this study tends to test the following hypotheses.

1.3 Research Hypotheses:

1.3.1 Hypotheses for Statistical modeling:

- Firstly, over time increasingly stringent environmental regulations in South Asian countries will negatively impact the different categories of pollutive industrial trade specialization patterns and competitiveness.
- Secondly, the difference in environmental regulations between South Asia and OECD countries will increase different categories of pollutive industrial bilateral exports from South Asia to the OECD countries-pollution haven effect.

1.3.2 Hypothesis for Econometric Modeling:

- Environmental regulations reduce total bilateral trade flows, the bilateral trade flows of most pollutive industries, and bilateral trade flows of relatively less pollutive industries.

- Relative stringent environmental regulations in OECD countries as compared to South Asian countries increase South Asian pollutive industrial exports to OECD-pollution haven hypothesis.
- Tariffs on pollutive industrial trade negatively affect the pollutive industrial trade and export competitiveness.

1.4 Methodological Framework

The present research on the methodological choices level will follow the dominant mainstream Neo-classical orthodoxy path, which holds that proper methodology should be positivistic, quantitative, and empirical. Given this methodological choice of doing research and as guided by both theoretical models and empirical literature on current study areas and resultantly choices made for this study research questions/hypotheses, this study adopts multi-pronged methodological approaches for South Asian countries pollutive industrial trade and their bilateral trade flows with environmentally stringent OECD countries. Firstly, for statistical analysis, the study will employ the comparative advantage model offered by Balassa (1965, 1979, 1986) and advancement in the Balassa model to developing trade specialization and competitiveness indicator by XU (1999) during the period 1984-2004. Secondly, for bilateral pollutive industrial trade analysis, the study computed structural effect and technique effects for three pollutive industrial groups as well as analysed the bilateral RCAs between South Asia and OECD and rest of world (REW) countries by deploying geographical controlled bilateral trade flow model offered by Grether and de Melo (2004) for the same period. Thirdly, the present research will use the econometric modeling approach using both panel and cross-sectional data analysis techniques. These techniques are applied to the extended gravity trade model to examine the impact of environmental regulations on various categories of pollutive exports and imports during 1990 (averaged 1986-90), 1998 (averaged 1994-98), and 2004 (averaged 2000-2004). To avert endogeneity/data sensitivity issues and for robust findings, the present research has computed both Random Effect model and Newey-West standard error models. The gravity model will be chosen for econometric analysis due to its accurate prediction power, which in the words of Anderson (1979:106): "probably the most successful empirical trade device of the last twenty-five years and usually produces a good fit" as well as in the words of Rose (2002: 3).."all one needs to know is that gravity model stands proudly on both theoretical and empirical legs."

Last but not least, when it comes to distinguishing between various categories of pollutive industries, the present research following UNIDO (2000) has identified three industrial groups viz. most pollutive industries, somewhat pollutive industries and, less pollutive industries. This study will follow this recent UNIDO (2000) industrial categorization for pollutive sectors using ISIC trade data for South Asian trade analysis and their bilateral trade with OECD countries. In light of a detailed survey conducted in the present research, the term competitiveness will be seen mainly through the lens of changing trade patterns, especially comparative advantage position over time, and through the impact of the environmental policy on various categories of pollutive manufacturing exports.

1.5 Sources of Data

The present study will use World Production and Trade Data covering 1984-2004 offered through the World Bank / UNIDO resources (Nicita and Olarreaga, 2001, 2006). The first data set on manufacturing production and trade was available covering the period 1976-1999 at 4-digit ISIC level for 81 industries and 67 countries (Nicita and Olarreaga, 2001), and later they provided an updated trade data for the period 1976-2004 but only at 3-digit ISIC by covering 100 countries (Nicita and Olarreaga, 2006). The updated data came up while the present research pursued analysis on earlier data at 4-digits ISIC level. Therefore, it was imperative to further extend the analysis until 2004 using manufacturing trade data at the 3-digit ISIC level to analyze any noticeable change in pollutive industrial trade specialization patterns.

Data on industrial tariffs were available for 1984-1998 at 4-digit ISIC level through World Bank, Production and Trade Data (Nicita and Olarreaga, 2001). Furthermore, the closed-sample covering 56 developed and developing countries of 67 totals has been chosen for 1984-98 at 4-digit ISIC trade data set. And for 3-digit ISIC trade data set, this closed sample of 56 countries covers the period 1984-2004. The reasons for choosing the closed sample countries are either missing data or balancing issues in industrial trade data witnessed in countries/years in open sample data. Especially for the first 5 years and last few years, many countries reported missing values of the open sample. Facing some of these problems and using the same trade data source at 3-digit ISIC level Grether and de Melo (2004) confined their data selection choice to 52 closed sample countries for most pollutive industries analysis globally. Nevertheless, the closed sample does not lose its efficacy nor the scope of coverage. Grether and de Melo (2004) indicated that when using 1995-96 average trade share for the years with maximum non-missing values, the closed sample of 52 countries represented about 95 percent of the open sample trade. And the present study is covering 56 countries instead of 52. Therefore, this study has carefully chosen both the study period and scope of coverage to examine the research questions/hypothesis. Finally, this study has transformed industrial trade and tariff data into three groups: most pollutive industries, somewhat pollutive industries, and less pollutive industries for the period under study.

The data on real GDP (constant, PPP), population, and land variables for all selected countries are available through World Development Indicator (World Bank, 2006). The data on distance, common language, contiguity, colonial links, and some other dummy variables are obtained from CEPII website: http://www.cepii.fr/anglaisgraph/bdd/distances.htm , CIA factbook. The data dummies for RTAs have been created based on information provided by (Batra, 2004). The regional trade agreements in the lights of the coverage of countries among others include APEC, South Asia, EEA, SAPTA, NAFTA and have been used according to their applicability to analysis. All regression analyses are conducted using Eview-10-11 software, and for statistical data analysis, Excel software has been relied upon.

As indicated in the methodology section for gravity modeling analysis, the study has chosen three-panel periods: 1990, 1998, 2004, which are an average of preceding 5-years data. For environmental regulations variable, the present research focuses on two sets of data sources available for these periods. For the year 1990, the set of environmental stringency variables, which is termed as Environmental Regulatory Index (ERI) is based on Dasgupta et al. (1995), the team from World Bank who mustered information from the individual 31 countries and compiled data in the light of UNCED guidelines. Their survey assessment report for 31 selected countries used identical 25 questions to classify and gather information on (1) state of environmental awareness;

(2) scope of environmental policies adopted; (3) scope of environmental legislation enacted; (4) environmental control mechanisms in place and (5) the degree of success in implementation. The higher the index number is higher the stringency of environmental policy is in the country for respective indices. Their research for cross-section analysis shows that countries with higher per capita income are pursuing stringent environmental regulatory policies. The ERI serves well to accomplish this study research objective and has also been used by other researchers for a similar line of research inquiry (XU, 2000). Eliste and Fredrickson (2001), using the same methodology adopted by Dasgupta et al. (1995), extended the ERI from 31 countries to 60 countries, which covers all the countries of this research sample countries-17 OECD and three South Asian. At the request of the author of this research, Eliste and Fredriksson (2001) provided the data set in excel files with permission to use it for research endeavors.

For the years 1998 and 2004, the study chose a new comprehensive database made available by the Centre for International Earth Science Information Network (CIESIN, 2006). CIESIN is a non-governmental organization and collaborates among the World Economic Forum's Global Leaders for Tomorrow Environment Task Force, the Yale Centre for Environmental Law and Policy, and the Earth Institute at Columbia University (CIESIN, 2002,2005 in Busse, 2004: 288). The most vital indicator the institutions have developed is the Environmental Sustainability Index, henceforth ESI, which measures overall progress toward environmental sustainability for 142 countries. The ESI goes well with environmental regulations and environmental stringency expectations. The analysis conducted based on the ESI scoring index clearly shows its positive association with the country's per capita income, i.e., the higher the per capita income of the country is higher the ESI/stringency of the regulatory regime will be (Emerson et al., 2012 in Jayawardane and Edirisingh, 2014).

1.6 Some Key Study Findings and Contributions to the Knowledge

The study has employed the comparative advantage model offered by Balassa (1965) and advancement in the Balassa model to developing competitiveness indicator by XU (1999) for tracing evidence on the comparative advantages positions of different categories of pollutive industries and their trade specialization patterns. The likely expectation is that due to the introduction of relatively stringent environmental regulations in 1990s onwards, as compared to the 1980s, environmental pollutive industries with a higher export performance at the beginning of the sample period became less competitive in the end sample period. The Balassa XRCA measured the competitiveness of each pollutive industry of selected South Asian countries- India, Pakistan and Bangladesh- in three different periods- 1984-88 and 1994-98 and 2000-04 by separating the specialized and non-specialized pollutive industries. The specialized industry is where XRCA for the industry is greater than one, and vice versa is true for non-specialized industry. Second, to examine how the trade share of those commodities that revealed both XRCA and XRCDA during the period under study, another competitiveness indicator following XU (1999) was calculated.

The study findings based on Balassa (1965) RCA model for most pollutive industrial group showed that India gained its competitiveness position in export for the number of pollutive industries and her comparative disadvantage in most of industries of same pollutive industries category reduced in late 1990s onwards compared to early 1980s. Therefore, Indian industries witness structure transformation mechanisms within most pollutive industries exports during the period 1984-2004. On the other hand, neither Pakistan nor Bangladesh gained a comparative advantage in most pollutive industries exports during 30 years of study analysis, and instead, these countries witness losses in most pollutive industries export comparative advantage. For somewhat pollutive industries, both India and Bangladesh improved their trade competitiveness in 1994-98 compared to the beginning period, whereas Pakistan seemed to have maintained its competitiveness position- if not increased- to some extent for the same category during the end period compared to the beginning period. In somewhat pollutive industries group, the study found that all three South Asian countries maintained their comparative advantage position in wearing apparel and footwear industries. Among the less pollutive industries group, in other industries, India and Pakistan depicted XRCA in the world market during 2000-2004. Therefore, the present study observed some if not drastic structural changes in pollutive industries trade patterns of South Asian countries due to the introduction of stringent environmental regulations in the 1990s onwards compared to the 1980s. The more common result that emerged among South Asian countries was that all three countries to some extend enjoyed revealed comparative advantage in non-footloose industries, resource-based and, low technology or labour-intensive manufacturing industries such as textile and leather wherein South Asian economies depicted a consistent exports comparative advantage performance during 1984-2004.

The results based on XU (1999) competitiveness indicator in most pollutive industries for India showed that her trade share in the specialized group rose in the end period compared to the beginning period. The significant change witnessed during the end period in most pollutive industries category was the rise in the number of pollutive industries, which moved from non-specialized group to specialized group. Pakistan and Bangladesh in most pollutive industries group remained non-specialized in end periods compared to beginning period hence lost their trade specialization in most pollutive industries. In both somewhat pollutive industries and less pollutive industries groups, all three South Asian countries either have maintained or increased their normalized trade share in the specialized group in end periods compared to the beginning period and thus seemed to have been less affected by the rise in the stringency of environmental regulations over the years. One plausible reason for gaining competitiveness in less pollutive industries by Bangladesh and Pakistan could be what theory predicted that stringent environmental regulations imposed on the most pollutive sectors, keeping other things constant, could shift the locus of production and trade specialization towards relatively cleaner sectors (Krutilla, 1999).

Accordingly, unlike most of the previous research that just focused on most pollutive industries category, a comparative analysis between most pollutive to least pollutive industries offered by this study provides a much better understanding regarding the impact of the environmental policy on pollutive industries structural transformation and trade specialization patterns over time for South Asia region. In the case of India, the study observed that the country was maintaining its industries trade specialization exports competitiveness position in both most pollutive and cleanest industries during the same period, which following comparative advantage trade theory suggested that other traditional sources of comparative advantage like labour and capital could be a vital contributing factor to industrial trade competitiveness. Therefore, the likely impacts of environmental policies introduced in South Asia regions on pollutive industrial trade following XU (1999) model produce a mix of results. The impact of the policy on industrial trade is sensitive to an industry group and individual industry, and results vary for different pollutive industrial groups from most pollutive industries to least pollutive industries. The findings for most pollutive industries clearly signaling the presence of pollution haven effect for India, but for other countries, there are shifts of locus of production and trade specialization pattern to least pollutive industries. At the same time, results for each South Asian countries provide evidence for shifting of normalized trade shares within and between pollutive industries and pollutive industries movements from specialized group to non-specialized group and vice versa. Overall, over time there seemed to be less systematic trends emerging regarding the impact of environmental regulations on pollutive industries trade specialization patterns for South Asian countries.

The study results regarding the application of geographical based comparative advantage trade model of Grether and de Melo (2004) inter alias show that both composition and structure effects computed for three pollutive manufacturing trade categories reinforce each others giving strong indications for the South Asia region to become a pollution haven for most pollutive manufacturing exports. The estimation of composition and techniques effects during the period 1984-2004 reflected whether the change in comparative advantage over time attributed more to productivity/technologies improvement via technique effect or due to change in industrial composition. These results are further supported by controlling the geographical location and direction of exports flows at bilateral levels wherein the sample of 56 countries bilateral trade for three pollutive manufacturing groups- most pollutive to less pollutive- split into two- rich North 17 OECD countries and remaining 39 group of countries henceforth termed as rest of world- REW. The research findings show clear evidence of the South Asia region becoming a haven for most pollutive industries exports to environmentally stringent OECD economies. The bilateral RCA exports of the South Asia region with the OECD region in both most pollutive and somewhat pollutive industries groups depicted positive RCA shares and their growth rates in majority industries during the study period. These results were consistent, especially in most pollutive industries group that showed positive bilateral RCA with OECD over time in almost all industries, except one. These results are a vital contribution of this study towards the pollution haven effect. It conveys that by confining the research analysis to just most pollutive industry trade could give incomplete information on trade flows when the impacts of environmental regulations are equally or perhaps more important for industries other than most pollutive industries in the South Asian region whose large volume of pollutive industrial trade flows both with OECD and REW falls in pollutive industries groups other than the most pollutive group. The findings based on the bilateral RCA model confirmed that South Asia had become a haven for pollutive exports to stringent environmental OECD. Nonetheless, South Asia regions bilateral exports share and RCA growth rates in same pollutive industries groups also rose over time with REW group, relatively laxer environmentally stringent countries. Also, for the last category of pollutive industries that are a less pollutive or relatively cleaner industrial group, the study inter alia found that bilateral RCA of South Asia with the OECD was more substantial and positive than with the REW countries group, confirming more of pollution halo hypothesis instead of pollution haven effect.

The study witnessed somewhat puzzling results in statistical modeling analysis. Therefore, a further data investigation to test this study's hypotheses by using gravity model application to both panel and cross-sectional data analysis was conducted. The results for panel data show that environmental regulations do have a significant and negative impact on different categories of pollutive export flows and competitiveness on South Asian countries and full sample countries data, including both OECD and South Asian countries. The statistically negative association between the stringency of environmental regulations and pollutive industrial export flows means that, at the economic policy level, there can be a possible trade-off between efforts towards trade expansions and improving environmental quality. The empirical findings further contributed to research by depicting that environmental regulation negatively affects the world's most pollutive industrial exports and relative less pollutive and total industrial exports in both OECD and South Asian countries. These findings remained consistent for full sample countries data analysis and when the analysis was conducted for South Asian countries export flows with the OECD. The study confirmed the neo-classical orthodoxy of negative environmental policy impact on pollutive industries trade flows and rejected the new trade theorists' assertion of the porter hypothesis. These findings also echoed the conclusions from related studies on the impact of environmental regulations on most pollutive industrial trade competitiveness that found the statistically significant negative impact of environmental policies on most pollutive industrial trade.

The panel estimates of the gravity model show that the finding empirical evidence of pollution haven effect in South Asia region for different categories of pollutive bilateral exports with OECD countries is remote. Therefore there is a lack of support to pollution haven hypothesis-PHH- to South Asia bilateral exports flows to OECD countries. This study's findings for cross-sectional data were generally in line with what it found in panel data analysis, except for 1990 data that showed the positive impact of the environmental policy on pollutive industrial trade flows. Lastly, this study finds that the countries' tariff barriers negatively affect all pollutive industrial trade groups and competitiveness to both the OECD and South Asian countries.

1.7 Structure of Thesis

The research thesis has been spread into nine chapters. Chapter 1 covers the study's highlights, research objectives, fundamental hypotheses, introduction to the methodology, data sources, key findings of the study, contribution to knowledge, and thesis structure. After an initial focus on bringing environmental pollution elements into the mainstream economic modeling, the research in chapter 2 focuses on elucidating the various environmental policy instruments and their impacts and some dynamics of environmental regulations and international trade. This chapter also highlights the different directions and burning issues surrounding the debate of environmental policy and international trade. In chapter 3, the study focuses on research design and theoretical approaches to address environmental policy and international trade linkages in static and dynamic frameworks. It explores different outcomes of environmental policy and international trade associations. Chapter 3 further offers a possible consensus to pursue an empirical quest to examine the research hypothesis of current research. Chapter 4, clarifying the definitional aspects regarding environmental regulations and trade competitiveness and emphasizes the empirical quest regarding the likely impacts of environmental policy on international trade to develop the case of appropriate statistical/empirical models to be applied in light of this study research questions/ hypotheses.

The data sources, data sorting, and scope of data to address the statistical modeling are discussed in chapter 5. In chapter 6, the study uses the Balassa model and advancement of Balassa modeling approach like competitiveness indicator and examine the impact of environmental regulation on trade competitiveness of selected South Asian countries and for all pollutive industrial groups during period 1984 2004. This chapter, after computing the specialization/non-specialization trade pattern of pollutive industries, further reflects why cross-methodological techniques are imperative to examine the impact of environmental regulations on competitiveness. In chapter 7, a geographical-based extension of the Balassa model by Grether and de Melo (2004) is deployed to pollutive industries trade data. To trace the evidence if South Asian countries have become a haven for pollutive manufacturing exports, the study in chapter 7 analyses compositional and structural effects and the bilateral RCA between the South Asian region and OECD countries and with REW. The study through chapter 7 further provides a comparative analysis between different categories of pollutive trade of the South Asian region with the most environmentally stringent OECD countries and with REW countries during the period 1984-2004. In chapter 8, this study, after the theoretical derivation of the gravity model in neo-classical and new trade theories, conducts the regression analysis on extended gravity modeling using both panel and cross-section data analysis. It aimed at examining the impact of environmental regulations on trade flows and competitiveness with 20 sample countries data (three South Asian and 17 OECD). The analysis in chapter 8 also looked into empirically whether South Asian countries have become a haven for most pollutive industrial exports to OECD countries and what estimation results reveal about the impact of environmental regulations on less pollutive or relatively cleaner industrial trade as well as total industrial trade. Moreover, in this chapter, the study tests the hypothesis regarding the impact of tariffs on total exports, most pollutive exports, and less pollutive exports and cross-examines the results using pollutive imports data for the same groups. In chapter 9, the study summarized the research findings and drew some conclusions. It also offers some policy recommendations, highlights the study's contributions to knowledge and future research directions. Chapter 9 ends by sharing some limitations of the current research.

Chapter 2

Environment Economics and Trade Links

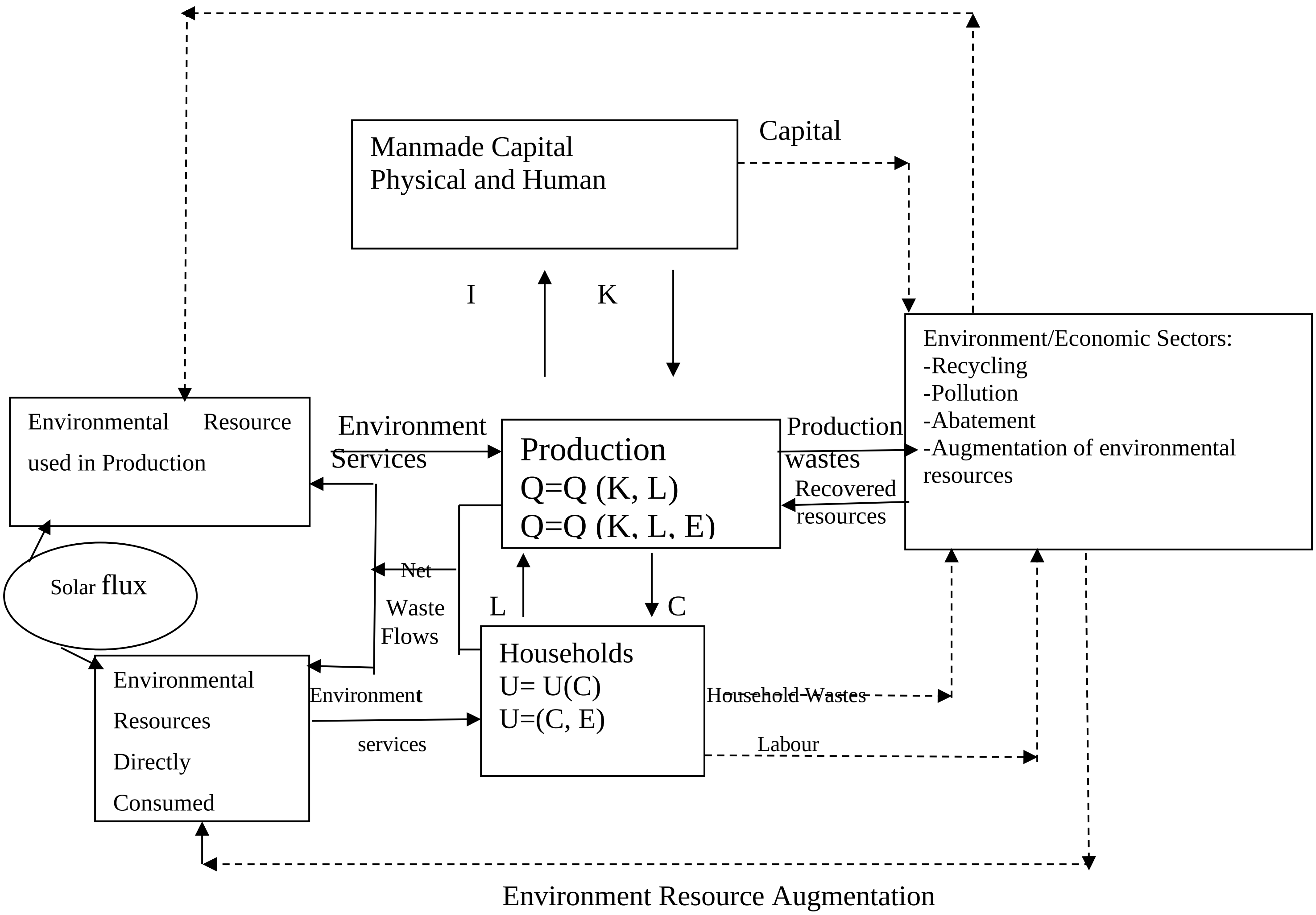
2.1 Introduction

The relationship between environmental regulations, international trade, environmental quality and economic growth are multi-dimensional and complex. In this chapter, the study will reflect on debated issues surrounded those areas. Therefore, this chapter will make a case that hardly any general equilibrium model exists that can incorporate all the dynamic links between environmental regulations and trade due to a series of theoretical modeling approaches required to address complex dynamic links between them. Section 2.2 will explain how the environment can be incorporated with mainstream economic activities after assigning an appropriate price to this negative externality. The study then discusses some environmental regulatory instruments and their strengths and weaknesses towards improving environmental quality worldwide. The dynamic links between environment and trade are discussed in section 2.3 to provide a critical review on debated issues/theories/hypotheses. Section 2.4 concludes this chapter by making a case for choosing partial analysis regarding the impact of environmental policies on pollutive trade and competitiveness.

2.2 Bringing Environment in Mainstream Economic Activities

The theoretical literature on economic growth indicates that ultimate sources of economic growth are the accumulation of productive resources and technological change that enhances the efficiency with which those resources are used. The environmental quality element in the growth process has been taken into account due to the challenge received from the environmentalists who argued that conventional macroeconomic theories and thus growth models did not give due attention to the fundamental relationship between macroeconomic activities and the environment, and that circular flow of income can only be maintained by intensive use of natural resources, intensive use of agriculture land and high levels of emissions of pollutants related to economic activities (Daly 1993). One possible way to bring the environmental resources in the mainstream economic framework can be depicted through figure 2.1.

Figure 2.1 Environment- Economic Flow Model



Note: Q is output; K and L are Capital and Labour; U is utility or social welfare C is flow of consumption goods; E is environment. **(**Source: Pearson, 2000:22**)**

In figure 2.1, the basic model on economic activities is augmented with natural and environmental resources. The vital box depicted through the sold line flow arrows, including capital, production and households, are at the center of the basic conventional economic model. The services of labor, human capital, and physical capital are input to the production sector. This conventional economic flow model is extended in four ways to bring environmental resource into economic activities: (1) accounting for directly consumed environmental services by expanding the utility function to include environmental services such as clean air and recreational activities; (2) recognizing the contribution of environment to the production function as input into the production process[2] and

[2] This is accomplished through assigning the proper price to the environmental resources through appropriate environmental policy such as Command and Control or market-based instruments i.e., environmental taxes/subsidies and paving the way for assigning property rights. The absence of property rights and well-functioning market is perhaps the central explanation of environmental degradation (Pearson, 2000).

considering environment as producer goods one can observe the positive contribution of environmental resources to economic output such as commercialized natural resources such as fossil fuel and ores, industrial process water etc.; (3) incorporating the detrimental effect of economic activities and related waste flows on the quality and quantity of environmental resources and (4) adding a new environmental economic sector that produces a pollution abatement, recycling, rehabilitation and augmentation of environmental resources using conventional capital and labour input, which in turn further generates the debate on the trade-off[3] between economic growth and environment: division of conventional given resources such as labour and capital either using to enhance economic activities or diverting those resources to protect environment (Pearson, 2000).

When market failures prevail, such as un-priced or underpriced resources are unaccounted for, then externalities[4] and or policy failure exists. To internalize these externalities, the economists normally divide policy instruments for achieving environmental objectives into two categories; (1) those which are said to provide firms with little flexibility in achieving goals are normally termed as command and control approaches and (2) those that are deemed to provide firms with better flexibility and incentives to look for more effectual ways and means of making sustained environmental progress are normally termed as market-based[5] or incentive-based mechanism (Stavins, R.N.1992).

Table-2.1 provides a comparative analysis of two vital environmental policy instruments that most governments worldwide are pursuing to address environmental issues.

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[3] The recent research on economic growth and environment sees no trade-off as productivity enhancement effect through cleaner technology can outweigh the cost incurred on abatement activities and ongoing innovations brings win-win solution i.e., the policies that are good for environment are also good for economic output and growth (Porter and Van der Linde, 1995).

[4] Externalities exist whenever, an agent has to tolerate a part of the cost of another agent activity without being compensated, and the agent responsible for this externality does take this into account and he or she bears only the private costs of the activities, whilst neglecting the total cost. The concept of externality was introduced by Sidgwick (1883) in nineteen century. Negative externalities are of concern not only in environmental economics but also in consumer theory (envy demand for social status), international trade theory, optimal tariffs and strategic trade policy, public choice (rent-seeking games), industrial organization (oligopolies, patent race) and many other areas (in Rauscher, 1997:19).

The other policy instruments to address negative externalities are (a) transaction cost approach due to Coase (1960) and (b) transferable emission permits, which are not discussed detail as mainstream literature on trade and environment has focused on two approaches mainly: command and control and market-based instruments.

Table-2.1 Comparative Analysis on Command and Control and Some Market Based Environmental Policy Instruments

Instruments	Categories	Description	Advantages	Disadvantages
Command and Control: Setting Standards; Role of Regulator	Ambient quality standard Emission or discharge standards Process Standards Product Standards	Elucidate the characteristics of receiving environment i.e. maximum concentrates of nitrates in water. Maximum allowable discharges of pollutant in environment i.e. maximum Biological Oxygen Demand in water. Production process, type of equipment installed. Explain the characteristics of potentially polluting products such as chemicals.	Regulator accumulates experiences in the public sector and this experience could be used for standards-setting. Regulators can be more effective in preventing hazards and irreversible effects requiring draconian control or ban. With a more inelastic marginal external cost curve shape compared to net marginal benefits, environmental damage would be higher, and standards are preferred over tax in those circumstances. Effective enforcements and simple prohibition. More effective in controlling pollution where there is little competition between firms, technology is uniform, and regulator is informed. The regulatory approach is useful when environmental damage is caused by large, highly visible enterprises such as mining operation.	The probability of being caught is lower due to week enforcement, monitoring, and rent-seeking activities. Easy to negotiate this and room for distortion in the standard settings compared to market-based principles. Regulators lack information about the costs and benefits in the industry. Standards leave less room for incentive for polluter as it is static by virtue of its nature. Costly both at enforcement level as well as on efficiency ground i.e. non-cost effective.
Market-based Instruments: User Charges	Taxes/Charges: Water Effluent Charges Waste charges Air Pollution charges Noise Charges (2) User Charges	Broadly speaking, they are all pertaining to the payments on quantity and quality of pollution discharge. Payment for the cost of collection and treatment i.e. collection by	Adjustment mechanism works, i.e., polluters lower their emissions until the marginal cost of abatement equals the tax rate. Cost-effectiveness. Provides incentive for the firm to go for cleaner technology.	Government intervention failure. Inappropriate resource prices or excessive subsidies induce resource degradation. In the absence of well-defined property rights environmental tax might aggravate the situation by facilitating over-exploitation of natural resources.

Instruments	Categories	Description	Advantages	Disadvantages
	(3) Product Charges or Taxes (4) Administration charges or fees	local authorities and treatment of solid waste. Applicable to the product prices that create pollution as they are manufactured, consumed or disposed of. Aimed at modifying the relative prices or products and or to finance collection and treatment system. Help fund license or license monitoring system.	Market-based instruments send the right long terms signals to resource uses. Provide flexibility to both public authorities and private entities. Resource conservation and transmission. Sources of revenue and environmental quality at least cost.	Information gap at regulator level regarding abatement cost function and thus inability to reckon the efficient tax rate. Distributional consequences of regressive taxation system and its negative impact on low-income group. Effective implementation of economic instruments calls for strong and independent institutions, which is lacking in LDCS. Highly taxed traded sectors compared to the other sectors can pave the way for losing trade competitiveness of home country if other industrial countries are not subject to the same tax structure in the short run. Avenues of misuse.
Subsidies	Grant, loan and accelerated depreciation	Subsidies are aimed at facilitating the industry and trade to catch up with the pollution control investment backlog.	Promotes environmental goals	Politically misused. Subsidies on energy sources create inefficient usage and increase urban and industrial air pollution. Economic in-efficiencies in the long run

Source: Summarized by author from World Bank (1996); Barde (1994); OECD (1994)

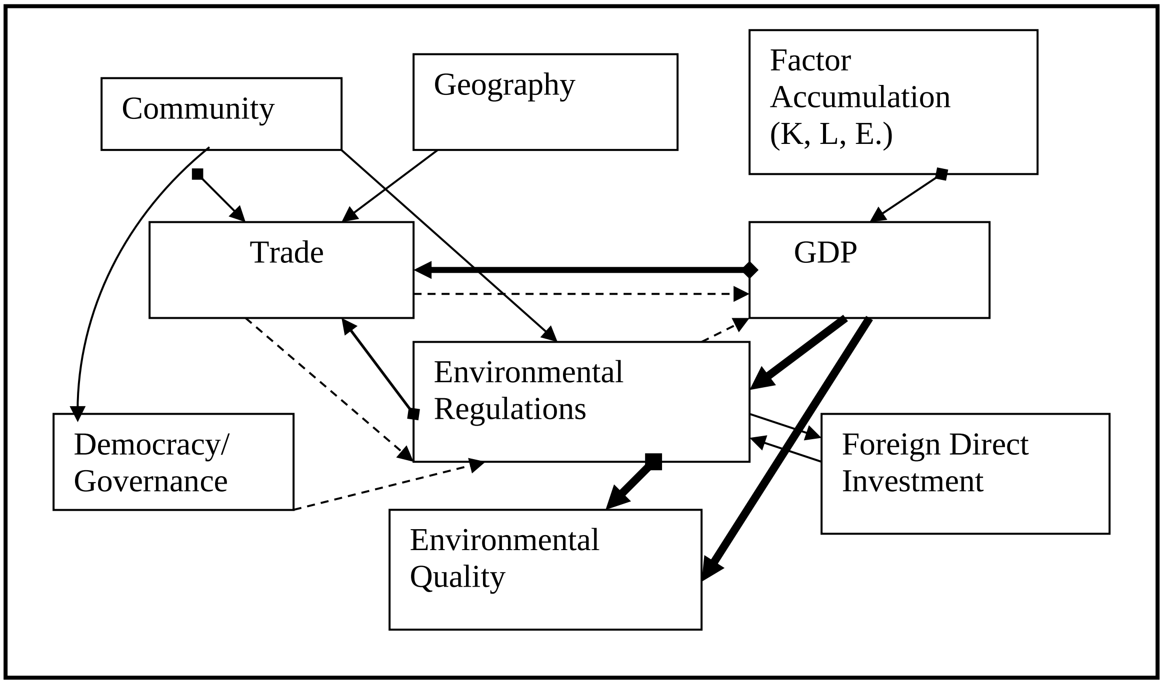
2.3 Dynamic Links between Trade and Environment

Before we move to the core issue, some dynamics of the environment and economic activities are presented in figure 2.2. The dynamics in figure 2.2 do show that the relationship between trade and environment is quite complex. In the forging paragraphs of this chapter, the study has endeavoured to elucidate some of these complex dynamic linkages. However, the core focus of present research is to examine environmental regulations and trade competitiveness links. These dynamics require due consideration as they leave vital theoretical and empirical links for the core subject of trade, environmental quality, and environmental regulations.

The theoretical literature on trade has demonstrated that free trade maximizes the efficiency of resource allocation by channelling economic activities to least-cost producers. It thus produces a given level of output at the least cost. If natural and environmental resources are efficiently priced i.e., all relevant social costs are accounted for, the global production resulting from it is also produced at the least environmental cost. Nevertheless, when market failures are prevailing, such as unpriced or under-priced resources are unaccounted for, then externalities and or policy failure exists. Therefore, the distortions such as environmentally harmful subsidies, if not removed or corrected, then the resources are misallocated to start with, and removal of trade barriers may exacerbate this misallocation. In these circumstances, the trade will not maximize social welfare though there would still be efficiency gains (positive effects) and welfare losses. Also, due to the adverse impact resulting from the wasteful resource depletion, the net effect would depend on the relative magnitude of the positive and negative effects (Panayotou, 2000). Therefore, policy theory is also vital, and different trade policies such as tariffs, quotas, and export restraints would have different effects on the level and quality of environmental resources (Steininger, 1999).

Trade and trade liberalization efforts by improving economic efficiency can give rise to more rapid economic growth in the medium run but maybe not in the very long run. Nevertheless, varieties of endogenous growth theories predicted that improved efficiency resulted through trade liberalization efforts could have permanent effects on economic growth. Also, as indicated in figure

Figure 2.2 Some Dynamic on Trade and Environment Linkages



Source: Frankel and Rose (2005) and author's extension based on other literature review

2.2, there is reverse causality, i.e., the effect of economic growth on trade that operates through the demand side of the economy compared to the supply-sides factors (USITC, 1998)[6].

How geography, as indicated in figure 2.2 does explain the interactions between economic agents? Lipsey (1960) natural trading partner hypothesis suggests that "higher the proportion of trade with the region and lower the proportion with rest of the world, the more likely is a regional agreement to raise welfare effects" (in Pitigala, 2005: 3). The volume of trade based on this hypothesis though become popular, but it ignored the effect of trade policy, transport logistics, and issues such as

[6] The key purpose here is to indicate the link between growth and trade. The detailed examination and critical analysis about linkages between trade and growth is beyond the purview of present research. However, Pro-trade liberalization economists advocate that openness encourages innovation and brings sustain increase in growth instead of one time increase in the level of real income. This openness could encourage innovation that is beneficial to both environmental improvement and economic progress (Frankel and Rose, 2005). On causality issue, another study by Frankel and Romer (1999) finds no evidence that increase in income leads to increase trade while the impact of trade on income was significantly substantial. Krueger (1997) Sachs and Warner (1995) found that the economies that are open grew 2.4 percentages faster than those that are not. Rodriguez and Rodrik (2000) made the case against openness and argued that there is a strong negative relationship in the data between opening trade barrier and economic growth. Openness, therefore, is not likely mechanisms to generate sustain economic growth. Others have rejected these cross-country based regression findings and in the lights of theoretical assumptions of classical trade theory presented the case for trade openness and growth and welfare (Bhagwati and Srinivasan, 1996). The empirical study regarding comparison for opened and closed economies with bifurcation of fast and slow moving low-, middle- and high-income groups for 1970s and 1980s has shown that closed economies are more pollutive than opened ones (Birdsall and Wheeler, 1992).

competitiveness and trade complementarities (Pitigala, 2005). Wonnacott and Lutz (1989) introduced the modified version of the natural trading partner hypothesis and brought transportation costs and location as vital determinants of trade flows and found an increasing tendency for countries to trade with other countries in geographical proximity. Deardorff and Stern (1994) on transportation costs opined that geographical proximity between countries tends to reduce trade diversion.

The natural barrier to trade such as distance directly increases transaction costs because of the transportation cost of shipping goods and the time cost of acquiring information about remote economies. The gravity model in the literature explains how rapidly distance reduces trade volume between countries (Overman et al., 2001). However, others have argued in the light of traditional trade theories of comparative advantage that countries with different comparative advantage profiles should, in principle, have more opportunities to trade with each other compared with those with similar comparative advantage (Ng and Yeats 2003 in Pitigala, 2005:4). The recent empirical research for regional trade experience in static framework for South Asia regional trade show that there is less evidence that the rise in intra-regional trade has provided the opportunities for most dynamic exports for which South Asia countries appear to be competing against each other in third market. Also, South Asian exports predominantly relying on labour-intensive manufacturing goods tend to support the Heckscher- Ohlin model of trade for developing countries (Pitigala, 2005). The relevancy of geography to trade for the present study point of view is to explore the possibility of pollutive industrial relocation or delocalization-pollution haven effect- of international trade from rich OECD countries to poor South after controlling for geography. Empirical results on delocalization hypothesis confirmed that the natural barriers- to-trade such as transportation cost in typically heavy polluting industry is one of the key factors of having a less than expected delocalization of polluting industries from most stringent environmentally regulated ‘North’ to relatively laxer regulated ‘South’ (Grether and de Melo, 2004).

The relationship between trade, income growth, and environmental regulation, and environmental quality is also vital in trade- environmental debate, as shown in figure 2.2. The studies that moved from partial equilibrium analysis to the general equilibrium analysis have identified three mechanisms via which income, trade, environmental regulations, and environmental quality are linked. Commencing from Grossman and Krueger (1991) work on NAFTA’S regarding trade and environmental quality linkages, it is customary to decompose the environmental impact of trade into three interacting elements: scale effect, composition effect and technique effects.

The increase in economic activities following neo-liberal policies may increase economic growth that in turn increases the demand for all inputs, including the stock of environment, hence increases emission (the scale effect). Higher income increases the demand for a clean environment that is that if clean environment is income elastic, then the consumer will only tolerate a higher level of pollution if the effluent charge is higher. Since higher effluent charges encourage firms to shift towards clean production processes, the technique effect reduces emissions. If income growth shifts preferences toward cleaner goods, i.e., if clean goods are relatively income elastic, then the share of pollution-intensive goods in output will fall (Composition effect). The core point in trade environment debate is that if with rising income first composition and then technology effects outweigh the scale effect then trade liberalization should improve environmental quality or reduce environmental degradation and increase the environmental degradation if vice versa is true (Fredriksson, 1999).

For developing countries that possess vital natural resources and facing income-constrained demand for environmental quality trade liberalization, environmental quality would largely depend on whether environmental resources are properly valued or priced and whether these values are taken into account by the world market (Panayotou, 2000). Strutt and Anderson (2000), in general equilibrium framework, showed that even for a business-as-usual scenario, i.e., in the absence of any change in resource pricing or environmental regulation, implementation of Uruguay Round trade reform would leave a positive impact on environmental quality in LDCs and other parts of world except for Western Europe, wherein resource policies are well developed. Their sectoral level research for the Indonesian economy during the predicted period 1992-2010 depicted that trade liberalization would allow the technique effect to outweigh the composition and income effects, thus reducing the emission rate for pollutive industrial waste of Indonesia for the sectors including textiles, pulp, and paper.

Recently some research has explained the demand-side effects related to environmental regulations through aggregate income in partial instead of the general framework, and critical argument in it is that stringency of environmental regulation increases with the level of development and to be more specific with the level of per capital income (Dasgupta et al., 1995). Figure 2.2 shows the link between GDP, environmental regulation, and environmental quality, and empirical models have extended those links with trade. The research has followed the EKC path to develop a relationship between environmental qualities, environmental regulations, and economic growth. The EKC path's primary purpose is to examine if economic growth eventually brings improved environmental quality.

The EKC drew its theoretical insight from the inverted U-shaped hypothesis introduced by the Kuznets (1955). This hypothesis states that environmental damage rises at a lower level of income and declines after a certain income level (turning point), and the proponent of EKC finds no contradiction between economic growth and environmental quality beyond this point (in Nordstrom and Vaughan, 1999). The vast empirical literature on EKC reveals that the EKC may follow the path of the Kuznets curve. These inter aliases include Grossman and Kruger (1991); Shafik and Bandyopanhyay (1992); World Bank (1992, 1997, 1999); Cropper and Griffiths, (1994); Seldon and Song, (1994); de Bruyn et al., (1998); Rothman, (1998); Kaufmann et al.. (1997). However, one can observe N-shaped EKC in the long run as once resources use or abatement opportunities have exhausted or become too expensive, and further income growth will result in net environmental degradation. Some researchers went a step ahead and did not rule out the possibility of M-shaped EKC (Rothman, 1998). The results of these studies, which though mostly based on cross-country data, are sensitive to the type of methodology adopted and assumptions used, and the type and measurement of environmental indicators chosen. Most of these studies have used trade 'openness'[7] indicators to analyse the impact on pollution measures of trade policies path followed by the country. Since the differences of environmental regulations can allow developing countries to possess a comparative advantage in pollutive industries or i.e. either most pollutive industries relocating from developed to developing countries or developed world's pollutive industries being displaced from the world market by a similar industries from developing countries-pollution haven hypothesis-this phenomena has often been cited as one explanation of inverted U-shaped relationship between per capital income and emissions of local air pollution (Cole and Elliott, 2003; Cole, 2004).

As highlighted through the technique effect above, a further possibility is that 'openness'- both via trade and investment- may bring technological and innovative improvements. Multi-national companies (MNCs) are more likely to bring "cleaner-state-of- the-art" production techniques from

[7] openness index is defined as exports+ imports / GDP (Frankel and Rose ,2005).

higher standard countries of origin to host countries where they are not known for a number of reasons as stated below:

"First, many companies find that the efficiency of having a single set of management practices, pollution control technologies, and training programs geared to a common set of standards outweighs any cost advantage that might be obtained by scaling back on environmental investments at overseas facilities. Secondly, multinational enterprises often operate on a large scale, and recognize that their visibility makes them especially attractive targets for local enforcement officials…Third, the prospect of liability for failing to meet the standards often motivates better environmental performance" (Esty and Gentry, 1997, p.161 in Frankel and Rose, 2005, p.7).

Multilateral trade rules such as GATT and WTO make a fundamental distinction between product standards and process and production methods (PPMs) as two are treated very differently and raise a vital concern about environmental regulations impacts on trade competitiveness, especially when environmental rules are used to meet trade objectives- tuna-dolphin case between USA and Mexico is the prime example. The national requirements on product standards and product-related PPMs are allowed, while non-product-related PPMs are not. Product standards apply to both local and international products, while process standards are mainly applied to domestic producers. If the production method affects the characteristics of the imported product, then border tax adjustments are permitted under WTO rules i.e., product-related PPMs are treated in the same way as product standards. Charges or standards on non-product-related PPMs, i.e., on production methods that do not affect the product characteristics, violate the principle that like products should be accorded like treatment and are prohibited under the WTO rules. Therefore, unlike product standards methods, standards are not the prime candidates for harmonization[8] (Panayotou, 2000; Adams, 1997). The study by Panayotou (2000) presents six channels: free trade linked to environment, which he summarized in box 2.1.

The level playing field argument advocated by the environmental group and lobbies is that it is unfair for countries to gain a comparative advantage through lax environmental or labor standards. Still, economist finds this idea of so-called fair trade and the thus the demand for harmonization at odd with international trade theory of comparative advantage (Ederington and Minier, 2003). They claim that there are legitimate grounds for cross countries diversity in environmental regulations as nations generally differ in five areas, viz. endowments, technologies, preferences, institutions, and coalition formation. Differences in comparative advantage arising from regulatory differences are part of the argument of mutually beneficial trade. These differences reflected in governmental

[8] Harmonization can be loosely defined as making the regulatory requirements of governmental policies of different jurisdictions identical or at least similar" (Leebron,1996:43).

Box 2.1 Trade Related Environmental Effects

1. **Scale effects**: - negative effects, when increased trade leads to more pollution without compensating product, technology policy developments; positive effects, when increased trade induces better environmental protection through economic growth and policy development that stimulates products composition and technology shifts that causes less pollution per unit of output.
2. **Structural effects**-: - changes in the pattern of economic activity or micro-economic production, consumption, investment or geographic effects from increased trade that either exert positive environmental effect, (e.g. reducing production or crops that rely on chemical intensive methods, in favor of more extensive agriculture) or cause negative consequence s (e.g. encouraging the drainage of wetlands to satisfy new trade demands).
3. **Income Effects**: - positive effects increased willingness to pay with increased personal incomes brought about by growth induced trade; also increased budgetary resources allocated to environmental protection both in absolute and relative terms.
4. **Product effects**: - either positive effects from increased trade in goods that are environmentally beneficial e.g. biodegradable containers, or negative effects from more trade in environmentally damaging products e.g. hazardous wastes.
5. **Technology Effects**: - either positive effects from reducing per unit of product, e.g., precision farming that reduces excess fertilizer use or negative effects from the spread of dirty technologies e.g. highly toxic and persistent pesticides, through trade channels.
6. **Regulatory effects**: - either through improved environmental policies in response to economic growth from enhanced trade through measures included in the trade agreement, or the relaxation of existing environmental policies, because of specific trade pressures of restrictions on environmental policy by the trade agreements.

Source: OECD (1994) and Panayotou (2000:4)

regulatory policies, including environment, are legitimate determinants of comparative advantage (Bhagwati and Hudec, 1996).

Developing countries face an additional challenge regarding the compliance of environmental regulation because process and production methods (PPMs) could act as non-tariff trade barriers against those countries that are pursuing lax environmental regulations viz-a-viz. their trading partners. Exporters of developing countries are much more concerned that their traded products could be denied having access in the developed market or they may have to incur high adjustment costs to maintain access to advanced nations who are pursuing stringent environmental regulations and demanding the harmonization of standards (Pearson, 2000). Therefore, the consequences of compliance with environmental regulations on competitiveness could be different in LDCs than what could be observed for advanced countries.

In figure 2.2 the link between foreign direct investment and environmental regulations is depicted, and causality runs in both directions. One theoretical aspect of pollution haven effect is that the introduction of stringent environmental regulations in industrialized countries paves the way for capital and investment to transfer to developing countries. And the developing countries may follow the path of what is generally referred to as the regulatory chill where countries refrain from enacting stricter environmental standards in response to fears of losing a competitive edge (Nordström and Vaughan, 1999). Mabey and McNally (1999) study show that strictness or laxity of environmental regulation in the host country is not a vital determinant of attracting FDI. The investors, especially MNC'S hardly consider the environmental costs into their location decision-making and other determinants such as availability of cheap labour cost, natural resource endowments of host country, infrastructure, presence of industrial base; taxes and transport structure, availability of raw material and market size are important determinants for location that make a higher priority for corporations.

Most of the examples are witnessed about the regulatory chill phenomena in energy and taxation sectors of the industrialized world (Neumayer, 2001; Panayotou, 2000; Adams, 1997). In developing countries case the example of regulatory chill phenomena can be quoted from the phosphate industry in Morocco and Tunisia wherein governments have deliberately intervened to change the environmental laws and kept the environmental standards lower in order to attract FDI and out of fear that other destinations should not become more attractive. Sometimes foreign companies can pressurize the host countries to lower the standards as British companies pressured local authorities in India to de-notify one of India's three designated eco-fragile areas so that they could go ahead with a port development (Mabey and McNally, 1999). On the other hand, foreign companies could be under pressure from the domestic authorities to keep the environmental standards low. This phenomenon happened in China when foreign energy companies in China were forced to reduce the environmental standards to satisfy the respective Chinese authorities that desired the lowest price for power generation (Esty and Gentry, 1997). What is emerging from such a discussion is that linkages between environmental regulations and FDI are not straightforward and would result from a host of social, economic, and political factors. The local pressure against the race towards bottom premised on NIMBY (Not in My Backyard) can act as a countervailing force against the race to the bottom. This local pressure against lowering environmental standards to attract FDI will vary, depending on the community's educational and income levels, in addition to what has been explained above (Zarsky, 1999).

The community link with environmental regulations and environmental quality is also vital, as shown in figure 2.2. In this context, the recent work experiences on industrial pollution in Asia reveals that in addition to formal regulations, the information regulations, i.e., community pressure has a vital and significant impact on strengthening the regulatory impact and improving environmental performance (Pargal and Wheeler, 1996). Also, Afsah et al. (1996) analyzed environmental performance in China, Brazil, Indonesia, and United States. They reported that community and market pressure could significantly influence environmental performance, although this outcome would ultimately depend on income, education, and bargaining power. Environmental groups, community organizations, NGOs, business associations, and other elements of society both at the national and international level can reinforce governmental environmental efforts and thus pave the way for institutional quality, good governance, and better regulatory regimes. These entities, i.e., community and environmental groups, can prove counterproductive when adopting extreme positions and utilizing a sole adversarial approach, unnecessary increasing cost (Esty and Porter, 2002).

The environmental regulations leave an impact on economic productivity, as indicated in the arrow from environmental regulations towards GDP and trade variables in figure 2.2. The famous theoretical debate between Palmer, Oates, and Portney (1995) and Porter and Van der Linde (1995) regarding environmental regulation and competitiveness has been cited in the literature. Porter and Van der Linde (1995) argue that there is no trade-off between environmental regulations and competitiveness as well-designed environmental standards bring efficiencies in the production process that can partially or more than fully offset the cost of complying with them. Palmer, Oates and Portney (1995) advocate that firms/industry are bound to face some adverse effects of environmental regulations. Whether environmental regulation cost can be fully or more than fully offset by the benefits gained after introducing new innovative environmental technology is an empirical quest[9](XU, 2000).

[9] The details on the theoretical debate regarding the possible impact of environmental policy on trade competitiveness between Porter and Van der Linde (1995) and Palmer, Oates and Portney (1995) are elucidated in theoretical section of chapter 3.

2.4 Conclusion

The issues surrounding trade and environmental relationships are multidimensional and complex, as depicted in chapter 2. Apart from theories pertaining to trade and environmental linkage, there are hosts of intervening theories/hypotheses influencing trade competitiveness and environmental regulatory associations. Most of the research in this area tended to examine various hypotheses in a partial-equilibrium modeling framework. This study, therefore, will focus on just the area related to the impact of environmental regulations on trade- more specifically at pollutive manufacturing exports-competitiveness, which is at the heart of the debate on the association between environmental regulations and trade competitiveness. Chapter 3 sheds light on the different strands of the theoretical debate surrounding environmental policy and trade competitiveness nexus.

Chapter 3

Research Design and Theory of Trade and Environmental Policy

3.1 Introduction

After explaining the research approach and research design, this chapter will shed light on the theoretical framework regarding environmental regulation and trade links. It will review the literature on the possible impact of environmental policy on trade flows and competitiveness under different assumptions and will make the case as to why empirical quest is imperative to examine the effects of environmental regulations on pollutive commodity/industry trade flows and competitiveness.

In section 3.2, the study briefly reflects why the positivistic/deductive approach at the methodological level is adopted in the present research. Based on that, the research design of the current study is embraced. In section 3.3, the study will present a wide variety of theoretical work conducted in environmental policies that impact trade flows and competitiveness. It will focus primarily on how environmental regulations work under autarky and free trade following neo-classical framework and how changes in certain assumptions and the country's size affect the outcomes. The chapter will also review the static and dynamic aspects of environmental regulations impacts on trade by covering the debate between 'old' and 'new' trade theorists and endeavor to produce some consensus on adopting the empirical approach to examine research questions of the current study. Section 3.4 will conclude the chapter and provide some reflections on the next chapter.

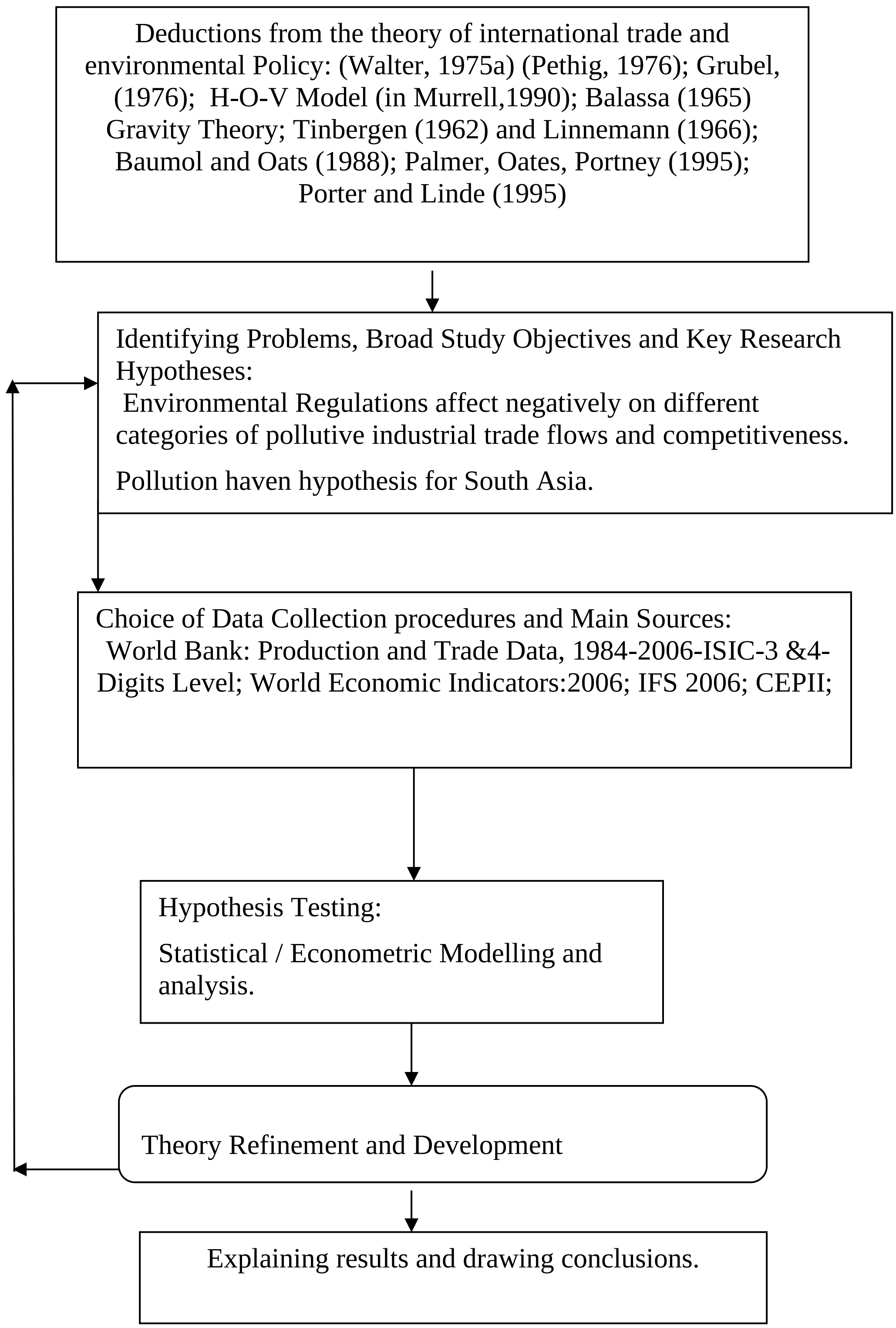
3.2 Approach to Research Methodology

The present research on the methodological choice level will follow the dominant mainstream Neo-classical orthodoxy path, which holds that proper methodology should be positivistic, quantitative, and empirical. To be more specific research methodology is premised on deductive thinking guided by Karl Popper, a famous twentieth-century philosopher of science. He was not first to advocate that *scientific truth must be verified through precise and accurate prediction* but he went a step ahead by contributing a more specific formulation of this idea by advocating that "prediction cannot prove that a statement is true, only that it is or is not false. Each confirmed prediction can still be falsified through an additional test"(Solo, 1991:10 in Hall and Elliott, 1999: 1255). Predictive veracity, however, is the best methodology. The famous philosopher, Blaug, in the following words, further shed light on the vital contribution made by Popper regarding the methodology of economics in particular and social science in general:

"No economist writing on methodology, whether in the nineteen or in the twentieth century, has ever denied the relevance of the now widely accepted demarcation rule of Popper's deductive methodology: theories are scientific if they are falsifiable, at least in principle and not otherwise….Popper view of falsifiability required that every scientific theory, hypothesis, proposition, statement be so formulated that it can be tested through inferential prediction and that it be discarded if false"[10](Blaug,1990, in Hall and Elliott, 1999:1255). The design of the present research at the methodological level is reported in Figure 3.

[10] The orthodoxy methodology of economics is challenged by heterodox methodology which describes any of numerous methodologies deviating in some vital way from orthodox methodology such as the one offered through radical and institutional methodology and methodological system and beliefs of Max Weber and Joseph Schumpeter and recently the Realists (Hall and Elliott, 1999). There are further issues of drawing a distinction between quantitative versus qualitative research which at times hardly make any sense as it is a research issue or study objective that determines as to which style of research is employed. An extensive quantitative research could be a qualitative and that some questions cannot be answered by the qualitative methods, and even post positivist debate on the methods of social science are not completely free from the reflections of positivism (Bryman, A., 1988). Since mainstream research in current study area followed neo-classical orthodoxy therefore, present research endeavours are not exceptional in this context. Also, an in-depth quest on the methodological controversies in economic is beyond the purview of present research.

Figure 3.0 Methodological Approach



Adopted from (Parker and Kirkpatrick, 2002)

3.3 Theory: Environmental policies and Trade Linkages

The theoretical literature on trade and environmental policy mainly following mainstream neo-classical orthodoxy, especially in comparative advantage framework, wherein factors of productions are immobile internationally and mobile domestically, show that introduction of environmental policies can generally in a static and both in partial and general equilibrium framework, have clear influence for production costs, trade pattern, industry location, and gains from trade for the economy, and relaxing one or more assumptions produces quite complex outcomes (Walter, 1975a,b; Grubel, 1976; Pethig, 1976; McGuire, 1982; Siebert, 1974 & Siebert et al.,1980; Copland and Taylor, 1994; Merrifield, 1988; Chichilnisky, 1994).

Given the assumptions of neo-classical trade theories, previous studies find a negative impact of environmental regulations on commodity exports (Pethig, 1976). And given two countries, two goods, and two factors of production, the argument between two countries trade still hold i.e., an introduction of stringent environmental regulation (say pollution tax) in the pollution-intensive sector by the first country as compared to the regulations being practiced by the second country would lead to decrease pollutive sector export of heavily regulated sector(s) of first country and shift of resources towards cleaner sectors, other things held constant (Adams, 1997). Given the factor, especially capital immobility and competitive market structure with other assumptions of comparative advantage theories including complete information etc. the stringency of environmental regulations is observed as internalization of environmental costs that would, if introduced on the exported sector will reduce home country exports of pollutive goods and increase the imports of those pollutive commodities (Rauscher, 1997).

Between advanced and poor nations trade context, one of the key theoretical outcomes is that comparative advantage created through the difference in environmental regulations between developed and developing nations under free trade era would cause developing countries to become a repository of the world’s dirty industries, assuming that developing countries follow lax environmental standards than those of developed ones (Baumol and Oates, 1988). Pethig (1976) and McGuire (1982), in their analytical framework, produce a somewhat similar theoretical outcome. Therefore, the shift in production and trade activities either due to capital (FDI) or industrial flight- capital flight hypothesis or industrial flight hypothesis- or due to price diffusion effect (McGuire, 1982) all can allow the developing countries to become a haven for the world pollutive goods production and export, which is termed as pollution haven hypothesis[11]. In developed part of the world, the fear of losing competitiveness in traded activities due to stringent environmental regulations created the possibility for a domestic pressure group to put pressure on these countries to lower the standards to ensure survival and avert loss of sales and job and above all export competitiveness of environmentally sensitive manufacturing commodities, which is termed as 'race towards bottom' hypothesis (Bhagwati and Hudec, 1996; XU, 1999).

The analysis in the next section begins from partial equilibrium analysis regarding environmental policy and trade linkages. Firstly, in the absence of environmental policy, the analysis focuses on the impact of international trade on environmental quality. Therefore, this study introduces the environmental policy role by assigned proper value to this free factor viz. environment and using command and control or market-based incentive systems. The instruments of the market-based system can be Pigouvian tax / subsidy, which leave the implications for international trade competitiveness (Krutilla, 1999). The study latter will extend this theoretical analysis at the general equilibrium level.

3.3.1 Free Trade, Environmental policy, and Environmental quality: Some Theoretical Enquiries: Partial and General Equilibrium Analysis

The key feature of the partial equilibrium model is that it facilitates the analysis for one single market, isolated market, without taking into account the response from other markets (XU, 2000). Certain standard assumptions underlie the analysis. The externality (production or consumption) exists due to economic activity, which creates the marginal divergence between the social and private cost of production (or benefits from consumption) by adding to the other producers' costs or decreasing the aesthetic pleasure provided by nature. This divergence could be due to increased information about the activity's pollutive effect or increased demand for a cleaner environment, or because a threshold level of pollution has been reached that raised concerns for the environmental quality. It is assumed that the property rights are not well defined and that high transaction cost restricts the full internalisation of the externality. Further, it is also assumed that there is no administrative costs or distortionary by-product costs of collecting taxes or disbursing subsidies and the income distributional effects of such transfer policies can be neglected.

[11] Other aspect of pollution haven hypothesis has been explained before in our discussion of FDI and production context. The present research following (Pethig, 1970), Tobey (1990), Low and Yeats, (1992), Mani and Wheeler (1998) and Grether and de Melo (2004) and others will explain the pollution heaven phenomenon in terms of changing trade and especially exports specialization patterns of pollutive industries over time.

The perfectly competitive world's assumption of complete information prevails, i.e., the producers, consumers, and policymakers are well informed, and they can value the aesthetic or material costs (or benefits) of the externality involved. Also, the assumption that the small country acted as price takers in international trade and that international prices were given. Furthermore, the assumption that the rest of the world does not respond strategically when a country initiates environmental regulation or trade policy reforms is maintained. Moreover, in partial equilibrium analysis, the environmental distortions being the only distortion in the economy are assumed. The externality is also assumed to be an outcome of the production (or consumption) activity itself and not from a particular process, implying that tax-cum-subsidy on production (or consumption is equivalent to the tax-cum-subsidy on the source of externality and thus is the optimal environmental policy tool for correcting the divergence between marginal private cost and marginal social cost. This assumption is much stronger than necessary but adopted to ensure that the economic adjustments to environmental policy actions influence commodity prices and international trade flows. Still, it is assumed in this form for illustrative convenience. Following conventional trade theory, changes in taste, technology is not considered, nor is the international factor mobility (Krutilla, 1999; Anderson, 1992).

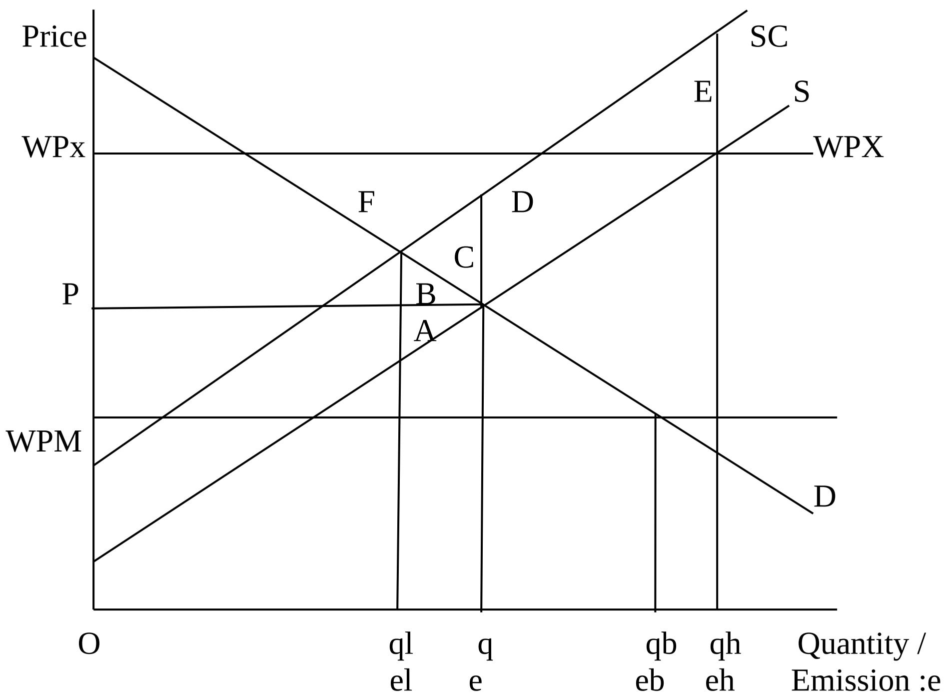
The study begins with the small country case with one pollution commodity (for simplicity) such that the $e = Aq$ where e is emissions, A is proportionality constant, and the q is the sector's output. Therefore, the production (not the consumption) of the good cause's pollution (air or water), which is referred to as negative externality for expositional purpose in figure 3.1.

Under autarky, the equilibrium points in figure 3.1 are P, q and e, which are, respectively, the price, quantity, and the emission equilibria as it is assumed not to commence trade in the short point equilibrium. First, considering the production side of the economy that causes negative externality, say, pollution that results in creating social cost curve (SC) above the private cost curve (S), which is drawn linearly for the expositional convenience. The linear relationship between output and emission is also assumed here.

Now entering into the free trade at world price after removing the trade barriers would enable the country to expect the price at WPx i.e., P< WPx if the country is net exporter of the product, where WPx is the high world price. Under such circumstances, the production and emission would increase, keeping everything else constant, including the absence of optimal environmental policy.

So, in the absence of environmental policy, say pollution tax, to redress the environmental damages, the conventionally measured welfare benefit of trade openness (F+C+D) is assuaged by the additional environmental damages (D+E), and could be negative if E > C+F in figure 3.1 above.

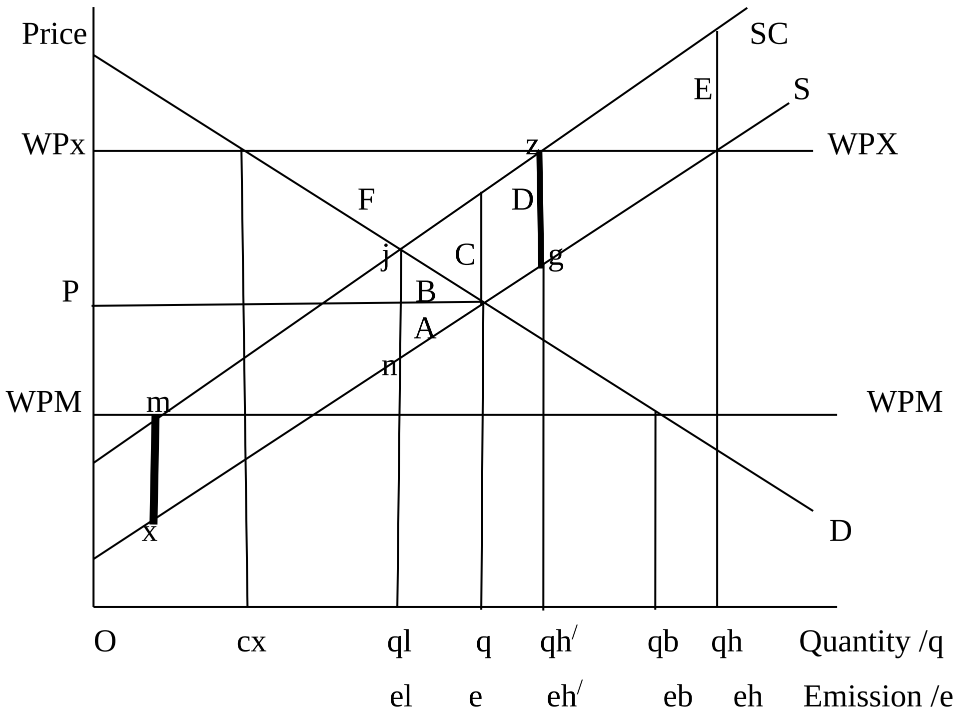
Figure 3.1 Welfare Consequences of Trade Liberalization for Small Country- a Case of Production externalities



Nevertheless, if a small country is a net importer of the product i.e., P > WPM, where WPM is the lower world price of the commodity, entering into the trade would curtail emission from e to el as the dirty import-competing sector would shrink (from q to ql). Under such circumstances, the environmental side effect would increase the welfare gain of the trade openness by the area of A+B+C (Krutilla, 1999:404-406).

The study extends the analysis where the country pursues optimal environmental policy before and after the trade. The optimal environmental policy in the light of figure-3.2 would be pollution tax on the production side equal to the vertical distance between the social cost (SC) and the private cost (S) at output level where marginal social cost of production equals the marginal social benefit. In the absence of trade (or autarchy case), the optimal intervention would be a tax of jn per unit produced following the Pigouvian approach, which would induce the output of Oql instead of Oq in figure 3.2, after internalising the external effects that would yield the welfare benefit of triangular

Figure 3.2 Environmental Policy and Trade Competitiveness a Case of Production Externalities of small country.



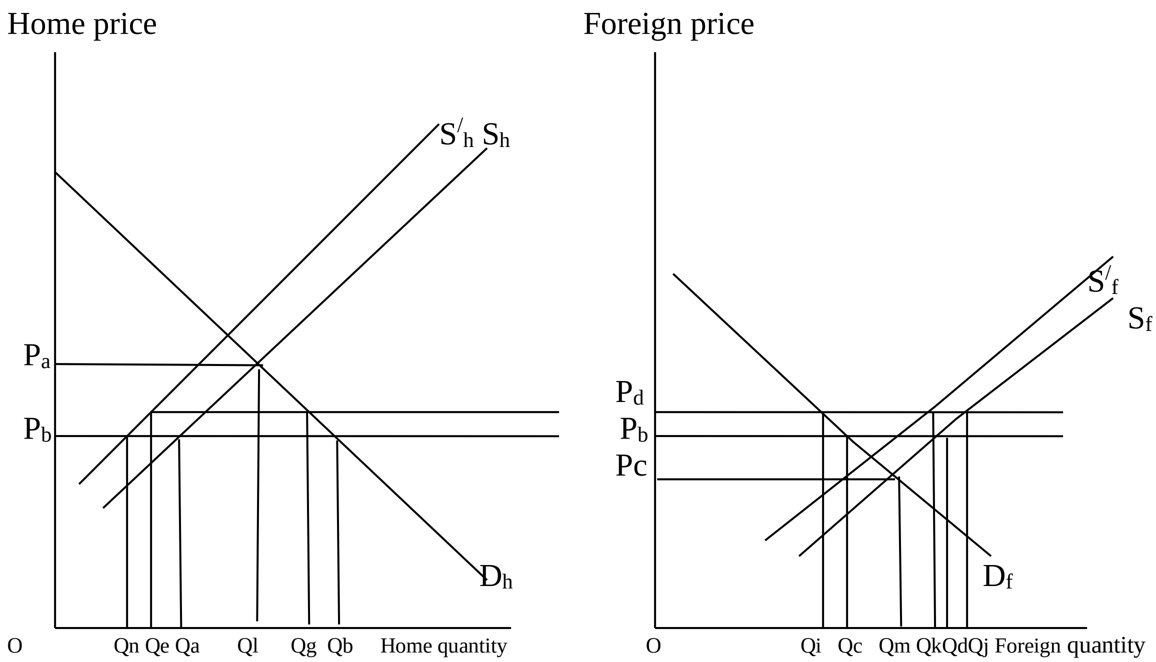
area C- the difference between the social costs and the benefits were of those ql q units. In a free trade regime, optimal production tax would be mx if the country is net importer of the product and facing the world price at WPM and zg if the country is net-exporter of the product at high world price WPh both of which would result in reducing the production and emission (or improving environmental quality) to some extent compared to the situation when no pollution tax is levied. The shift in the supply curve from S to SC after the introduction of the environmental tax will reduce exports of pollution-intensive goods from cxqh to cxqh/ (developed from Krutilla, 1999; Anderson, 1992; XU, 2000).

The analysis elucidated above produces the standard results, which most of the theoretical work in the area has come up in a neo-classical framework that is that environmental policy in the static framework would leave adverse effects for both production and international trade flows and thus competitiveness. While drawing the conclusion for the real world through such theoretical analysis, two key issues, as pointed by XU (1999), are worth noting. First, this is a partial equilibrium model, and results are ascertained based on a single isolated market. And second, as the study shed light in the previous section while explaining the dynamic link of environmental regulations, productivity, and trade that these results are subject to criticism by those who believed in the dynamic effects that environmental regulation brings productivity change and innovative activities and leave a positive impact for external sectors trade competitiveness (Porter and Van der Linde, 1995). Some earlier efforts to sort out the theoretical level link between environmental policy and international trade of commodity provide further insight into the issue under review. Among those, one of the theoretical research conducted in partial and general equilibrium framework is the one pioneered by Walter (1975).

Walter (1975a) examined the question of whether environmental management or pollution control alters the long-term comparative advantage in trade and production among the world's economies? The comparative advantage for him is based on various factors, including the availability of natural resources, labour, investment in human capital, investment in technology, and so forth, all employed in the production of tradeable goods and services. The unique pattern of a nation's capabilities in the supply of tradable products and services relative to its demand determines trade patterns among nations. He opined that one of the simple ways to integrate environmental control policy issue with international trade is through the supply side by considering environmental assimilative capacity another factor of production like labour and capital whose relative abundance will enter production costs in a conventional manner. It allows concluding that countries with relatively abundant environmental resources- in terms of high environmental assimilative capacity- will tend to have an international competitive advantage in the production and supply of goods and services whose production is relatively pollutive. If each country moves to the internationalization of environmental externalities, then the comparative advantage will inevitably shift, and so will be the trade flows and the economic structure of the countries.

In figure 3.3, Walter (1975a), for a single commodity and at a partial equilibrium level, shows the trade between one country and the rest of the world. The demand and supply curves for the home economy are Sh and Dh, respectively, and those of foreign countries are Sf and Df. In the absence of international trade, the price of a product in home country would be Pa and equilibrium quantity produced and sold is at point Ql. In the foreign country, the correspondence equilibrium price and quantity are Pc and Qm. Home price of the commodity is higher than abroad, and once trade is allowed between the two, then Pa will fall due to availability of import supply while Pb would rise when supplies are withdrawn from the domestic market for export. Equilibrium is achieved when trading price between two countries become equal at Pb assuming zero transportation costs and excess production abroad QcQd is exported to the home market which is exactly matched by the production shortfall or import demand QaQb at that price. In trade environment, home country will

Figure 3.3 Trade and Pollution Control Policy linkages: Partial equilibrium Approach



Source :(Walter,1975a:80)

produce at Qa and consume at Qb and the difference of home demand QaQb is imported while foreign country production and consumption points are Qd and Qc with export quantity at QcQd.

It is shown in figure 3.3 that the introduction of environmental pollution controls and polluter pays principle supply curve at home shifts leftward from Sh to S/h, depicting that each quantity can only be supplied at a higher price. When import price remained constant at P_b in the above figure, then there would be no change in domestic price or quantity consumed but an increase in the imports from Q_aQ_b to Q_nQ_b with increased imports displacing a reasonable amount of domestic production. In abroad, the additional export demand would increase price abroad shift the price up to the point Pd at which the import demand by home country Q_eQ_g will be matched by the export supply Q_iQ_j by the foreign country. The output in a foreign country would increase by Q_dQ_j and that of consumption decline by Q_cQ_i both due to rise in commodity export price and increased export demand. At home, the price will increase, and that of quantity demanded to reduce by Q_bQ_g, and domestic supply reduced by Q_aQ_e but not as much as it would have fallen if import supply had been perfectly elastic. In a nutshell, the domestic pollution control will increase the volume of imports and the share of imports in satisfying demand, perhaps at a higher price. At the same time, the supplier countries will offer more exports given no change in environmental policy but with upward pressure on prices that will discourage domestic consumption for export goods and increase production for exports.

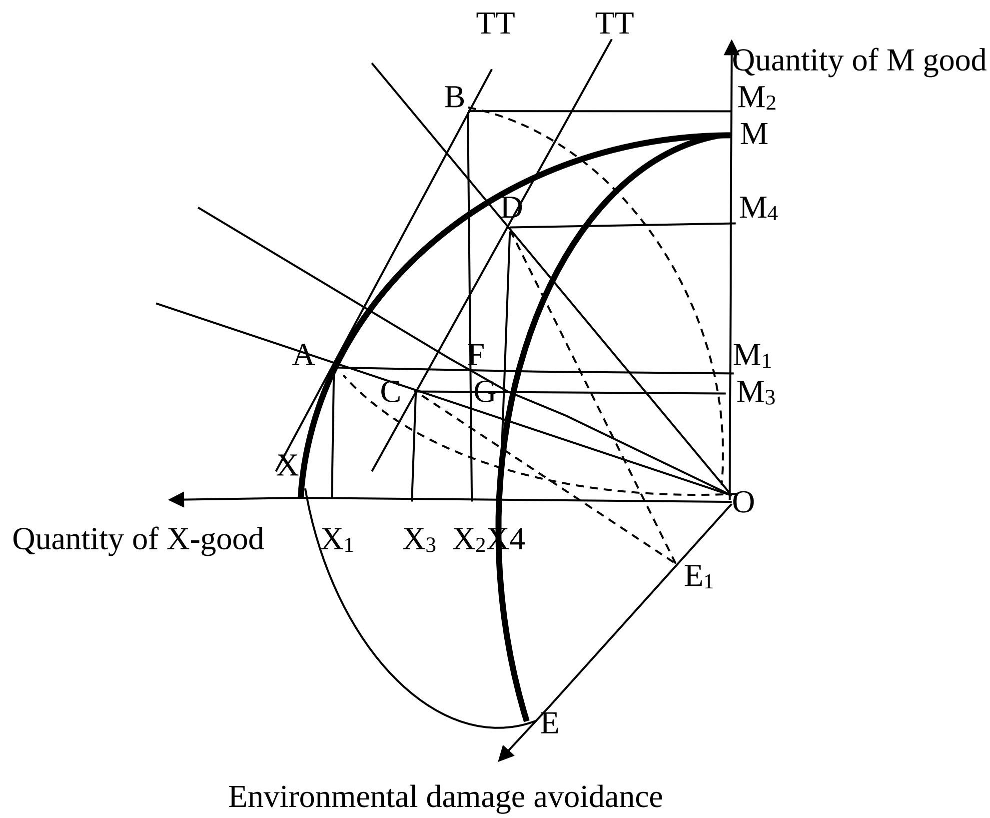
The other possibility is that if the foreign country government also introduces the environmental control policymaking polluter liable to pay for pollution then supply curve in abroad would also shift leftward from S_f to S'_f. The higher price that results will tend to depress domestic consumption, and via increased export prices, Pd reduces consumption (QbQg) in-home country. It increases the domestic production in the home country from Qn to Qe, partly replacing the reduced volume of imports QeQg. Walter (1975a), therefore, for the partial equilibrium analysis depicts that international trade commodities flow is affected by the pollution control costs, and the question that big effect of pollution control policies would be on traded commodities largely depend on the respective supply and demand elasticities of the commodity in question. What is clearer in this analysis of environmental policy and international trade is that some of the production displaced by the environmental policy will be taken up abroad, thus reallocating pollution and production and consumption through international trade. Therefore, environmental policy measures in countries leave discernable implications for production, consumption, pollution, and trade patterns.

The above partial equilibrium analysis can be extended to general equilibrium level for two goods case in international trade under the assumption that following appropriate environmental control policy country will divert its productive resources from traded sectors to mitigate and or alleviate the environmental pollution controls in line with the polluter pay principle and thus to meet the international demand for environmental controls. Consequently, each country's ability to produce goods and services is lower than it would be in the absence of environmental control policy. Accordingly, the transformation function between importables and exportables would fall below where it would be in the absence of environmental protection. The further question is to examine if the impact observed in the form of reduced output due to environmental controls is symmetrical between those goods that a country wishes to export and those it tends to import. If the impact of pollution control policy on trade is relatively neutral, then the country's comparative advantage remains unchanged though the volume of and gain from international trade declines. The country's terms of trade would also remain unchanged as the price of both export and import rising with the same proportion. However, the impact of environmental control policy on traded sectors might not be symmetrical due to the fact that pollution abatement activities required a relatively large amount of factor capital than that of labor- both in terms of plant equipment and research and development activities- thus, pollution control activities would employ more capital than a joint factor of production (Walter, 1975a).

Following neo-classical H-O trade theory, if the country is abundant in capital compared to labour and export capital intensive goods and services, then the impact of environmental control on trade cannot be symmetrical. The potential output of importable-non-capital-intensive goods and services- expected to decline relatively less than those of potential output of exportables- capital-intensive sectors output dependent- and as a result, the comparative advantage of a nation will be eroded more in export sectors in the international market. Assuming balanced trade, the volume of trade declined significantly vis-à-vis a situation of neutral environmental pollution control effect on traded sectors. On the other hand, if the country specializes in the production of labour-intensive goods and services and pollution abatement efforts require capital-intensive technology, then the outcome will be the opposite of what analysis observes when the country specializes in capital-intensive production and export. In this case, potential output in the import-competing sector is reduced substantially more than labour-intensive exportables. Assuming balanced trade, the volume of trade may reduce, but less than compared to the earlier case, and the erosion of gains from international commerce may also be less severe. From a structural economic viewpoint, the country tends to specialize to a greater extent in exports than it did before pollution control measures were imposed. These arguments are supported through graphical illustration by Walter(1975a).

Walter (1975a) defines goods and services produced by an economy into exportable X, importable M, and environmental damage avoidance E in figure 3.4. Using a three-dimensional space XME transformation surface is depicted in figure 3.4 with the standard transformation function for tradeable goods and services lying in the XM plane. Assuming convex social preferences in XME plane community indifference curve-not drawn above- in the absence of environmental resources devoted to environmental management, the indifference curve, and transformation curve will be tangent at some point in XM plane and so will be common tangent relative product prices, with environmental damage avoidance given at zero price. The slope TT gives the international terms of trade, XM price ratio is equal to the marginal rate of transformation at A and marginal rate of substitution in consumption at B in XM plane.

Figure 3.4. Environmental Pollution Control Policy and Trade: General Equilibrium Analysis



(Walter, 1975a:83)

The production mix is OX_1 andOM_1 with X_1X_2 exported and the consumption mix is OM_2 and X_2 with M_1M_2 imported. Now, if consumer preference shifts from conventional goods and services, XM plane to the avoidance of environmental damage, then the value the society attached to control environment and their willingness to pay increase relative to goods X and Y. Other things held constant, the respective tangencies of price-indifference and price transformation surfaces will move along vectors BO and AO. The relative price plane will tilt and thus become steeper in ME and XE planes as the price attached by society to environmental damage avoidance rises. At new equilibrium point C the positive environmental damage avoidance is E_1, but tradeable production mix points are OX_3 and OM_3 with X_3X_4 exported, and consumption mix is now OX_4 and OM_4, of which M_3M_4 is imported (Walter, 1975a).

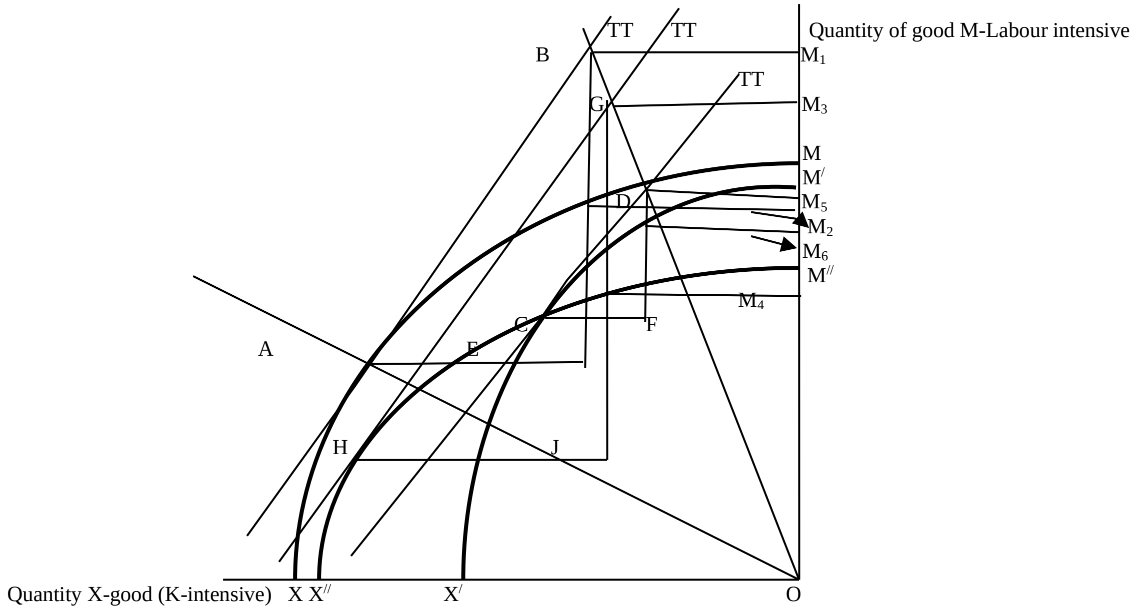
The resources diverted from conventional production activities to environmental management leaves production, export, import, and consumption effect for the economy. The environmental control activities have; the reduced output of tradeable goods by $X_1X_2 + M_1M_3$; reduced exports by X_1X_2 - X_3X_4; reduced imports by M_1M_2-M_3M_4; and increased production and consumption of environmental damage avoidance by OE_1. The social welfare at consumption point D is higher compared to point B and social preferences towards the control of environmental pollution will lead to an inward shift of production function along with vector AO and consumption point along vector BO in XM plane. Increased environmental control, therefore, reduces the volume of both imports and exports. Given that terms of trade, XM transformation frontier and community indifference curve remain unchanged when a large number of resources are diverted to environmental management, the export volume reduces as per horizontal distance between vector AO and FO in figure-3.4. The volume of imports declines as per the corresponding vertical distance between vectors FO and DO[12] (Walter, 1975a).

The traditional neo-classical factor endowments theoretical H-O model aimed at determining the direction and product composition of trade flows, assumes biased production functions and thus good X is say naturally K-intensive and good M labor-intensive so on and so forth, and it is further assumed that environmental assimilative capacity can be added as another factor of production in production function in terms of E-intensity of tradable goods and services. Suppose environmental controls representing the production of non-tradable goods is itself K-intensive, then following figure-3.4 it would employ that the environmental control induced shift of transformation function toward the origin of XM plane occurs asymmetrically. Accordingly, considering X as capital intensive good and M labour intensive, for every ΔE the $(-\Delta X/X) / (- \Delta M/M) > 1$.

The results can be further explained using figure 3.5, wherein asymmetrical resource case is presented by specifying the export and import-competing goods are specified as capital intensive and labour intensive, respectively. Environmental control policy would cause diversion of resources again towards environmental management, and this action would cause both production and consumption points to recede along with AO and BO. When environmental control is capital intensive, then the new transformation frontier could be $X^{/}M^{/}$ as indicated in figure 3.5 and $X^{//}M^{//}$ when environmental controls are labour intensive.

[12] The detailed analysis on terms of trade effect is beyond the purview of this research. However, in Walter (1975a) analysis of general equilibrium framework and assuming that the export good has inelastic foreign demand and country face constant import price then terms of trade of economy will improve as environmental control costs lead to rise in export prices and thus slope of TT curve in figure3.4 become steeper as production point A moves toward origin. Given that production and consumption frontiers do not change their shapes then path of production point fall below to AO and is asymptotic to the X-axis and consumption path fall to the right of BO and is asymptotic to the M-axis. Thus, pollution control-induced improvement in terms of trade may lead to bias the output mix towards export good X and thus increase the degree of production and trade specialization. On the other hand, it leads to create bias in the consumption mix toward the M-good and allow for the maintenances of a level of welfare above than that of without positive terms of trade effects.

Figure 3.5 Asymmetrical Resource Absorption for Environmental Control and Implications for Trade Flows



(Walter, 1975a:85)

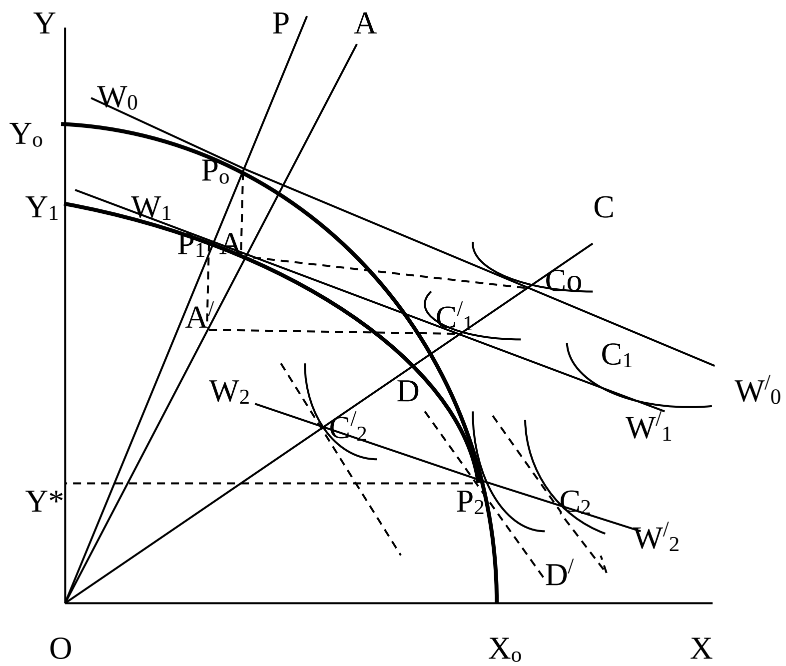
In the first case scenario, given proportionate change in consumption pattern, the comparative advantage of the country would be seriously affected due to reduced specialization in production and major reduction in the volume of trade. If the second case represents the country's characteristics, then that sort of bias strengthens the country's comparative advantage, and the volume of trade might increase after the introduction of environmental control management. The asymmetrical resource diversion from conventional production goods to environmental control following figure 3.5 will reduce comparative advantage and initial gain from trade measured in terms of good M from M_1M_2 to M_5M_6 when pollution control requires capital-intensive technology. Thus the country faces both reductions in production specialization and gain from trade. Following the second case when environmental control requires labor-intensive technology, as depicted in figure 3.5, the gain from trade changes from M_1M_2 to M_3M_4**,** which may even increase after pursuing the environmental control technology.

In the light of the above theoretical linkages, Walter (1975a) concluded that diversion of resource for environmental management would leave a negative effect on a country comparative advantage and thus gain from trade when the country uses those productive resources for environmental control in which a country's comparative advantage is based, and positive if the vice versa is true. Thus, from the comparative advantage point of view, factor intensity of environmental control techniques affects the gain from trade both in absolute and relative terms as international prices respond to pollution control induced import and export price changes. Therefore, even though it is assumed that the nations follow identical environmental standards using the same mix of factors inputs, the trade effects of environmental control would have not symmetrical effects on the economies around the world. The countries whose comparative advantage is based on the same factor/resource/efficiency matrix underlying environmental control will be affected differently from those countries whose trade position relies on a different pattern of supply factors. Therefore, the appropriate assessment of the likely impact of environmental controls on individual economies' economic structure and trade is quite complex and will require an appropriate empirical investigation.

Grubel (1976) used the production possibilities frontier to extend his argument regarding the likely impact for a small country of environmental policy on trade flows and welfare by pursuing pure trade theory Heckscher-Ohlin model assumptions of international trade. The analysis is drawn in a partial equilibrium framework because it is assumed that the size of the country's expenditure on pollution control is given after an in-depth evaluation of the costs and benefits of pollution control among scientists, engineers, economists, and the public. All of them are presumed to reach the same conclusion that to ascertain the desired ambient level of environmental quality, the producers of export good are expected to install certain environmental control equipments to reduce the emission level that in turn requires the expenditure of capital and labor that has a primary effect of shrinking the country's production possibility frontier. In the following analysis, apart from assuming the small country case, no spillover effect of pollution is also assumed.

Figure 3.6 shows a small country production possibility frontier XoYo derived following the H-O model and other assumptions of neo-classical theory already elucidated and further assuming the existence of given production functions stocks of labor and capital. Given the international trade possible at world price ratio $W_0 W'_0$ the country is in equilibrium, producing at point Po and consuming at point Co. Y is an export good and also assumed to be one that making pollution problems more acute, and that of X is an import for small country analysis, and welfare level is depicted through the indifference curve tangent to the world price at C_o.

Figure 3.6 Environmental Policy and Trade Flows: Small Country good Y Production Externality Case



Source: (Grubel, 1976:12)

In figure 3.6, the environmental control measures in the light of the theoretical assumptions lead to reduce the production of export good Y by shrinking the country's production possibility frontier in terms of goods from its initial level X_oY_o to X_oY_1. The production frontier has common segment X_oP_2 that is in line with most cited assumption that up to an output level of OY^* of good the assimilative capacity of the country's environment is good enough to allow maintenance of the desired level of environmental quality without any environmental expenditure or installation of environmental pollution control equipments. It is well known that a complete model in the light of H-O framework in the presence of pollution should have three goods X,Y,Z, where Z is environmental quality variable but an extension of H-O model for more than two goods produces ambiguous outcomes for trade and welfare. Thus Grubel (1976) restricted his analysis at two goods level by assuming that the determinant of the precise amount of pollution is outside of the preview of the model.

The interpretation in the light of figure 3.6 and assumptions of the model is that at new equilibrium after the introduction of environmental policy measures in say manufacturing industry by installing the environmental control equipments the community indifference curve tangent to the world price line $W_1W'_1$ at point C'_1 depicts a higher level of welfare than that associated with C_o. This outcome is based on the fact that though the country at C_o consumes more of X and Y than at point C'_1 the level of welfare derived from this bundle of goods is diminished by the disutility derived from the pollution created by the production of good Y thus making consumption point C'_1 superior to C_o and therefore, this framework cannot interpret the indifference curve in a conventional way.

Now assuming that small country consumes all its capital and labor to produce the normal goods X and Y and environmental quality good Z, employing the linear homogenous production function in a three-dimensional production frontier, trade takes place wherein all three variable are utilized as an argument by making two cuts along the X-Y plane. The first cut is made wherein environmental quality variable, Z is zero in X-Y plan production possibility frontier is X_oY_o. The second cut is made at the equilibrium output of Z at which figure 3.6 shows in X-Y plane the production frontier points X_oY_1, the world trade ratio $W_1W'_1$ and the indifference map C_1. These outcomes reveal the two-dimensional projection of the full three-dimensional equilibrium condition at which the positive production of Z requires the use of some capital and labor which is not available for the production of other goods viz. X or Y and causes the shrinkage of the production possibility frontier in the X-Y plane from X_oY_o to X_oY_1 (Grubel, 1976).

The analytical framework by Grubel (1976) has allowed him to depict the validity of the trade principle offered by Johnson (1965) and generalized by Bhagwati (1971) that the first best principle for dealing with an externality is to eliminate it directly, leaving international trade unrestricted rather than introducing a new distortion of economic efficiency through the restriction of trade. Thus, the country could achieve the same level of environmental quality as was achieved under the free trade at point of consumption C'_1 and production P_1 by granting export subsidies on good Y or imposing an import duty on good X such that domestic relative price is established at DD' in figure 3.6. This relative price level induces domestic producers to reach the production point P_2, and at a low output level for good Y, even in the absence of pollution abatement equipment that allows a country to maintain the desired level of environmental quality at consumption point C_2 on world price ratio's $W_2W'_2$ going through P_2 where the domestic price ratio DD' is tangent to the indifference curve. Depending on taste, the new consumption could be at point C'_2, where good Y is an import good rather than an export good as it is at point C_2. The desired level of environmental quality using trade interference would lead to a lower level of consumption opportunity loan for good X and Y than that the establishment of the same level of environmental quality through the legislation to check environmental pollution without affecting the pursuit of free trade.

Using the same set of analytical models, he develops a taxonomy of the effects of pollution control on international trade as a proportion of total output parallel to the model developed by Johnson (1958) for the impact of economic growth on trade. First, considering the consumption alone, if before and after pollution control the consumption points are along the ray such as C_o and C'_1 then the consumption effect of environmental control on international trade is neutral. If the two consumption points before and after trade are C_o and $C_{1,}$ then the effect is pro-trade biased because, at a lower level of income, proportionately less export good is consumed less and thus available for international trade or exchange for import good X, which is consumed in proportionately greater quantity than was initially the case. Nevertheless, it is very much likely to see the public preference for good X consumption to be higher when the availability of that good is lower than the situation of higher-level availability. In these circumstances, the consumption point would be On $W_1W'_1$ but to the right of the line from C_o to the X-axis, and the effect would be ultra-pro-trade biased. In the same way, the consumption could be at $W_1W'_1$ but to the left of the ray OC. If the absolute amount of Y consumed is less than at C_o, the consumption effect has been termed antitrade biased; if it is more than at C_o it is known as ultra-antitrade biased (Grubel, 1976).

Next is to explore the possibility of combined effects on production-consumption of pollution control activities for a small country's economy. In figure 3.6, the ray OA goes through the corners of the pre-and post-pollution control trade triangles P_oAC_o and $P_1A'C'_1$, respectively. These points result from the fact that both production at P_o and P_1 and consumption at C_o and C'_1 are independently neutral, leaving the relative quantities of traded X and Y unchanged and resulting in overall neutral effects on trade. Now consider that the production remains unchanged at P_1 but taste changes so that consumption is to the right of $C'_{1.}$ In such circumstances, the overall trade effect of the pollution control program would be pro-trade biased, and the corner of the trade triangle would on the right of the ray OA. One can expect the various combinations of production frontier and consumption tastes. If the corner of the new triangle is to the left of the ray OP it is known as ultra-trade biased and between OA and OP it is known as anti-trade biased; location of trade triangle corner between OA and OC would depict pro-trade bias and to the right of OC ultra-pro-trade bias (Grubel, 1976).

In the light of the neo-classical modeling framework Grubel (1976) argued that once the information about the relative capital intensity of the production process for good X and Y and of the anti-pollution capital goods themselves as well as income elasticities of demand of both pollutive and non-pollutive goods are known only then one can predict something about the plausible impact of pollution control programme on international trade. He quoted Heller (1973 in Grubel,1976) study's outcome that in Cobb-Douglass production function case underlying H-O model production effect is neutral if pollution control requires capital and labor in the same ratio as the country's overall ratio of capital to labor. On the other hand, if the pollution control equipment requires capital and labor in the same proportion as good Y, then the production effect is anti-trade biased because the production frontier is shifted inward so that the output of good Y is reduced and that of good X remains unchanged. If demand for good Y is relatively more income elastic than the demand for good X then the lower income in terms of good X and Y- resulting from diverting resources into pollution control investment- would lead to reducing both the demand for good X and Y, and consumption effect would be anti-trade biased too. So it is the combination of factor intensities of productive goods, income and demand elasticities, and preferences for both export and non-exports goods that allows the possible impact of pollution control measures on trade flows under given assumptions of the neo-classical trade and production models (Grubel, 1976).

Potier (1976), raised valid criticism on Grubel (1976) and other theoretical work conducted at that time by arguing that though they provide valued insight on trade and environmental policy but do not contribute directly to the daily problems with which the decision-makers are confronted with. The models presume that information required to carry out the analysis is available and reliable, which is not the case in the real world. And the critical problem is to ascertain reliable pollution control cost data for the major polluting industries for both old and new plants as a prerequisite to assessing the international trade implication for environmental policy.

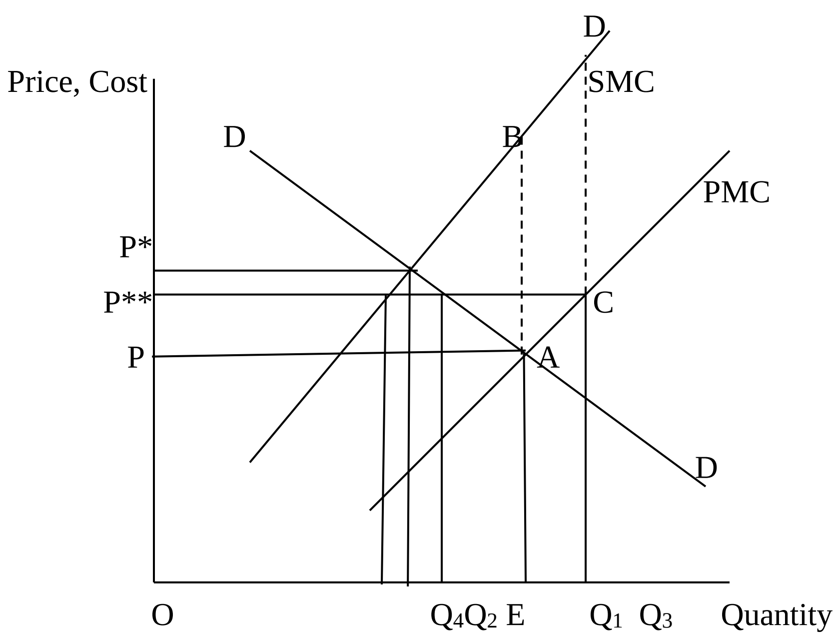
Several theoretical models on trade and environmental policy context that have worked along with the neo-classical trade theories, especially in Ricardo and H-O framework, are summarized in table 3.1 that generally tends to draw the negative effect of environmental policy for pollutive trade goods though produce complex outcomes depending on assumptions of the model and the outcomes expected when one ore few assumptions of the theory are relaxed. Nonetheless, one vital piece of research produced by Copland and Taylor (1994) regarding North-South trade is worth elucidation for the present research point of view. Given the assumptions of neo-classical H-O trade theory with the assumption that all else equal between two regions, except income that is higher in North compared to South and that trade flows are income determined the introduction of stringent income induced environmental regulations would reduce North pollutive sectors exports and increase South's pollutive sectors exports and thus there will be relocation of pollutive industries and production and specialization activities from North towards South.

One mostly cited theoretical level inquiry that deviated to some extent from the traditional approaches to address the trade and environmental policy interaction is one offered by Chichilnisky (1994), who also indicated the possibility of developing countries to become a haven for world industries production and exports. She argued that income-induced stringency of regulations might not produce the same effect for relatively less developed South in North-South trade context if property rights in South are either absent or not well-defined. Chichilnisky (1994) has offered a new direction to the North-South theoretical debate on trade and environmental policy and environmental quality. She proposes that it is the differences of property rights in two regions- North and South- that can provide the basis of trade incentives between them even if they are identical in all other aspects that is same taste, technology, endowments and preferences between two countries or if the world is presumed to be composed of two regions viz. North and South. In the general equilibrium-modeling framework, she presents two key findings. First, by defining South as having ill-defined property rights on environmental resources compared to North, where property rights are well defined, the author depicts that South trade with North aggravates the environmental quality problem as South overproduces the underpriced environmental resource-intensive goods and North over-consume the same. Second, on the choice of environmental policy between property rights policies or using taxes to address environmental issues, the study shows that with ill-defined property rights in South the use of environmental tax policy by South will exacerbate the environmental problems as southern countries producers would over-extract the environmental resources to adjust the additional cost. This led her to make a case for depicting the superiority of property rights policies over the tax policy to address the environmental problems.

Sanyal (2001) examined the impact of ill-defined property rights on trade and, following the North-South trade framework of Chichilnisky (1994), used a modified H-O model. He has summarized the pollution heaven impact in figure 3.7 when environmental pollution effects are local, given the assumptions of the same taste, preferences, and sharing same technology in the world two regions viz. North and South and good in question is most pollutive good. An externality is created through production that led to making social costs higher than private costs. Also, assuming that regulations are more stringent in North due to several factors including well-defined property rights, consume pressure due to high demand for environmental quality that forces the producer to set prices at the level of social cost. On the other hand, in the South region, low-income level, low demand for environmental quality, and poor property rights records would mean that environmental regulations are absent.

Given the assumptions of the H-O model and assumptions that difference in environmental regulatory regimes in North and South, the autarchy prices in two regions will be different: the price, P, in the South, being equal to the private rather than the social cost, will be lower than P*, the price in North. The figure-3.7 shows that the absence of environmental regulations resulted in the production of large-country of polluting goods in the South, paving the way for the South to enjoy the comparative advantage in pollutive good production that resulted from the differences in environmental regulations between two regions.

Figure 3.7 Private and Social Cost of Dirty Goods in North-South Framework



When international trade opens up, the arbitrage[13] begins, and the South exports the pollutive good. The final free trade equilibrium price is settled somewhere between two autarchic prices at p** that being higher from P induces South to expand production activities up to Q_3 and trade lead the South region to specialize in dirty good. The gap between social and private costs also increases due to trade from AB to CD in figure 3.7.

[13] The act of buying cheap and selling dear and thereby making a profit by the traders is termed as 'Arbitrage' (Sanyal., 2001).

The inefficiency that resulted from the absence of regulation is thus reinforced and magnified by trade specialization. The North produces less of good at home- OQ_4 instead of OQ_2- but consumes more of them (OE instead of OQ_2) as they are cheaper under trade situation than that in autarky i.e. P** is less P*. The gap between increasing consumption and reduced production is met through imports from the South who enjoy the comparative advantage created through the difference of regulatory regimes between two regions. Figure 3.7 also shows that the price North pays for consuming the pollutive good under trade is less than its social cost of production, that is, a part of the social cost that is unpaid for by North and thus is borne by the South. In this debate, therefore, unlike the conventional sources of comparative advantage such as labor productivity between two regions and or relative abundance or availability of factors of production, the difference in environmental regulations between countries and or regions provides the basis for trade and comparative advantage. It is important to note that such a comparative advantage is fundamentally different from conventional sources of comparative advantage. The latter rests on the economy's particular line of production i.e. strength in labour productivity, or relative abundance of that factor used more intensively in that production activities. On the other hand, comparative advantage generated through the differences of environmental efforts between two regions does not rest on the economy's strength (Sanyal, 2001).

Most of the literature on the subject of environmental regulations and trade competitiveness association has cited the famous theoretical debate between Palmer, Oates and Portney (1995) and Porter and Van der Linde (1995), which can also be seen as debate between new versus old trade theorist. Porter and Van der Linde (1995), following new-trade theory, offered the new concept of trade and environmental policy relationship normally termed as the race towards top and thrust of their argument is that there is no trade-off between environmental-related social benefits and private cost as properly designed environmental standards can trigger innovation that may partially or more than fully offset the costs of complying with them. They argued that the old notion of a trade-off between trade and environment at the theoretical level has resulted from the static and narrowed view of environmental regulation. In that technology, products, processes, and customer needs are all fixed. In this static world wherein firms have already made their cost-minimizing choices, environmental regulation inevitably raises costs. It will tend to reduce the market share of domestic companies in global markets.

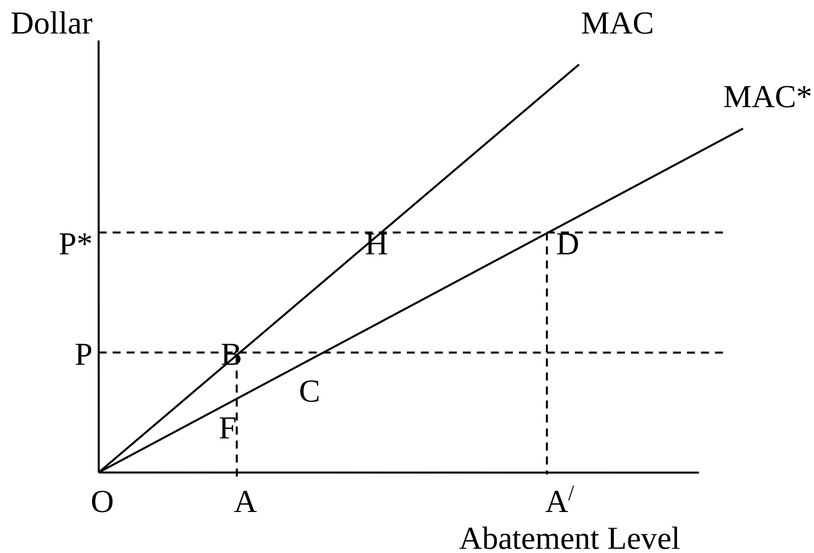
For Porter and Van der Linde (1995), dynamic competitiveness at the industry level arises from superior productivity in terms of lower costs than rivals or the ability to offer products with a superior value that justifies a premium price. Their detailed research at the industry level for the number of economies depicts that internationally competitive companies are not those with the cheapest inputs or the largest scale, but those with the capacity to improve and innovate[14] continually. These innovation offsets[15] can not only reduce the net cost of complying with environmental regulations. Still, they can even lead to absolute advantages over firms in foreign countries that are not subject to similar regulations.

Palmer, Oates and Portney (1995) advocate that there is no free lunch in this world, and following conventional neo-classical approach, they argue that some adverse effects of environmental regulations are out there to be borne by the firm in terms of cost to get benefits that environmental regulation ultimately brings to firm(s). They tend to agree with Porter and Van der Linde (1995) that incentive-based regulatory approach in lieu of command and control do a better job and that regulations have led to the discovery of cost-savings quality-improving innovations, i.e., firms are not ever vigilantly rested on their efficiency frontier. They criticized the new-trade theorist dynamic argument on regulations and competitiveness links in two areas. First, they advanced that Porter and Van der Linde (1995) study perceived the private sector as if it systematically overlooks the profitable opportunities for innovations. Second, they foresee the regulatory authority is in a position to correct this market failure. Accordingly, the enlightened regulators are well informed to provide the needed incentives for cost-saving and quality-improving innovations that competition apparently fails to provide. The regulations thus help firms to overcome organizational inertia and foster creative thinking, thereby increasing profit. Palmer, Oates and Portney (1995) strongly disagreed with these presumptions. Their analytical model proved that even incentive-based environmental regulations result in reduced profit for the regulatory firm, and some loss of

[14] Innovation is defined as to include a products or services design, the segments it serves, how it is produced, how it is marketed and how it is supported (Porter and Van der Linde ,1995).

[15] Innovation offsets cover both product offsets and process offsets. Product offsets occurs when environmental regulations lead to reduce pollution but also creates better performing or higher quality safe products and, lowering product cost etc. Process offsets occur when environmental regulation not only leads to reduced pollution but also results in higher resource productivity such as higher process yield, material savings due to substitution, reuse or recycling, lower energy consumption during the production process and reduce waste disposal costs (Porter and Van der Linde, 1995).

Figure 3.8 Incentive to Innovation under Emission fee



(Palmer, Oates and Portney, 1995:123)

competitiveness will be there. This model set the basis of the conventional approach that even additional (or tightening) constraints on a firm set of choices are hardly expected to increase that firm's profit level and thus gain competitiveness.

The analytical model reflected through figure 3.8 is static in nature and does not address the uncertainty issue regarding research and development decisions. The model is based on these assumptions: polluting firms maximize profits and operates in a perfectly competitive market; the firms take competitors outputs and research and development expenditures as given and also takes any regulations as exogenously determined, and last but not the least in the light of these assumptions the model does not cover the strategic interaction aspect between firms and between polluting firms and regulator either.

In figure 3.8, for the polluting firm, the horizontal axis shows the pollution abatement level i.e., pollution reduces while moving from left to right, and that of the vertical axis is measured in dollar terms. This enables to graph both firms' costs of various levels of pollution abatement and compares those costs with market-oriented effluent charges imposed by environmental regulators. MAC is a marginal abatement cost function without innovations showing the marginal abatement cost incurred by the firm to reduce pollution by an additional unit. The upward slope of the curve indicates the positive association between marginal abatement cost and abatement level i.e. reducing pollution level. Assuming now the firm decides to decrease marginal abatement cost function from the curve MAC to MAC*- marginal abatement cost under innovation- then with MAC* a given marginal expenditure leaves more effects on reducing the pollution level than that of MAC. Nevertheless, the firm requires to allocate fund to research and development activities for new pollution abatement technology, assuming that the R&D expenditure necessary for new technology requiring the movement of marginal abatement cost function from MAC to MAC* are known in the absence of uncertainty as well firm follow the market-oriented strategies of using effluent charges to encourage pollution abatement.

The analysis in figure 3.8 shows that initially, the firm is facing the pollution charges at point P, and polluting firm chooses the profit maximization level of abatement activity at A corresponding to point B where marginal abatement cost equals the effluent charge. If this observation turned out to be true, then the firm's implication for operating at A is that annualized cost of research and development (R&D) efforts to reduce MAC to MAC* should surpass the gains to the firm. Therefore, R&D investment efforts will not pay off, but outcome B should pay more profit for the firm than attainable point C, later is obtainable with innovative activities to reduce marginal abatement cost for the polluting firm. The gain to the polluting firm from undertaking the R&D efforts can be divided into two parts: the first one is that the earlier level of abatement activity become cheaper, which is shown through the amount of gain through the triangle OFB; second comes from new technology whereby the firm can reduce a relatively greater amount of pollution thus avoid paying the pollution charge on that additional pollution and gain to the firm is the triangle BCF. The total gain to the polluting firm from innovative activity would thus be the area bounded by OFCB. Since the firm has not chosen this option, the R and D programme cost that would move the firm from MAC to MAC* exceeds the profit area that would gain OFCB. Their study assumes that stringent environmental incentive-based controls are introduced by the authority, increasing the effluent fee to P^*. The question of vital interest here would be that whether the rise in effluent fee forces the firm to invest in new technology and move toward point D or should the firm be sticking to old technology and ending up at point H. However, it can be proved that the profit at both points D and H given the assumptions of the model would be lower compared to point B, leading to the unambiguous conclusion that higher effluent standards reduce the profits for the firm. The firm is paying the same amount to abate pollution up to point B as it was paying before. Between B and H, it is paying more to abate pollution than compared to the previous lower pollution charges, and above H, it is paying the higher effluent charges compared to the previous lower one. For the innovative marginal abatement cost function, MAC* profits at choice D given the higher effluent charge must be lower than profits at point C given the lower previous effluent charge. As elucidated above, under the assumption of constant technology, the higher effluent charge unambiguously reduces the profit. However, the model has based on the presumption that at lower effluent charges, the firm preferred not to invest in new technology for pollution abatement as profits were lower at C than at B. By transitivity, if profits at B exceed C and profits at C exceed D, even in the presence of innovative efforts, investment in abatement technology-higher pollution charge reduces profits for the firm. The outcome leads the authors to conclude that in the dynamic world of innovation in abatement technology, an increase in the stringency of environmental regulations unambiguously makes the polluting firm worse off. While the firm could invest and adopt new and more efficient technology but if that technology were not worth investing in before, its benefits would not be sufficient to raise the company profits after the environmental standards were raised either. Therefore, just making the model dynamic and or introducing the uncertainty will not overturn the result. The authors point out two vital elements that could give rise to an increase in profits following the levy of stringent environmental regulations: first, the strategic behaviour that requires interactions between firms and regulatory agency or between regulatory agencies in different countries and; second, is the presence of the opportunities for profitable innovation in the production of the firm output, which due to some factors have been overlooked by the proponent of new trade theorists and that can only be realized in the wake of new and stricter environmental regulations (Palmer, Oates and Portney,1995, XU, 2000).

The XU (2000) tended to synthesize the Palmer, Oates and Portney (1995) and Porter and Van der Linde (1995) arguments by advancing the point that while it is clear that both studies tend to agree that environmental cost is to be offset through the benefits ascertained through the introduction of new technology. The difference of opinion is whether the environmental regulation cost can be fully or more than fully offset by the benefits gained after introducing new innovative environmental technology, which is an empirical question to investigate. He offers an analytical framework regarding the impact of environmental regulation on trade competitiveness. Assuming that the objective function of the national government is to maximize total net benefit, i.e., beneficial environmental effects of regulation to society-social benefits-, minus the cost to industry plus the discounted gain of innovations effects in the following periods arising from the regulation. Following that sort of formulation, there are current gains and an additional innovation effect that benefits the future, which is depicted in the following inter-temporal optimization problem.

$$Max\int_{t}^{\infty}\{B_t(e_t)-[C_t(e_t)-R_t(e_t)]\}e^{-\rho t}dt$$ with respect to e_t

where $B_t(e_t)$ and $C_t(e_t)$ are the social benefits and private costs are arising from the introduction of e_t that shows the stringency of environmental policy. The notion $R_t(e_t)$ can be regarded as the benefits from the innovation as a result of research and development in abatement technology and $(C_t(e_t)-R_t(e_t))$ is the net cost incurred to the firm. The conventional approach compares the beneficial effects of regulation, $B_t(e_t)$ and the costs that should be borne to secure these benefits $C_t(e_t)$. $R_t(e_t)$ is zero in this case as in the light of the conventional approach, there is a static world wherein firms have already made their cost minimization choices, and therefore, environmental regulations inevitably raise costs and will tend to reduce the market share of domestic companies in global markets. Porter and Van der Linde (1995:98) new paradigm argument that properly designed environmental standards can trigger innovation that may partially or more than fully offset the cost of complying with them would imply that $R_t(e_t)$ is not zero and that $\partial R_t(e_t)/\partial e_t \geq 0$. That is, there are additional gains to the regulations in the form of innovation effects. The dynamic perspective on environmental regulations and competitiveness following new trade theorists is that there is no one-to-one trade-off between costs and a firm's profit. This is a dividing line between Palmer, Oates and Portney (1995) and Porter and Van der Linde (1995). Palmer, Oates and Portney (1995) demonstrated in their paper that even in the dynamic model wherein firm tries to minimize:

$$Min\int_{t}^{\infty}(C_t(e_t)-R_t(e_t))e^{-\rho t}dt$$ with respect to e_t - if the technology was not worth investing in before, its benefits will not be enough to raise the company's profits after the environmental standards are raised either. The model which Palmer, Oates and Portney (1995) put forward advocates that environmental regulations must reduce the profit of the firm. These authors also propose two other possibilities, including strategic behavior of the firm and the existence of opportunities for profitable innovation in the production of the firm's output. Therefore, XU (2000) points out that even Palmer, Oates and Portney (1995) do tend to agree that environmental regulation cost may be partly offset by adopting new technology but not fully offset by it. Both Palmer, Oates and Portney (1995) and Porter and Van der Linde (1995) studies tend to agree that environmental cost is to be offset through the benefits gained via introduction of new technology. However, they differ on whether environmental regulation cost can be fully or more than fully offset by the benefits earned after the introduction of new innovative environmental technology, which is an empirical question to investigate.

Frankel and Rose (2005) challenged the analytical rationale of Porter and Van der Linde (1995), which according to them, is not even clear at a theoretical level. They raised the question of whether the claim that any sort of change in regulation, regardless of direction, stimulates innovation, or is there something special about pro-environmental regulations? This hypothesis of the race towards the top seemed to be more plausible for the developed part of the world where property rights are well-defined compared to LDCS' which faces a poor record of property rights.

In table 3.1, this study summarizes the theoretical research in the area at general equilibrium framework elucidating the key study objectives, type of theoretical framework/ key model assumptions, and the study's main conclusions, which provide further insight to the theoretical debate regarding environmental policy impact on international trade between nations.

Table 3.1 Summary of Theoretical Models on Trade and Environment

Author(s)/Year	Key Study objective(s)	Type of Theoretical Model / Key Assumptions	Key Finding (s)
Pethig (1976)	To examine trade and environment policies interaction between countries and to examine if trade causes cross border pollution.	Ricardian type 2×2 ×2 general equilibrium model. Negative externality exists in production. Labour and Environment (waste disposal services) are two factors of production. Pollution is a by-product of production and not an international model but can be imported or exported in two goods. Labour intensive good is relatively clean. Environmental intensive good is relatively pollutive. No factor intensity reversal. Technology is explained through factor intensity. An environmental regulation determines factor endowments. Fixed consumption ratios that guarantees fixed international production ratio's of two goods. Pollution does not directly harm the labour or capital productivity.	In the absence of environmental policy, export of environmentally intensive goods would increase pollution. The introduction of environmental policy by one country increases its comparative advantage (comparative disadvantage) if it exports labour intensive good (environmental intensive good) and would increase welfare gains (welfare loss) from trade. Given identical labour productivities in two countries, country with lax environmental regulations (lowest shadow price for pollution) would specialize in and export pollution-intensive goods. Thus If developing countries have comparative advantages in the production of environmentally intensive goods, then while doing trade with advanced economies, they will specialize in and export pollution-intensive goods. This lead to create what Bhagwati (1996) called 'race towards bottom'.
McGuire (1982)	To examine Environmental regulations and trade relations; implications of (1) factor price equalization theorem (2) Rybcznski theorem	H-O theory and its standard assumptions apply in general equilibrium framework. However, the assumption of factor immobility of the standard H-O model is relaxed at a later stage. Pollutive and	Given constant substitution factor elasticities, with the homogenous production function and factor immobility for a closed economy, stringent environmental regulations would make factor used intensively in the production of pollutive good worse-off in both regulating and un-regulating industry while other factor of

Author(s)/Year	Key Study objective(s)	Type of Theoretical Model / Key Assumptions	Key Finding (s)
		non-pollutive goods are produced using three factors of production viz. labour, capital and environment (waste disposal services). Commodity prices are constant following small country assumptions. Environmental tax increases production costs. Economy is composed of both regulating and non-regulating industry. Pollution does not directly harm the labour or capital productivity.	production used intensively in the non-regulating industry would gain in the production of both good. In open economy and for a small country case and assuming the same (coordinated) environmental policy in two trading countries, a factor used intensively in the production of pollutive goods would lose while other production factor would gain from trade. When environmental policy is un-coordinated between the country, trade will hurt the factor of production used intensively in the production of pollutive good by lowering its price and benefits than other (s) factors of production in small country case. For a large country that can influence the world commodity prices, tight environmental regulations increase the world commodity price of pollutive goods ("price diffusion effect") and, thus, reward factor used intensively in pollutive good production. Given factor mobility between nations in unilateral environmental policy situation, capital will relocate across the border and move towards the economy with lax environmental regulations. Recently this phenomenon is termed as capital flight hypothesis.
Copland and Taylor (1994)	To examine trade and environmental policy, and environmental quality relationship between North-South mainly in the light of Scale effect, Composition effect and Technique effect**.**	H-O style static perfectly competitive general equilibrium modeling framework. The environment is input to the production and pollution affect locally not internationally. North and	Income induced pollution tax will be higher in North compared to South thus North produces the least pollution-intensive goods and South produced most pollution-intensive goods. In North, composition effect outweighs income and technique effect as the pollutive industry shrinks in North.

Author(s)/Year	Key Study objective(s)	Type of Theoretical Model / Key Assumptions	Key Finding (s)
		South regions are identical in all respect except the level of per capita human capital, which is high in North compared to South. Income-induced differences in level of pollution tax determine trade flows. The government in autarky follows optimal endogenized environmental pollution policy. Substitution elasticities in production and consumption are constant. Small country assumption of 'price taker' applies. The government does act strategically to set trade and environmental policy. Environmental pollution does not affect the productivity of labour and capital.	In South, the composition effect dominates over the rest two, and pollutive sectors expand even if optimal environmental policy is in place as pollutive industry relocates from North to South. If South is well endowed with human capital, then pollution-intensive industry relocates from South to North. More densely populated country exports labour intensive goods while less densely populated country export pollution-intensive goods. The country having a comparative advantage in assimilative capacity exports pollutive intensive goods. Assuming asymmetric growth in two regions, when North gets richer, the world pollution increases, and when South gets richer, the world pollution decreases.
Copland and Taylor (1995)	To examine how free trade affects pollution level and the role that environmental policy, international income transfer, international agreements play in addressing the environmental quality issue under the free trade era.	H-O type Comparative static general equilibrium model, retaining most of the Copland and Taylor (1994) theoretical model assumptions. Pollution instead of local now has global damaging effects. Environmental quality is pure public good whose supply responses endogenously to trade-induced changes in relative price and income. The study looks for Nash equilibrium in Pollution. Factor price equalization theorem holds.	When all countries have a similar human capital level, then world pollution may not increase given the factor price equalization theorem. Due to differences in human capital in North and South, free trade does not equalize factor prices. International trade reduces Pollution in North while pollution increases in South with trade, assuming pollution permits are not traded internationally. Given factor price equalization and other standard assumptions, South gains from trade increase while North loss from trade, as welfare is solely income determined. This makes the case of linking international trade agreements with environmental agreements. When South prevented from increasing pollution North gains from trade increases.

Author(s)/Year	Key Study objective(s)	Type of Theoretical Model / Key Assumptions	Key Finding (s)
			International income transfer lowers the recipient pollution but increases the donor's pollution only if factor prices are not equalized between north and south. Using terms of trade as strategic environmental policy, North being a pollution importer, gains a strategic advantage as terms of trade are strengthened. If world income distribution is highly skewed then free trade harm the environmental quality. However, when North and South having similar income then free trade would not harm environmental quality. Trade and environment relations at the global level produce complex and surprising results.
Chichilnisky (1994)	Trade and property rights interactions between North and South.	Modified H-O type static general equilibrium model with standard Neo-classical assumptions. In the North, property rights are well defined, while in South property rights are ill-defined.	South trade with North aggravates the environmental quality as South overproduces the underpriced environmental resource-intensive goods and North over-consumes the same good. In the presence of ill-defined property rights in South, taxing the use of environmental resources by the South will further damage the environmental quality by over-extracting the resources.
Merrifield (1988)	How transnational pollution flows, production, terms of trade, and factor prices are affected by two abatement strategies, viz. production tax and regulatory measures.	Comparative static strategic type general equilibrium model. Pollution does harm the productivity of labour and capital. Capital endowment in two countries is fixed and capital ownership is internationally immobile. Labour is immobile between two countries, but capital, pollution, and goods are internationally mobile. Neo-	Introduction of the new tax on output of polluting industry may lead to increase global pollution. Tightening environmental standards in either country reduces the pollution flows and can increase the relative scarcity of a good produced in the country tightening its standards.

Author(s)/Year	Key Study objective(s)	Type of Theoretical Model / Key Assumptions	Key Finding (s)
		classical assumptions such as identical taste and technology apply in the model.	
Siebert (1980)	To examine inter alias the impact of environmental policy on the changes in initial trade.	Ricardian style trade model and its standard assumption of perfectly competitive economy apply in2×2 ×2 general equilibrium model. Pollution intensities are defined as emissions per unit of output. Environmental damage arises from production and not consumption. Small country assumption i.e., it cannot influence world prices, is retained. The environmental policy would affect the allocation of resources. Relative prices remained fixed, and the balance of payment is in equilibrium	Emission tax introduces on the export of commodity in a country that has a comparative advantage in pollution-intensive goods would reduce production, trade volume and emission in a small country.
Baumol and Oates (1988)	To examine the impact of environmental regulations on the country's trade competitiveness	Partial equilibrium approach in two goods two country analysis. One good is clean. Other good whose production involves pollution unless prevention measures are introduced. Two countries don't differ in assimilative capacity. Cleaner production processes involve resources and thus would increase costs. Differences in transport costs, tariff, and like are assumed non-existed between two countries. Pollution is local in nature in initial analysis.	A country that follows the less expensive commodity production process would have a comparative advantage over another country under certain assumptions. Assuming developing countries adopt lax environmental standards compared to the advanced countries, then developing countries will enjoy the comparative advantage in the production of pollution-intensive goods and export the dirty products.

Source: Summarized by the author of this research.

3.4 Conclusion

The discussions in this chapter revealed theoretical interconnections between trade and environmental regulations which are complex and produced divergent outcomes. It essentially involved the allocation of productive resources diverted from the output of tradeable goods to the improvement of environmental quality. The magnitude of such reallocation of resources depends on the demand for improved environmental quality against the demand for other goods and services that has to be given up to achieve environmental quality. This, given underlying model assumptions, will influence both short-term competitive, associated adopted costs and long terms comparative advantage, shift industrial production and trade composition, and lead to industrial/pollution displacement/de-localization.

Depending on theoretical model assumptions, the large literature in neo-classical orthodoxy showed environmental management efforts would leave negative effects on a country's trade comparative advantage and competitiveness when country uses those productive resources for environmental control in sectors wherein its comparative advantage is based, hence there is trade-off between environment regulations and trade competitiveness. Nonetheless, the outcomes are complex as reviewed in this chapter and depend on combinations of factor intensities of productive goods, income and demand elasticities, preferences for export and non-exports goods, and among other things, price diffusions effects. New trade theory followers argued that no trade-off exists between compliance with environmental regulations and trade competitiveness due to cost savings achieved via innovative environmental technology, which promotes a race to the top. At the same time, theoretical literature reviewed in this chapter concluded that differential of environmental standards between rich North and relatively poor South and poor records of property rights in South had created the possibilities for South to become a haven for world pollutive commodities exports to North. Neo-classical researchers also challenged the race to the top hypothesis, especially in the wake of poor records of property rights in developing and poor countries. This chapter developed a synthesis that while neo-classical theories seemed to be more relevant to the quest of current study research endeavours but in the lights of limitations for the theories to produce conclusive outcomes contends that environmental regulations impact on trade could best be examined via empirical quest.

Chapter 4 clarifies some notions about the environment and trade for the empirical inquiry and reviews pertinent empirical research conducted in the area.

Chapter 4

Environmental Regulation and Trade: Empirical Endeavors

4.1 Introduction

This chapter will lay the foundation for testable empirical research methods that fit the research questions/hypotheses set in by this study. Accordingly, section 4.2 of this chapter will make a case for industrial-focused analysis for international trade and environmental regulations as inter alias the dynamics of competitiveness take place at the industrial level as opposed to firm/country level. In section 4.3, the channel via which the environmental regulations can affect competitiveness and components of what constitute total environmental costs are elucidated. Furthermore, measurement issues regarding environmental expenditure/costs that research faces at the industry level and dearth of comparable data at both cross country/ time series levels on pollution abatement control expenditures are discussed in the same section. In section 4.3.1, the study discusses vital empirical definitions of pollutive industries. It further explains why there was a need to broaden the pollutive industries scope from most pollutive to less pollutive industries. Section 4.3.2 defines what constitutes competitiveness and its association with environmental regulations. The term competitiveness is reviewed from the firm, industry, and national perspectives. The study made a case for competitiveness to be seen in terms of changing industrial trade patterns. In sections 4.4 and 4.4.1, this study elucidates a critical survey of empirical literature regarding the association between environmental regulations and trade with a special focus on research methods adopted, regulatory variables chosen, compatibility of research questions and their outcomes, scope of study in terms of countries and pollutive industries and challenges faced with at measurement stages by earlier studies. Indirect approaches, especially during 1970s and 1980s periods, mainly focused on calculating the environmental control costs and their associated impact on trade competitiveness. The literature surrounding this study's research questions/hypotheses review critically a number of direct empirical approaches-statistical and econometric. The statistical models examine pollutive industrial trade specialization patterns over time. Whereas econometric studies examine the environmental policy impact, keeping other things constant, on pollutive industrial exports/imports and trade competitiveness. Section 4.5 concludes this chapter and develops the research process of this study.

4.2 Why Industry Focused Analysis?

Several reasons justify the present study's concentration at industry level analysis instead of firm-level in a quest for empirical investigation about environmental regulations and trade competitiveness links. First, the dynamic of competitiveness takes place at the industrial level. The individual firm behavior and its competitiveness strategies, investment decisions, and locational choices need to be understood in the competition the firm faces. The reactions to environmental regulation by the firms depend primarily on the competitive characteristics of the industries within which they operate. Secondly, technological development and production processes are industry specific. The response of the industry to environmental regulations over time also very much depends on the technological trajectory of the industry. From the competitiveness point of view, competition at the firm level does not provide a good analysis at the international level because firms compete with each other. Some of the competitiveness gains that a firm may make through becoming more environmentally sound may be at the expense of other firms. Above all, it is an industrial trade flow that is a debated issue an international trade competitiveness perspective. For international level analysis of environmental stress, it is imperative to take account of how assorted products are produced in different regions and how various stages of the production process are distributed internationally. This phenomenon is again guiding research focus at the industry level (Jenkins et al., 2002).

4.3 Defining Environmental Regulations and Competitiveness: Measurement Issues in Empirical Analysis

Due to the complexity of the relationship between environmental regulations and competitiveness, there are various channels through which regulations could affect competitiveness. First, environmental regulations affect firms/industry costs of production directly through increased expenditure incurred on pollution abatement and indirectly through the high price of a certain factor of production affected due to stringent environmental regulations. Also, innovative environmental technologies have a role in leaving an impact on competitiveness (Pethig, 1970; McGuire, 1982; Porter and Van der Linde,1995; Palmer, Oates and Portney, 1995).

One vital aspect of understanding environmental cost measurement is to judge as to what should comprise in measuring environmental cost. The total cost of environmental regulations to the general masses can encompass the on-budget cost to the government of administering (monitoring and enforcement) environmental laws and regulations; private costs i.e. capital and operating cost at the industrial level associated with regulatory compliance. It further includes the legal and other transaction costs; negative costs i.e., benefits associated with environmental regulations such as productivity and innovative effects; general equilibrium effect linked to product substitution; discouraged investment (plant closure); retarded innovation constitute another layer of costs and social cost associated with the impact on job and economic security (Jaffe et al., 1995).

At the firm level, the environmental pollution control cost would entail both direct and indirect costs. Direct costs, including capital investment, monitoring, administrative, and management oversight costs, are incurred to comply with the new standards. Indirect costs are those that downstream industries incur when input becomes more expensive. The fixed cost would be a one-off expenditure for new equipment required because of standards. Variable cost rise involves the increase in energy and water price resulting from environmental standards or restricted emission. Therefore, every unit of output becomes more expensive to produce (Adams, 1997).

While the total cost of environmental regulations comprises both public and private costs, in practice, due to the dearth of data and complexity of linkages, it is incredibly complicated to consider these fundamental factors while measuring the environmental costs. Even for advanced countries such as the USA for which data on environmental regulations are available, there are problems of measuring the direct cost of environmental regulations at the industrial level i.e., just the private cost of compliance to regulations. For example, when new pollution control equipments are installed through new investment, which could reduce industrial emissions and increase the productivity of producing final goods, it is much more difficult to reckon how much expenditure is attributed to the environmental regulations (Jaffe et al., 1995).

It has been noted that within a given compliance cost estimate at the industrial level, there would be considerable problems in allocating expenditure to the environment when environmental improvements are part of overall processing design or redesign. Moreover, at empirical level analysis, there are many shortcomings in the availability and comparability of data and methodological tools. Data on environmental costs even collected for few countries are not precisely comparable among those countries, especially when it is less clear whether offsetting subsidies are accounted for in the cost data. Indirect costs associated with regulations are not well measured, and measurement problems related to the benefits side are even greater (Adams, 1997).

4.3.1 Definition of Environmental Regulations for Empirical Analysis.

One vital issue in environmental regulation and trade competitiveness at the measurement level is how to define the notion of environmental regulations. The terms environmental regulations are usually defined in the framework of command and control (CAC) and or market-based or incentive-based instruments to correct the externalities by assigning the proper price to the typical public good. In practice, it is not straightforward to draw a clear distinction or dividing line between command-and-control policy and incentive or market-based instruments. The programme where the regulator specifies what treatment technology is to be employed falls in CAC class. However, what would one conclude to the situation about a programme where the regulator assigns overall emission limitations but leave the sources to find the most effective method of compliance. So, regulation is not only applied to CAC but also market-based instruments. It should further include the degree of enforcement, internal and external market pressure or otherwise, that induce firms/industry and other economic agents to internalize external environmental costs and benefits (Cropper and Oates, 1992; Alanen,, 1996; Jenkins et al., 2002).

Given the complexities of measuring pollution abatement costs at both firm/ industry levels, contemporary empirical literature on environmental regulations and pollutive industrial production and trade associations has followed two pronged approaches to define the pollution-intensive industry. The first approach identifies those industries which constitute relatively high abatement costs in total costs or relative to their turnover as pollution-intensive (Robison, 1988; Tobey, 1990; Low and Yeats, 1992; Sorsa, 1994). The second approach is to pick those industries which rank high on actual emission intensity, i.e., emission per unit of output or value-added or per person employed (Mani and Wheeler, 1998). These two approaches lead to identifying the same group of most pollution-intensive industries. There seems to be a strong correlation between the ranking of industries by share of pollution abatement costs and the measures of toxic pollution intensity. Based on these two approaches and following an in-depth US industrial data analysis five most pollutive industries have been identified in most of empirical literature viz. iron and steel, nonferrous metals, industrial chemicals, pulp and paper and nonmetallic products (Lucas et al., 1992; XU, 1999; Jenkins et al., 2002; Eskeland and Harrison, 2003).

Recently, for pollutive industries, productivity analysis of Pakistan viz-a-viz. South Asia and South East Asian countries UNIDO (2000) have classified another sector, petroleum refineries, among the most pollutive industries. UNIDO (2000), for South Asia and Southeast Asia analysis, ranked the pollutive industries by their high and low emission intensity per unit of output. Accordingly, they identified three categories of pollutive manufacturing industries at disaggregated ISIC level data viz. most pollutive industries, somewhat pollutive industries, and less pollutive industries. The present study for South Asian countries' trade analysis follows this recent UNIDO (2000) industrial categorization. Another issue is to define competitiveness for empirical research.

4.3.2 Competitiveness: Definitional Clarity for Empirical Analysis in Environmental Policy and Trade Perspective

At the firm level, competitiveness means the ability to compete with firms at the international frontier of best practice. At firm-level competitiveness, can also be defined as its ability to sell its goods or services in the marketplace and stay in business. Loss of competitiveness could be seen in the form of loss of market share, both internal and external. Eventually, that could lead to lower output, employment, and ultimately plant closure or relocation. Stringent environmental standards may increase the firm's cost directly or indirectly, in terms of fixed and variable expenses, or differently depending on the type of the environmental policy instrument. A different form of environmental policy instrument will leave different cost effects that in turn affect competitiveness. For example, emission tax would lead to increased variable cost but at a relatively low administrative burden and ongoing economic incentive to reduce emissions in contrast to highly perspective legal instrument mandating technologies, process and compliance procedures. And Product standards have a different competitiveness impact than do process standards (Pearson, 2000; Adams, 1997).

As far as the environmental cost impact on a firm’s competitiveness of various environmental policy measures is concerned, if all firms observed the same rise in cost, then there will be no relative shift in cost and price increase, but there might be reduced demand if the increase in cost passed on to the consumer and demand is price elastic. In the real world, the firm that uses regulated input or output most will be affected most, i.e., the most pollutive industry is more rise of cost effect on competitiveness. Nonetheless, the impact of the new cost differential between the producers in one jurisdiction and their external competitors on sales and competitiveness depends on the market structure, ability of the firm to pass on the cost to the consumer, price response of competitors, and price sensitivity of demand for the product (Adams, 1997, Pearson, 2000). Then there is a further distinction drawn between the short-run and long-run impact of regulatory policy on trade competitiveness at both producers and consumers. In the short run, the firm may react to the imposition of environmental tax by reducing the supply of the product or through the change in input mix. At the consumer level, environmental costs might change the consumption basket with import substitutes, assuming imports are not fully taxed. In the long run, the firm's reaction involves either technology change, i.e., innovation or relocation of plant, i.e., capital exports. Technological advancement improved environmental management, and factor substitution can reduce the initial cost over time. As explained in chapter 3, in large and small country cases, the impact of environmental policy on trade competitiveness produces different results. In a small country case, the effect of the policy might not alter the relative world market prices, while for that of a large country case, it will. These results assume that when environmental tax is imposed on tradeable goods of a small country, consumer prices that are determined by perfectly elastic world market supply will not change, and therefore any adaptation in terms of adjustment in the economy will take place within the sectoral production structure. Whereas in large country case, environmental policy implementation will influence both supply and demand of tradeable goods of the world market; thus, international commodity prices will change. It leads to the concept coined as price diffusion effect that is the price rise of the most pollutive commodities due to action of a large country can act as an incentive for a small country's economy to specialize in production and export of those commodities (OECD, 1996; Adams, 1997).

The present study is cognizant of the fact that environmental policy is only one of the large factors that determine the competitiveness of firms. There are many other factors, including management ability; capacity to innovate to continuously improve efficiency; product quality, and customer service; the pattern of world supply and demand; and access to raw material and important market structure that play a vital role in determining the competitiveness of the firm (Panayotou, 2000; Adams, 1997; Pearson, 2000).

At the industry level, competitiveness arises from lower costs than those facing international rivals or a higher value to the customer in the form of delivery, services, or quality. Since Ricardo, the term Comparative Advantage is coined to explain the international patterns of trade specialization and competitiveness. The notion of comparative advantage describes the relative performance of different industries within a country as a determinant of what gets produced where. A vital assumption of the theory is that factors of production are immobile between the country and mobile within the same country's industry. A move from autarchy to free trade allows the flow of resources from the industries where the country is relatively disadvantaged (generally due to its factor endowments) to those industries where it enjoys a comparative advantage (Balassa,1986). In this context, industries competitiveness could be seen as the ability to attract resources from other industries within the same country. Nonetheless, with global economy that is facing a high degree of factor mobility, especially capital mobility the environmentalist such as Daly (1993) argued that trade flows are determined by absolute advantage instead of comparative advantage. This implies that the competitiveness notion at the industry level suggests comparing the same industry in different countries rather than different industries in the same countries. Regarding trade competitiveness, the researchers have reviewed the competitiveness in the light of the Revealed Comparative Advantage index due to Balassa (1986), and its advancement and changing pattern of exports in particular and trade flow in general over time.

At the national level, Competitiveness is a meaning less word when applied to national economies and the obsession with competitiveness is both wrong and perilous. The central determinant of competitiveness is productivity growth for some, while others argued that the notion of competitiveness would entail different meaning to different people like lower cost, exchange rate level, technological leadership, and even economic growth rate, etc. (Krugman, 1994; Lall, 2001; Boltho, 1996). Most of these determinants of competitiveness can be traced through the comparative trade advantage and empirical literature, therefore, has captured the impact of environmental regulations on trade competitiveness in terms of changing patterns of revealed comparative advantage of most pollutive traded manufacturing sectors over time (XU, 1999; Cole and Elliott, 2003; Low and Yeats, 1992; Sorsa, 1994). Further advancement in the comparative advantage index developed initially by Balassa (1965) for pollutive industrial trade flows at the bilateral level are examined by Grether and de Melo (2004). The specific environmental policy impact on competitiveness has further been examined by deploying empirical models such as factor flows H-O-V model and bilateral trade flows gravity models (Tobey, 1990; Ratnayake, 1998; Van Beers and Van den Bergh, 1997 & 2000; XU, 2000; Harris et al., 2002; Wilson et al., 2002; Babool and Reed, 2010; Jayawardane and Edirisinghe, 2014; Cantore and Cheng, 2018). The research conducted earlier in 1970 and 1980 heavily relied on measuring pollutive abatement costs at industrial levels and their implications for traded sector's competitiveness (Walter, 1973; Evans, 1973). Internalizing environmental costs either through environmental standards or environmental tax will increase industrial costs, and provided this cost is a substantial part of the industrial expenditure plan, it can affect the comparative advantage and trade competitiveness of most pollutive industries negatively, allowing cleaner industries to enjoy an improved comparative advantage, other things held constants.

4.4 Empirical Literature Review: Environmental Policy and Trade Competitiveness

The study in this chapter reviews some vital work conducted in the 1970s and 1980s that adopted indirect methods of analyzing the competitiveness impact of environmental control costs and then turn to recent empirical research endeavors that encompass a relatively direct way of addressing the research inquiry. The focus of the literature survey will be on both environmental regulations impact on trade competitiveness of the country and competing hypothesis viz. pollution haven effects in industrial trade flows. The literature survey will further reflect on the development in research methods in estimating hypothesis as the recent evidence showed that pre-1997 consensus that difference in environmental regulations between countries will have no impact on trade competitiveness was premature and beginning to change. The earlier studies suffered from inadequate accounting of un-observed heterogeneity in country/sector characteristics and from the endogeneity of pollution abatement cost measures. Therefore, the panel data technique is the preferred choice over cross-sectional data. The literature survey by Brunnermeier and Levinson (2004: 6-7) concluded that "the earlier consensus that regulatory differences do not matter is beginning to change" (p-7), and with methodological improvement, studies have found "statistically significant pollution haven effects of reasonable magnitude" (p-6) both at sectoral and national levels (in OECD, 2009: 26). This chapter will critically review several studies that will guide to develop the right choices for this study's research methods.

4.4.1 Environmental Control Cost and Competitiveness: Empirical Literature Review

Earlier research conducted in the 1970s and 1980s has primarily used indirect ways to analyse the competitiveness impact of environmental regulations. The focus of attention has been on measuring environmental control costs for traded sectors of the economy. The theoretical models reviewed in chapter 3 indicated the negative impact of environmental regulations on most pollutive goods exports competitiveness and thus the tendency for industries to move towards cleaner goods specialization (Pethig, 1976; McGuire, 1982; Siebert, 1980; Copland and Taylor, 1994 & 1995;

Merrifield,1988; Walter, 1975a). However, the degree to which the production and export shifts take place largely depends on the extent to which environmental regulations raise costs. If the environmental cost differentials at the inter-industry level are very high, then there would be a significant change in comparative advantage and trade flows. Nonetheless, when the differences in environmental control costs between industries are relatively minute, the change in trade patterns is also likely to be small (Jenkins et al., 2002).

Inspired by theoretical studies, one of earlier empirical research, in this context, is the one conducted by Walter (1973), who argued that environmental control cost is likely to affect volume, composition, balance, direction, and terms of international trade, industrial location, transport costs and a variety of related variables including national policy responses. Walter (1973) examined the impact of environmental control loading (ECL) on trade patterns for U.S economy using input-output tables containing data for 83 goods and services during the year 1966. The study through environmental control tended to depict that if export goods of US economy were more pollution-intensive than those of imported goods, then environmental policy pursued by US could affect trade competitiveness.

Walter (1973) has estimated direct environmental control cost and overall (direct and indirect) environmental control cost. The direct environmental control loading cost is calculated by comparing the actual market prices of trade product or product group with the value of given international traded good that accompanied environmental norms without absorbing any economic resource. Nevertheless, each of the raw material and intermediate inputs into the traded product is also subject to environmental charge. The overall Environmental Control Loadings (OECL) of a given tradable product includes the sum of direct environmental control loading and each input weighted by the contribution of the input to final export or import value. The author stated that it was not possible to work out the observable value of a given international traded product. However, direct and indirect costs attributed to environmental management could be worked out. The environmental control cost in his analysis included: current research and development expenditures, depreciation charges on in-place pollution-control equipment, the capital cost of in-place pollution control equipment, and current operating costs associated with environmental management.

Based on input-output modelling results, Walter (1973) depicted that the average annual overall environmental control loading for U.S. exports during 1968-70 was 1.75 percent of the value of U.S. export, which was to the tune of $751 million. In the absence of the availability of overall environmental control loading values of foreign suppliers, the author used U.S. import-competing sectors to reckon the average annual overall environmental control loading of U.S. imports. It was assumed that the product mix of imports within each group was similar to the mix of total sales of the import-competing industry and that imported, and import-competing prices were the same. The results indicated that during 1968-70 the U.S. average annual overall environmental control cost of imports was to the tune of $609 million or 1.52 percent of total imports. The cost differential between import and export goods was deemed to be insignificant to the author and allowed him to conclude that environmental control costs were trade neutral or at most could marginally biased against U.S trade sector. He nevertheless indicated that the vulnerability of some individual industries would be higher when (1) products of those industries were more competitive at the international level, (2) overall environmental control loading costs in those industries or sectors were higher. Using export/import ratio as the proxy for international competitiveness and multiplying this ratio with overall environmental control cost Walter (1973) indicated that competitiveness of industries such as ordnance accessories, construction, and mining equipment, and plastic would be substantially affected due to environmental control costs. Using OECL figures, the study also indicated that US imports from Japan are less pollutive compared to US exports to Japan whereas, for the same trade variables for US-Canada trade, the OECL figures were not noticeably different.

Evans (1973) examined the economic effects of pollution control on macroeconomic indicators and industry levels for the U.S.A from 1972 to 1980. The study used the data mainly from environmental protection agency (EPA) for fifteen pollution-intensive industries. He first determined the extent to which pollution control cost would increase the *ex-ante* price at the industry level and then translated these into prices and output changes at the macro level. Thereafter, the author determined the *ex-post* changes, which would be seen through the changes in prices and output of pollutive industries. The pollution control cost for industries worked out by the EPA, which covered both capital cost-amortization and interest charges- and maintenance costs expressed in 1971 dollars. These figures were divided by forecasts of shipment in 1971 dollars for respective fifteen industries. The mark-up factors, i.e., the proportion of the additional cost increase reflected in industry prices, were calculated by the author using Chase 2Econometrics Industry

Model wherein the prices were, in general, regressed on unit labour costs capacity utilization and price of material input. How much pollution cost could be passed on to the industry prices and thus product prices would depend on the type of the market system and whether industry faces perfectly elastic or inelastic demand schedule as well as if pollution control emission added anything to total product.

The study by Evans (1973) calculated the direct and indirect effects of pollution control using input-output tables for 81 industries. He further used an econometric model to compute the coefficients in the total requirement matrix. The reverse bridge matrix allowed him to witness product prices change due to pollution control costs, which showed *ex-ante* price increases. These outcomes would show the full pass-on effect of costs to the prices at the final demand level with no change in capacity utilization. The study also calculated mark-up factors at the aggregate demand level. The sum of price components in constant terms increased due to pollution cost at both industry and aggregate demand level were incorporated in the Chase Econometric Model to analyse the dynamic macroeconomic effect of pollution control costs for the period 1972 to 1980.

Evans (1973) calculated both baseline projections and a distributional solution that encompassed all those pollution control costs in an aggregate general equilibrium framework. The results depicted that the effects of pollution control costs on number of economic indicators such as GNP, growth rate of GNP, consumer price index (CPI), wholesale price index (WPI) and unemployment rate etc. would be small except for changes in the net foreign balance. The prices would be 1.5-2 percent higher, depending on whether one used CPI, WPI, or GNP deflator. The study further drew a comparison for price change at the industry level at various stages such as direct, intermediate, and final changes in the USA. The relative differences in prices between direct, intermediate, and final changes were noticeable among various industries. For example, inter-industry effects added more than 50 percent to the price increase of primary non-ferrous metal, mainly due to large energy input into aluminum. Auto price increased due to relatively large inputs of steel and nonferrous metals. At the same time, the secondary price effects for paper and electric power were tiny and negligible. On the contrary, the unexpected outcome observed for the cement industry wherein the final price increase was smaller than the intermediate price increase, which occurred due to high price elasticity for new housing in the USA.

The analysis of the relative price and output changes for each of the fifteen industries indicated the low-price elasticities for food, paper, petroleum, and electric power industries, while the results indicated conspicuously high elasticities for leather tanning, steel, non-ferrous metals, and automobiles. Evans (1973) pointed out that while the effects of environmental control costs could be absorbed on an aggregate level without significantly disrupting the economy, the overall impacts of pollution controls were unknown as the magnitude of the ultimate expenditures, which would be needed were undecided. The author also concluded that while some industries would be severely hit by the pollution control costs, the changes were not big enough to alter consumer or investment decisions.

Dorfman (1973), while discussing the paper by Evans (1973) and others, pointed out that fundamental and ineluctable impediment in the way of ranking the alternative pollution control programmes using mathematical models was the absence of a satisfactorily way of measuring the social cost of pollution or of valuing the external effects and public goods involved and excludability of those costs from the GNP measures of economic performance. While GNP is one of the most powerful economic performance tools, it has its limitations for such sort of sustainable level research as this measure does not consider pollution and externalities in the accounting framework. Therefore, Evans (1973) paper that estimated the aggregate effects inter alias GNP of pollution control costs ignored or misstated these consequences. He argued that following pollution abatement, the accompanied industrial productivity increases at the same time when pollution control costs lead to increasing costs of production. Evans (1973) work focused only on cost increase while ignoring the industrial productivity change. Furthermore, technological developments would change cost structure, production methods, and design and treatment of pollution controls and thus environmental policy but most of the mathematical models, including Evans (1973), were based on static assumptions about production methods and treatment technology, and therefore estimates derived can be misleading (Dorfman,1973)

Mutti and Richardson (1977) examined the impact of unilateral environmental cost controls on domestic output and international trade. Their model offers the four alternative methodologies, their scope of coverage, for estimating the industry-by-industry displacement caused by deterioration in the U.S. international competitiveness while adapting unilateral environmental controls. First, in partial equilibrium modelling approach, inter-industry linkages, inter-industry substitutability of demand, and secondary multiplier effect of decreased output on aggregate real economic activities, real exchange consequences are not considered and that full pass through of environmental control costs is considered. Second, following intermediate approach, inter industry linkages are considered while others are the same as in the case of partial equilibrium approach. Thirdly, in macro-orthodox general equilibrium approach study incorporates all the linkages that were ignored at partial equilibrium level while assuming full pass through of environmental control costs into prices. Finally, in classical general equilibrium approach wherein apart from inter-industry linkages price flexibility has been allowed to keeping real aggregate economic activity unchanged. Since domestic elasticity of supply is no longer elastic in classical general equilibrium approach therefore, in no income and exchange rate consequences are considered and thus environmental control costs are not fully passed into the prices.

The study used input-output tables for 81 U.S. industries for the year 1967, the one used by Walter, (1973). In each approach, the environmental control costs are financed by using polluter pays principle and subsidization out of general taxation. The author pointed that in practice financing of environmental control is almost always a combination of polluter pays and subsidization out of general tax revenue. Mutti and Richardson (1977) using general equilibrium approaches for macro-orthodox and classical and for each polluter pays principle and subsidy and tax categories produced results that indicated the consistent negative impacts of environmental control on industry output through loss of international competitiveness. Nevertheless, the results also indicated the diversity of the impacts from industry to industry. Furthermore, the output and thus competitiveness loss following subsidy-and-tax approach instead of polluter pays approaches to finance the environmental control are high in general equilibrium analysis. The chief objective of adapting alternative approaches by the authors was to compare the displacements effects that vary from one approach to another. depicted that regardless of financing method partial equilibrium approach underestimate output effect to the tune of 50 percent when compared with the outcomes of intermediate approach. This mean to say that following intermediate approach on an average only half of an industry’s displacement of output is due to its own cost of environmental clean-up while the rest half is attributed to the higher input costs caused by environmental control in intermediate supplier industries. Further, considering the general equilibrium refinement the results indicate that refinements have little effect on the estimated dislocation when macro-orthodox approach pursued, and environmental control financed through the polluter pays principle. The methodological refinements have significant impacts on estimated dislocation when macro-orthodox under subsidy tax scheme and both classical approaches taken into consideration. For these three cases, the general equilibrium refinements reduce predicted displacements costs by 30 percent and thus even out the inter-industry incidence of displacement substantially. In the light of markedly differences in outcomes witnessed using general equilibrium approach compared to partial equilibrium ones the authors concluded that general equilibrium approaches do make the difference (Mutti and Richardson, 1977).

Robison (1988) sees number of problems in using the general equilibrium approach adopted by among others Mutti and Richardson (1977). First, since the study used ex-ante forecasting, which requires either assuming or estimating abatement costs and second, the strong assumptions are made as to how the abatement costs are required to be allocated between return to capital, labour etc. to do forecasting analysis. The third problem of using general equilibrium approach to address such sort of research question regarding competitiveness is one which is observed by the Dorfman (1973) (in Robison, 1988) and that is that there would never be a true general equilibrium model until pollution emitted by all sources was included in the production functions of all industries. He, therefore, used ex-post partial equilibrium approach to analyse the impact of marginal changes in industrial pollution abatement costs on the U.S. balance of trade and US balance of trade with Canada. Hi study adopted Walter (1973) estimates for 1973, 1977 and 1982 and made use of input-output tables by incorporating the inter alia import and export price elasticities in the model to capture the impact of one percent increase in industrial pollution abatement costs on U.S. trade balance. By adopting the extended model, the measurements of trade impacts of marginal increases in abatement expenditures are made for each sector. The study assumed the full cost pass through assumption to ascertain the upper bound estimates thereby neglecting all mitigating variables such as improved terms of trade, offsetting governmental policies, and adjustment in exchange rates (Robison, 1988).

Robison (1988) also highlighted that studies by Walter (1973) and Mutti and Richardson (1973) to measure price changes due to environmental regulations in input-output analysis simply multiplied the abatement cost vector by the standard requirements matrix. This approach, according to the author, doesn’t capture the abatement costs implicit in capital goods used in the production process. To analyse the effect of these additional costs, the author has added the capital flow coefficient to the total requirements matrix. The abatement costs for each firm are defined as covering only the costs of abating pollution generated by the firm and not the cost of abatement equipment built into the goods the firm produces.

The analysis by Robison (1988) showed that the level of abatement costs implicit in both exports and imports rose sharply from 1973 to the periods 1977 and 1982 but the costs rose relatively more quickly for total imports than those of total exports. The ratio of exports to imports abatement content increased from 1.17 in 1977 to 1.39 in 1982. The study also found the evidence of shift in comparative advantage when compared the abatement content of U.S. exports, imports and output. The abatement content of imports rose faster during the period under review, rising above that of output in 1982 indicating that if United State had produced the goods it imported, the average abatement content of U.S. output would have been higher. However, the study found no shift in the trading pattern when same abatement content ratios were estimated for U.S. - Canada trade. The plausible explanation for this outcome could be attributed to the pursuit of similar environmental regulations by Canada. The study further tested the hypothesis: if an increase in abatement costs would raise the sectoral price by one percent. Based on 78 sectors of U.S economy covering both manufacturing and non-manufacturing sectors the study captured both direct and indirect impact on 1977 trade balance of the change in relative price. The similar exercise was made for U.S- Canada trade balance. For sectoral level impacts on U.S. trade balance the results depicted that direct impacts were large relative to indirect impacts in most manufacturing sectors such as food and tobacco, ferrous metals, and motor vehicle whereas, the indirect effects were relatively large for services sectors such as gas utilities, retail trade and business services. The overall result was that the rise in environmental control cost would reduce the U.S. balance of trade, which when measured at individual sector level ranged from (–0.12) percent (special industry machinery) to (–7.08) percent (copper) for the merchandize sectors and with an overall average of (–2.69) percent. The similar results of trade with Canada depicted that the impact ranged from .2 % (coal mining) to (–8.9 %) for petroleum refining. However, the study found the positive impact on sectoral trade balance of U.S. and those of U.S-Canada trade balance of the increase in environmental controls cost for sectors that has low export and import elasticities. By ignoring all general equilibrium mitigating effects that might arise due to either income or exchange rate changes the study by Robison (1988) also estimated the total impact on U.S trade of the industrial pollution abatement costs, which would provide the maximum potential effect. The outcome indicated the net reduction for all trade in the trade balance to the tune of $2392.3 million (0.67 percent of trade volume) and $4405.3 million for the years 1977 and 1982, respectively. The trade balance reductions with Canada for the same years were $544 (0.12 percent of trade volume) million and $850 million. The author indicated that the growth in the size of industrial pollution abatement impact over time is much higher when compared with the earlier work. This according to the author could be both due to general equilibrium effects in the forecasting studies and due to miss-estimating the size of pollution abatement costs and the length of the adjustment period in the earlier work on the subject. The main implication of this work for U.S policy makers was that marginal changes in the abatement costs would affect the U.S. trade balance (Robison, 1988).

For South Asia regions while there is a limited work done on measuring pollution mitigation costs at industrial level Khan and Khawaja (2001) study has provided some estimates on pollution mitigation costs for Pakistan's textile and leather industries during period 1996-2004. One of the key study objectives was to estimate a rise in exports of clothing, leather and footwear based on Uruguay Round Agreement on Textile and clothing and measure costs-benefits of pollution mitigation in addition to change in pollution levels. Using ARIMA model the study results showed that, once mitigation measures both in plant and external were in place, emission in clothing and tanning could, respectively, be reduced up to 91 percent and 66 percent. The costs of pollution mitigation measures for clothing sector at macro level was around .0011 percent of GNP 1996-97 and 1.6 percent of clothing exports. For leather industry the same pollution mitigation cost was estimated to be .0025 percent of GNP and to the exporters it was to the tune of .0048 percent of their export revenue. The study concluded that pollution abatement costs were rather modest and there were more benefits for manufacturing sectors to adopt cleaner production technologies (Khan and Khawaja, 2001).

4.4.2 Relatively Direct Approaches Measuring Environmental Policy Impact on Trade Competitiveness: Empirical Survey

The empirical research carried out in 1970s and 1980s decades pursued an in-direct approach to examine environmental policy and competitiveness through largely incorporating the environmental control costs with production and trade activities and their changing patterns whereas theoretical work on trade and competitiveness also envisaged the direct link of environmental policy measures and trade competitiveness. Since 1990s onwards, the focus of research therefore, shifted from indirect to direct efforts of analysing the environmental policy consequences for trade competitiveness.

As number of empirical studies took theoretical inspiration from one of the most venerated trade model, Heckscher-Ohlin-Samuelson (H-O-S) model for the empirical examination of the relationship between environmental regulations and trade competitiveness in multi-country and multi-commodities case, which was first empirically tested by Leamer (1980,1984) to explain the determinants of net commodity exports in factor abundance framework. Therefore, a complete theoretical description of the model is worth elucidating. In its original formulation, 2x2x2 (H-O-S) model says that the different commodities use the factor in different proportions and the countries are endowed with the factor of production in different proportions. Nevertheless, the situation wherein trading countries are endowed with more than two factors of production then it would highly complex and ambiguous process to have a unique ordering of technologies in the light of relative factor intensities (Tobey, 1990; Cole and Elliott, 2003; Wilson et al., 2002).

H-O-V model explains that it is relative factor intensities that cause the problem under the circumstance when more than two factors are considered for analysis, and he introduced the alternative way of elucidating the H-O-S model that is linked with his name and coined as H-O-V model, which for more than two goods, more than two countries and more than two factors cases state that a country relatively well endowed with one factor of production will be a net exporter of the services of that factor and a net importer of the services of the other factor, given the standard assumptions of the elegant H-O-S model. Therefore, the H-O-V model is the factor content version of the H-O-S model and helps avert the problem of explaining the factor intensities for more than two factors and thus paves the way for empirical investigation for more than two goods and more than two-factor situation for the multi-country scenario. The formal H-O-V generalized model for empirical analysis mainly elucidated by Murrell (1990, 237-239), Cole and Elliott (2003) and Tobey (1990) can be presented as under:

H-O-V (1) The standards H-O-V model assumes that there are many goods (i, = 1,…N), many endowments (k = 1………..S) and many countries (j = 1……….T) where S = N[16].

H-O-V (2) The primary factors endowments, S are fixed, mobile within country but immobile between countries. V_{kj} shows the jth country endowment of factor k.

H-O-V (3) Each country produces N goods. The amount produced of each good is a function of total endowments used in the sector, wherein that depicts constant return to scale.

H-O-V (4) Individuals consume as if each were maximizing an identical

[16] The general cases wherein $N \geq S$ can considered to prove that $N \geq S$ can converted to N=S following standard assumptions of the trade theory.

homothetic utility function.

H-O-V (5) No transportation costs.

H-O-V (6) Trade is balanced for all the countries.

H-O-V (7) There are no tariffs, export subsidies or other trade impediments.

The model for multi-goods, multi-country and more multi-products analysis also assume the sufficient factor endowments similarities so that all countries within the same 'cone of diversification, as well as perfectly competitive market structure i.e., perfect competition both in goods and factor markets along with a constant return to scale, would lead to *factor price equalization*. Given the assumption of identical technology, input-output coefficients are identical across countries.

Let Q_{ij} be the amount of good is produced by country j where Q_j is the vector of N outputs and as stated above, V_{kj} is defined to be jth country endowments of factor *k* and V_j is the vector of S factor endowments. Assuming a_{ki} be the amount of resource k utilized in order to produce one unit of good i. Then we can write the following expression.

$$V_{kj} = \sum_{i=1}^{S} a_{ki} Q_{ij} \qquad \text{(i)}$$

This is a system that allows to solve the output (Q)as function of a factor endowments(V) and in matrix form we can write the above expression as $V_j = AQ_j$ whereas $a_k i = A$ and if the A is invertible then we get:

$$Qj = A^{-1} V_j \qquad \text{(ii)}$$

Factor price equalization and constant return to scale brings:

$$G_j = \sum_{i=1}^{N} p_i Q_{ij} = \sum_{K=1}^{S} \gamma_k V_{kj} \qquad \text{(iii)}$$

where G_j is national income of country *j*, pi is the price of good *i* and γ_k is the price of endowment *k*.

Net exports, W_{ij} are the difference between production and consumption and thus, the assumption of trade balance requires that the value of production be equal to the value of consumption:

$W_j = Q_j - C_j$ wherein Cj is the consumption vector of country *j*. Following assumption H-O-V (4) we are saying that each country under analysis consumes the commodities in the same proportion. Therefore, introducing c_i, which shows the proportion of national income spends on the good *i*, the following equation explains the country's consumption share in output.

$$C_j = cG_j \qquad \text{(iv)}$$

Denoting world value with a w subscription and by assumption, the world production of every good should equal to world consumption thus can get:

$$c = A^{-1}V_w/G_w \quad \text{(v)}$$

The net export, as stated before, is the difference between consumption and production.

$W_j = Q_j - C_j$ and the substituting the values for Q_j and C_j from the equations (ii), (iv) and (v) gets:

$$Wj = A^{-1}V_j - c.G_j \quad \text{(vi)}$$

$$Wj = A^{-1}V_j - A^{-1}V_w(G_j / G_w) \quad \text{(vii)}$$

and indicating the elements of A^{-1} by $\bar{a}_{ij}$ and using equation (iii) it can arrive at the following expression:

$$Wij = \sum_{k=1}^{S}\left[\bar{a}_{ik} - \gamma_k / G_w (\sum_{s=1}^{S}\bar{a}_{is} V_{sw})\right]V_{kj} \quad \text{(viii)}$$

In equation (viii) the expression within the square brackets is independent of j and therefore constant across countries, and one can arrive at the following equation for empirical estimation.

$$W_{ij} = \sum_{k=1}^{S} b_{ik}V_{kj} \qquad i = 1,\ldots,N \quad \text{and } J = 1,\ldots\ldots\ldots\ldots T \quad \text{(ix)}$$

where

W_{ij}= is the net exports of good i by country j

V_{kj} = is the endowment of resource K in Country j.

b_{ik} = parameter, constant across countries.

Environmental resource endowments variable in this framework in addition to other explanatory variables such as labour and capital is added in factor flows model by assigning the price to it, which comes via environmental stringency variable i.e., stringent the environmental control policy is of particular country the less that country endowed with the factor, environment (Tobey, 1990). Most of the empirical work conducted in the 1990s and even in the present decade who adopted HOV methodology used equation (ix) to analyse the environmental policy and trade competitiveness linkages. One of the first rigorous research in this context is one conducted by Tobey (1990).

Tobey (1990) work is vital in this context, as it is the first attempt to employ the trade theory to analyse the direct impact of domestic environmental regulations on international trade patterns at the cross-country level. The study tested the hypothesis of whether stringent environmental policy caused trade patterns to deviate in commodities produced by the world's dirty industries. Pollution intensive commodities are the product of those industries whose direct and indirect abatement costs in the U.S. are equal to or greater than 1.85 percent of total costs. This cut-off 1.85 percent is selected because it results in a set of industries considered the most polluting industries in the world. Following this criterion, he has identified 34 pollutive industries that are aggregated into five commodity groups encompassing mining, primary nonferrous metals, paper and pulp, primary iron and steel, and chemicals for analysis purposes. He used cross-section factors flow-based Heckscher-Ohlin-Vanek (HOV) multifactor, multi-commodity model of international trade using 1975 United Nations trade data for 23 economies-both OECD and non-OECD. The net export variable is regressed on the factors of production variable including variables of capital accumulated and discounted gross domestic investment; various categories of labour and land; natural resource variable such as coal, mineral and oil as well as environmental stringency variable. The environmental stringency measure is based on 1976 UNCTAD that ranked the country in 7 categories ranged between 1(tolerant) to 7(strict), which served as a proxy for the stock of the environment[17](Tobey, 1990).

The study extends the analysis for omitting variable tests as well. At a later stage, the author relaxed some of the HOV model assumptions to capture non-homothetic preferences and scale economies/ product differentiation. Based on empirical findings, the study concluded that the stringent environmental regulations imposed in the 1960s and 1970s by most advanced economies have not measurably affected the patterns of trade and thus competitiveness on most polluting industries (Tobey,1990).

One problem in Tobey (1990) approach was that it was based on multilateral trade flows, which meant to say that differential effects of environmental policy on various trade flows might cancel out due to aggregation of bilateral trade flows to multilateral trade flows (Van Beers and Van den

[17] It is clarified here that though pollution emissions are joint product of the production process they can be interpreted as an input in the production function because they can be seen as one of the various uses of the environment (Baumol and Oates, 1988). As the use of environment is typically a public good the environmental endowment has no price attached to it and will be used freely by industries until pollution control measures are instituted. Therefore, the country environmental endowment is measured by their stringency of pollution control measures (Tobey, 1990:186).

Bergh, 1997). Their study offered to avert this problem and undertook more disaggregate analysis based on bilateral trade flow, which is composed of imports and exports gravity model pioneered by Tinbergen (1962) and Linnemann (1966). Second, they believed that the formation of environmental stringency measures might be responsible for ascertaining the Tobey (1990) results being using input-oriented environmental stringency measures such as current and investment expenditure in pollution abatement and control activities. These sorts of measures are inappropriate as high abatement control cost could be counterbalanced by the government through export rebates and import surcharges to the most pollutive industries, therefore, failing to represent the real cost incurred by the firms/industries. Therefore, such sort of measures might exaggerate the costs of environmental regulations (Van Beers and Van den Bergh, 1997).

Van Beers and Van den Bergh (1997) revisited Tobey (1990) to address the same hypothesis, i.e., whether domestic environmental regulations would affect the trade pattern of developed and developing economies. They differed from Tobey (1990) study regarding the stringency policy indicators used, the methodology employed, and a slight change in the sample of country and sectors focused. Instead of multilateral trade flows, the study used three different bilateral trade flows data for both OECD and non-OECD countries. The bilateral trade flows include (1) total bilateral trade flows; (2) dirty bilateral trade flows, which encompass a high degree of resource base (non-footloose) industries; and (3) footloose: trade flows relating to specific dirty sectors covering mining, paper, chemicals, and steel and non-ferrous metals sectors. For regression analysis, the study employed the gravity model[18] of international trade, which considers the relative economic sizes and geographical distances involved in bilateral trade flows. The model is of the following form:

$$X_{ij} = \beta_0 Yi^{\beta 1} Yj^{\beta 2} Ni^{\beta 3} Nj^{\beta 4} Dij^{\beta 5} e^{\beta 6 Pij} e^{uij} \qquad \text{(A)}$$

In equation (A) X_{ij} is the trade flows of country *i* to country *j*; *Yi* is gross domestic product of country *i*; *Yj* represents gross domestic product of country *j*; *Ni* is population of country *i*; *Nj* is population of country *j*; *Dij* is the distance between country *i* and *j* in nautical miles; *Pij* shows dummy variable(s) and *Uij* represents log-normally distributed disturbance term.

[18] The detail derivation of gravity model has been discussed in chapter 8. Also, in the same chapter, study provides more elucidation regarding and pros and cons of comparative analysis between the methodological usage for cross-section and panel data analysis.

The study used two output-oriented environmental stringent measures keeping in view the inappropriateness of input-oriented environmental stringency measures. Output-oriented measures encompass the effects of compensating subsidies and facilitate assessing the effective (ex-post) strictness. The first one, the broad-based measure, sums the seven environmental indicators, including the rate of sewerage connection, recycling rates, energy intensity, and proportion of territory in environmentally protected areas. The environmental stringency measure is created through a ranking procedure by assigning number 1 to the worst performer, 2 to the second-worst performer, etc. The same exercise is conducted for each sample country, and outcomes are divided by the number of countries, and therefore, an index is developed ranging between 0 for no environmental policy and 1 for stricter environmental policy. One shortcoming of aforesaid indexes as themselves indicated by authors is that they failed to reveal environmental costs reflected in producer prices. Therefore, they proposed a second measure of environmental stringency- a narrow (energy-based) one- which did consider the private environmental costs, which effectively depicts how the energy intensity of the economy evolved and more in line with the polluter pay principle. For each stringency measure the countries were ranked between 0 (week regulations) to 1 (stringent environmental regulations). In their gravity model, independent variables included the gross domestic product of bilateral trade countries, their population, land areas of bilateral trading countries, respective stringency measures of exporting countries and importing countries, and dummy variables to captures (i) adjacent country affect, (ii) European Community membership affect and (iii) EFTA membership affect (Van Beers and Van den Bergh, 1997).

The study by Van Beers and Van den Bergh (1997) using the same 1975 data the one used by Tobey (1990) and the same ordinal measures of environmental stringency did not find a significant association between environmental regulations and pollutive intensive industrial trade. The results showed that stringent environmental regulation places a positive influence on exports and has no significant effect on imports in total bilateral trade flows and non-resource-based pollution-intensive trade flows, which is perhaps in line with what the porter hypothesis envisages. However, the same authors in another study provided three reasons for the positive association between environmental regulations and exports. First, countries facing stringent environmental regulations in polluting industries might be subsidized to compensate for increased production costs. And if the counterbalancing effect is stronger, one could see the positive effect of environmental regulations on trade patterns. Second, other than non-environmental factors like available labour skills and political instability of countries might have influenced plant-relocation and export decisions. Third, the result might indicate that Tobey (1990) study chose an inaccurate stringent environmental regulation measure (Van Beers and Van den Bergh, 2000).

The regressions outcomes, which relied on OECD sample countries only to avert the political instability factor of developing countries, did not find a significant impact of environmental regulations on the pollution-intensive bilateral exports. The second set of analyses is conducted for 1992 SITC- revision-3 trade data set for 21 OECD countries for both broad and narrow-based environmental stringency measures, and developing countries are excluded in the analysis mainly because of the dearth or absence of data for a later group of countries. The key findings are what follow. For aggregated total trade data**,** the broad measure of environmental stringency variable does not leave a significant impact on total bilateral trade flows, but the narrow measure does affect export competitiveness**.** For most pollutive industries or what they called dirty industries, both narrow and broad measures failed to produce the statistically significant impact on dirty sectors exports. Once the dominant effect of natural resources on competitiveness trade patterns is eliminated by focusing just on non-resource-based or footloose bilateral trade flows data the expected negative impact of environmental control measures (narrow-based) on dirty exports was observed. These results led the authors to draw another theoretical-based conclusion that strict environmental regulation policies do (not) have a significant strong impact in the case of non-resource-based (resource-based) industries. Last but not least, import side bilateral industrial trade flows data-based results indicate that irrespective of the type of trade flows, a significant negative impact on the competitiveness of environmental control measures observed. That seemed to suggest that the government’s effort towards introducing the import barriers in pollutive industries go parallel to the endeavours for environmental control measures (Van Beers and Van den Bergh, 1997).

Van Beers and Van den Bergh (2003) updated the same study using 1992 data using 21 OECD countries data in the light of broad environmental regulation measures and using 14 OECD countries data by applying narrow environmental regulation measures. The overall results of environmental stringency for total bilateral industrial trade, bilateral trade for most pollutive industrial trade, and non-resource based most pollutive bilateral industrial trade showed statistically insignificant impacts for both exporting and importing countries. However, at the sectoral level for the mining and non-ferrous metals sector, the effect of regulation on exporting countries was negative and statistically significant. Those of paper industries depicted positive and statistically significant effects. For the import data side, the results of environmental policy remained insignificant for all sectors. Again, the study found less conclusive results.

XU (2000), apart from analyzing the time series effect by using competitiveness indicator, used the extended gravity model/OLS approach to examine the impact of environmental stringency on bilateral export flows. He tended to agree with Van Beers and Van den Bergh (1997) that the H-O-V model has dis-advantaged when it comes to problems of aggregation in data as the effect of differences in strict environmental regulation on trade between countries will cancel out because multilateral trade flows are an aggregate of bilateral trade. Firstly, using statistical modelling framework and covering 134 countries industrial trade data at dis-aggregated SITC during the period 1965-95, he examined whether domestic environmental regulations reduce the international trade competitiveness of environmentally sensitive goods (ESG). The time-series results show no systematic change in the trade pattern of ESG's during this period despite the introduction of stringent environmental regulations around the globe during that period. He then empirically provided comparative analysis by dis-aggregating industrial trade flows of 31 countries of both developed stringent environmental regulatory North and poor South countries. The trade data was computed at three industrial trade categories viz. total bilateral export flows, bilateral export flows of (ESG) and, bilateral export flows of non-resource based (footloose) industries for the year 1990. To compute cross-sectional data study used a five-year average to arrive at 1990 figures and took care of macroeconomic distortion in the data. The study also examined the hypothesis that new trade barriers emerge to offset the trade effects of more stringent environmental regulations.

For environmental stringency impact on trade flows XU (2000) utilized the Environmental Performance Index for the year 1990 developed by the team of World Bank, Dasgupta et al. (1995) for randomly selected 31 countries covering environmentally stringent countries in North to with lax environmental standards countries of South. The data on other gravity model variables such as exporter and importers GDP and population, distance variable and proxy of tariff barriers variables viz. tariff revenue as share of total imports are mainly chosen from World Development Indictors and bilateral trade from UNIDO sources with 3-digit industrial SITC data. He applied all appropriate diagnostic tests, especially for cross-sectional analysis the data showed the violation of the homoscedasticity assumption in OLS. Hence, the study reported all estimated t-coefficients using correct standard error after using White (1980) heteroscedasticity adjusted covariate matrix. The estimated results showed the correct signs for most variables as its double log model; hence the results are all in elasticities. The variables of income are positive and statistically significant for all categories of industrial bilateral export flows and distance is negatively and statistically significantly associated with export flows. The environmental stringency impact on bilateral export flows is positive and statistically significant for total export flows, export flows of ESG and export flows of ESG non-resource based i.e., footloose industries such as iron and steel, cement, metal manufacturer and chemical industries. The results are different from earlier work and seemed to be in line with the porter hypothesis. The study found no evidence that footloose pollutive industry exports were more responsive to the stringency of environmental regulations. Regarding tariff measures, the estimated coefficients show that tariff measures imposed by partner country do leave a negative effect on exports including total bilateral exports, bilateral exports of ESG as well as ESG which are non-resource based.

XU (2000) study faces a number of problems. Firstly, his analysis has drawn conclusions based on cross-sectional data estimation techniques while ignoring the endogeneity issues in data because results can be sensitive to the choice of modeling technique. Secondly, the study used proxy for tariff barriers- tariff revenue/imports ratios, which might not be a true representative of tariff walls. The study should have chosen actual tariff data for different categories of pollutive industrial trade flows compatible with SITC. Thirdly at the modeling specification level, the study suffered from omitted variable bias as it ignored the use of dummy variables such as common language, colonial links, and contiguity. These paired variables are generally part and parcel in most gravity model specifications in the cross-countries analysis.

The study by Ratnayake (1998) noticed that some earlier empirical work, such as Tobey (1990) failed to consider the vital determinants of trade, such as the role of industrial characteristics and trade policy-induced variables, while explaining the trade patterns. According to him, in addition to the factor endowments, many other factors influence trade patterns. Therefore, explanatory variables should include environmental stringency along with other vital factors that elucidate export competitiveness. His empirical inquiry on environmental policy and export competitiveness association is a departure from earlier work. First, it focuses on inter-industry trade data compared to some earlier work that focused on either aggregate or sectoral level trade data. Second, it covers the individual country named New Zealand’s manufacturing industries trade with its trading partners. His approach to examine the environmental policy impact on trade competitiveness is three-fold. First, the paper examines the changes in New Zealand’s aggregate trade flows classified by environmental sensitive goods and environmental non-sensitive goods with three country group categories, OECD, ASEAN, and DCs, over the period 1980-1993. Second, New Zealand competitiveness with these three groups of countries in manufacturing exports of 109 industries was examined using exports revealed comparative advantage index (XRCA) for manufacturing export sector at three-digits SITC data. Thirdly, following the H-O-V model, regressions were conducted. The sensitive environmental industries are the one which encompasses the highest pollution abatement cost, expressed as a percentage of the value of output.

The study by Ratnayake (1998), among others shows that New Zealand's export penetration in environmental sensitive goods (ES) is more than that of non-environmental sensitive goods (NES) in the selected group markets. The composition of ES and NES imports to New Zealand shows that the imports of environmentally sensitive goods from OECD and developed countries and ASEAN have increased during the period 1980-93 while for NES the data show a mixed trend. The XRCA results show that New Zealand's international competitiveness of environmental sensitive goods has not changed noticeably during 1980-93. For cross-examination of results of the XRCA model his study adopted the modified version of the HOV model. If further brought into imperfect competition aspects in the analysis following the debate on intra-industry trade and role of technology in industrial growth (Helpman and Krugman, 1985). The dependent variable is net export of the country, and the explanatory variables include; industry concentration ratio, the profitability of firms in the domestic market, industry growth as percentage in sales, two variables representing industry structure, foreign ownership of industry (industry sales accounted for by foreign-owned firms divided by total industry sales) and nominal rate of protection, dummy variable approach to represent environmental sensitive commodities, the variables of capital intensity in physical capital and human capital, and technology variable (research and development expenditure to sales). The regressions are performed both with and without environmental variables to examine the trade patterns of New Zealand with its major three classified groups of countries-ASEAN, developed countries, and OECD. The vital finding again was that environmental regulations do not affect the trade pattern of New Zealand. Also, results show that the traditional determinants of comparative advantage like physical and human capital were more significant to explain international trade patterns of New Zealand. The limitation of this study was an implicit assumption that both US and New Zealand have similar environmental standards and a preference for environmental quality. It is less realistic to apply that assumption when pollution abatement technologies and plant productivities vary between countries.

Harris et al. (2002) study to examine environmental regulations impact on pollutive industrial trade revisited the Van Beers and Van den Bergh (1997) research. It drew attention towards model misspecification issues by offering panel estimates instead of the cross-section data estimation technique. The study examined if a change in gravity model specification could alter the main findings regarding trade and environment advocated by Van Beers and Van den Bergh (1997). Instead of using a double-indexed cross-sectional OLS approach, their study has employed a three-dimensional panel data framework for 24 OECD countries during the period 1990-96. The three-way fixed effects modeling analysis captures importing and exporting countries' effects and time-specific effects (business cycle effects). They argued that panel data is preferred over cross-sectional data to ascertain more reliable results, as bilateral trade is generally prone to strong annual fluctuations. The stringency of environmental regulations was estimated using six different indicators based on either the relative energy consumption or relative energy supply variables. The study concluded that the relationship between stringent environmental regulations and pollutive industrial trade was insignificant. Therefore, environmental costs do not have a real impact either positive or negative, on the international trade of OECD economies.

One recent work by Wilson et al. (2002) examined the industrial specialization hypothesis, i.e., whether environmental regulations affect exports of pollution-intensive or dirty goods in 24 economies-both OECD and non-OECD- between 1994 and 1998. The study mainly adopted Tobey (1990) cross-sectional and multifactor HOV model. It used trade data on five pollution-intensive industries: metal mining, primary non-ferrous metals, pulp and paper, primary iron and steel, chemicals. Their study like XU (2000), also employed the cross-country index of stringency in environmental regulation developed by Dasgupta et al. (2005) for their analysis. They focused on two environmental regulation variables, viz. the scope of environmental legislation and the control mechanism for environmental enforcement, to analyse their impact on net exports of pollution-intensive industries. They pointed out three critical issues raised in earlier empirical work about measuring the environmental standards on exports. First, the variation of exports because of environmental standards was much subtle than the variation due to traditional factors of production and other determinants of trade pattern, FDI, and location choice. Second, an omitted variable such as input quality and technological level make it formidable to ascertain a reliable parameter estimate. Thirdly, the difference in the community or country’s control mechanism for environmental enforcement may affect the effectiveness of environmental regulation. The first problem was addressed using an instrumental variable for the standard variables. Omitting variables problem was solved by incorporating variables in the model that measures the quality of factor endowments (secondary school enrolment rate), and the third one was addressed by adding in the structure in which control mechanisms for environmental enforcement interact with an environmental standard. Using H-O-V style an econometric model the net export of five pollution-intensive industries were regressed on measures on factor endowments including capital stock, labour, coal, oil, arable land, and secondary school enrolment rate- the measure of labour skills and technology control-, two environmental regulation variables separately and in product form. The product term would allow capturing the differences between the legislation and mechanism between countries. The slope dummy for OECD membership was also incorporated as an explanatory variable to control the unobserved differences between developed and developing economies. The study also used the instrumental variable approach for diagnostic tests. The regression results for factor endowments variables depicted impact- positive/negative and statistically significant/insignificant- depending on the type of the industry. The labour skills showed a positive and significant relationship with net exports for all five environmental intensive industries, except for pulp and paper industries, where it was insignificant (Wilson et al., 2002).

The Wilson et al. (2002) study results regarding the legislation variable supported the industrial specialization hypothesis: more stringent environmental regulations are less export of pollution-intensive sectors would be. However, the impact of the control mechanism on net export for mining, nonferrous metals, and chemical industries was found to be positive and statistically significant, whereas, for pulp and paper and iron and steel industries, the impact of environmental control mechanism was positive but insignificant. Based on their estimated slope parameters, the study reckoned that if no-OECD countries were to harmonize environmental standards at the most stringent level, then the pollutive intensive exports of non- OECD countries would reduce much more than those of OECD countries. This outcome suggests that trade agreement on a common environmental standard would cost non-OECD countries, especially less developed countries, much more than OECD countries. The overall conclusion of the study was that environmental regulations could affect pollutive industrial export competitiveness.

Cole and Elliott (2003) examined the impact of environmental regulations on international trade using two models. The first was the extension of Tobey (1990) HOV analysis by increasing countries sample size from 23 to 60. They used data set for the year 1995 instead of mid-1970 to examine if increased stringency of environmental regulations would have changed the relationship between such regulations and net exports during the intervening period. The study includes two alternative measures of environmental regulations: first, the one based on Dasgupta et al. (1995) and extended by Eliste and Fredriksson (2001). The second measure of environmental regulations used as proxy for stringency of environmental regulation is based on each country's change in energy intensity (energy use / GDP) over the period 1980-95, together with the level of energy intensity 1980. Also, where applicable, the study includes the industry dummies to control for un-observed industry characteristics/endogeneity that may affect the relationship between regulations and industrial net-exports hence employed instrumental variable approach, 2SLS method.

One vital contribution of research conducted by Cole and Elliott (2003) is the use of a new trade model characterized by monopolistic competition and differentiated products following the development in trade theory due to the co-existence of inter-and intra-industry trade (Dixit and Norman, 1980; Krugman, 1980; Helpman and Krugman, 1985). These models are based on differentiated products and an element of imperfect competition with increasing returns to scale. Their research focused on estimating the Grubel and Lloyd (GL) index designed to measure the share of trade which is intra-industry trade (IIT) in nature, as offered by Grubel and Lloyd (1975). The researchers further use the differential endowments variables, differential of environmental variables between countries, and differential of per capita income variables as an explanatory variable in addition to other controlled variables as possible determinants of intra-industry trade. Here the nature of research inquiry is slightly different as through such sort of model, the authors tested whether environmental regulations like other factor endowments influence the composition of trade, i.e., the extent to which the countries trade differ within the same or differentiated industries. Their research hypothesis would not provide information on the direction of the trade. The data for both models covers 60 developed and developing countries for the year 1995. In the HOV modelling framework, dependent variables in each country's net exports in one of four dirty sectors- iron and steel, chemicals, pulp and paper, and non-ferrous metal- are regressed on 14-factor endowments with 2 environmental policy variables. The study tended to confirm the Tobey (1990) results that environmental regulations do not significantly affect the pattern of dirty exports. The outcomes of the analysis remained the same regardless of treating environmental regulation as an exogenous and or endogenous variable, nor did it change when energy intensity varaibel was replaced with environmental stringency index (Cole and Elliott, 2003).

For the intra-industry trade model, the study further analyzed full sample countries as well as split data to North-South trade to examine whether environmental regulations impact on trade is stronger between North-South trade than countries with the full sample. The results for full sample data show that environmental differential variable is negatively and statistically significantly associated with all five pollutive sectors of IIT. It suggested that the greater the environmental difference between the two countries, the smaller will their share of intra-industry trade in total trade and more will be their share in inter-industry trade in total trade. Furthermore, the environmental regulations variable did not leave a significant impact on the IIT of pollutive sectors in North-South trade analysis. On the possibility of finding evidence of pollution haven hypothesis, the authors concluded that while their research modelling did not focus on the direction of net trade, but a finding of an increased share of net trade in total due to differential environmental regulations was consistent with pollution haven hypothesis (Cole and Elliott, 2003).

A notable limitation of using the H-O-V model lies in its inability to explain the trade between two countries within the same industry, i.e., it fails to explain the intra-industry trade. The model advanced by Cole and Elliott (2003) averted this weakness as it allowed separating the potential determinants of intra-industry trade (country size and preference) from the potential determinants of inter-industry trade. Nevertheless, the drawback in the later model is that it does not identify the direction of any change in inter-industry trade. The model does not estimate the net export but the share of total trade that is intra and inter-industry. The regression results show that the differences in environmental regulations between two countries do affect the shares of trade that are intra and inter-industry and further offer a less affective and rather week methodological framework to examine pollution haven hypothesis.

One of the reasons of finding ambiguous and insignificant effects of environmental regulations on trade pattern and lack of evidence of pollution haven hypothesis could be due to deficiencies in earlier research regarding the choice of inappropriate methodological measurements, geographical coverage of data and more specifically due to issues of endogeneity, especially treating environmental policy as exogenous when its endogenous (Ederington, Levinson and Minier, 2005 and Levinson and Taylor, 2004).

Levinson and Taylor (2004) highlighted the measurement issues pertaining to pollutive industries' environmental regulations and trade flows. Their study used the data on 133 industries at 3-digits dis-aggregation level during 1977-86 and geographically covering US net imports from Mexico and Canada. They re-iterated the argument that neither small environmental costs nor the porter hypothesis was the main issues in trade environmental policy nexus but the inability of cross-sectional to capture endogeneity issues. Therefore, panel data estimation techniques and instrumental variable/2SLS could be more appropriate methods to examine the impact of environmental policy on pollutive trade competitiveness. Their study findings based on both fixed-effect / instrumental variable approaches showed a positive and statistically significant relationship between industry pollutive abatement costs in net US imports cases from Mexico and Canada. The results showed that a 1 percent increase in pollution abatement costs was linked with 0.2 percent increase in net imports (or decrease in net exports) from Mexico and 0.4 percent increase in net imports from Canada. They then computed the 2SLS model after indicating several reasons why fixed effect might understate the pollution haven effect, but 2SLS results were consistent with fixed effect outcomes except that the estimated coefficients of the 2SLS model were larger than the fixed effect model.

Ederington, Levinson and Minier (2005) examined why it was difficult for earlier studies to find a more discernible impact of environmental stringency on trade patterns and put forward three main explanations, and empirically examined all of them. They, like some of earlier work, again used panel data with fixed-effect analysis covering the period 1978-92 at highest dis-aggregated SIC data for US net imports with both OECD and non-OECD countries wherein mainly net US industrial imports are regressed on environmental control costs at 4-digit SIC level, average *ad valorem* tariff levels and factor abundance variable of human and physical capital. Firstly, they argued that most trade takes place between developed countries and those countries also share a similar high level of environmental stringency policies, and the US imports its products from those countries. Therefore, any conclusion drawn based on US net imports with developed countries would violate the pollution haven hypothesis and raise heterogeneity concerns in results estimation. After the initial findings of the insignificant impact of environmental regulations for pollutive industrial trade between US and OECD countries, the study re-constructed the US trade data at the industrial level with OECD and Non-OECD. It further bifurcated the data between higher environmental standards and lower environmental standards countries- the study used higher and low income of the countries as a proxy for the difference in environmental standards. They further employed the environmental stringency index developed by Eliste and Fredriksson (2002). While Eliste, and Fredriksson (2002) used the environmental stringency index for both manufacturing and agriculture sectors Ederington, Levinson and Minier (2005) utilized it for pollutive manufacturing industries as correlation coefficients of agriculture and manufacturing stringency was .96. The results with the new data set showed that while environmental stringency variable remained insignificantly associated to net imports of US with OECD countries, but for Non-OECD countries, US net imports were statistically significant and positive due to stringency of environmental policies. The results indicate that US pollutive sectors net imports have risen from developing countries during the sample period. That implied elasticities for trade with non-OECD countries was higher than the elasticity of trade observed for full sample countries. The results also show that factor abundance variables are a source of comparative advantage to US trade and those of industrial tariffs leave a negative and statistically significant impact on pollutive industrial trade (Ederington, Levinson and Minier, 2005).

The second argument by the same authors was that some industries are less geographically mobile than other industries due to transportation costs, plant fixed costs or agglomeration economies hence less sensitive to environmental regulatory differences between countries and less likely to relocate to other countries. The results for interaction variables of environmental regulation with these immobile geographical factors showed negative and statistically significant estimations hence most pollutive industries appeared to be immobile or not footloose industries. Thirdly, the study investigated whether environmental regulations leave a measurable impact on industrial competitiveness. This was in response to the generally held belief that the cost of compliance of most pollutive industries as a percentage of total industrial costs was significantly small and hence less evidence for those costs to change pollutive industries trade pattern. To test this hypothesis, firstly, the study calculated the average of environmental costs for each pollutive industries at highest dis-aggregated level and created an interaction variable of this average cost with the current level cost of pollutive industry in each year again. Accordingly, the industry that pollutes more is likely to be more sensitive to environmental costs increase. The estimated coefficient of this interaction variable turned out to be negative and statistically significant, implying that change in environmental cost was in fact small in most pollutive industries and again less footloose. Overall, the study results suggested that the impact of environmental regulation on trade patterns is significant once issues of industrial characteristics/cost-effectiveness, heterogeneity, geographical mobility factors are dealt with (Ederington, Levinson and Minier, 2005).

Busse (2004) study was worth reviewing. He examines the relationship between environmental regulation and trade competitiveness by using a new comprehensive environmental regulatory data applied to 119 countries and the five most pollutive sectors for 2001 using cross-section data analysis. Following the H-O-V factor abundance approach like Tobey (1990) and others, the study tested the model using new environmental stringency data impact on industrial trade competitiveness.

The specification of the model is as follows:

$$NETEXPORTS = \alpha_0 + \alpha_1 CAP\_AREA + \alpha_2 LAB\_AREA + \alpha_3 CROP + \alpha_4 FOREST + \alpha_5 COAL + \alpha_6 COPPER + \alpha_7 IRON + \alpha_8 LEAD + \alpha_9 OIL + \alpha_{10} ZINC + \alpha_{11} ENV + \alpha_{12} REGIONAL\ DUMMIES + ei \quad (1)$$

where NETEXPORTS stands for net exports of each of the five industries, e is an error term, α_i are parameters and ENV represents the two environmental variables.

In the above equation, CAP-AREA is representing the sum of total investment over the period 1992 to 2001 divided by land area, as a proxy for the relative capital endowment, LAB_AREA is total labour force divided by land area as a reflection of relative labour endowments. The capital endowment variable is generally expected to have a positive association with most pollutive net exports variable whereas, the labour endowments to have a negative association with net exports. The other controlled variable such as CROP and FOREST represents total cropland and forest land area and are expected to have a negative impact on NETEXPORTS. Other explanatory variables included in the model are natural minerals such as COAL, COPER, IRON, LEAD, ZINC and regional dummies.

The study argued that there was a lack of availability of reliable environmental regulations data and many institutions who tried to compile the survey-based data for environmental regulations were not without shortcomings when it comes to standardization of data for cross-country comparison. And full, accurate measures of the abatement costs of environmental regulations are still difficult to obtain. Moreover, it is well known that many costs associated with environmental pollution controls also come with some cost-savings termed as cost-offsets. It is quite formidable to segregate the element of investment or operational cost with purely environmental consequences ((Hilton and Levinson 2001 in Busse, 2004). Keeping that in mind, they have used environmental stringency variable data created by the Centre for International Earth Science Information Network (CIESIN) for the year 2001. One of the key indicators CIESIN has developed is called Environmental Sustainability Index (ESI) that measures the overall progress towards environmental sustainability for 146 countries. Nonetheless, the key variables that are more pertinent to the current research, according to the author, are two folds; (1) ENV_REG: environmental governance that focuses on enforcement of environmental laws and treaties and (2) ENV_CONV: participation of countries in the ratification of international environmental conventions and treaties, hence covering international regulatory aspect. According to the author, the study has used these two key environmental regulatory variables, which have never been used in the past and are the most comprehensive environmental stringency index for cross country analysis regarding trade and environmental regulations association[19](Busse, 2004).

The regressions are conducted for most pollutive traded sectors viz, industrial chemical, paper and pulp, non-metallic minerals, iron and steel, and non-ferrous metals. The results show that industrial capital is positively and significantly associated with export flows for all industrial trade except paper and pulp, where the association is negative but insignificant. The paper and pulp industry requires relatively less capital as compared to all other industries. The variable of labor endowments is also in line with the expected sign. It is negatively associated with all pollutive industries' net exports, except the paper and pulp industry, where the policy's impact on net exports is positive but insignificant. The other variables such as CROP, FOREST, and some natural mineral variables show a mixed impact on the explanatory variable of different categories of pollutive trade flows. The effects of environmental stringency variables on all pollutive industrial net exports were found statistically insignificant except for iron and steel where the impact of the policy variables on net exports are negative and significant. These results led the author to believe that environmental regulations are not major determinants of pollutive industries net exports except for iron and steel industry (Busse, M., 2004).

Secondly, the study computed export/import ratios of the five most pollutive industries to examine the time series trend during 1978-2000. It focused on advanced economies where environmental regulations were more stringent. The results indicated the declining trade ratio of four out of five most pollutive industries in world total and thus loss of competitiveness. The iron and steel industry was more noticeable, which showed a relatively sharp decline in trade ratio and loss of competitiveness in the 1980s compared to the 1970s. The study also found less evidence for developing countries to become pollution haven for dirty industrial trade (Busse,2004).

[19] The detail discussion regarding the formation of the ESI index developed by CIESIN can be found in chapter eight.

The study by Babool and Reed (2010) challenged the work of Busse (2004) on methodological grounds. It argued that the insignificant impact of environmental policy on pollutive industries competitiveness could result from employing a cross-sectional estimation technique when an accurate estimation technique uses panel technique and examines if environmental policy is endogenous. Their study used the same new comprehensive environmental stringency data of CIESIN in panel data analysis in the H-O-V framework for six countries (Finland, France, Italy, Netherlands, Norway, and United States) during 1987-2003. The research hypothesis was whether environmental stringency adversely affects the international competitiveness of pollutive manufacturing exports. Data on exports, labour, capital, research, and development variables were collected from OECD STAN Database. For panel data analysis, the study followed the fixed-effect model with a constant slope and varied intercept at cross-sectional level, countries being cross-section. At the analysis stage, the study examined the relevant diagnostic tests and corrected the model for autocorrelation and heteroscedasticity and run the regression by transforming the data using the weighted least square method. The expected signs for explanatory variables such as labour, capital, technology/research, and development were positive, with net exports of 14 selected manufacturing industries. Environmental regulation variables were expected to affect negatively net exports.

The empirical analysis shows that all factor abundance variables like capital labour and technology variables positively impact trade of most industries like textile, food industries; paper and pulp; chemical and chemical products, etc., except few exceptions where capital and technology-research and development expenditure were negative. One plausible reason, according to the authors, could be the still presence of multicollinearity and heteroscedasticity in data. The environmental regulatory variable turned out to be negatively and statistically significantly associated with net exports of most of the industries, including textile, textiles products, leather and footwear industry, machinery, and equipment; industry and manufacturing (n.e.c), except for iron and steel industry where its association was negative but not significant. The results supported the hypothesis that environmental standards lead to a loss of pollutive industrial competitiveness. (Babool and Reed, 2010).

Given some of the limitations of the H-O-V model to explain bilateral trade flows and the importance of geographical aspect, especially the roll of distance in pollutive industries locational choices, etc., recent studies have focused on gravity modelling/panel data analysis to address environmental regulations impact on trade flows. In this context, the study by Jug and Mirza (2005) examined the impact of environmental regulations on trade flows and suggested that apart from identifying the clean and dirty industry, a further distinction between homogenous and differentiated goods can give better insight into environmental stringency and trade competitiveness associations. Consumers are more sensitive to the price of homogenous products, and industries/countries known to produce more miniature differentiated goods face more pollution abatement costs. Their study focused on Eastern European and EU countries by covering the period 1996-1999 for 9-industrial trade sectors for panel F.E analysis and further used instrumental variable approach GMM to address the endogeneity issue of the environmental regulation variable.

For environmental stringency variable, the study by Jug and Mirza (2005) made use of current environmental expenditure data available through Eurostats database, and for GMM, two additional instruments such as total lagged investment as well as total public expenditures have been incorporated into standard gravity model. They constructed interaction variables of environmental expenditure with homogenous products, dirty industry, and EU and other variables to capture specific effects of these interaction variables on relative industrial imports at a disaggregated level. The estimated coefficient computed using OLS, F.E, and GMM modelling framework all depicted the same results that stringency of environmental regulations leaves a negative and statistically significant impact on trade flows, although the elasticities produced using GMM are higher than those ascertained from OLS and F.E. models. Also, the effects of abatement costs on trade flows are higher for homogenous goods than differentiated goods. By choosing pollutive industrial trade flows between EU and non-EU countries, the study reported that pollution haven effects were unfounded as trade elasticities with respect to environmental regulations for dirty sectors were positive and statistically significant.

One specific missing aspect in most regression-based analyses reviewed earlier, except Ratnayake (1998), is that direct analysis on changing comparative advantage of pollutive industrial exports over time has hardly been the focus of attention. One of earlier works that drew attention towards that aspect was the one conducted by Low and Yeats (1992). Their research traces the evidence for pollution haven hypotheses and loss of competitiveness due to the introduction of stringent environmental policies by OECD economies. The study examined the pollution redistribution phenomenon following two-pronged strategies. Firstly, the study considered the actual trend in pollutive industries exports in developed and developing countries covering 1965-88. Secondly, the study analysed what Export Reveal Comparative Advantage (XRCA) model explains about the location displacement or pollution haven hypothesis for the same period. The study uses the modified version of the Balassa (1965, 1979) XRCA model and applies it to 109 selected countries- both to developed and developing. In its simple form, XRCA in an industry is measured by the share of that industry in the country's total exports relative to its share in total world exports of manufacturers. If this ratio (index) is turned out to be less than one, then the country is said to be at a comparative disadvantage in goods trade. Nevertheless, suppose the revealed comparative advantage (XRCA) index is greater than one, which is observed when industry's share in a particular country's total exports surpasses its share in world trade. In that case, Balassa index suggests that the country has XRCA in the sector. Instead of analysing the pattern of a specific country's XRCA in different industries, the research investigated the pattern of different countries XRCA within a specific industry in the light of the model developed by Yeats (1985). For selecting the dirty industry's product, the paper has mainly focused on five groups viz, iron and steel; nonferrous metal; refined petroleum; metal manufactures; and paper manufacturers, which are treated as the most pollutive industries in manufacturing production sectors (Low, and Yeats, 1992).

The results showed that environmentally dirty goods accounted for about 16 percent of world trade in 1988. The relative importance of environmental dirty goods has reduced by about 3 percent (from 18.9) during the period 1965-88. Moreover, the shares of environmentally dirty products originating in the region of industrial countries in general and North America gradually reduced and that of southeast- Asian countries increased. Also, the study depicts that the share of environmentally dirty goods in all exports from the regions of industrial countries has decreased. North America and 10 (EEC) countries account for 16.1 and 14.2, respectively, exporting environmentally dirty goods. However, Eastern Europe, followed by Latin America and the Caribbean, have turned out to be vital regions with the highest concentration of dirty goods as 'dirty' products accounted for generally over one-fifth of total export during 1965-88 (28 percent in case Eastern Europe). The shares of dirty goods in total exports for South-East Asian and West Asian economies are 10.8 and 13.4, respectively (Low and Yeats, 1992).

The empirical level analysis of Low and Yeats (1992) depicts a disproportionately large rise in the average number of developing countries with XRCA greater than unity in dirty industries, and, expansion was observed in almost all polluting sectors. While developed countries showed a rise of 14 percent with a comparative advantage of dirty industries, the developing countries' increase in dirty industries was almost three times greater during the sample period. These outcomes suggested that the polluting industry activities were being dispersed internationally, and the dispersion was highest in the direction of developing countries. The empirical results also indicated the strong tendency of developing countries to establish an XRCA in polluting industries vis-à-vis non-polluting industrial sectors. These results led the authors to conclude that developing economies are strong candidates for pollution havens effects. Nevertheless, for in-depth analysis for both developed and developing countries, only iron and steel industry was center of their research that might produce an incomplete picture of the changing pattern of export performance of environmentally sensitive commodities, as indicated by XU (1999).

Sorsa (1994) also examined the trade flow data of environmentally pollutive industries and environmental expenditures in seven OECD high-standard countries: Austria, Finland, and Germany, Japan, Norway, Sweden, and US. He drew a comparative analysis of world trade shares in the environmentally sensitive goods in 1970 with those of 1990 for industrialized and developing countries. He further calculated XRCA following Yeats (1985). His study results on the changing share of environmentally sensitive goods in industrialized countries vis-à-vis developing countries were similar to what Low and Yeats (1992) provided earlier. Nevertheless, his statistical results showed that the world market share of environmentally sensitive goods did not change dramatically over the decades as industrial countries' imports share of most pollutive industries, which stood at 78.2 percent of the world total in 1970, accounted for 72.9 percent in 1990. The corresponding figures for exports during the same period were 81.3 and 81.1, respectively. These results were further confirmed through the regression analysis based on time series data for trade and environmental expenditures for these seven developed countries. The estimated results could not depict a significant negative impact of environmental regulations on trade performance for selected OECD economies. XRCA analysis also confirmed his study findings that industrialized countries had maintained their competitiveness in environmentally sensitive industries.

The research by XU (1999) contended that earlier studies have seldom effectively explored the changing patterns of most pollutive industries trade at the highest dis-aggregated level. He has criticized those who did endeavour to examine the changing trade patterns of pollutive industries for being either following too narrowed approach in terms of choice of just one specific industry i.e., iron and steel industry such as Low and Yeats (1992) or looking at the issue at highly aggregated trade data level such as Sorsa (1994). By covering the period from 1965 to 1995 and using the UN-COMTRADE database for 34 both OECD and non-OECD countries, he analyzed the impact of stringent environmental regulations on trade competitiveness. He employed the Balassa index and trade data normalization technique offered by Gagnon and Rose (1995). Firstly, he examined what percentage of the export flows of environmental sensitive goods (ESGs)[20] change in 1995 compared with those in 1965 for each sample country. The expectation was that the environmentally sensitive commodities with a higher export performance at the beginning of the sample period would become less competitive in the end period. Then he used XRCA indexes (Balassa, 1965) to measure the comparative advantages of each commodity and country in two periods, 1965 and 1995, by separating the specialized and non-specialized pollutive industries. Specialized industry is where XRCA for the commodity is greater than one and vice versa is true for non-specialized commodities. He used a weighted version i.e., using normalized trade share of each commodity in 1990 as weight, and express this percentage.

The study has measured the time-series pattern of export performance of ESGs to provide a scenario of export performance of ESGs in the intervening period. To accomplish this task, it measured the percentage share of those ESGs that indicated a specialization (i.e., XRCA is greater than one) in total ESGs trade for each year and country. As the Balassa index is a dichotomous measure, the normalized trade share of those commodities is summed to provide a percentage share of the normalized trade of all ESGs[21]. He characterized this index as a competitiveness indicator. The study further conducted histogram analysis and correlation test of association to examine the export performance association between beginning and end period year. The overall conclusion based on all these methodological approaches was that export performance of environmentally sensitive goods in most part of the world did not change, i.e., the comparative advantage of ESG

[20] XU (1999) followed the standard literature in terms of identifying five most pollutive sectors which earlier studies such as Tobey (1990) Low and Yeats (1992) and others did and termed them as environmental sensitive goods (ESGs).

[21] $$C_{it} = \left\{ \sum^{k} NV_{it} \middle| XRCA_{it}^{\ k} \geq 1 \right\}$$

Where C_{it} is the competitive indicator for country *i* at time *t*, *k* shows commodity (ESGs), NV_{it} shows the normalized trade share of the commodity *k* in country *i*'s total trade at time *t*. $XXRCA^{k}_{it}$ is the export revealed comparative advantage of commodity *k* in country *i* at time *t*.

did not change between 1965 to 1995 due to the introduction of stringent environmental regulations, especially in the 1970s and 1980s in the advanced part of the world (XU, 1999).

While research by XU (1999) offered an innovative and powerful methodology to address research question regarding the impact of environmental regulations on trade competitiveness, one particular shortcoming in his study was the area of coverage, i.e., South Asian countries like India and Pakistan, which engaged in pollutive commodities exports were not included in the analysis among the list of non-OECD developing countries. Secondly, his study concluded that developing countries are not pollution haven for developed countries based on findings of developed countries could be seen as a violation of the pollution haven hypothesis test. Grether and de Melo (2004) argued that pollution haven is more of a bilateral trade phenomenon between developed and developing countries after introducing some control on geography.

Whether South is becoming a haven for the world's pollutive manufacturing production and trade for North consumers is discussed by Grether and de Melo (2004). The study aimed at re-examining the evidence of North-South delocalization of heavily polluting industries, i.e., tracing evidence of pollution haven hypothesis by placing some control on geography during the period 1981-1998. They argued that changing production patterns and trade could be due to omitted variables and unobserved heterogeneity that could not be easily controlled for in large samples where aggregated data say little about the industry. Based on the World Bank database on trade (mirror exports) and production at 3-digits ISIC for 52 countries, the study examined if due to the environmental regulatory gap between North and South the production and trade loci of most pollutive industries moved towards South. The authors described this phenomenon as the delocalization effect. The study based on earlier work by Hettige et al. (1992) and Mani and Wheeler (1999) have identified the five most pollutive sectors based on US industrial pollution intensity at 3-digit ISIC viz. paper and products; industrial chemicals; other non-metallic mineral products; iron and steel and non-ferrous metals. The cleaner industries for the US following Mani and Wheeler (1999) at 3-digit ISIC are textiles, non-electric machinery; electric machinery; transport equipment, and instruments.

At the modeling level, the study used a new decomposition by extending the Balassa based revealed comparative model that apart from paving the way for analyzing the composition and technique affect encompassed the geographical control aspect. The study further employed the gravity model and panel data methods. One of the key hypotheses in their research was whether or not the transport costs acted as a brake in North-South relocation of pollutive industries. The study used differential income gaps between rich North and developing South as a proxy for environmental regulations (Grether and de Melo,2004).

At the global level, the study found that export revealed comparative in polluting products fell in advanced countries and increased for South, which one would expect if the environment were considered a normal good in consumption. Further, after controlling for geography, the study found evidence of location shift from North to South countries in terms of changing export patterns. The trend remained consistent for all pollutive industries except the non-ferrous metal industry that showed a reverse of delocalization. The later result for a non-ferrous metal industry that shows South-North industrialization seemed expected following comparative advantage driven response of trade liberalization in a sector where trade barriers turned out to be relatively small. Furthermore, a gravity model was estimated for trade data and its determinants, emphasizing whether polluting industries are likely to be obstructed in terms of relocation to the South due to relatively high transportation costs. In addition to trade data, the model specification for panel estimates included gross national income variable of bilateral countries, index of infrastructure, geographical distances, differences of per capita income between countries to capture the regulatory gap, dummy variables for borders, and country-specific effects and real exchange rates. The panel data results by Grether and de Melo (2004) for most pollutive industries, except non-ferrous metal, showed higher barrier to trade in the form of larger elasticities of bilateral trade with respect to transportation costs, confirming the conjecture that most polluter industries, on average, incur high barrier to trade cost thus rejecting the delocalization hypothesis. The study further found very little evidence of delocalization, i.e., pollution heaven hypothesis, due to the regulatory gap between North and South countries. The study concluded that only moderate support could be provided to the pollution haven hypothesis in North-South pollution industrial production and trade debate (Grether and de Melo, 2004).

Recently, Sawhney and Rastogi (2015) examined if India has become a pollution haven for pollutive industrial trade with particular reference to US-India manufacturing trade. The study first computed statistical indexes such as Michaely index[22] and RCAs for most pollutive manufacturing

[22] Michaely index is internal specialization index due to Michaely (1962) and is defined as under:

industrial trade with the USA, high-income countries, low-income countries, and the world for 1991-2009. The revealed symmetric comparative advantage results for dirty industries showed that India gained a comparative advantage in dirty industries, including industrial organic chemical, iron and steel foundries, and miscellaneous industries. The Michaely index measures revealed that India's pollutive industrial trade with low-income countries has increased and that specialization in some specific pollutive industries trade with high-income countries and USA increased. However, India's overall trade with rich countries remained under-specialized as Michaely Index remained below zero for whole period 1991-2009.

The study by Sawhney and Rastogi (2015) using US-India trade data further examined the pollution haven effect for India. They employed the reduced form Levinson and Taylor (2004) regression model wherein net imports are regressed on explanatory variables including environmental policy and country and time-specific dummies. In the absence of data availability for India pollutive industrial abatement costs, the study used proxy of US pollution abatement operating costs obtained from Pollution Abatement Cost and Expenditure (PACE) survey, conducted by the US Environmental Protection Agency for two periods- 1991-94 and 1999-2005. The regression results found no evidence of pollution haven effects in US-India trade for overall manufacturing trade. The study did find some evidence of pollution haven for most pollutive industrial trade with the US during 1999-2005.

The study by Sawhney and Rastogi (2015) is a valuable addition in the literature regarding pollution haven effects for one of the South Asian countries. The authors themselves shared that there were no earlier efforts made for India to examine the time-series patterns of the pollutive industrial trade. However, the study is not without limitations. The study provided a comparative picture between the RCA model and Michaely Index. One of the problems in the latter index is that it underestimates the country's comparative advantage when intra-industry trade occurs as firms in other sectors purchase equipment both domestically and via imports (Laursen, 1998). That could be one possible reason for finding two different outcomes in the statistical modeling approach. Secondly, this study faces the same criticism as the H-O-V model faced that differential effects of

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$$MICHAELY_{it} = \frac{X_{it}}{\sum_i X_{it}} - \frac{M_{it}}{\sum_i M_{it}}$$

Where X_{it} and M_{it} are, country's exports and imports of commodity i in year t respectively. Michaely Index ranges between plus one and minus one. The positive (negative) value implies a country is specialized (under-specialized) in that commodity or industry (in Laursen, 1998: 6).

environmental policy on various trade flows might cancel out due to aggregation of bilateral trade flows to multilateral trade flows. Thirdly, the study used the US- industries survey-based data PACE as proxy of environmental stringency for Indian industries, which according to Dechezleprêtre and Sato (2017), is far from an ideal proxy due to these reasons. Firstly, the production level is used as a denominator which is not exogenous. Second, as it is survey data, PACE cannot be comparable across countries as survey methodologies differ across countries regarding what should and what should not be a part of abatement expenditure. Thirdly, PACE data do not account for how compliance costs may impact market competition. Fourthly, PACE data are available for the surviving firms and note on the firms that exist due to environmental regulations; hence the impact of later firms would not be counted in the measurement. Also, it will be less accurate to presume that the US and India share the same technological efficiencies in pollutive industries and incur the same abatement costs. The authors did not cover a comparative analysis between most pollutive and relative less pollutive industries in their research, which is vital in South Asian countries' perspectives. Lastly, while moving from statistical analysis to econometric analysis, the study narrowed the country focus by choosing just India-US trade flows only and ignored the cross comparison of India's pollutive industrial bilateral trade with other environmentally stringent countries. Bilateral trade analysis between India and European countries was vital for the pollution haven effect considering India trade concentration in most European countries.

Wang and Winters, (2016) research endeavors address the environmental regulation impact on international trade flows for China manufacturing sectors to examine the sectoral sensitivity to environmental regulation and international trade competitiveness. It employed both feasible generalized least squares (FGLS) and seemingly unrelated regression (SUR) / panel data of international trade in China from 1985 to 2010 across nine traded sectors. The dependent variables for regression analysis include import, exports, and net exports at the sectoral level using Standard International Trade Classification (SITC). The independent variables are real GDP growth rate-proxy for level of development, Environmental Regulation level (ERL) measured by the rates of pollution abatement, and bilateral exchange rates. Furthermore, abatement rates of discharged waste and pollutants are used as instrumental variables to assess ERL. China being heavily relying on command-and-control environmental policy pollution limits are set by the Chinese central government, the abatement rate of wastewater, purified rate of atmospheric pollution, and the recycling rate of solid waste were taken into consideration at the analysis level to assess ERL.

For data robustness and primarily to facilitate comparability between the results and their corresponding trading values, regression analysis covered both Praise Winsten and Cochrane Orcutt formulations to primary and manufacturing trade data. The impact of environmental policies on trade flows on primary good exports and imports is positive and statistically weakly significant but negative for the net exports variable. According to the authors, for primary goods trade, the importers are more influenced by environmental regulation compliance than exports. On the manufacturing side, Chinese export sectors that implemented environmental regulation following both national and international pressures tend to adopt a cleaner production process. After the promulgation of environmental regulations in China, there is visible migration from primary product trade to manufacturing commodities trade over the period under study. The regression analysis at the sectoral level revealed that apart from the chemical industry that suffered the negative effect of environmental regulation on exports, the results for both exports and imports for sectoral level manufacturing industries showed positive effects of environmental regulation on trade flows and that environmental regulations have paved the way for the development of China trade. Other determinants of trade, such as exchange rate, depict a negative and significant effect on most trade categories. The change in GDP real growth is positively and significantly associated with pollutive industrial sectors of China, except primary goods of net exports (Wang and Winters, 2016).

The study by Wang and Winters (2016) has provided a good insight into the relationship between environmental regulation and trade for China's economy both at aggregate and sectoral level. However, as authors of the studies themselves pointed out that the study is not without limitation. Firstly, they do not consider the impact of trade patterns in the international trade context. Secondly, this paper ignores a possible correlation between explanatory variables like ERL and GDP that environmental regulations might be stricter as their people become wealthier. Some technical analyses such as instrumental variables application should be considered in a future study to distinguish the effect of environmental regulations from GDP.

Martínez-Zarzoso et al. (2017) examine the effects of environmental stringency on trade flows using European Content data covering 1999-2008. The study examines if recent accessions of the CEECs into the EU group and resultant changes in the regulatory framework of the new members have affected intra-EU trade flows at the industry level. They tested two main hypotheses: first, whether enacting the stringent environmental policy can result in observing the phenomena of pollution haven. Second, the study analyzed if the results differ when they further distinguish the analysis for a specific industry like footloose dirty exports industries and between old and new EU member countries.

Using panel data technique and augmented gravity model for Europe, the analysis is conducted for total trade flows, trade flows of dirty industries, and exports of specific footloose industries. This is done with the expectations that to find PHH possibilities, the impact of environmental stringency/regulations should be more powerful for dirty industries and particularly on footloose industries, later are non-resource-based industries and more prone to relocate. Two types of environmental regulation variables are used in the analysis. First, total environmental tax revenue as a percent of GDP and second proxy for environmental regulations is the current environmental protection expenditure on the public and private sector. All standard explanatory variables of gravity models are used for analysis Martínez-Zarzoso et al. (2017) by presenting different scenarios of regressions analysis among others find some evidence of PHH i.e., CEECs countries becoming a pollutive haven for EU countries. The results also show the positive and significant association of environmental expenditure/total expenditure with total exports and exports of dirty industries for non-CEECs or WESTERN EU countries. The study concludes that environmental regulations pave the way for innovative industrial efficiencies for European countries to gain the exports comparative advantage, thus supporting the porter hypothesis.

While many studies focused on developed and especially OECD countries for the impact of environmental regulation and trade, the Cantore and Cheng (2018) study has covered both developed and developing countries' trade flows in their analysis covering the period 2000-2014 for 38 developing and 33 developed countries. They, following OECD classification (Steenblik, 2005), chose 151 classification environmental goods. The study used an extended gravity model and estimated both fixed effect and random effect panel estimation techniques. For the gravity model, in addition to standard explanatory variables such as variables of GDP of both exports and importers, distance, and cultural variables, the model is extended using an environmental tax of the importing country and patent ratio-export/importers, later shows the impact of environmental innovation on exports. The rationale for choosing environmental tax on the import side is to test the porter hypothesis to explore whether environmental taxes trigger competitiveness in the countries. In this setup, a negative sign of the estimated coefficient would mean that environmental taxes in importing countries reduce imports and encourage domestic production of environmental goods. Innovation is representative of green patent applications. The underline motivation for introducing this variable was that exports tended to be positively correlated to exporters' capacity to innovate and negatively correlated to importer countries' innovation capacity. The study also used the volatility of the bilateral exchange rate as a controlled variable.

The study estimates the gravity model for total export, developed countries' export flows, and export flows for developing countries. The F.E panel analysis inter alia shows that environmental tax on import side coefficients for all bilateral exports categories is negative and statistically significant both for developed and developing countries. This means that importing countries tend to import less environmental goods due to environmental policy implementations, especially the developing countries wherein impacts are stronger. Therefore, due to domestic environmental taxes, the importing country, rather than increasing its imports, diverted resources to enhance domestic production of environmental goods. This finding is in line with a robust version of the porter hypothesis that advocates the win-win solution for environmental regulations and trade competitiveness. The coefficients of patent ratio were also positive and statistically significant for both developed and developing countries (Cantore and Cheng, 2018).

For robust analysis, Cantore and Cheng (2018) measured the Variance Inflation Factor (VIF) that broadly remained under 10 for explanatory variables. After that, to check the endogeneity issue i.e., the possible correlation between explanatory variable(s) with the error term, which could be due to autocorrelation and heteroscedasticity in data, they conducted random effect/ Hausman-Taylor estimates due to Hausman and Taylor (1981). The study argued that the random effect model could take care of simultaneity biases and in case of any suspect violation of orthogonality between some of the covariates and the unobservable error component. The study used the Newey-West model by assuming first, second, and third-order autocorrelation to detect autocorrelation and heteroscedasticity in the data (Wooldridge, 2008). The results for the variables of interests by applying a new methodology produced overall consistent results, i.e., the environmental tax introduced by importing countries is good for the competitiveness of those countries and confirming the porter hypothesis. In few cases like where results were insignificant in the F.E model became significant, like the exchange rate variable, which is negatively associated with trade flows.

4.5 Conclusion and Research Process

This chapter discussed some conceptual and measurement issues regarding associations of environmental regulations and trade competitiveness. The chapter indicated that at conceptual levels measuring the impacts of environmental policy on competitiveness are multidimensional and complex. It developed a consensus on empirical definitions that would pave the way for assessing the association between environmental regulations and pollutive industrial trade competitiveness. Next, after critically reviewing the literature, an attempt is made to sort out theoretical guided empirical models enabling the current research on available choices which would fit best to examine the research questions/hypothesis. This chapter, accordingly, reviewed the literature on both direct and indirect approaches adopted to measure the impact of environmental policies on trade competitiveness.

The studies using indirect methods such as input-output/CGE models determined the abatement costs for most pollutive traded sectors in developed countries. The results produced mixed conclusions. Some studies found negligible environmental control costs and did not affect pollutive industrial trade competitiveness. Nor environmental regulations affected pollutive industries' trade composition, delocalization, and international trade patterns. Nevertheless, other carefully assessed research highlighted the limitations of adopting the correct measurements of environmental costs and modeling choices and showed that environmental control costs could substantially affect pollutive industrial trade competitiveness and the country's balance of payments.

For the direct approach, the mainstream empirical literature broadly chose three empirical methodologies to examine the impact of the environmental regulations on trade flows and competitiveness. These included Comparative Advantage modeling and extension to that modeling to covering geography, gravity model, and H-O-V model. Then there are further departures in the estimation mechanism, which changed over time, subject to the availability of environmental regulations data, mainly from cross-sectional to panel data analysis.

Studies that followed the comparative advantage Balassa index and trade ratios have analyzed the impact of environmental regulations on trade via changing trade patterns of most pollutive industries between two periods assuming environmental stringency on pollutive trade sectors has risen over time. Some studies found that developed countries' trade shares and comparative export advantages in most pollutive industries were reducing overtimes. Whereas developing countries with lax environmental standards were gaining trade shares in world total and increasing their comparative export advantages in most pollutive manufacturing sectors. Based on these results, the researchers concluded pollutive industries displacement/delocalization hypotheses and that developing countries becoming pollution haven for most pollutive exports to developed countries. Nonetheless, other rigorous analyses by employing extensions in comparative advantage models like normalized competitiveness index found less evidence of change in pollutive industries trade specialization patterns over time in developed countries.

The research on the subject has been confined mainly to the developed part of the world, and less attention is given to LDCs. The empirical outcomes based on bilateral trade flows like gravity models and multilateral trade flows- H-O-V models- depict that the impact of environmental regulations on trade competitiveness is positive and negative depending on the choice of methodology and pollutive industries, and geographical coverage. On PHH, some studies indicated the possibilities for developing countries to become a haven for world dirty production and trade. In contrast, others failed to find any systematic evidence for the pollution haven hypothesis. Also, regarding PHH, research that drew conclusions based on developed countries' data analysis depicted a violation of the pollution haven hypothesis as PHH demands the investigation between developed and developing countries with differential stringencies in environmental regulations.

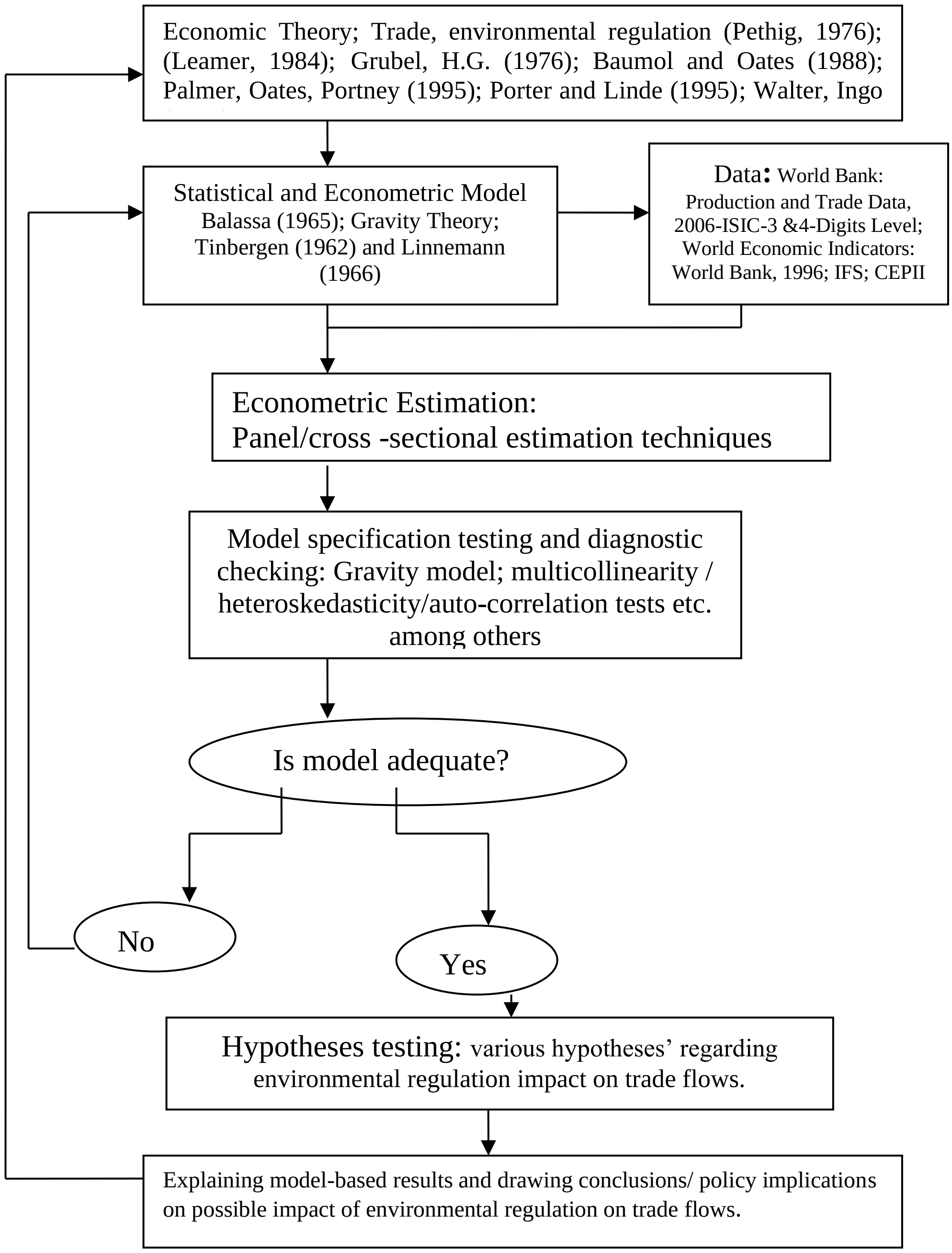
The results in most of the empirical work reviewed are sensitive to the type of model chosen/estimation technique employed, country (s) / period selected, and the nature of pollutive commodities/ types of environmental regulations. There are also clear measurement problems, especially in comparing the environmental laws in different countries, using a proxy of US-based environmental stringency for other countries, and assigning numbers that quantify environmental regulations. Also, issues pertaining to the definition of pollutive sectors and data quality required due attention. Some studies lack a theoretical basis regarding the choice of model others failed to report or perform diagnostic tests/sensitivity analysis and ignored endogeneity issues in data analysis, thus leaving the issue regarding the effect of environmental regulations on trade competitiveness at the global level unresolved. Therefore, for effective assessment of the possible impact of environmental policy on competitiveness requires analysis to address issues of industrial/country characteristics, environmental policy choice variables, heterogeneity, geographical coverage, etc. Broadly speaking, the debate on the subject continued. One could say that there are still reasons to believe that no consensus emerged from the literature survey about the possible impact of environmental regulations on trade competitiveness.

One notable problem in the existing empirical literature on environmental regulations and trade associations is the lack of attention given to drawing a comparative analysis between most pollutive and relatively less pollutive industries' export patterns over time. This area is worth examining if classifying different pollutive categories of environmentally sensitive industries produce somewhat similar or different conclusions. Secondly, there is a dearth of literature regarding the association of environmental regulations and trade that put the same data to the security of cross-methodological analysis, especially when the results are sensitive to the choice of the methodology chosen. Furthermore, the author of the present research did not find any comprehensive study for South Asian countries that analyzed the possible impact of environmental regulations on industrial trade competitiveness using the most pollutive to least pollutive industry trade at the highest dis-aggregated ISIC levels. The present study tends to fill these gaps in the literature.

Given the gaps highlighted in the literature, the study focuses on four broad key research questions. Firstly, whether South Asian countries due to internal and external environmental regulations lost trade competitiveness in most pollutive industrial trade, somewhat pollutive industrial trade, and relatively less pollutive industrial trade during 1984-2004. Secondly, the study examines whether, due to the difference in environmental regulations compliance between stringent OECD countries and lax South Asia, South Asian countries have become a haven for most pollutive manufacturing exports to the OECD. Thirdly, which is linked with the first two research questions, whether the impact of environmental regulations on relatively less pollutive industries trade competitiveness will be the same as the literature predicts for most pollutive industrial trade. Fourthly, while it is not this study's main objective but while doing extensive exercise to transform pollutive industrial tariffs variable for South Asia and OECD countries, the research examines whether tariff walls created by the countries against pollutive industries trade leave negative effects on different groups of pollutive industrial trade and exports competitiveness. Accordingly, the study will use World Production and Trade Data at 4-digit ISIC level covering the period 1984-2004 offered through the World Bank / UNIDO resources. This study, considering available data, has chosen three countries viz. India, Pakistan, and Bangladesh from South Asia region vis-à-vis 17 environmentally stringent OECD countries.

As guided by theoretical models and empirical literature reviewed and resultantly following the choice of this study, the present study focuses on two-pronged methodological approaches. Firstly, for statistical analysis, the study will employ the Comparative Advantage model offered by Balassa (1965, 1979, 1986) and advancement in Balassa model to developing competitiveness index by XU (1999) and bringing geographical aspect into Balassa based modeling offered by Grether and de Melo (2004). Secondly, this study will use an extended gravity model to examine the impact of environmental regulations on pollutive industrial groups bilateral trade flows for South Asian countries and between South Asian countries and most stringent high-income OECD countries. Accordingly, a systematic research process has been developed in figure 4.1.

Figure 4.1 Research Process



Source: developed from Maddala (1992:7)

Chapter 5

Sorting Data for Statistical Trade Analysis

5.1 Introduction

Chapter four has developed the process of present research that required sorting the data for both statistical and econometric analysis for different categories of pollutive trade over time. This chapter will be discussing trade data, its compilation, transformation process, and pollutive industries trends around the world. In this context, section 5.2 discusses the data sources their scope of coverage at industry, country, and time period and sheds light on the data transformation process. Section 5.3 provides the comparative analysis from most pollutive to least pollutive industrial export patterns over time for each pollutive group and individual industries and regions around the world during 1984-2004. Section 5.4 concludes the discussion.

5.2 Data Sources and Sorting Mechanism for Industrial Trade

The present study makes use of Trade and Production Database (1979-1999) available from World Bank (Nicita and Olarreaga, 2001) and Trade and Production Database (1976-2004), from World Bank (Nicita and Olarreaga, 2006). The Bank source for trade data is the United Nations Statistics department Comtrade database through World Bank's World Integrated Trade Solution (WITS) software. It covered data on exports, imports, and mirrored exports i.e., exports reported by partner country and expressed in current thousands of US dollars. By applying appropriate standard concordance that effectively approximates SITC codes within the ISIC classification the World Bank offered sectoral level industrial trade data for International Standard Industrial Classification (ISIC) Revision-2 at 3-digit level for 28 manufacturing sectors covering the 67 developed and developing countries and at 4-digit level for 81 industries for 24 countries.

Following the same concordance at the 4-digit level used for 24 countries by Bank / UNIDO, the present study authors have transformed the other 32 countries using pivot-tables analysis at Excel software, making 56 closed-sample countries ensuring that 4-digit sum for each industry collapses to 3-digit ISIC dataset. The closed-sample for 56 developed and developing countries of 67 totals have been chosen for 1984-98 at 4-digit ISIC data and 1984-2004 for 3-digit ISIC data. For the remaining countries, the data on trade flows was neither balanced nor available at the bilateral level (by partner) and at the industry level. The number of years, product groups, and or partner countries could differ across reporters. Also, in the new World Production and Trade data (2006), trade variables are available at the 3-digit ISIC level only. Therefore, trade data at 4-digit ISIC levels have not been extended after 1998. Accordingly, the present research analysis will provide insight on both 3-digit and 4-digit ISIC trade data keeping in view that traces of trade comparative advantage can be found at the highest dis-aggregated ISIC levels. The closed sample of 56 countries was also chosen because many countries reported missing values of the open sample for the first five years and last few years. Facing some of these problems even at 3-digit ISIC level for the same data set but using mirror export variable of most pollutive industries Grether and de Melo (2004) confined their analysis to 52 closed-sample countries of 67 total.

Nevertheless, the closed sample chosen for this study analysis does not lose its efficacy about the scope of coverage. Grether and de Melo (2004) indicated when using 1995-96 average trade share for the years with maximum non-missing values, the closed sample of 52 countries of the same data set represents about 95 percent of the open sample world trade. And the present study is covering 56 countries instead of 52. While the current study's main aim is to examine the South Asia region’s pollutive industrial trade flows and competitiveness due to stringent environmental regulations, it is worth depicting a comparative analysis of different categories of pollutive manufacturing exports in regions around the globe.

5.3 Comparative Analysis of World’s Pollutive Manufacturing Exports– Regional Overview

Table 5.1.1 the study explains the manufacturing exports data at the 3-digit ISIC level for the OECD, North America, East Asia, Latin America, and South Asia regions. The key characteristics regarding the choice of these regions are attributed to the liberalization efforts made by these regions to embark on the path of export-led development as advocated by Bender and Li (2002). Table 5.1.1., for international comparison purpose and working with 28 industries at 3- digits ISIC data and following UNIDO (2000), three pollutive industry groups have been categorized viz most pollutive industries, somewhat pollutive industries, and less pollutive industries. The most pollutive industrial category includes these industries: iron and steel, nonferrous metals, industrial chemicals, pulp and paper, and non-metallic products, and petroleum refineries. The second group of industries at the 3-digit ISIC level, which is termed as somewhat pollutive industries, includes food products, beverages, textiles, leather products, printing and publishing, other chemicals, fabricated metals, machinery and electrical, transport equipments. Last but not least, the less pollutive industries group includes tobacco products, table 5.1.1. Commodity Export Shares of Regions in World Exports

	year	1984-88	1994-98	2000-04	change 94-98	change 2000-04	Growth rates	Growth rates
	Commodity Group	% share	% share	% share	over 84-88	over 84-88	1984-98	1984-2004
High Income OECD(1)	Most pollutive	82.67	75.00	70.71	-	-	-0.97	-0.78
	Somewhat pollutive	79.67	70.86	68.18	-	-	-1.17	-0.78
	Less pollutive	74.26	64.65	63.85	-	-	-1.38	-0.75
East Asia (2)	Most pollutive	12.38	14.52	13.63	+	+	1.60	0.48
	Somewhat pollutive	17.01	16.26	14.04	-	-	-0.45	-0.96
	Less pollutive	17.87	17.32	14.30	-	-	-0.32	-1.11
North America(3)	Most pollutive	16.12	16.65	16.48	+	+	0.32	0.11
	Somewhat pollutive	14.36	15.03	14.37	+	+	0.45	0.00
	Less pollutive	14.99	16.65	16.65	+	+	1.05	0.53
ASEAN 4(4)	Most pollutive	1.54	2.43	3.27	+	+	4.66	3.83
	Somewhat pollutive	1.72	3.34	3.41	+	+	6.90	3.50
	Less pollutive	3.12	5.65	5.06	+	+	6.11	2.44
Latin America(5)	Most pollutive	4.96	5.19	4.81	+	-	0.46	-0.15
	Somewhat pollutive	1.88	3.56	4.10	+	+	6.61	3.98
	Less pollutive	0.95	2.36	3.10	+	+	9.47	6.06
South Asia (6)	Most pollutive	0.28	0.62	1.48	+	+	8.23	8.68
	Somewhat pollutive	1.72	1.54	1.81	-	+	-1.06	0.27
	Less pollutive	1.20	1.36	1.57	+	+	1.20	1.33

Notes: (a): Author's calculation based on ISIC data at 3-digit level of 56 closed sample countries out of 67 total
(b): Source: World Bank: Production and Trade Data:(2001) and (2006)
(c): compund growth rates are reported
(1): Australia,Austria,Canada,Denmark,Spain,Finland,France, United Kingdom, Germany,Ireland, Itlay, Japan,Netherlands,Norway,New Zealand,Sweden, United States
(2): Japan, Hong Kong, Korea, Singapore
(3):Canada USA
(4):Argentina, Chile, Colombia, Peru, Mexico, Venezuela, Bolivia, Ecuador
(5):Indonesia, Malaysia, Philippines,Thialand
(6): India, Pakistan, Bangladesh

wearing apparel, footwear, wood products, furniture, Misc. petroleum and coal, rubber products, plastic products, pottery, glass, machinery except electrical, prof. and scientific. equipment, other. Also, as industrial analysis is being conducted at the highest dis-aggregation ISIC levels, following standard literature on industrial, it is common practice to use the term commodity and industry alternately. This research will follow the same.

The study analysis in table 5.1.1 clearly shows that high-income OECD countries own the highest share of world manufacturing exports of both most pollutive and relatively less pollutive commodities at the 3-digit ISIC level. And most of these countries are also the ones engaged in pursuing stringent environmental regulations in the world economy (Sorsa, 1994). Their share of most pollutive manufactured commodities exports of world total pollutive exports was stood at 83 percent in 1984-88 followed by North America at 16 percent, East Asia 12 percent, Latin America 5 percent whilst South Asia region is with just .28 percent share. Similarly, for somewhat pollutive commodities group OECD region occupies the largest share of almost 80 percent in manufacturing exports of the world total, followed by North America with 14 percent and East Asia exports share of 12 percent. For the same pollutive industrial category, the exports shares of ASEAN, Latin America, and South Asian countries in total world exports stood at just under 2 percent in 1984-88.

The share of most pollutive industries export of OECD countries in total world export has gradually reduced and stood at 75 percent during 1994-98 and further declined to 72 percent in 2000-2004. A similar trend has been seen in the case of other pollutive industries of the same regions and period. North America, ASEAN, and South America have depicted gains in terms of more exports share in world total during 1994-98 and 2000-2004 compared to 1984-88 in almost all pollutive categories whilst Latin America showed a decline in its share of most pollutive exports group in end period compared to beginning period. However, Latin America depicted an increase of export share in world total among other pollutive industries groups during the period ending 2000-04 compared to 1984-88. What is more noteworthy is not the overall size but the changing share of industrial exports in commodity groups, i.e., most pollutive and other pollutive industries groups. The manufacturing exports share in total world export of most pollutive industrial group for OECD has receded over time while for those of developing economies regions such as ASEAN-4, Latin America, and South Asia regions the export shares have risen during the period under review.

In table 5.1.1, average annual growth rates of different regions around the world for both most pollutive and somewhat pollutive industrial exports further shed some light on time series export patterns during 1984-2004. South Asia region shows the highest export growth rate of 8.7 percent during 1984-2004 for most pollutive industrial group amongst all world regional group followed by ASEAN4 with a growth rate of 3.8 percent, East Asia .48 percent and highest concentrated pollutive export industrial region, OECD with a negative growth rate of 0-.78 percent during the same period. This gives some indication of most pollutive industrial trade delocalization from advanced to developing countries. Moreover, for the other two categories of pollutive industries groups, export growth rates of the OECD and East Asia regions show a negative trend over time and those of North American, ASEAN-4, Latin America, and South Asia regions indicate a positive trend during 1984-2004.

Table 5.1.2

Regional Analysis of Pollutive Commodity Exports: 1984-1998

Percentage Share

			HIGH INCOME OECD(1)		Growth Average	East Asia (2)		Growth Average	North America(3)		Growth Average	ASEAN 4(4)		Growth Average	Latin America(5)		Growth Average	South Asia (6)		Growth Average
ISIC	dustrial Group		1984-88	1994-98	1984-98	1984-88	1994-98	1984-98	1984-88	1994-98	1984-98	1984-88	1994-98	1984-98	1984-88	1994-98	1984-98	1984-88	1994-98	1984-98
341	paper&	product	94.4	87.65	-0.74	4.15	5.84	3.48	32.84	30.16	-0.85	0.35	2.15	19.87	1.34	2.16	4.93	0.03	0.09	12.92
351	industrial	chemical	89.8	78.87	-1.29	11.02	17.43	4.69	19.66	20.10	0.23	0.55	1.97	13.60	1.43	2.25	4.63	0.22	0.75	13.07
353	petrloeum	refineries	61.4	55.91	-0.93	13.08	21.33	5.01	10.92	12.21	1.13	2.61	4.46	5.48	12.01	9.77	-2.04	0.83	0.55	-4.04
369	other non-	metallic minr	86.2	78.68	-0.91	10.98	9.33	-1.61	9.59	8.81	-0.84	1.11	2.10	6.61	2.23	2.95	2.85	0.27	1.10	15.10
371	iron &	steel	87.0	75.92	-1.35	27.76	22.18	-2.22	5.45	7.99	3.89	0.61	1.33	8.12	2.17	3.58	5.15	0.18	0.89	17.05
372	non-ferrous	metals	77.2	72.95	-0.57	7.31	10.98	4.15	18.26	20.61	1.22	4.03	2.59	-4.32	10.58	10.42	-0.14	0.16	0.34	8.25
311	food	products	73.8	69.71	-0.57	4.40	3.64	-1.89	14.99	14.65	-0.23	7.01	8.27	1.67	4.73	6.27	2.87	1.79	2.02	1.19
313	Beverages		91.9	85.34	-0.73	2.42	4.21	5.67	7.37	9.34	2.40	0.30	0.70	9.03	1.96	4.14	7.76	0.02	0.09	13.52
321	Textiles	Industry	55.6	43.83	-2.36	23.70	21.98	-0.75	6.44	7.49	1.53	2.25	4.19	6.39	1.24	2.33	6.49	5.14	6.30	2.05
323	Leather	products	56.7	41.32	-3.11	19.31	28.48	3.96	5.52	4.54	-1.95	1.68	4.03	9.13	3.86	4.63	1.84	7.07	3.71	-6.24
342	printing &	publishing	91.0	83.86	-0.81	9.20	9.71	0.54	21.11	23.80	1.21	0.23	1.32	18.86	1.45	2.95	7.32	0.20	0.20	0.40
352	other	chemicals	89.7	85.81	-0.45	14.73	13.13	-1.14	17.10	16.50	-0.36	0.55	1.37	9.66	0.77	1.78	8.73	0.65	0.77	1.77
381	fabricated	metals	85.8	76.20	-1.18	15.35	13.60	-1.20	14.75	16.10	0.88	0.45	1.86	15.16	0.92	2.68	11.23	0.37	0.53	3.66
383	machinery	electric	78.5	63.02	-2.17	38.46	31.42	-2.00	15.23	17.11	1.17	2.81	7.58	10.43	1.01	3.86	14.30	0.11	0.12	0.51
384	transport	equipment	94.1	88.64	-0.59	25.54	20.16	-2.34	26.75	25.72	-0.39	0.15	0.77	17.49	0.97	3.44	13.52	0.09	0.15	5.06
314	tobacco	products	84.09	73.60	-1.32	7.64	14.94	6.93	44.02	35.03	-2.26	0.93	1.81	6.91	1.52	1.89	2.23	1.88	0.36	-15.18
322	wearing	apparel	38.30	33.15	-1.43	29.71	18.35	-4.70	2.98	5.61	6.52	4.36	7.15	5.06	0.77	3.34	15.80	4.12	6.14	4.07
324	footwear	xcept rub.plst	55.46	44.87	-2.10	18.65	18.27	-0.21	2.43	2.76	1.26	1.36	7.52	18.67	0.77	1.57	7.38	2.11	1.97	-0.69
331	wood prod.	except furn.	69.82	67.69	-0.31	4.66	3.38	-3.16	32.23	32.54	0.09	14.92	16.98	1.30	1.28	2.56	7.16	0.07	0.10	3.47
332	furniture	except mtl	83.76	72.87	-1.38	4.18	3.67	-1.31	10.58	16.08	4.27	1.95	6.96	13.56	0.77	3.76	17.18	0.02	0.03	4.84
354	misc.petrol.	&coal prods	82.01	70.72	-1.47	12.17	11.47	-0.59	11.94	19.44	4.99	7.68	1.37	-15.86	0.93	1.44	4.44	0.09	0.09	-0.51
355	Rubber	Products	87.43	77.08	-1.25	21.31	19.64	-0.81	13.41	15.93	1.74	2.00	6.56	12.60	0.58	1.80	11.97	0.48	0.85	5.73
356	plastic	products	62.31	55.13	-1.22	19.42	21.63	1.09	8.19	12.84	4.59	1.67	4.44	10.28	0.61	2.30	14.18	0.09	0.31	13.03
361	pottery		73.13	60.16	-1.93	27.87	20.54	-3.01	4.27	6.40	4.13	1.12	6.47	19.12	1.37	3.06	8.33	0.16	0.39	9.32
362	glass		85.82	78.10	-0.94	11.82	14.84	2.30	11.36	15.90	3.42	1.07	2.59	9.29	2.41	3.55	3.92	0.19	0.39	7.45
382	machinery	except electr.	91.44	77.98	-1.58	20.28	24.00	1.70	22.74	20.03	-1.26	0.31	3.62	27.74	0.44	1.40	12.40	0.16	0.15	-0.39
385	orf.&scientifi	equipment	88.51	78.54	-1.19	30.43	28.97	-0.49	20.69	21.72	0.49	0.41	2.16	17.97	0.34	1.74	17.82	0.20	0.19	-0.45
390	others	Industries	63.30	50.53	-2.23	24.21	25.40	0.48	10.07	12.18	1.93	2.83	5.90	7.62	0.61	2.25	13.92	6.08	6.68	0.95

Notes: (1): Australia,Austria,Canada,Denmark,Spain,Finland,France, United Kingdom ,Germany,Ireland, Itlay, Japan,Netherlands,Norway,New Zealand,Sweden United States

(2): Japan, Hong Kong, Korea, Singapore

(3): USA, Canada

(4):Indonesia, Malaysia, Philippines,Thialand

(5):Argentina, Chile, Colombia, Peru, Mexico, Venezuela, Bolivia, Ecuador

(6): India, Pakistan, Bangladesh

(a): Author's calculation based on ISIC data at 3-digit level of 56 closed sample countries out of 67 total

(b) Data Source: World Production and Trade Data (2001)

(c): compound growth rates are reported.

The decomposition of three pollutive industrial exports viz. most pollutive industries, somewhat pollutive industries and less pollutive industries during 1984-2004 on 3-digit industrial classification level is elucidated through table 5.1.2. and 5.1.3. Sectoral level data for OECD vividly depict that both in terms of shares and growth rates, the most pollutive industries are losing market concentration of their exports share in total world export over time. The growth rate during this period is negative for all most pollutive industries group in OECD countries. Whereas both export share and growth rates of pollutive industries of other regions around the world showing increasing trends hence indicating the shift in the export pattern of most pollutive industries from developed to developing countries. During 1984-2004, South Asian region following growth rates criteria shows positive and high industrial export growth rates in most pollutive industries such as iron and steel and paper and products that grew on average 13 percent and 11 percent, respectively. Therefore, South Asian countries are on the path of increasing their most pollutive industries export shares in the world total during the period under review.

For somewhat pollutive industries group and less pollutive industrial groups, OECD and East Asian economies industrial level time series data show a negative growth rates for most of the commodities during 1984-94 and 1984-2004 as reported in tables 5.1.2. and 5.1.3. Other regions such as ASEN-4 and Latin America and South Asia have gained in trade by increasing their share in world export and high export-growth rates for somewhat pollutive industries and less pollutive industries groups in several individual sectors and there are some industries in the same groups with negative growth rates. The sectoral level export data analysis across regions among others, shows that South Asia has gained in terms of both its share and growth rates in most pollutive industrial exports during 1990s compared to 1980s in world's most pollutive industries and trend mainly continued till 2000-2004 for most of the industries, expect few industries that depicted negative growth rates.

Table 5.1.3. **Regional Analysis of Pollutive Commodity Exports: 1984-2004**

Percentage Share

ISIC	Commodity Name		HIGH INCOME OECD(1) 1984-88	2000-2004	Growth Rates 1984-2004	East Asia (2) 1984-88	2000-2004	Growth Rates 1984-2004	North America(3) 1984-88	2000-2004	Growth Rates 1984-2004	ASEAN 4(4) 1984-88	2000-2004	Growth Rates 1984-2004	Latin America(5) 1984-88	2000-2004	Growth Rates 1984-2004	South Asia (6) 1984-88	2000-2004	Growth Rates 1984-2004
341	paper&	product	94.45	84.10	-0.58	4.15	5.08	1.02	32.84	28.69	-0.67	0.35	3.62	12.37	1.34	2.87	3.89	0.03	0.19	10.54
351	industrial	chemical	89.77	74.68	-0.92	11.02	18.17	2.53	19.66	19.56	-0.02	0.55	3.00	8.86	1.43	2.23	2.23	0.22	1.26	9.11
353	petrloeum	refineries	61.40	56.13	-0.45	13.08	17.57	1.49	10.92	12.30	0.60	2.61	4.28	2.50	12.01	5.97	-3.44	0.83	2.78	6.23
369	other non-	metallic minr	86.20	72.58	-0.86	10.98	6.59	-2.52	9.59	9.60	0.01	1.11	3.52	5.95	2.23	3.60	2.43	0.27	1.94	10.40
371	iron &	steel	86.97	69.65	-1.10	27.76	20.66	-1.47	5.45	8.21	2.07	0.61	1.97	6.03	2.17	3.48	2.39	0.18	2.12	12.99
372	non-ferrous	metals	77.22	67.10	-0.70	7.31	13.73	3.20	18.26	20.52	0.59	4.03	3.26	-1.05	10.58	10.72	0.07	0.16	0.61	7.08
311	food	products	73.85	71.46	-0.16	4.40	2.53	-2.73	14.99	15.84	0.27	7.01	8.59	1.02	4.73	6.39	1.52	1.79	1.70	-0.26
313	Beverages		91.86	84.55	-0.41	2.42	2.71	0.56	7.37	7.39	0.01	0.30	0.78	4.95	1.96	7.33	6.82	0.02	0.07	5.34
321	Textiles	Industry	55.64	44.17	-1.15	23.70	18.56	-1.21	6.44	8.51	1.40	2.25	4.27	3.25	1.24	2.08	2.61	5.14	7.39	1.83
323	Leather	products	56.69	42.06	-1.48	19.31	23.23	0.93	5.52	4.88	-0.62	1.68	3.28	3.41	3.86	3.73	-0.17	7.07	4.34	-2.41
342	printing &	publishing	90.96	79.63	-0.66	9.20	11.88	1.29	21.11	23.04	0.44	0.23	1.48	9.65	1.45	2.70	3.14	0.20	0.39	3.47
352	other	chemicals	89.74	87.44	-0.13	14.73	8.02	-2.99	17.10	15.79	-0.40	0.55	0.99	3.01	0.77	1.91	4.62	0.65	1.00	2.18
381	fabricated	metals	85.80	66.50	-1.27	15.35	11.41	-1.47	14.75	14.93	0.06	0.45	2.23	8.29	0.92	3.77	7.30	0.37	1.06	5.41
383	machinery	electric	78.48	53.23	-1.92	38.46	29.32	-1.35	15.23	14.84	-0.13	2.81	8.23	5.52	1.01	4.82	8.10	0.11	0.15	1.42
384	transport	equipment	94.05	84.55	-0.53	25.54	18.66	-1.56	26.75	24.10	-0.52	0.15	0.84	8.92	0.97	4.22	7.64	0.09	0.21	4.25
314	tobacco	products	84.09	78.42	-0.35	7.64	11.42	2.03	44.02	18.92	-4.13	0.93	3.22	6.43	1.52	1.06	-1.76	1.88	0.47	-6.68
322	wearing	apparel	38.30	28.96	-1.39	29.71	15.63	-3.16	2.98	5.00	2.62	4.36	6.69	2.16	0.77	4.90	9.69	4.12	6.60	2.38
324	footwear	xcept rub,pls	55.46	44.92	-1.05	18.65	14.10	-1.39	2.43	1.69	-1.82	1.36	5.77	7.50	0.77	1.08	1.70	2.11	2.02	-0.21
331	wood prod.	except furn.	69.82	70.03	0.01	4.66	2.31	-3.45	32.23	33.28	0.16	14.92	12.03	-1.07	1.28	3.21	4.70	0.07	0.09	1.32
332	furniture	except mtl	83.76	60.69	-1.60	4.18	3.10	-1.48	10.58	14.88	1.72	1.95	7.42	6.91	0.77	6.75	11.47	0.02	0.28	14.53
354	misc.petrol	&coal prods	82.01	92.89	0.62	12.17	12.30	0.05	11.94	32.58	5.15	7.68	0.72	-11.14	0.93	1.47	2.32	0.09	0.57	9.49
355	Rubber	Products	87.43	75.29	-0.74	21.31	17.78	-0.90	13.41	16.91	1.17	2.00	3.94	3.45	0.58	2.17	6.81	0.48	1.06	4.01
356	plastic	products	62.31	58.87	-0.28	19.42	13.44	-1.82	8.19	16.50	3.56	1.67	3.71	4.07	0.61	3.22	8.68	0.09	0.46	8.49
361	pottery		73.13	52.95	-1.60	27.87	12.35	-3.99	4.27	7.19	2.63	1.12	7.39	9.87	1.37	4.81	6.47	0.16	0.52	6.08
362	glass		85.82	71.54	-0.91	11.82	14.78	1.12	11.36	15.24	1.48	1.07	4.06	6.91	2.41	4.17	2.77	0.19	0.66	6.39
382	machinery	except electr	91.44	68.85	-1.41	20.28	21.47	0.28	22.74	16.81	-1.50	0.31	4.95	14.80	0.44	2.77	9.67	0.16	0.25	2.30
385	prf.&scientif	equipment	88.51	75.23	-0.81	30.43	23.65	-1.25	20.69	22.83	0.49	0.41	2.22	8.76	0.34	2.79	11.13	0.20	0.24	0.98
390	others	Industries	63.30	51.36	-1.04	24.21	23.56	-0.14	10.07	14.67	1.90	2.83	3.60	1.21	0.61	1.85	5.70	6.08	7.15	0.81

Notes (1): Australia,Austria,Canada,Denmark,Spain,Finland,France, United Kingdom ,Germany,Ireland, Itlay, Japan,Netherlands,Norway,New Zealand,Sweden United States

(3): USA, Canada

(2): Japan, Hong Kong, Korea, Singapore

(4):Indonesia, Malaysia, Philippines,Thialand

(5):Argentina, Chile, Colombia, Peru, Mexico, Venezuela, Bolivia, Ecuador

(6): India, Pakistan, Bangladesh

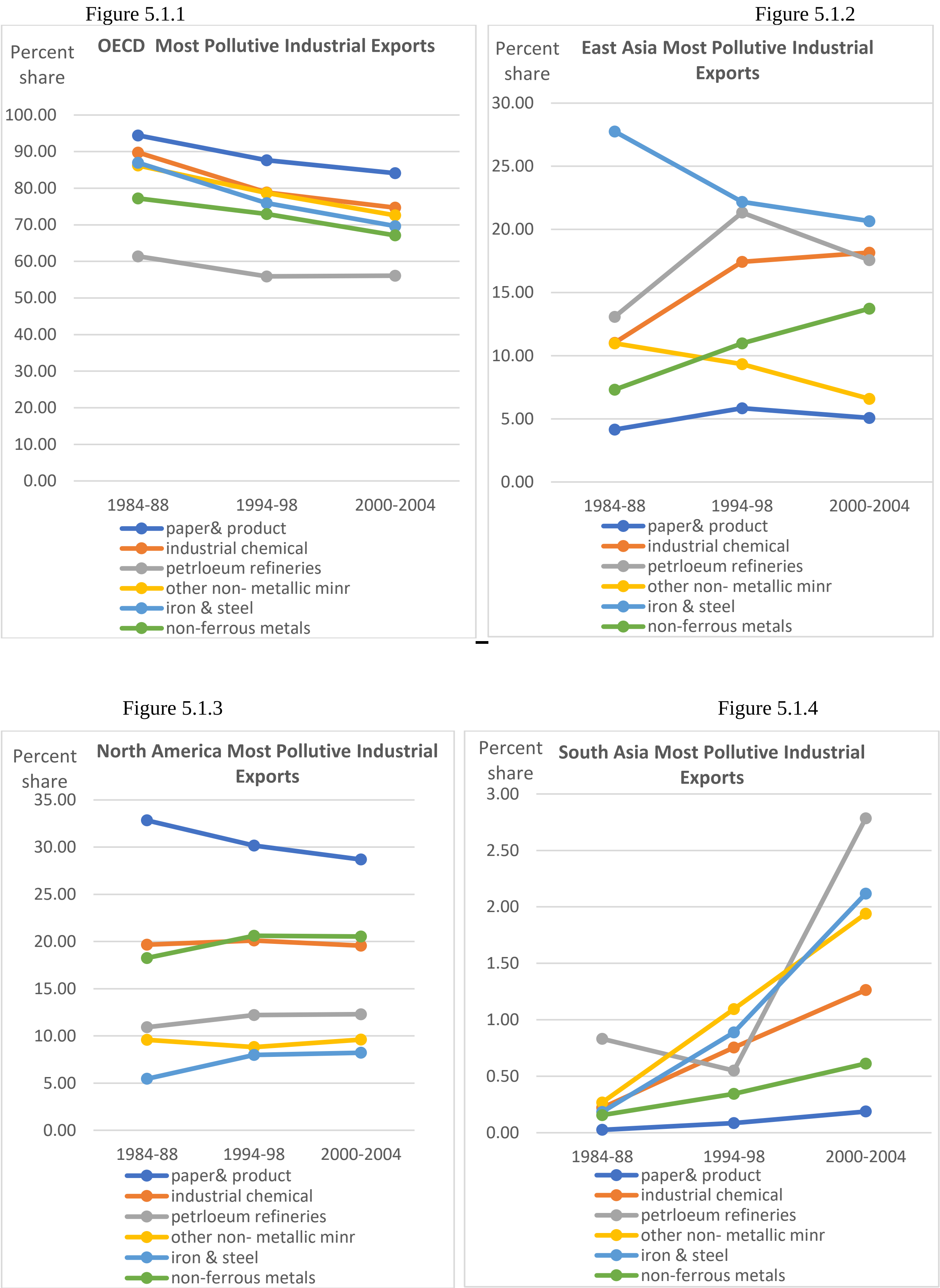
(a): Author's calculation based on ISIC data at 3-digit level of 56 closed sample countries out of 67 total

(b) Data Source: World Production and Trade Data (2001,2006)

(c): compound growth rates are reported.

Graphical trends in figures 5.1.1.-6 covering the period 1984-2004 and using industrial trade data on 3-digit industrial classification for most pollutive industrial group and various regions again confirmed the assertion that inter alia while South Asian countries are deemed to be increasing their export share in world total among pollutive industries and those of world high-income OECD countries share declined over time. Other regions around the globe depicted a mixed picture over time for the most pollutive industrial export pattern.

Figure 5.1.1-6. Graphical Analysis of Some Regional Most Pollutive Industrial Exports: Share in world Total (ISIC-rev.2)



Source: Author's calculations based on World Bank Trade and Production Data-3 digits ISIC (2001,2006).

Figure 5.1.5

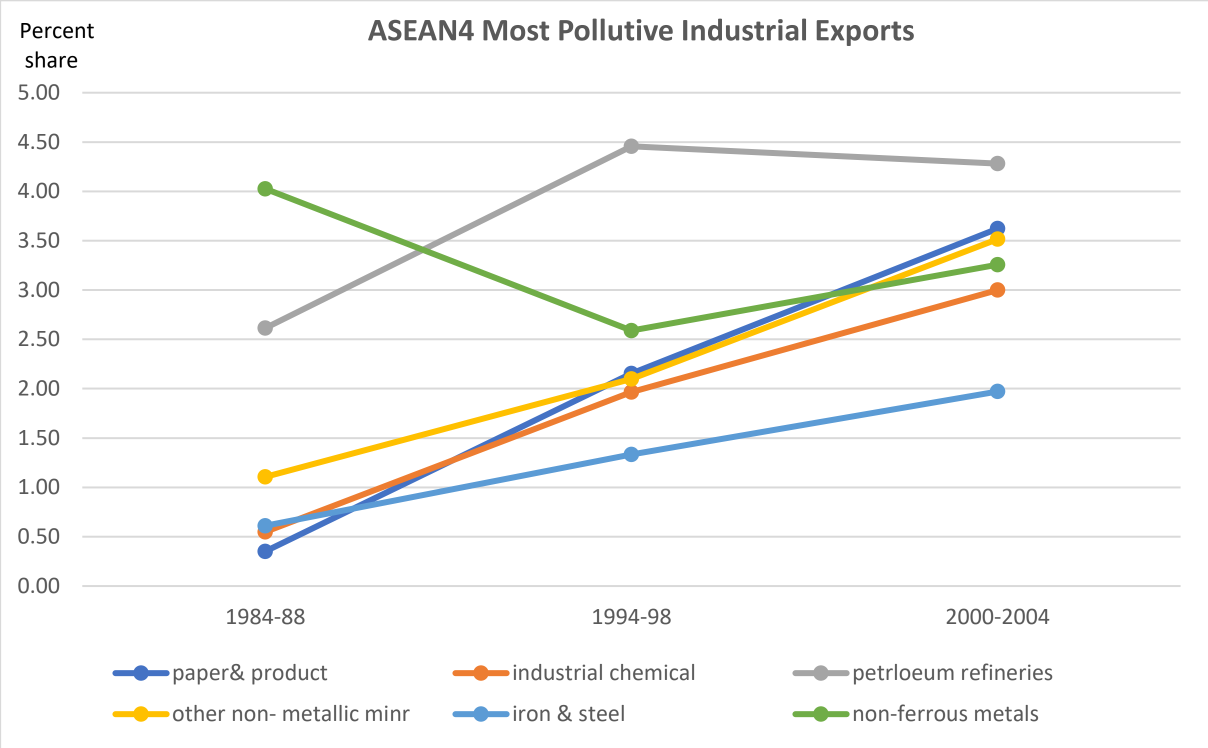
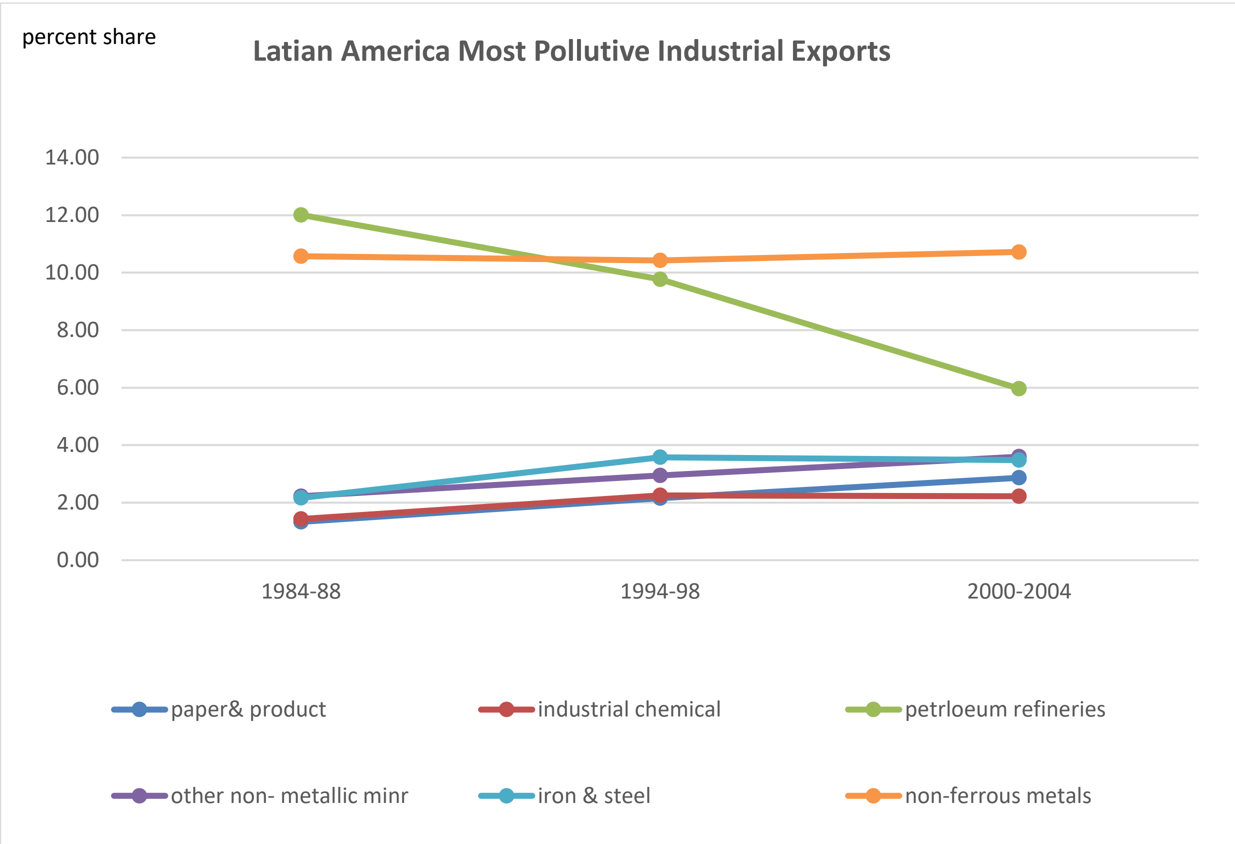


Figure 5.1.6



Source: Author’s calculations based on World Bank Trade and Production Data-3 digits ISIC (2001,2006).

5.4 Conclusion

This chapter explained the data source and data sorting process, especially considering the statistical comparative advantage modeling analysis. It discusses the data sources, compilation, and data transformation mechanism imperative to apply the comparative advantage models and econometric models for pollutive industrial trade and environmental regulations association. Furthermore, the study in this chapter shed light on comparative analysis on trade patterns for different categories of pollutive industries around the world at the regional level. It inter alia found that the South Asian region increased its share and growth rates over time for most pollutive industries exports. Those of high-income OECD countries as a whole reduced their export share over time in the same pollutive industrial group, indicating industrial/pollution displacement effects. The graphical analysis of most pollutive industrial trade has further confirmed these findings. The data further revealed varied trend over time in industrial export flows for somewhat pollutive and less pollutive industries groups. The analysis show that for pollutive industrial trade competitiveness consequences of environmental regulations, a more in-depth analysis of cross-methodological techniques is vital for South Asian pollutive industrial trade patterns and their trade flows with environmentally stringent OECD countries. The chapters 6-8 will cover those aspects in detail.

Chapter 6

Environmental Regulations and Trade Competitiveness: Statistical Modeling and Data Analysis

Introduction 6.1

The literature reviewed in previous chapters, especially in chapter four, concluded that results regarding the likely impact of environmental regulations on pollutive manufacturing trade are sensitive to the chosen methodology. Accordingly, the research process has guided this study to use cross-methodological empirical approaches to examine environmental policies' impact on pollutive industrial trade competitiveness. Chapter six, given study research questions/hypotheses, discusses the trade patterns for three pollutive industrial trade groups and their trade specialization patterns for selected South Asian countries, India, Pakistan, and Bangladesh. Section 6.2 explains the theoretical basis of the Revealed Comparative Advantage (RCA) model offered by Balassa (1965, 1979, 1986) at measurement levels and sheds light on the strengths and weaknesses of the Balassa index and suitability of the index to measure pollutive industrial trade pattern over time. Thereafter, the significance of normalized trade index offered by Gagnon and Rose (1995) for pollutive industries to avert macroeconomic issues in trade data due to inflation, growth, and the needs for computing competitiveness indicator reflecting pollutive industries trade specialization patterns developed by XU (1999) are explained.

In Section 6.3, the results based on RCA models for three South Asian countries across three pollutive manufacturing categories and individual industries within each category are described for 1984-2004. The study examines structure shifts in comparative advantage from most pollutive to least pollutive industries exports of selected South Asian countries. It provides a comparative analysis between both pollutive industries groups and countries. To better understand how pollutive industrial specialization trade patterns changed over time and how industrial trade shares moved between different pollutive industries groups, the results based on competitiveness indicators for South Asian countries at the highest dis-aggregated ISIC level are discussed in sections 6.4. and 6.4.1. The focus of research here is to compute the trade competitiveness index based on normalized exports share and overall trade shares for pollutive industries following the methodology offered by Gagnon and Rose (1995) and XU (1999). Section 6.5 concludes this chapter.

6.2 Comparative Advantage Modeling

At the modeling level, the starting point of the present research is the Heckscher-Ohlin-Samuelson (H-O-S) theory of Comparative Advantage which in two countries, two factors and two commodity cases advocates that *other things held constant* the factor in which a country is abundant with should produce and export that factor intensive goods. The determinant of comparative advantage nonetheless differed among trade theories. The Ricardian theory explained the comparative advantage from the cost and technological differences, and Heckscher-Ohlin-Samuelson (H-O-S) theory, as mentioned above, relies on the factor price differences. The Neo-factor-proportion theory looked at factor efficiency, whereas the technological gap and Product Cycle theory focus on technological innovation as the cause of comparative advantage differences (Bender and Li, 2002). Theoretical literature showed more relevancy of factor abundance H-O-S theory for trade and environmental issues as environment when properly priced is treated as another factor of production and, other things held constant, stringent the environmental regulations are less the country abundance with factor, environment and more the loss of competitiveness (Pethig, 1976; Walter, 1975; McGuire, 1982; Copland and Taylor, 1994 & 1995; Merrifield, 1988; Rauscher, 1997).

The theoretical concept of comparative advantage in the famous Heckscher-Ohlin-Samuelson (H-O-S) model has usually been specified in terms of pre-trade relative prices in a distortion-free world wherein the market function perfectly under complete information, which is difficult to observe in real-world and thus this concept faces a measurement problem. Trade statistics reflect the only post-trade situation. The empirical literature follows the observable data to reveal what would be the pattern of pre-trade prices. Numbers of specialization measures based on a country's trade variables are used in the literature to reveal which of the goods a country has a pre-trade comparative advantage in. The most popular and widely used for both single and multi-country analysis is the one pioneered by Balassa (Vollrath, 1991; Bender and Li, 2002; Balassa, 1965; Cole and Elliot, 2003).

Balassa (1965; 1979; 1986) coined the concept of Revealed Comparative Advantage to measure the country's relative export performance of product categories, which assumed that the true pattern of comparative advantage could be observed from post-trade data. Although a large body of literature has used the Balassa model to analyze the trade competitiveness of manufacturing sectors for single and multi-countries trade specialization analysis recently, this methodology has been applied with some adjustments to examine if developed and or developing countries are gaining the comparative advantage or disadvantages in environmentally sensitive goods due to introduction of stringent environmental regulations in most part of the world (XU, 1999; Ratnayake, 1998; Sorsa, 1994; Low and Yeats, 1992; Sawhney and Rastogi, 2015). And one of the key hypotheses examined using Balassa (1965) model is whether stringent environmental regulations have affected the comparative advantage of pollutive industry trade patterns over time. Balassa and other indexes explained below elucidate this objective well. The Balassa having a theoretical inspiration from Comparative Advantage Theory has developed an index of trade specialization, expressed as follows.

Balassa (1965) index shows the share of the specific industry in the country's total exports relative to that industry's share in total world exports of manufacturers. If this ratio is greater than one, then the country has export revealed comparative advantage henceforth XRCA. If this ratio is less than one, exports revealed comparative disadvantage, henceforth XRCDA. The higher the value of XRCA the greater is the country's comparative advantage in the commodity concerned. The Balassa XRCA index is based on some restrictive assumptions that the trade patterns show the inter-country differences in international competitiveness in terms of relative costs as well as non-price factors. The index assumes the value between zero and infinity.

The index is specified as under:

$$RCA_i = \left[\frac{X_{ij} / \sum_i X_{ij}}{\sum_j X_{ij} / \sum_j \sum_i X_{ij}} \right]_t \qquad \textbf{(6.1)}$$

where in equation **(6.1)** X_{ij} are the exports of commodity *i* at country *j* ; $\sum_i X_{ij}$ are the total exports of country *j*; $\sum_j X_{ij}$ are the world exports of commodity *i*(sum of countries commodity's *i* exports; and $\sum_j \sum_i X_{ij}$ are the total world exports (Balassa,1965 in Bender and Li,2002:10-11).

This index is not free from limitations. Bowen (1983: 465) criticized the Balassa index because it deals with both "exports and imports separately when comparative advantage is properly a net trade concept." But as pointed out by Balassa himself that the net export index used by him has the practical disadvantage of being affected by the idiosyncrasies of national import protection; in the case of intermediate products, the net exports are affected by the demand for the purpose of further transformation in export production. Also, those other indicators offered to measure comparative advantage are not free from limitation either (XU, 1999).

Hillman (1980) using the analytical and mathematical model, has proved the theoretical justification for the use of Balassa type index for comparative advantage analysis as it provides pre-trade revealed comparative advantage based on post-trade data. Vollrath (1991), in a comprehensive survey on comparative advantage model indexes, justified the superiority of the Balassa index over other comparative advantage measures/indexes offered during the 1970's and1980's decades. He depicted the superiority of the Balassa index over others as inter alias Balassa index drew a clear distinction between a specific commodity and all other commodities and between a specific country and the rest of the world.

Vollrath (1991), while showing the superiority of Balassa's index over several other indexes introduced in the 1980s on comparative advantage analysis at the commodity level, indicated a double-counting problem in the Balassa index and proposed the following measure that reveals the significance of the country's export performance in a given industry or sector and at world level while eliminating the double-counting problem. The Vollrath index can be defined in what follows:

$$RCAV_i = \frac{\left\{ \dfrac{X_{ij}}{(\sum_i X_{ij}) - X_{ij}} \right\}_t}{\left\{ \dfrac{(\sum_j X_{ij}) - X_{ij}}{[(\sum_j \sum_i X_{ij} - (\sum_j X_{ij})] - [(\sum_i X_{ij}) - X_{ij}]} \right\}_t} \quad (6.1\text{-A})$$

where in equation (6.1-A) X_{ij} are the exports of commodity *i* at country *j;* $\sum_i X_{ij}$ are the total exports of country *j*; $\sum_j X_{ij}$ are the world exports of commodity *i*(sum of countries commodity's *i* exports; and $\sum_j \sum_i X_{ij}$ are the total world exports (in Bender and Li, 2002:10-11).

This study tends to adopt the Balassa model for the present research analysis[23]. Balassa index offers analysis closer to the true comparative advantage model because the design on which this index is based- two countries and two commodities- is quite consistent with what neoclassical

[23] This study examines the both Balassa (1965) XRCA model using equation (6.1) and Vollrath (1991) XRCA model as in equation (6.1-A) by choosing Pakistan trade data at 3-digit ISIC levels. The comparative analysis regarding XRCA based on two methodological approaches reported at Appendix-6.1 did not reveal any significantly change in XRCA position of different categories of pollutive manufacturing industries. This study, therefore, will stick to most widely accepted Balassa model for pollutive industrial trade analysis.

trade theory offers. Recent empirical work on South Asian and South-East Asian economies' trade structure transformation analysis further endorsed the Balassa index (and Pitigala, 2005; Bender and Li, 2002).

It is argued that the availability of data at different levels of aggregation and the data bias caused by government policy distortions (e.g., non-trade barriers and export subsidies) caused immeasurable damage to the true pattern of comparative advantage. Therefore, the Balassa index might not reveal the true comparative advantage in the presence of domestic and international distortions. Nonetheless, the Balassa stages of comparative advantage thesis advocated a catch-up process that shifts economies from one area of comparative advantage to another. Especially when developing countries take over the labor-intensive product lines from industrialized countries, the production shift provides room for the developing countries to concentrate on the export of technology-intensive products (Bender and Li, 2002). Furthermore, Ballance et al. (1987), and Fertö and Hubbard (2003), at commodity level analysis, in terms of producing consistent outcomes, show the superiority of ordinal and dichotomous, especially dichotomous measures over ordinal measures. Since at this stage of analysis for most and less pollutive industrial categories of exports of selected South Asian countries, the objective is to find evidence for changing pattern of comparative advantage in exports that could be seen as dichotomous measure and Balassa index perform this job more accurately. The index reflects inflationary effects in data, especially if there is across the broad rise in the price of all manufacturing exports. The export ratio of commodity ascertained through dividing particular commodity exports by total country manufacturing exports the index by Balassa also considers the macro-economic trade balance effect. Another characteristic of the Balassa index is that by dividing the country’s sectoral share of a particular industrial category by the same sectoral share in the world exports of manufactured goods, a general increase or decrease in world exports of a particular good, i.e., growth effect will not change (XU, 1999).

It is well known that the value of international trade has grown substantially during the last more than four decades which is partly due to economic growth, inflation, and some of it is because of the increasing relative importance of trade (Gagnon, and Rose ,1995, XU, 1999). One vital contribution in literature by Gagnon and Rose (1995) for commodity level analysis is the introduction of the Normalization Index that can take account of inflation, growth, the relative importance of trade, as well as macroeconomic imbalances and facilitate the comparison between two periods. Following the same approach, XU (1999) has also used this measure along with Balassa index to examine the environmental regulations and trade competitiveness linkages of polluting goods or industry analysis of both OECD and Non-OECD countries around the world.

The Normalization index stated below has been used for South Asian trade analysis in present study as well.

$$NV_{it} = 1/2\left(\frac{X_{it}}{X_{et}} + \frac{M_{it}}{M_{et}}\right)100 \qquad (6.2)$$

Where *i* refers to a particular industry within a pollutive industries group, t refers to the point in time and e depicts total polluting goods. X is for exports and M is for imports of manufacturing commodities. The sum of any time period over industries is 100 and therefore, NV_{it} is a percentage measure (XU, 1999:1218-19).

Firstly, to judge the export competitiveness of different categories of pollutive industries, the study examines what percentage the export flows of various categories of environmental pollutive industries change in 1994-98 and subsequently in 2000-04 compared with those in 1984-88 South Asian country. Following theoretical results concluded in chapter 3, the likely expectation is that due to the introduction of relatively stringent environmental regulation in the 1990s and early 2000-04 compared to 1980s environmental pollutive industries with a higher export performance at the beginning of the period would become less competitive at the end sample period. Accordingly, comparative advantage in industrial exports should be moving from most pollutive to less pollutive industries. The study used Balassa XRCA to measure the competitiveness of each pollutive industry of selected South Asian countries- India, Pakistan, and Bangladesh- in three different periods- 1984-88 and 1994-98 and 2000-04 by separating the specialized and non-specialized pollutive industries. A specialized industry is where XRCA for the industry is greater than one, and vice versa is true for non-specialized industry. By using these specialized and non-specialized industrial trade categories, the study then separates the export flows of various pollutive categories of 81-industries at 4-digit ISIC level for 1984-98 and 28 pollutive industries 3-digit ISIC level covering the period up to 2004. The study has employed a weighted version to express the percentage share of export flows, i.e., using the average export flows of the intervening 5-year period i.e., 1988-93 as weight. The procedure has applied to all 81- manufacturing export data at 4-digit ISIC level data and 28 manufacturing trade data at 3-digit ISIC level for three pollutive industrial group- most pollutive industries, somewhat pollutive industries and less pollutive industries.

Second, to examine how the trade share of those commodities revealed both XRCA and XRCDA during the study period, another competitiveness indicator following XU (1999) is calculated. For accomplishing that task, the study used a percentage share of those environmental sensitive goods that indicated a specialization (i.e. XRCA is greater than one) out of three categories of pollutive industrial traded good for each period and South Asian country. As the Balassa index is a dichotomous measure, normalized trade share of pollutive industries calculated using equation (6.2) can be summed to provide a percentage share of the normalized trade of all industries within each pollutive group. This process can be summarized through equation (6.3) below:

$$C_{it} = \left\{ \sum^{k} NV_{it} \middle| XRCA_{it}^{\ k} \geq 1 \right\} \qquad (6.3)$$

C_{it} is the competitive indicator for country *i* at time *t*, *k* shows pollutive industries, NV_{it} shows the share of the industry *k* in country *i*'s total trade at time *t*. $XRCA^{k}_{it}$ is the export revealed comparative advantage of industry *k* in country *i* at time *t* (XU, 1999:1219-20).

The outcomes of equation (6.3) will elucidate whether the various categories of pollutive industries weighted normalized trade shares of South Asian countries have changed over time. If industries trade share for a specific pollutive industries category such as the most pollutive industries group shows a decline in trade share from total in end period compared to beginning period, then, in that case, one could argue that industries trade competitiveness position for that specific industries group has deteriorated over time. The competitiveness indicator will reflect on the movements of trade share within and between pollutive industries over time.

6.3. Export Patterns: Balassa index Application to South Asian Countries

In this section, using empirical results ascertained through the Balassa index, the study, in dichotomous framework, mainly concentrates on the competitive position of exports for three different pollutive industries during 1984-98 and 1984-2004. The XRCA ratios for three South countries including, India, Pakistan, and Bangladesh, have been computed at the highest dis-aggregated 4-digit level for 81-industries based on a balanced closed sample of 56-countries exports data for two periods- 1984-88 and 1994-98 and for the years 2000-2004 the XRCA are computed at 3-digit ISIC level.

Table 6.1

RCAs and Changing Exports Pattern of Selected South Asain Countries

			INDIA			PAKISTAN			BANGLEDASH		
			RCA	RCA	Rate of Growth(%)	RCA	RCA	Rate of Growth(%)	RCA	RCA	Rate of Growth(%)
	IND-Code	Group(4-digits ISIC)	1984-88	1994-98	1984-88	1984-88	1994-98	1984-98	1984-88	1994-98	1984-98
	3411	pulp paper and paper boar	0.018	0.114	20.06	0.007	0.002	-13.72	0.189	0.000	-49.96
Most	3412	contaniers, boxes of paper	0.063	0.131	7.63	0.219	0.024	-19.78	0.001	0.005	24.13
Pollutive	3419	pulp paper, paperboard atic	0.035	0.119	13.02	0.002	0.009	18.21	0.000	0.028	79.29
Industries	3511	basic industrial chemical e	0.472	1.355	11.13	0.020	0.009	-7.59	0.001	0.017	29.51
	3512	fertilizers and pesticides	0.381	1.350	13.48	1.145	0.114	-20.61	0.550	4.164	22.45
	3513	synthetic resins plastic, ma	0.117	0.451	14.41	0.042	0.274	20.56	0.003	0.001	-15.38
	3530	petroleum products	1.307	0.712	-5.90	0.255	0.113	-7.79	0.518	0.201	-9.03
	3691	structural clay products	0.102	0.302	11.45	0.025	0.020	-1.95	0.079	0.088	1.14
	3692	cement lime and plaster	0.221	2.053	24.94	0.002	0.093	43.61	0.000	0.000	-
	3699	non-metallic mineral produ	0.639	2.212	13.23	0.524	0.384	-3.06	0.007	0.000	-38.07
	3710	iron and steel basic industr	0.256	1.239	17.09	0.174	0.009	-25.40	0.003	0.003	-1.05
	3720	non-ferrous metal basic ind	0.273	0.482	5.86	0.001	0.002	2.28	0.002	0.001	-8.04
Somewhat	3111	preparing and preserving	0.610	0.605	-0.08	0.218	0.200	-0.86	1.675	0.066	-27.59
Pollutive	3112	dairy products	0.046	0.077	5.29	0.015	0.055	13.46	0.041	0.003	-23.02
Industries	3113	preserving of fruits & veg	1.593	0.812	-6.52	0.599	0.701	1.57	0.001	0.150	76.50
	3114	preserving & processing f	2.050	2.624	2.50	1.688	1.445	-1.54	7.763	5.133	-4.05
	3115	vegetable, animal oils & fa	2.232	4.182	6.48	0.033	0.047	3.51	0.006	0.001	-18.93
	3116	grain mill products	7.451	14.578	6.94	29.175	22.053	-2.76	0.322	0.018	-24.95
	3117	bakery products	0.139	0.089	-4.38	0.364	0.180	-6.79	0.006	0.003	-6.12
	3118	sugar factories & refineries	0.619	2.052	12.74	4.386	9.532	8.07	0.237	0.000	-56.59
	3119	cocoa chocolate & sugar c	0.060	0.110	6.32	0.306	0.339	1.04	0.000	0.000	-
	3121	food prodcuts nes.	8.104	3.153	-9.01	0.618	0.407	-4.10	6.233	1.567	-12.90
	3122	manfucture of prepared ani	0.126	0.243	6.74	0.367	0.009	-30.68	0.000	0.000	-
	3131	distilling rectifying and ble	0.061	0.253	15.29	0.059	0.098	5.19	0.000	0.039	-
	3132	wine industires	0.006	0.004	-4.79	0.000	0.000	38.89	0.000	0.000	-
	3133	malt liquors and malt	0.029	0.070	9.35	0.000	0.007	100.99	0.000	0.027	-
	3134	soft drinks and carbonated	0.012	0.015	1.77	0.133	0.004	-30.21	0.000	0.000	-
	3211	spinning weaving and finish	3.433	4.854	3.53	14.553	17.396	1.80	7.265	2.749	-9.26
	3212	made-up textile goods exc	5.763	3.680	-4.38	23.628	25.495	0.76	46.549	11.728	-12.88
	3213	knitting mills	2.075	3.072	4.00	1.553	5.839	14.16	0.884	10.905	28.56
	3214	manufacture of carpets and	17.799	14.648	-1.93	29.197	16.108	-5.77	6.279	1.428	-13.77
	3215	cordage rope and twine ind	0.423	2.125	17.51	1.201	1.019	-1.64	7.443	44.918	19.69
	3219	textiles nes.	0.438	0.677	4.47	0.425	6.730	31.82	0.269	0.012	-26.48
	3231	tanneries and leather finish	13.552	3.270	-13.25	19.074	8.370	-7.91	31.506	12.132	-9.10
	3232	fur dressing and dyeing	0.036	0.000	-35.19	0.000	0.003	-	0.000	0.000	-
	3233	leather, leather subst. exc	3.237	3.708	1.37	0.442	0.365	-1.90	0.019	0.073	14.30
	3420	printing publishing and alli	0.283	0.256	-1.01	0.132	0.103	-2.46	0.113	0.004	-28.51
	3521	paints varnishes and lacqu	1.509	0.124	-22.09	0.141	0.021	-17.46	0.004	0.004	-0.66
	3522	drugs and medicines	1.972	1.942	-0.15	0.079	0.233	11.44	0.013	0.007	-6.59
	3523	soap, cleaning preparation	1.745	0.764	-7.93	0.183	0.070	-9.08	0.296	0.036	-19.10
	3529	chemical products nes.	0.368	0.480	2.70	0.074	0.071	-0.44	0.010	0.003	-10.12
	3811	cutlery hand tolls and gene	1.193	1.188	-0.04	0.542	0.423	-2.43	0.274	0.020	-23.04
	3812	furniture and fixtures prim	0.170	0.095	-5.64	0.022	0.003	-18.71	0.004	0.004	-0.12
	3813	structural metal products	0.457	0.492	0.75	0.071	0.045	-4.55	0.101	0.159	4.58
	3819	facribated metal prod. exce	0.505	0.732	3.78	0.141	0.065	-7.48	0.044	0.018	-8.55
	3831	electrical ind. Machinery &	0.181	0.221	1.99	0.030	0.015	-6.97	0.016	0.051	12.41
	3832	radio t.v. communication e	0.094	0.131	3.41	0.008	0.002	-13.07	0.001	0.001	-3.51
	3833	electrical appliances and ho	0.132	0.113	-1.58	0.018	0.007	-8.32	0.007	0.005	-1.99
	3839	electrical apparatus, suppl	0.736	0.243	-10.50	0.018	0.021	1.85	0.020	0.137	21.00
	3841	shipbuilding and repairing	0.027	0.142	17.88	0.256	0.035	-17.95	0.169	0.092	-5.95
	3842	railroad equipment	0.564	0.241	-8.14	0.006	0.040	21.82	0.000	0.000	-
	3843	motor vehicles	0.118	0.186	4.63	0.004	0.004	-0.24	0.010	0.007	-3.65
	3844	motorcycles and bicycles	1.719	1.881	0.91	0.059	0.025	-8.01	0.001	0.192	78.96
	3845	aircraft	0.052	0.022	-8.15	0.157	0.025	-16.78	0.000	0.001	-
	3849	transport equipment nes.	0.005	0.035	21.95	0.000	0.003	-	0.000	0.000	-
Less	3140	tobacco manufacture	2.945	0.462	-16.92	0.842	0.094	-19.73	0.298	0.150	-6.66
Pollutive	3220	wearing apparel except foo	4.443	4.408	-0.08	4.417	5.967	3.05	11.307	20.236	5.99
Industries	3240	footwear except vulcanized	3.446	2.431	-3.43	0.632	0.698	0.99	0.002	0.943	81.10
	3311	sawmills planing and other	0.095	0.083	-1.33	0.002	0.001	-5.68	0.001	0.359	86.55
	3312	wooden and cane containe	0.119	0.232	6.88	0.006	0.010	5.43	2.056	0.838	-8.59
	3319	wood and cork products ne	0.223	0.098	-7.93	0.078	0.180	8.65	0.126	0.004	-29.94
	3320	furniture and fixtures exce	0.019	0.029	4.40	0.033	0.040	1.93	0.004	0.001	-15.53
	3540	miscellaneous porudcts of	0.022	0.061	10.93	0.132	0.212	4.86	0.926	0.001	-49.75
	3551	tyres and tube industries	0.889	1.579	5.91	0.036	0.008	-13.99	0.000	0.000	-
	3559	rubber products nes.	0.699	0.712	0.19	0.156	0.020	-18.37	0.014	0.001	-24.85
	3560	plastic products nes.	0.121	0.395	12.52	0.096	0.048	-6.71	0.002	0.169	56.91
	3610	pottery china and earthenw	0.189	0.326	5.63	0.222	0.039	-15.91	0.079	1.718	36.06
	3620	glass and glass products	0.281	0.534	6.65	0.137	0.039	-11.79	0.006	0.003	-7.36
	3821	engine and turbines	0.290	0.472	4.98	0.106	0.086	-2.08	0.073	0.062	-1.66
	3822	agriculture machinery and	0.149	0.233	4.58	0.050	0.067	2.94	0.080	0.022	-11.99
	3823	matal and woodworking ma	0.445	0.240	-5.99	0.013	0.069	17.90	0.042	0.013	-11.37
	3824	special ind. machinery exce	0.335	0.271	-2.11	0.189	0.067	-9.81	0.050	0.125	9.49
	3825	office computing and accou	0.106	0.116	0.90	0.003	0.002	-7.78	0.001	0.000	-7.84
	3829	macinery & equipment exc	0.243	0.191	-2.34	0.028	0.031	1.00	0.159	0.088	-5.80
	3851	prof. & scientific, equipme	0.128	0.134	0.41	0.876	0.804	-0.86	0.045	0.004	-20.68
	3852	photographic and optical g	0.261	0.065	-13.00	0.011	0.003	-12.93	0.005	0.144	40.31
	3853	watches and clocks	0.019	0.273	30.77	0.017	0.006	-9.89	0.000	0.000	13.26
	3901	jewellery and related articl	23.875	22.299	-0.68	0.223	0.145	-4.22	0.000	0.000	-100.00
	3902	musical instruments	0.309	0.361	1.57	0.125	0.231	6.34	0.000	0.000	-
	3903	sporting and athletic goods	1.038	0.754	-3.14	7.166	11.971	5.26	0.000	4.543	161.63
	3909	industries nes.	0.213	0.437	7.46	0.148	0.644	15.85	0.132	0.180	3.19

Note: (1) Analysis is based on ISIC data at 4-digit level of 56 closed sample countries out of 67 total

(2) Revealed Comparative Advantages (RCA's) are depicted in **bold colours and growth rates in red's.**

(3) - : shows the industrial values were zero for one of the periods and thus not allowing to calculate growth or RCA'S

Tabel 6.1.1. **RCAs of Selected South Asain Countries 2000-2004**

				India	Pakistan	Bangladesh
IND. Category	IND. CODE	industrial	Name	RCA	RCA	RCA
Most Pollutive Industries	341	paper&	product	0.20	0.03	0.01
	351	industrial	chemical	**1.29**	0.28	0.24
	353	petrloeum	refineries	**2.82**	0.83	0.21
	369	other non-	metallic minr	**1.97**	0.57	0.15
	371	iron &	steel	**2.25**	0.10	0.08
	372	non-ferrous	metals	0.65	0.02	0.01
Somewhat Pollutive Industries	311	food	products	**1.43**	**2.12**	0.04
	313	Beverages		0.06	0.06	0.01
	321	Textiles	Industry	**4.25**	**18.61**	**4.22**
	323	Leather	products	**3.37**	**4.16**	**8.28**
	342	printing &	publishing	0.38	0.10	0.25
	352	other	chemicals	**1.03**	0.20	0.05
	381	fabricated	metals	**1.10**	0.21	0.05
	383	machinery	electric	0.15	0.02	0.02
	384	transport	equipment	0.20	0.12	0.02
Less Pollutive Industries	314	tobacco	products	0.46	0.07	0.48
	322	wearing	apparel	**3.90**	**7.52**	**28.33**
	324	footwear	except rub.plstc	**1.78**	**1.39**	**2.13**
	331	wood prod.	except furn.	0.08	0.08	0.01
	332	furniture	except mtl	0.19	0.56	0.02
	354	misc.petrol.	&coal prods	0.58	0.15	0.00
	355	Rubber	Products	**1.13**	0.04	0.00
	356	plastic	products	0.45	0.20	0.16
	361	pottery		0.37	0.41	**1.82**
	362	glass		0.68	0.12	0.05
	382	machinery	except electr.	0.25	0.05	0.06
	385	porf.&scientific	equipment	0.17	0.46	0.10
	390	others	Industries	**7.42**	**1.31**	0.13

Note: (1) Analysis is based on ISIC data at 3-digit level of 56 closed sample countries out of 67 total
(2) Revealed Comparative Advantages (RCA's) are depicted in **bold**
(3) World Production and Trade Data (2006)

An analysis on pollutive industrial comparative advantage in table 6.1, shows that in the world's most pollutive industries group, India had virtually revealed comparative disadvantage henceforth XRCDA in all those industries in the beginning period 1984-88, except petroleum products. Nevertheless, in the end period 1994-98, India has a XRCA in resource or labour-intensive industries such as fertilizers and pesticides, and basic industrial chemicals for the same pollutive commodities group. In the same most pollutive industries, India also showed XRCA in cement lime and plaster, non-metallic mineral products, and iron and steel basic industry. Following Lall (2001) technological sophistication-based classification for manufacturing exports, the latter industries come under the category of medium technology products or using

UNCTAD (2002) categorization for industrial exports these latter industries could be termed as low capital or technology-intensive products in which India has increased her export competitiveness position over time. The growth rates in RCA revealed high growth rates[24]in most pollutive industrial exports group in India except petroleum products. Some RCA growth rates are conspicuously high for industries such as pulp and paper board at 20 percent and iron and steel at 17 percent, to mention a few. India continued to enjoy XRCA in most pollutive industries during 2000-2004, as reported in table 6.1.1.

For the most pollutive industrial group in table-6.1 results show that Pakistan was facing XRCDA in the beginning period 1984-88 in most of the commodities, except fertilizer and pesticide, which showed XRCA, but for the end period, 1994-98 ratios show that Pakistan is facing XRCDA in all industries in the category of most pollutive industries. Furthermore, the XRCDA for most industries has deteriorated in the 1990s compared to the 1980s when observed through the high negative growth rates of the industries such as pulp paper and paper board, containers, boxes of paperboard, fertilizer and pesticides and iron and steel, among others. For some other industries in most pollutive group, although industries are experiencing XRCDA but positive growth rates showing improvement in 1994-98 over 1984-88. These industries include pulp, paper nes; synthetic resins plastic; cement lime and plaster; non-ferrous metal basic Ind., etc. Moving to the latest years performance during 2000-2004, Pakistan was witnessing XRCDA in all industries under most pollutive industrial categories.

The comparative advantage results for Bangladesh, as exhibited in table 6.1, reveal that the country faces XRCDA in almost all industries among the most pollutive industries group both in 1984-88 and during 1994-98. An exception is the fertilizer and pesticides industry, wherein the country had XRCDA during the beginning sample period 1984-88 that turned into XRCA during the end sample period 1994-98. In table 6.1, RCA growth rates also show that over time XRCDA for most of the industries has reduced among the most pollutive industries group including the industries; containers, boxes of paper & paperboard, pulp paper, paperboard article nes., basic industrial chemical except fertilizer and fertilizers and pesticides. A cursory look at the latest available data on manufacturing trade in table 6.1.1 shows that there are not much vivid change in most pollutive industries comparative advantage during period 2000-2004 and country has not been able to enjoy XRCA in any industry within most pollutive industrial group.

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[24] The average annual growth rates are based on two period- 1984-88 and 1994-98- exports ratios resulted from Balassa index. For brevity we termed these two periods as 1984-98.

For somewhat pollutive industries category in table 6.1., India during 1984-88 has XRCA (Balassa index ratio > 1) in industries including preserving of fruits and vegetables; preserving and processing fish crustaces; vegetable, animal oils & fats; grain mill products; food products nes; tobacco manufacture; spinning weaving and finishing textiles; made-up textile goods except w. apparel; knitting mills; manufacture of carpets and rugs; tanneries and leather finishing; leather, leather subst. except footwear; paints varnishes and lacquers; drugs and medicines; soap, cleaning preparation perfumes cosmetics; petroleum products; cutlery hand tolls and general hardware and motorcycles and bicycles. For the same pollutive group during 1994-98, India has maintained XRCA for most of these commodities at 4-digit ISIC level, especially in the resource-intensive and low technology-based commodities, but some industries that were enjoying XRCA in the beginning period faced with XRCDA in 1994-98. These industries include preserving fruits and vegetables; paints varnishes and lacquers; soap, cleaning preparation perfumes cosmetics. On the other hand, in the same industrial group, for some industries wherein India had an XRCDA during 1984-88 turned to XRCA in 1994-98, which include sugar factories & refineries, cordage rope, and twine industries. In table 6.1.1, extending the analysis to 2000-2004, the index shows that India had XRCA in textile, leather as well as other chemical and fabricated metals among somewhat pollutive export categories. When compared 1984-88 results with 2000-2004, India continued to enjoy the XRCA in food, textile, and leather industries.

Among the group of less pollutive industries India showed XRCA during 1984-88 in industries including tobacco manufacture; wearing apparel except footwear; footwear except vulcanized rubber of plastic; jewellery and related articles and sporting and athletic goods and maintained its comparative advantage in most of the industries during end sample period 1994-98 except tobacco manufacture and sporting and athletic goods. Also, it gained XRCA in tyres and tube industries in the later period compared to the first period where the industry had XRCDA. During 2000-2004, among the less pollutive industrial export group i.e. the industries where environmental regulations are least stringent India had XRCA in wearing apparel, footwear except rubber, rubber products and other industries, table 6.1.1. When the study compared it with the beginning sample period of 1984-88, India had XRCA in most of these industries except rubber products, where it witnessed XRCDA. India, therefore, did maintain its comparative advantage position in most of the cleaner industries trade in world exports.

In Table 6.1., Pakistan for somewhat pollutive industries group has shown a revealed comparative advantage (Balassa index ratios >1) at 4-digit ISIC level during 1984-88 for the commodities including: preserving & processing fish crustaces; grain mill products; sugar factories & refineries; spinning weaving and finishing textiles; made-up textile goods except w. apparel; knitting mills; manufacture of carpets and rugs; cordage rope and twine industries; tanneries and leather finishing. The XRCA in most of these industries remained intact during 1994-98. However, Pakistan faced comparative dis-advantage for textiles nes. in 1984-88 but enjoyed comparative advantage in textiles-nes in the end period of study 1994-98. Extending the end sample period to 2000-2004, the results in table 6.1.1 for the same industrial category show that Pakistan was comfortably enjoying the comparative advantage i.e., XRCA in food, textile and leather industries, and faced with XRCDA in other industries in the same group. Among the less pollutive industries group, the industries such as wearing apparel except footwear and sporting and athletic depicted revealed comparative advantage both during 1984-88 and 1994-98 and rest of industries have XRCDA. However, compared the results of XRCA 1984-88 with 2000-2004 Pakistan comparative advantage position maintained in wearing apparel, other industries but industry such as footwear wherein Pakistan was facing XRCDA in 1984-88 started gaining comparative advantage position in 2000-04 with XRCA >1 and stood at RCA 1.39 in table 6.1.1. The results also reveal that Pakistan's competitive position in manufacturing sectors exports primarily fall in resource-based and low technology products such as textiles, wearing apparel, etc. production of which generally requires labour intensive technology.

Following the results based on Balassa model produced in table 6.1 at 4-digits ISIC level, Bangladesh for somewhat pollutive industries category witnessed a revealed comparative advantage during 1984-88 in commodities including: preparing and preserving meat; preserving & processing fish crustaces; food products nes.; spinning weaving and finishing textiles; made-up textile goods except w. apparel; manufacture of carpets and rugs; cordage rope and twine industries; tanneries and leather finishing. The country maintained its XRCA during 1994-98 in all industries of the same pollutive category, except preparing and preserving meat. The country continued to maintain the high XRCA in the textile industry and leather products during 2000-2004, as reported in table 6.1.1.

Among the last category of pollutive industries, i.e., less pollutive industries, Bangladesh like India and Pakistan, has gained her revealed comparative advantage in wearing apparel and footwear industry, and her XRCA in both industries was higher as compared to its competitors in South Asia region. Also, it showed XRCA in wooden and cane containers in the beginning sample period of 1984-88 and turned to XRCDA in 1994-98 and suffered the loss of trade competitiveness in 1990 compared to the beginning period. For the same less pollutive industry group, results showed that some industries such as pottery china earthenware and sporting and athletic that were having XRCA during 1984-88 turned to XRCA during 1994-98 and thus gained export competitiveness in these pollutive industries. While other two South Asian countries had XRCDA in pottery industry during the period 2000-2004, Bangladesh, since 1994-98, continued to maintain her comparative advantage of the same industry in world exports. Like its neighboring countries of the South Asia region, Bangladesh, in general, depicted XRCA in resource-based and or low technology-based exports.

In the light of the above analysis, the key broader results that seemed to emerge from Balassa based methodological approach for selected South Asian countries are what follows. First, for most pollutive industrial group, India seemed to have clearly gained its competitiveness position in export for the number of pollutive industries. Her comparative disadvantage in most industries of the same pollutive industries category has receded in the late 1990s and 2000-04 as compared to the early 1980s. Therefore, the structure of manufacturing exports within the group of most pollutive industries in India's trade specialization patterns has changed to some extent during 1984-2004. Pakistan is not having a comparative advantage in the most pollutive industry group. Her RCDA has increased in most pollutive industries in the later 1990s and 2000-04 compared to the early 1980s. For the most pollutive industrial exports category, Bangladesh also failed to gain a comparative export advantage in 2000-2004 compared to the 1980s.

In somewhat pollutive industries, all three South Asian countries have maintained their comparative advantage position in wearing apparel and footwear industries. Among the less pollutive industries group, other industries where both India and Pakistan depicted XRCA in the world market in 2000-2004. Therefore, the study finds some, if not drastic, changes in South Asian countries' comparative advantage positions due to among others introduction of relative stringency of environmental regulation in the 1990s onwards compared to the 1980s. Moreover, to some extent, all three South Asian countries consistently enjoyed revealed comparative advantage in non-footloose, resource-based industries and low technology or labor-intensive manufacturing industries such as textile and leather during 1984-2004. Kemal et al. (2000) for South Asia inter and intra-regional manufacturing trade analysis conclude that South Asian countries depict a similar pattern of revealed comparative advantage and that export interest of these countries mainly lies in the similar products. Nonetheless, India's manufacturing exports at a dis-aggregated level are much more dispersed than those of the other two countries under study. There is evidence that India is gaining some comparative advantage of manufacturing exports in medium technology products. Lastly, the South Asia region lags in achieving a comparative advantage in high-technology-based goods such as electronic and electric-related industrial and optical instruments exports. Following UNCTAD (2002), these latter products in which the region is lagging are categorized as the finished product and the industries entailing high research and development expenditure and are characterized as high technological complexity and or economies of scale.

6.4 Pollutive Industries and Trade Competitiveness: More Evidence from South Asian Countries

For further insight into the subject, the study examines how commodities export shares in particular and trade share in general for three pollutive industries groups have changed over time. The study, therefore, has estimated the two types of competitiveness indexes based on equation (6.3). Firstly, export competitiveness indexes or indicators are computed for selected three countries by weighted export version i.e., using averaged commodity export share of 1989-93 as weight and expressed the results in percentage for commodities with XRCA >1 termed as specialized commodities and others XRCA<1 termed as non-specialized commodities. Secondly, as explained in equation (6.3), the normalized averaged weighted trade weights of the period 1989-93 at commodities level have been chosen as a weight to express the results for each three countries in percentage for beginning sample 1984-88 and end sample 1994-98 periods using 4-digit ISIC dis-aggregated industrial trade data. The analysis has been extended to covering the end sample period till 2000-2004 using 3-digit ISIC industrial trade data by applying the same methodological tools. The following two sections explain how exports and trade specialization patterns have changed over time between pollutive industry groups.

6.4.1 South Asian Economies: Export Competitiveness of Pollutive Industries

The analysis in tables 6.2-4 shows the export performance of the three South Asian countries in the beginning period 1984-88 and end sample period 1994-98. Table 6.2 describes the manufacturing export competitiveness of India measured through the changing weighted export shares and separating industrial export share based on Balassa (1965, 79, 1986) revealed comparative advantage model for beginning and end sample period of three different pollutive industries groups at 4-digits ISIC level. South Asian countries have made concerted efforts to adhere to environmental regulatory compliance from the 1990s onwards compared to the 1980s, as witnessed in recent work (Dasgupta, et al., 2001; UNEP, 2000). The expectation is that If environmental regulations constitute a considerable proportion of abatement costs at the industry level, then, in that case, specialized pollutive commodities, especially the most pollutive ones, exports share will decrease over time, and the specialized industries in the beginning period may become non-specialized in the end period. Specialized industries are those showing normalized weighted export or trade shares in pollutive groups with XRCA>1 and vice versa for non-specialized pollutive industries. The results for Indian regarding most pollutive industries reveal that India's export competitiveness position of these industries has improved over time as depicted through the rising weighted export share from a total of the specialized industries (with XRCA>1) that rose from 1.5 percent in 1984-88 to 3.5 percent 1994-98. In the same pollutive industries category, the specialization pattern has changed as the industries such as fertilizer, cement, iron and steel, etc., that were not specializing in the beginning sample period in 1984-88 became specialized in the end sample period. The weighted export shares of non-specialized commodities for the same most pollutive industries group have reduced over time from 1.4 percent in 1984-88 to .79 percent in 1994-98. The somewhat pollutive industries category of India that constitute the largest number of industries- 43 from total of 81 industries- improved its export competitiveness position as the weighted exports share of industries with XRCA>1 has slightly improved from 22.3 percent in 1984-88 total to 23.4 percent during end sample period 1994-98. Also, there seems to be less shift in changing industrial export structure in the same group of pollutive industries as most of the industries in a group of specialized in 1984-88 remained specialized end period 1994-98, except two exceptions. For the last category of pollutive industries viz. less pollutive industries, that comprise the largest weighted export share in total trade, the export competitiveness position of India has deteriorated as the weighted export share of industries with XRCA has reduced from 73 percent to 70 percent. Contrary to the expectation, the most pollutive sectors showed improvements in export competitiveness position, which would imply that other competing theories such as pollution haven are at work for India, earlier research did find evidence of pollutive haven effects for developing countries (Low and Yeats, 1992; Mani and Wheeler, 1999).

Table-6.2

India's Manufacturing Export's Competitiveness: 1984-98

Most Pollutive Industries

Ind.Name	Exp Share (%) 1984-88 with XRCA>1	Ind.Name	Exp Share (%) 1984-88 with XRCA<1	Ind.Name	Exp Share (%) 1994-98 with XRCA >1	Ind.Name	Exp Share (%) 1994-98 with XRCA <1
petroleum products	1.4762	pulp paper and pa	0.0004	basic industrial ch	2.2925	pulp paper and p	0.0018
		contaniers, boxes	0.0000	fertilizers and pes	0.0358	contaniers, boxe	0.0000
		pulp paper, paperb	0.0001	cement lime and	0.0044	pulp paper, pape	0.0004
		basic industrial che	0.9347	non-metallic mine	0.0410	synthetic resins	0.1252
		fertilizers and pesti	0.0158	iron and steel basi	1.1490	petroleum produ	0.4841
		synthetic resins pla	0.0340			structural clay pr	0.0007
		structural clay prod	0.0003			non-ferrous meta	0.1825
		cement lime and p	0.0006				
		non-metallic minera	0.0123				
		iron and steel basic	0.3178				
		non-ferrous metal b	0.1198				
Total weighted average indsutrial *Exports shares(%)*	*1.4762*		*1.4357*		*3.5227*		*0.7948*

Some What Pollutive Industries

Ind.Name	Exp Share (%) 1984-88 with XRCA >1	Ind.Name	Exp Share (%) 1984-88 with XRCA <1	Ind.Name	Exp Share (%) 1994-98 with XRCA >1	Ind.Name	Exp Share (%) 1994-98 with XRCA<1
preserving of fru	0.0272	preparing and pres	0.1026	preserving & proce	0.3141	preparing and pres	0.0771
preserving & pro	0.2778	dairy products	0.0001	vegetable, animal	1.3564	dairy products	0.0002
vegetable, anim	0.8503	bakery products	0.0000	grain mill products	1.1000	preserving of fruits	0.0156
grain mill produc	0.6778	sugar factories & re	0.0063	sugar factories & re	0.0184	bakery products	0.0000
food prodcuts ne	2.8268	cocoa chocolate &	0.0000	food prodcuts nes.	0.9873	cocoa chocolate &	0.0001
spinning weaving	12.2965	manfucture of prepa	0.0000	spinning weaving a	14.3623	manfucture of prep	0.0001
made-up textile	0.2738	distilling rectifying	0.0002	made-up textile go	0.1821	distilling rectifying	0.0008
knitting mills	1.1965	wine industires	0.0000	knitting mills	2.3339	wine industires	0.0000
manufacture of c	1.4527	malt liquors and ma	0.0000	manufacture of car	0.9420	malt liquors and ma	0.0000
tanneries and lea	1.2577	soft drinks and carb	0.0000	cordage rope and t	0.0004	soft drinks and carb	0.0000
leather, leather	0.1806	cordage rope and tw	0.0001	tanneries and leath	0.3292	textiles nes.	0.0087
paints varnishes	0.0057	textiles nes.	0.0044	leather, leather sul	0.2573	fur dressing and dy	0.0000
drugs and medici	0.7804	fur dressing and dye	0.0000	drugs and medicine	1.0906	printing publishing	0.0030
soap, cleaning p	0.0492	printing publishing	0.0034	cutlery hand tolls a	0.0653	paints varnishes ar	0.0005
cutlery hand tolls	0.0603	chemical products	0.0726	motorcycles and bi	0.1079	soap, cleaning pre	0.0343
motorcycles and	0.0792	furniture and fixtur	0.0001			chemical products	0.0998
		structural metal pro	0.0174			furniture and fixtur	0.0001
		facribated metal pro	0.2249			structural metal pro	0.0161
		electrical ind. Mach	0.0248			facribated metal pr	0.3381
		radio t.v. communi	0.0653			electrical ind. Mac	0.0421
		electrical appliance	0.0011			radio t.v. communi	0.1442
		electrical apparatu	0.0793			electrical appliance	0.0010
		shipbuilding and re	0.0004			electrical apparatu	0.0412
		railroad equipment	0.0006			shipbuilding and re	0.0014
		motor vehicles	0.3789			railroad equipmen	0.0003
		aircraft	0.0011			motor vehicles	0.5447
		transport equipmer	0.0000			aircraft	0.0005
						transport equipme	0.0000
Total weighted average indsutrial *Exports shares(%)*	*22.2925*		*0.9837*		*23.4471*		*1.3698*

Less Pollutive Industries

Ind.Name	Exp Share (%) 1984-88 with XRCA >1	Ind.Name	Exp Share (%) 1984-88 XRCA <1	Ind.Name	Exp Share (%) 94-98 XRCA >1	Ind.Name	Exp Share (94-98 with XRCA <
tobacco manufactu	0.1079	sawmills planing	0.0015	wearing apparel e	22.097	tobacco manufacture	0.0194
wearing apparel e	20.5426	wooden and can	0.0000	footwear except v	0.760	sawmills planing and	0.0013
footwear except vu	1.1539	wood and cork p	0.0000	tyres and tube indu	0.094	wooden and cane co	0.0000
jewellery and relat	51.5744	furniture and fix	0.0000	jewellery and rela	47.509	wood and cork produ	0.0000
sporting and athlet	0.0051	miscellaneous p	0.0000			furniture and fixtures	0.0000
		tyres and tube in	0.0563			miscellaneous porud	0.0000
		rubber products r	0.0084			rubber products nes.	0.0112
		plastic products r	0.0106			plastic products nes.	0.0489
		pottery china an	0.0005			pottery china and ea	0.0008
		glass and glass p	0.0038			glass and glass produ	0.0081
		engine and turbi	0.0097			engine and turbines	0.0144
		agriculture mach	0.0008			agriculture machinery	0.0010
		matal and woodw	0.0381			matal and woodworki	0.0207
		special ind. mach	0.1740			special ind. machiner	0.1389
		office computing	0.0329			office computing and	0.0534
		macinery & equip	0.0715			macinery & equipmen	0.0574
		prof. & scientific	0.0088			prof. & scientific, equ	0.0100
		photographic an	0.0049			photographic and op	0.0013
		watches and clo	0.0000			watches and clocks	0.0006
		musical instrume	0.0002			musical instruments	0.0002
		industries nes.	0.0057			sporting and athletic	0.0040
						industries nes.	0.0148
Total weighted average indsutrial *Exports shares(%)*	*73.3840*		*0.4280*		*70.459*		*0.4064*

Notes: (1) Analysis is based on ISIC data at 4-digit level of 56 closed sample countries out of 67 total
(2) Data Source: World Bank: Production and Trade Data:2001

The competitiveness indicator for Pakistan's manufacturing export sectors in table 6.3 reveals that the country is not a key player in specializing in most pollutive industrial export and capturing the large share of weighted exports in total weighted exports flows in both the beginning and end sample period. The industrial exports are highly concentrated on somewhat pollutive industries group that encompasses the most significant chunk of total trade flows. Within that group, as observed through the staggering over 80 percent exports share within the specialized group, i.e., XRCA>1 from the total, the textile industry is acting as the backbone of industrial exports. However, the same pollutive industries group depicted a loss of competitiveness over time as the weighted export share reduced to 86 percent in 1994-98 compared to 90 percent in 1984-88. On the other hand, relatively cleaner sectors, i.e., less pollutive industries, gained export competitiveness as observed through the rising weighted average export share to around 13 percent in 1994-98 from around 9 percent in 1984-88.

Table 6.4 the results pertaining to the export competitiveness indicator for the Bangladesh industrial sectors cover the 1984-98 period. They show that not even a single industry in the most pollutive industries group was in the specialized category in the beginning sample period. And in the last sample period, there was only one industry in the specialized group with a weighted export share of just .15 in total export flows and depicted some competitiveness improvement in the group of most pollutive industries. There is a drastic reduction in weighed export shares among somewhat pollutive industries category and thus loss of export competitiveness of specialized industries with XRCA>1 from about 25 percent in 1984-88 to around 9 percent in the end sample period, 1994-98. For the last category of pollutive industries, less pollutive industries covering the largest weighted export share of the total in specialized industries between 74 percent in 1984-88 to staggering 91 percent 1994-98 depicted the gain in competitiveness over time.

Table-6.3

Pakistan's Manufacturing Export's Competitiveness: 1984-98

Most Pollutive Industries*						Some What Pollutive Industries								Less Pollutive Industries							
Ind.Name	Exp Share (%) 1984-88 with XRCA>1	Ind.Name	Exp Share (%) 1984-88 with XRCA<1	Ind.Name	Exp Share (%) 1994-98 with XRCA <1	Ind.Name	Exp Share (%) 1984-88 with XRCA >1	Ind.Name	Exp Share (%) 1984-88 with XRCA <1	Ind.Name	Exp Share (%) 1994-98 with XRCA >1	Ind.Name	Exp Share (%) 1994-98 with XRCA <	Ind.Name	Exp Share (%) 1984-88 with XRCA >1	Ind.Name	Exp Share (%) 1984-88 XRCA <1	Ind.Name	Exp Share (%) 94-98 XRCA >1	Ind.Name	Exp Share 94-98 with XRCA <1
fertilizers and pestic	0.0003	pulp paper and paper	6E-07	pulp paper and paper	1.1E-07	preserving & pro	0.074	preparing and preservir	0.005	preserving & processing	0.054	preparing and preserving	0.004	wearing apparel excep	9.159	tobacco m	0.002	wearing a	12.939		
		contaniers, boxes of p	5E-07	contaniers, boxes of pa	7.4E-08	grain mill produc	2.511	dairy products	0.000	grain mill products	1.519	dairy products	0.000	sporting and athletic g	0.150	footwear	0.015	sporting a	0.256	tobacco manufacture	0.000
		pulp paper, paperboa	2E-07	pulp paper, paperboard	9.8E-07	sugar factories &	0.037	preserving of fruits & ve	0.003	sugar factories & refiner	0.069	preserving of fruits & veg	0.003			sawmills p	0.000			footwear except vul	0.015
		basic industrial chem	1E-04	basic industrial chemic	4.8E-05	spinning weaving	81.897	vegetable, animal oils &	0.000	spinning weaving and fi	77.994	vegetable, animal oils &	0.000			wooden a	0.000			sawmills planing and	0.000
		synthetic resins plasti	3E-03	fertilizers and pesticide	2.1E-05	made-up textile	3.271	bakery products	0.000	made-up textile goods	3.544	bakery products	0.000			wood and	0.000			wooden and cane c	0.000
		petroleum products	1E-02	synthetic resins plastic	1.8E-02	knitting mills	0.438	cocoa chocolate & suga	0.000	knitting mills	2.095	cocoa chocolate & sugar	0.000			furniture	0.000			wood and cork prod	0.000
		structural clay product	7E-07	petroleum products	3.1E-03	manufacture of ca	0.964	food prodcuts nes.	0.008	manufacture of carpets a	0.404	food prodcuts nes.	0.004			miscellar	0.000			furniture and fixture	0.000
		cement lime and plas	7E-07	structural clay products	5.3E-07	cordage rope and	0.000	manfucture of prepared	0.000	cordage rope and twine	0.000	manfucture of prepared a	0.000			tyres and	0.000			miscellaneous poru	0.000
		non-metallic mineral p	2E-03	cement lime and plast	2.2E-05	tanneries and lea	1.276	distilling rectifying and b	0.000	textiles nes.	0.337	distilling rectifying and bl	0.000			rubber pr	0.000			tyres and tube indus	0.000
		iron and steel basic in	8E-04	non-metallic mineral pi	1.0E-03			wine industires	0.000	tanneries and leather fir	0.586	wine industires	0.000			plastic pr	0.000			rubber products nes.	0.000
		non-ferrous metal bas	1E-06	iron and steel basic ind	2.9E-05			malt liquors and malt	0.000			malt liquors and malt	0.000			pottery cl	0.000			plastic products nes.	0.000
				non-ferrous metal basic	1.2E-06			soft drinks and carbonat	0.000			soft drinks and carbonate	0.000			glass and	0.000			pottery china and ea	0.000
								textiles nes.	0.017			fur dressing and dyeing	0.000			engine a	0.000			glass and glass proc	0.000
								fur dressing and dyeing	0.000			leather, leather subst. ex	0.001			agricultur	0.000			engine and turbines	0.000
								leather, leather subst. e	0.001			printing publishing and a	0.000			matal and	0.000			agriculture machine	0.000
								printing publishing and a	0.000			paints varnishes and lac	0.000			special in	0.010			matal and woodworl	0.000
								paints varnishes and lac	0.000			drugs and medicines	0.004			office cor	0.000			special ind. machine	0.003
								drugs and medicines	0.001			soap, cleaning preparati	0.000			macinery	0.000			office computing an	0.000
								soap, cleaning preparat	0.000			chemical products nes.	0.001			prof. & sc	0.124			macinery & equipme	0.000
								chemical products nes.	0.001			cutlery hand tolls and ge	0.002			photogra	0.000			prof. & scientific, eq	0.119
								cutlery hand tolls and ge	0.003			furniture and fixtures pri	0.000			watches a	0.000			photographic and o	0.000
								furniture and fixtures pr	0.000			structural metal products	0.000			jewellery	0.002			watches and clocks	0.000
								structural metal products	0.000			facribated metal prod. ex	0.001			musical i	0.000			jewellery and relate	0.001
								facribated metal prod. e	0.003			electrical ind. Machinery	0.000			industries	0.003			musical instruments	0.000
								electrical ind. Machiner	0.000			radio t.v. communicatior	0.000							industries nes.	0.016
								radio t.v. communicatio	0.000			electrical appliances and	0.000								
								electrical appliances an	0.000			electrical apparatus, sup	0.000								
								electrical apparatus, su	0.000			shipbuilding and repairin	0.000								
								shipbuilding and repairi	0.002			railroad equipment	0.000								
								railroad equipment	0.000			motor vehicles	0.000								
								motor vehicles	0.000			motorcycles and bicycles	0.000								
								motorcycles and bicycle	0.000			aircraft	0.000								
								aircraft	0.002			transport equipment nes	0.000								
								transport equipment ne	0.000												
Total weighted average indsutrial *Exports shares(%)*	*0.0003*		*2E-02*		*2.3E-02*		*90.470*				*86.603*		*0.023*		*9.309*		*0.157*		*13.195*		*0.157*

Notes: (1) Analysis is based on ISIC data at 4-digit level of 56 closed sample countries out of 67 total
(2) Data Source: World Bank: Production and Trade Data:2001
*: No industry among "most pollutive industries" category had RCA >1 in 1994-98.

Table-6.4

Bangladesh's Manufacturing Export's Competitiveness: 1984-98

Most Pollutive Industries

Ind.Name	Exp Share (%) 1984-88* with XRCA>1	Ind.Name	Exp Share (%) 1984-88 with XRCA<1	Ind.Name	Exp Share (%) 1994-98 with XRCA >1	Ind.Name	Exp Share (%) 1994-98 withXRCA<1
		pulp paper and paper	0.000	fertilizers and pesticid	0.14959	pulp paper and paper	0.000
		contaniers, boxes of p	0.000			contaniers, boxes of p	0.000
		pulp paper, paperboar	0.000			pulp paper, paperboar	0.000
		basic industrial chemi	0.000			basic industrial chemi	0.000
		fertilizers and pesticid	0.049			synthetic resins plastic	0.000
		synthetic resins plastic	0.000			petroleum products	0.017
		petroleum products	0.117			structural clay product	0.000
		structural clay product	0.000			cement lime and plas	0.000
		cement lime and plas	0.000			non-metallic mineral p	0.000
		non-metallic mineral p	0.000			iron and steel basic in	0.000
		iron and steel basic in	0.000			non-ferrous metal basi	0.000
		non-ferrous metal basi	0.000				
Total weighted average indsutrial ***Exports shares(%)***			0.166		0.150		0.017

Some What Pollutive Industries

Ind.Name	Exp Share (%) 1984-88 with XRCA >1	Ind.Name	Exp Share (%) 1984-88	Ind.Name	Exp Share (%) 1994-98 with XRCA >1	Ind.Name	Exp Share (%) 1994-98 with XRCA<1
preparing and preserv	0.066	dairy products	0.000	preserving & processi	0.473	preparing and preserv	0.066
preserving & processi	1.287	preserving of fruits & v	0.000	food prodcuts nes.	0.090	dairy products	0.000
food prodcuts nes.	0.631	vegetable, animal oils	0.000	spinning weaving and	2.050	preserving of fruits & v	0.000
spinning weaving and	10.423	grain mill products	0.000	made-up textile goods	1.221	vegetable, animal oils	0.000
made-up textile goods	7.395	bakery products	0.000	knitting mills	3.357	grain mill products	0.000
manufacture of carpets	0.015	sugar factories & refine	0.000	manufacture of carpets	0.002	bakery products	0.000
cordage rope and twin	0.028	cocoa chocolate & sug	0.000	cordage rope and twin	0.100	sugar factories & refine	0.000
tanneries and leather f	4.949	manfucture of prepare	0.000	tanneries and leather f	1.301	cocoa chocolate & sug	0.000
		distilling rectifying and	0.000			manfucture of prepare	0.000
		wine industires	0.000			distilling rectifying and	0.000
		malt liquors and malt	0.000			wine industires	0.000
		soft drinks and carbona	0.000			malt liquors and malt	0.000
		knitting mills	0.328			soft drinks and carbona	0.000
		textiles nes.	0.000			textiles nes.	0.000
		fur dressing and dyeing	0.000			fur dressing and dyeing	0.000
		leather, leather subst.	0.000			leather, leather subst.	0.000
		printing publishing and	0.000			printing publishing and	0.000
		paints varnishes and l	0.000			paints varnishes and l	0.000
		drugs and medicines	0.000			drugs and medicines	0.000
		soap, cleaning prepar	0.000			soap, cleaning prepar	0.000
		chemical products nes	0.000			chemical products nes	0.000
		cutlery hand tolls and	0.000			cutlery hand tolls and	0.000
		furniture and fixtures	0.000			furniture and fixtures	0.000
		structural metal produ	0.001			structural metal produ	0.001
		facribated metal prod.	0.000			facribated metal prod.	0.000
		electrical ind. Machin	0.000			electrical ind. Machin	0.000
		radio t.v. communicat	0.000			radio t.v. communicat	0.000
		electrical appliances a	0.000			electrical appliances a	0.000
		electrical apparatus, s	0.000			electrical apparatus, s	0.000
		shipbuilding and repai	0.002			shipbuilding and repai	0.002
		railroad equipment	0.000			railroad equipment	0.000
		motor vehicles	0.001			motor vehicles	0.001
		motorcycles and bicyc	0.000			motorcycles and bicyc	0.000
		aircraft	0.000			aircraft	0.000
		transport equipment n	0.000			transport equipment n	0.000
Exports shares(%)	24.794		0.333		8.593		0.067

Less Pollutive Industries

Ind.Name	Exp Share (%) 1984-88 with XRCA >1	Ind.Name	Exp Share (%) 1984-88 XRCA <1	Ind.Name	Exp Share (%) 94-98 XRCA >1	Ind.Name	Exp Share 94-98 with XRCA <
wearing apparel exce	74.67642	tobacco manufacture	0.001	wearing apparel exce	91.200	tobacco manufacture	0.000
wooden and cane con	0.00079	footwear except vulca	0.000	pottery china and eart	0.003	footwear except vulca	0.007
		sawmills planing and	0.000	sporting and athletic g	0.004	sawmills planing and	0.001
		wood and cork produ	0.000			wooden and cane con	0.000
		furniture and fixtures	0.000			wood and cork produ	0.000
		miscellaneous porudc	0.000			furniture and fixtures	0.000
		tyres and tube industri	0.000			miscellaneous porudc	0.000
		rubber products nes.	0.000			tyres and tube industri	0.000
		plastic products nes.	0.000			rubber products nes.	0.000
		pottery china and eart	0.000			plastic products nes.	0.000
		glass and glass produ	0.000			glass and glass produ	0.000
		engine and turbines	0.000			engine and turbines	0.000
		agriculture machinery	0.000			agriculture machinery	0.000
		matal and woodworkir	0.001			matal and woodworkir	0.000
		special ind. machinery	0.008			special ind. machinery	0.012
		office computing and	0.000			office computing and	0.000
		macinery & equipment	0.020			macinery & equipment	0.007
		prof. & scientific, equi	0.000			prof. & scientific, equi	0.000
		photographic and opti	0.000			photographic and opti	0.000
		watches and clocks	0.000			watches and clocks	0.000
		jewellery and related	0.000			jewellery and related	0.000
		musical instruments	0.000			musical instruments	0.000
		sporting and athletic g	0.000			industries nes.	0.000
Exports shares(%)	74.677		0.030		91.207		0.028

Notes: (1) Analysis is based on ISIC data at 4-digit level of 56 closed sample countries out of 67 total

(2) Data Source: World Bank Production and Trade Data(2001)

*: No industry among "most pollutive industries" category had RCA >1 in 1984-88.

Overall results for three South Asian countries based on the export competitiveness index showed that over time while India and Bangladesh depicted the gain in export competitiveness among the group of most pollutive industries, Pakistan showed the loss in competitiveness position in the same group. Following the same competitiveness indicator, India experienced a rise in weighted export share in specialized industries over time and thus competitiveness in somewhat pollutive industries category. The other two countries showed a decline in export shares of specialized industries and experienced export competitiveness lost in the same pollutive industrial category. For the third category of relatively cleaner industries, both Pakistan and Bangladesh have increased their share in the specialized commodities and thus improved competitiveness whereas, India lost it. The theoretical outcomes described in theoretical chapter-3 revealed that *ceteris paribus*, environmental regulation cause most pollutive industries to lose competitiveness, and industry production and export specialization patterns could move towards cleaner sectors. The empirical results for Pakistan support this theoretical prediction, while in the case of India and Bangladesh, the results are not convincing to support the theory. One plausible reason for getting less support from the theory for India and Bangladesh empirical results could be the prevalence of competing hypothesis- pollution haven hypothesis - thus differential of environmental regulations between rich North and poor South allowing later to specialize in most pollutive industries through protective trade and tariff policies. For example, South Asian countries have had a long track record of pursuing import substitution and protective industrialization policies in the 1980s and early 1990s (Naqvi and Schuler, 2007). The study gathered further information by extending the analysis on South Asian countries and examining how the trade (export and import) specialization patterns changed during 1984-2004. It, therefore, measures the competitiveness index following equations 6.2 and 6.3, which is a preferred methodology for pollutive industrial trade (XU, 1999).

6.4.2 South Asian Economics: Trade Competitiveness of Pollutive Industries

In tables 6.5-6.7.1, based on equations 6.2 and 6.3, the trade specialization patterns have been reported for the time series analysis covering the period 1984-2004 for three South Asian countries, including India, Pakistan, and Bangladesh. It shows the normalized weighted (commodity weights are average trade share during period 1989-93) trade volume of three industrial categories viz. most pollutive, somewhat pollutive and less pollutive industries with further bifurcation of specialized and non-specialized traded commodities. The weighted trade shares are computed to examine the impact of environmental policy on trade flows of those industries having both XRCA and XRCDA. Results are expected to provide further in-depth information regarding the competitiveness impact of environmental regulation on different industries trade categories. Moreover, as indicated before XRCA index is a dichotomous measure and each commodity at a particular point and time is either in a state of specialization or non-specialization. The analysis, therefore, would judge the competitiveness position of these traded industries in terms of changing specialization patterns of weighted normalized trade shares between beginning and end study periods.

Tables 6.5 and 6.5.1 show India's trade specialization patterns of manufacturing industries during 1984-88 and 1994-98 and 1984-88 and 2000-2004 in a dichotomous framework. These percentage figures of trade flows in three different categories of pollutive manufacturing exports should sum to 100 in a specific period. For example, in table 6.5, the number in columns 2, 5, 14, 17, 26, 29 for the beginning of sample period 1984-88 for Indian should sum to 100. Comparing the results of 1984-88 with 1994-98, the normalized weighted trade share of most pollutive specialized industries, i.e., with XRCA >1, stood at around 15 percent (ISIC: 3530-synthetic resins plastic, man-made fiber) in 1984-88 which remained around 15 percent during the end period 1994-98. However, the significant change that has been witnessed during the end period in most pollutive industries category is the rise in the number of pollutive industries that moved from non-specialized group in 1984-88 to specialized group. These industries include basic industrial chemical except fertilizer, fertilizers and pesticides, cement lime and plaster, non-metallic mineral products nes, iron and steel basic industries. India increased its trade share in most pollutive industries to 19.43 percent with XRCA>1 during 2000-2004, as reported in table 6.5.1, and kept the majority of most pollutive industries in the specialized group. Also, the normalized percentage share of non-specialized industries i.e., industries with XRCA <1 was around 24 percent in 1984-88 that slightly reduce to 23 percent in 1994-98. The non-specialized share in the same group reduced drastically to 3 percent in 2000-2004, indicating that in end period, the share of non-specialization industries being shifted either to specialized industries group and or to other industrial pollutive trade categories. The results suggested that India's overtime trade competitiveness position in most pollutive industries has improved both in terms of the rising number of commodities moved to the specialized group within the same industry group and increased most pollutive industries group trade share between the pollutive categories groups.

Table 6.5

IndiaTrade Specialization Pattern: Comparative Analysis of 1984-88 Versus 1994-98

Most Pollutive Industries

1	2	3	4	5	6	7	8	9	10	11	12
1984-88						1994-98					
	RCA > 1			RCA < 1			RCA > 1		Ind.code	RCA <1	
Ind.code	Normalized trade share	RCA	Ind.code	Normalized trade share	RCA	Ind.code	Normalized trade share	RCA		Normalized trade share	RCA
3530	15.414	1.307	3411	0.665	0.018	3511	9.849	1.355	3411	0.408	0.114
			3412	0.000	0.063	3512	1.450	1.350	3412	0.000	0.131
			3419	0.003	0.035	3692	0.002	2.053	3419	0.002	0.119
			3511	9.678	0.472	3699	0.022	2.212	3513	1.637	0.451
			3512	2.489	0.381	3710	3.304	1.239	3530	19.183	0.712
			3513	2.312	0.117				3691	0.003	0.302
			3691	0.004	0.102				3720	1.721	0.482
			3692	0.000	0.221						
			3699	0.007	0.639						
			3710	7.106	0.256						
			3720	1.865	0.273						
Normalized Weighted Total Trade Share	**15.414**			**24.128**			**14.628**			**22.954**	

Some What Pollutive Industries

13	14	15	16	17	18	19	20	21	22	23	24
1984-88						1994-98					
	RCA > 1			RCA < 1			RCA > 1			RCA < 1	
Ind.code	Normalized trade share	RCA	Ind.code	Normalized trade share	RCA	Ind.code	Normalized trade share	RCA	Ind.code	Normalized trade share	RCA
3113	0.014	1.593	3111	0.053	0.610	3114	0.157	2.624	3111	0.042	0.605
3114	0.139	2.050	3112	0.009	0.046	3115	0.968	4.182	3112	0.001	0.077
3115	1.003	2.232	3117	0.000	0.139	3116	0.553	14.578	3113	0.008	0.812
3116	0.365	7.451	3118	0.016	0.619	3118	0.016	2.052	3117	0.000	0.089
3121	1.438	8.104	3119	0.000	0.060	3121	0.517	3.153	3119	0.000	0.110
3211	6.286	3.433	3122	0.000	0.126	3211	7.366	4.854	3122	0.000	0.243
3212	0.138	5.763	3131	0.000	0.061	3212	0.091	3.680	3131	0.000	0.253
3213	0.598	2.075	3132	0.000	0.006	3213	1.167	3.072	3132	0.000	0.004
3214	0.726	17.799	3133	0.000	0.029	3214	0.471	14.648	3133	0.000	0.070
3231	0.632	13.552	3134	0.000	0.012	3215	0.000	2.125	3134	0.000	0.015
3233	0.090	3.237	3215	0.000	0.423	3231	0.176	3.270	3219	0.013	0.677
3521	0.004	1.509	3219	0.012	0.438	3233	0.129	3.708	3232	0.000	0.000
3522	0.628	1.972	3232	0.000	0.036	3522	0.743	1.942	3420	0.024	0.256
3523	0.025	1.745	3420	0.046	0.283	3811	0.034	1.188	3521	0.001	0.124
3811	0.032	1.193	3529	0.344	0.368	3844	0.055	1.881	3523	0.018	0.764
3844	0.049	1.719	3812	0.000	0.170				3529	0.304	0.480
			3813	0.075	0.457				3812	0.000	0.095
			3819	0.393	0.505				3813	0.021	0.492
			3831	0.494	0.181				3819	0.333	0.732
			3832	1.586	0.094				3831	0.361	0.221
			3833	0.001	0.132				3832	1.261	0.131
			3839	0.202	0.736				3833	0.001	0.113
			3841	0.047	0.027				3839	0.119	0.243
			3842	0.016	0.564				3841	0.036	0.142
			3843	0.693	0.118				3842	0.008	0.241
			3845	0.324	0.052				3843	0.607	0.186
			3849	0.000	0.005				3845	0.403	0.022
									3849	0.000	0.035
	12.168			**4.310**			**12.443**			**3.561**	

Less Pollutive Industries

24	26	27	28	29	30	31	32	33	34	35	36
1984-88						1994-98					
	RCA > 1			RCA < 1			RCA > 1			RCA < 1	
Ind.code	Normalized trade share	RCA	Ind.code	Normalized trade share	RCA	Ind.code	Normalized trade share	RCA	Ind.code	Normalized	RCA
									3140	0.010	0.462
3140	0.054	2.945	3311	0.002	0.095	3220	11.049	4.408	3311	0.001	0.083
3220	10.271	4.443	3312	0.000	0.119	3240	0.381	2.431	3312	0.000	0.232
3240	0.577	3.446	3319	0.000	0.223	3551	0.047	1.579	3319	0.000	0.098
3901	26.208	23.875	3320	0.000	0.019	3901	30.527	22.299	3320	0.000	0.029
3903	0.003	1.038	3540	0.009	0.022				3540	0.039	0.061
			3551	0.028	0.889				3559	0.022	0.712
			3559	0.017	0.699				3560	0.032	0.395
			3560	0.010	0.121				3610	0.000	0.326
			3610	0.000	0.189				3620	0.015	0.534
			3620	0.019	0.281				3821	0.076	0.472
			3821	0.096	0.290				3822	0.001	0.233
			3822	0.001	0.149				3823	0.455	0.240
			3823	0.481	0.445				3824	2.146	0.271
			3824	3.491	0.335				3825	0.229	0.116
			3825	0.176	0.106				3829	0.986	0.191
			3829	2.002	0.243				3851	0.370	0.134
			3851	0.499	0.128				3852	0.012	0.065
			3852	0.024	0.261				3853	0.001	0.273
			3853	0.004	0.019				3902	0.000	0.361
			3902	0.000	0.309				3903	0.002	0.754
			3909	0.007	0.213				3909	0.012	0.437
	37.114			**6.866**			**42.003**			**4.410**	

Notes: (1) Analysis is based on ISIC data at 4-digit level of 56 closed sample countries out of 67 total
(2) Data Source: World Bank: Production and Trade Data:2001

Table-6.5.1

IndiaTrade Specialization Pattern: Comparative Analysis of 1984-88 Versus 2000-2004

	Most Pollutive Industries								Some What Pollutive Industries										Less Pollutive Industries					
		Trade Share (%)		Trade Share (%)		Trade Share (%)		Trade Share (%)		Trade Share (%)		Trade Share (%)		Trade Share (%)		Trade Share (%)		Trade Share (%)		Trade Share (%)		Trade Share (%)		Trade Shar
		1984-88		1984-88		2000-04		2000-04		1984-88		1984-88		2000-04		2000-04		1984-88		1984-88		2000-04		2000-04
	Ind.code	with XRCA>1	Ind.code	with XRCA<1	Ind.code	with XRCA>1	Ind.code	with XRCA<1	Ind.code	with XRCA>1	Ind.code	with XRCA <1	Ind.code	with XRCA>1	Ind.code	with XRCA <1	Ind.code	with XRCA>1	Ind.code	with XRCA <1	Ind.code	with XRCA>1	Ind.code	with XRCA <1
			341	0.55	351	17.35	341	0.40	321	9.67	311	2.50	311	2.53	311	0.00	322	6.691	314	0.0001	322	8.06	314	0.00
			351	17.95	353	0.05	372	1.77	323	2.23	313	0.00	321	8.84	342	0.03	324	0.073	331	0.0007	324	0.09	331	0.00
			353	0.13	369	0.05					342	0.02	323	0.97	352	1.20	390	28.617	332	0.0000	355	0.06	332	0.00
			369	0.02	371	1.98					352	0.83	381	0.56	383	7.23			354	0.0029	390	27.65	354	0.00
			371	3.57							381	0.39			384	3.19			355	0.0333			356	0.02
			372	0.74							383	4.08							356	0.0042			361	0.00
											384	2.34							361	0.0001			362	0.01
																			362	0.0136			382	17.13
																			382	18.8970			385	0.81
																			385	0.6301				
Total weighted Industries																								
Trade share (%)				22.966		19.433		2.165		11.904		10.167		12.904		11.656		35.381		19.582		35.859		17.982

Notes: (1) Analysis is based on ISIC data at 3-digit level of 56 closed sample countries out of 67 total

(2) Data Source: World Bank: Production and Trade Data:2006

For the somewhat pollutive Industries category, the normalized weighted trade flow share of specialized traded industries, which was around 12 percent in 1984-88, remained the same in 1994-98. It did not change till the end sample period 2000-04 and stood at 12 percent. The industry that captured the highest share within this category was code 3211(spinning weaving and finishing textiles) with 6.3 percent in total in 1984-88 and rose to a little over 7 percent in 1994-98, and the share of the textile industry in the category of the somewhat pollutive industry was to the tune of 8 percent during 2000-2004, indicating that textile maintained its trade share and have not moved significantly during almost 20 years. Moreover, some industries such as food products fabricated metals in non-specialized groups in 1984-88 moved to specialized groups in 2000-2004 hence increasing their competitiveness in the world market, as reported in table 6.5.1. Turning to a non-specialized group of industries for the same pollutive industry category trade share from 1984-88 to 1994-98 dropped from 4.3 percent in the beginning period to 3.6 percent in the end period, but the share of the non-specialized group rose drastically to 12 percent in 2000-2004, the significant contributors were industries such as machinery electric (7.23%) and transport equipment industry (3.19 %) as seen in table 6.5.1. India maintained its competitiveness of trade specialization patterns in somewhat pollutive industries group.

Among three pollutive industrial categories for India less pollutive industries category account for the largest percentage share in total trade flows in both sample periods. However, the trade share in specialized group is concentrated on a selected few industries and not seen widely dispersed within cleaner sectors of manufacturing trade. The normalized weighted trade share of less pollutive industries which were in a position of specialization (XRCA>1) in 1984-88 stood at 37 percent and the same increased to 42 percent in 1994-98, as in table 6.5. The largest contributing industries in this pollutive category for both periods were 3220 (wearing apparel except footwear) with share of around 10 percent in 1984-88 and 11 percent in 1994-98 and industrial commodity with ISIC- code 3901 (jewelry and related articles) with weighted trade share of 26 percent in 1984-88 and 30 percent in 1994-98 that remained highest compared to all other industries in the less pollutive industries category. These industries were also found to have the highest export share in total trade flows during both sample periods. The trend continued in 2000-2004. The trade share of specialized industries was around 36 percent and key contributing industries to capture this large share were wearing apparel (8.06%) and other industries, including jewelry (27.65%). A further comparison between the shift of industries between specialized and non-specialized between the period 1984 till 2004 show that sectors which were in a specialized group in 1984-88 remained specialized in 2000-2004, and also industry such as rubber industry (ind. Code 355) which was in a non-specialized group in 1984-

88 moved to the specialized group in 2000-2004. The competitiveness position of India for least pollutive category has overall strengthened in end sample period compared to beginning period in the light of the rising weighted trade share in total trade flows and an increase in number of industrial trade specialization in the same pollutive group.

When the study compared the less pollutive industries category with the most pollutive category of manufacturing trade, India showed competitiveness gains in both groups. The results show that in addition to compliance with environmental standards, other conventional sources of comparative advantage such as skills and productivity could be a vital determinant of industrial production and trade competitiveness. The results show that environmental regulations have not negatively impacted on most pollutive to least pollutive industries of India's manufacturing trade. In light of competitiveness gains in most pollutive sectors over time, the pollution haven effect seemed relevant to India’s pollutive industrial trade flows.

The results reported in tables 6.6 and 6.6.1 explain the trade specialization patterns for the same three pollutive industries groups for Pakistan’s economy covering from 1984 till 2004. For most pollutive industries group, the results show that Pakistan’s trade share in a specialized group with XRCA>1 was just around 1 percent in total trade flows in 1984-88, and that was in chemical industries. For the remaining most pollutive industries, the country was in a non-specialized group in 1984-88 and 1994-98, and that position did not improve till 2000-2004. For the same most pollutive industrial category where most of the research in trade and environmental regulations is concentrating on the trade shares of the non-specialized group have increased in 1994-98 to 27 percent from 21 percent in 1984-88 and remained around 20 percent in 2000-2004. Pakistan's manufacturing sectors have not been able to gain trade competitiveness during the period under review, and the country instead lost the comparative advantage and industrial trade specialization in end sample periods.

It is a somewhat pollutive industries category that depicts the highest weighted trade share in total trade flows for Pakistan manufacturing sectors, which in 1984-88 for specialized groups stood at 45.5 percent for industries with XRCA >1. This share slightly dropped to 43.5 percent during 1994-98 and remained at 42.77 percent in 2000-2004 (see tables 6.6 and 6.6.1). The most significant contributing industry in trade specialization share was that of the textile industry whose trade share in specialized remained conspicuously high in somewhat pollutive trade category during entire sample period 1984-2004. Moreover, almost all manufacturing commodities that were in a specialized group in 1984-88 remained in the same specialized group during 1994-98. Furthermore, the commodity that moved from non-specialized group to specialized group was Ind code-3219 (textiles nes.). Also, the country's food industry (ind code 311) that was in the specialized group in 1984-88 moved to the non-specialized group in 1994-98 and remained in the non-specialized group in 2000-2004. For the same industrial category, the weighted trade shares of the non-specialized group were around 16 percent during 1984-88. It reduced to 13.1 percent during 1994-98. Part of this industrial category share moved to less pollutive industries whose weighted trade share for the specialized industries group rose to 6.6 percent in 1994-98 from 4.6 percent in 1984-88. However, a further comparison for a somewhat pollutive industry category in the non-specialization trade group shows that during 2000-2004 the trade share of the non-specialized group did not change significantly and observed at 13.7 percent, a very marginal change from 13.1 percent from 1994-98.

In the less pollutive industry group, which by definition is the least pollutive industry group, normalized weighted trade shares of non-specialized industries in both periods have just dropped by around 1 percent in 1994-98 to 9 percent from total trade flows from around 10 percent in1984-88. These industrial trade share further dropped to 7.16 percent in 2000-2004. Table 6.6.1 further looks at the movement of industries from specialized groups to non-specialized groups in the cleaner sector shows that other industries (Ind. code 390) were in a specialized group in 1984-88 but moved to the non-specialized group in 2000-2004. However, compared to the trade share of specialized groups between periods 1984-88 to 2000-2004 it remained around 7 percent but with a smaller number of specialized industries. Therefore, these results indicate that firstly, Pakistan has lost its industrial trade specialization or at least has not gained it in most pollutive industries. Secondly, it is a somewhat pollutive industries category that captures the large chunk of weighted trade shares from total trade flows, and the same pollutive industrial category broadly maintained its competitiveness. Thirdly, less pollutive industries group has to some extend maintained its trade specialization over the period 1984-2004. Lastly, key manufacturing sectors contributing to international trade with the relatively largest trade specialization shares are textile, leather, and wearing apparel.

In the case of Bangladesh, following results presented in tables 6.7 and 6.7.1, the country is less concentrating in terms of weighted trade share for the most pollutive industries category. There was only one industry during 1984-88 in the same pollutive category XRCA>1 with 3-digit trade analysis. For the same category, the weighted trade share from total trade flows of non-specialized groups has also decreased to 10 percent in 1994-98 and remained at 10 percent in 2000-04 compared to 20 percent trade share in 1984-88. Almost all most pollutive category industries were in non-specialized trade group in end periods, and Bangladesh, like Pakistan, lost over time the trade competitiveness in most pollutive industries.

The trade share of somewhat pollutive industries specialized group was about 29 percent in 1984-88 that rose to around 36 percent in 1994-98 and trade share of the same category was around 23 percent in 2000-04. Also, most of the industries that were in a specialized group in 1984-88 remained in the specialized group in 1994-98 except ind. code 3111 (preparing and preserving meat), which was in the specialized group became non-specialized in 1994-98. The industris within the same category, such as ind. code 3213(knitting mills) in a non-specialized trade share group in 1984-88 moved to specialized groups 1994-98. The share of non-specialized industries for the same category of industries (industries with XRCA <1) also reduced to around 5 percent in 1994-98 from initial period of 10 percent in 1984-88 and it rose to 12 percent in 2000-04. In 1994-98, the reduction of trade share in somewhat pollutive industry partly shifted to less pollutive industries category and partly to the specialized industries group within less pollutive industries whose weighted trade share in total trade increased to 46 percent (industrial code 3220: wearing apparel except footwear having 45.6 percent trade share) compared to around 37 percent (with industrial code 3220: wearing apparel except footwear having 37.3 percent trade share) in 1984-88. The share of the specialized group for the same less pollutive industry rose to almost 47 percent in 2000-04. Furthermore, industries such as ind. code 324 (footwear) and 361(pottery) in a non-specialized group in 1984-88 moved to a specialized trade group in 2000-04. Hence, Bangladesh increased its trade competitiveness position in relative cleaner products over the years.

The results for Bangladesh convey that the country in most pollutive trade sectors has lost industrial trade specialization and competitiveness in the 1990s and onwards compared to the 1980s. In somewhat pollutive industries, it increased her trade share in the 1990s but dropped again in the end sample period 2000-04. For less pollutive industries, Bangladesh improved its trade specialization and competitiveness position during end sample periods compared to the beginning period. One plausible reason for gaining competitiveness in less pollutive industries could be what theory predicted that stringent environmental regulations imposed to the most pollutive sectors, keeping other things constant, could shift the locus of production and trade specialization towards relatively cleaner sectors (Krutilla, 1999).

Table 6.6

Pakistan's Trade Specialization Pattern: Comparative Analysis of 1984-88 Versus 1994-98

Most Pollutive Industries

1984-88 RCA > 1 Ind.code	Normalized trade share	RCA >1	1984-88 RCA < 1 Ind.code	Normalized trade share	RCA <1	1994-98* RCA <1 Ind.code	Normalized trade share	RCA <1
3512		1.145	3411	0.362	0.007	3411	0.227	0.002
			3412	0.000	0.219	3412	0.000	0.024
			3419	0.021	0.002	3419	0.017	0.009
			3511	3.791	0.020	3511	4.970	0.009
			3513	3.201	0.042	3512	1.698	0.114
			3530	11.595	0.255	3513	3.017	0.274
			3691	0.005	0.025	3530	16.088	0.113
			3692	0.001	0.002	3691	0.003	0.020
			3699	0.002	0.524	3692	0.000	0.093
			3710	1.839	0.174	3699	0.001	0.384
			3720	0.207	0.001	3710	1.673	0.009
						3720	0.190	0.002
Normalized Weighted Total Trade Share		1.145		21.025			27.885	

Some What Pollutive Industries

1984-88 RCA > 1 Ind.code	Normalized trade share	RCA >1	1984-88 RCA < 1 Ind.code	Normalized trade share	RCA <1	1994-98 RCA > 1 Ind.code	Normalized trade share	RCA >1	1994-98 RCA < 1 Ind.code	Normalized trade share	RCA <1
3114	0.037	1.688	3111	0.034	0.218	3114	0.027	1.445	3111	0.023	0.200
3116	1.256	29.175	3112	0.037	0.015	3116	0.759	22.053	3112	0.012	0.055
3118	0.128	4.386	3113	0.002	0.599	3118	0.106	9.532	3113	0.002	0.701
3211	41.112	14.553	3115	6.142	0.033	3211	39.147	17.396	3115	6.108	0.047
3212	1.637	23.628	3117	0.000	0.364	3212	1.773	25.495	3117	0.000	0.180
3213	0.219	1.553	3119	0.000	0.306	3213	1.048	5.839	3119	0.000	0.339
3214	0.482	29.197	3121	1.088	0.618	3214	0.202	16.108	3121	0.668	0.407
3215	0.000	1.201	3122	0.000	0.367	3215	0.000	1.019	3122	0.000	0.009
3231	0.638	19.074	3131	0.000	0.059	3219	0.169	6.730	3131	0.000	0.098
			3132	0.000	0.000	3231	0.294	8.370	3132	0.000	0.000
			3133	0.000	0.000				3133	0.000	0.007
			3134	0.000	0.133				3134	0.000	0.004
			3219	0.009	0.425				3232	0.000	0.003
			3232	0.000	0.000				3233	0.001	0.365
			3233	0.001	0.442				3420	0.004	0.103
			3420	0.004	0.132				3521	0.002	0.021
			3521	0.001	0.141				3522	0.731	0.233
			3522	0.801	0.079				3523	0.000	0.070
			3523	0.000	0.183				3529	0.280	0.071
			3529	0.243	0.074				3811	0.003	0.423
			3811	0.005	0.542				3812	0.000	0.003
			3812	0.000	0.022				3813	0.145	0.045
			3813	0.105	0.071				3819	0.307	0.065
			3819	0.434	0.141				3831	0.787	0.015
			3831	0.530	0.030				3832	0.586	0.002
			3832	0.845	0.008				3833	0.004	0.007
			3833	0.012	0.018				3839	0.256	0.021
			3839	0.262	0.018				3841	0.001	0.035
			3841	0.005	0.256				3842	0.009	0.040
			3842	0.037	0.006				3843	2.947	0.004
			3843	5.159	0.004				3844	0.038	0.025
			3844	0.043	0.059				3845	0.208	0.025
			3845	0.398	0.157				3849	0.000	0.003
			3849	0.000	0.000						
Normalized Weighted Total Trade Share	45.510			16.199			43.525			13.123	

Less Pollutive Industries

1984-88 RCA > 1 Ind.code	Normalized trade share	RCA >1	1984-88 RCA < 1 Ind.code	Normalized trade share	RCA <1	1994-98 RCA > 1 Ind.code	Normalized trade share	RCA >1	1994-98 RCA < 1 Ind.code	Normalized trade share	RCA <1
3220	4.580	4.417	3140	0.001	0.842	3220	6.470	5.967	3140	0.000	0.094
3903	0.075	7.166	3240	0.007	0.632	3903	0.128	11.971	3240	0.007	0.698
			3311	0.001	0.002				3311	0.001	0.001
			3312	0.000	0.006				3312	0.000	0.010
			3319	0.000	0.078				3319	0.000	0.180
			3320	0.000	0.033				3320	0.000	0.040
			3540	0.002	0.132				3540	0.003	0.212
			3551	0.034	0.036				3551	0.035	0.008
			3559	0.013	0.156				3559	0.009	0.020
			3560	0.009	0.096				3560	0.009	0.048
			3610	0.001	0.222				3610	0.001	0.039
			3620	0.009	0.137				3620	0.010	0.039
			3821	0.286	0.106				3821	0.471	0.086
			3822	0.159	0.050				3822	0.060	0.067
			3823	0.080	0.013				3823	0.038	0.069
			3824	8.517	0.189				3824	6.687	0.067
			3825	0.047	0.003				3825	0.052	0.002
			3829	0.933	0.028				3829	1.207	0.031
			3851	0.343	0.876				3851	0.244	0.804
			3852	0.003	0.011				3852	0.002	0.003
			3853	0.001	0.017				3853	0.000	0.006
			3901	0.001	0.223				3901	0.000	0.145
			3902	0.000	0.125				3902	0.000	0.231
			3909	0.009	0.148				3909	0.034	0.644
Normalized Weighted Total Trade Share	4.654708			10.458			6.59785			8.869	

Notes: (1) Analysis is based on ISIC data at 4-digit level of 56 closed sample countries out of 67 total
(2) Data Source: World Bank: Production and Trade Data:2001
(3) For "Most Pollutive Industry" category no industry had RCA>1 for the period 1994-98

Table 6.6.1

PakistanTrade Specialization Pattern: Comparative Analysis of 1984-88 Versus 2000-2004

Most Pollutive Industries						Some What Pollutive Industries								Less Pollutive Industries							
	Trade Share (%) 1984-88		Trade Share (%) 1984-88		Trade Share (%) 2000-04		Trade Share (%) 1984-88		Trade Share (%) 1984-88		Trade Share (%) 2000-04		Trade Share (%) 2000-04		Trade Share (%) 1984-88		Trade Share (%) 1984-88		Trade Share (%) 2000-04		Trade Share (%) 2000-04
Ind.code	with XRCA>1	Ind.code	with XRCA<1	Ind.code	with XRCA<1	Ind.code	with XRCA>1	Ind.code	with XRCA<1	Ind.code	with XRCA>1	Ind.code	with XRCA<1	Ind.code	with XRCA>1	Ind.code	with XRCA<1	Ind.code	with XRCA>1	Ind.code	with XRCA<1
		341	0.268	341	0.209	311	6.752	313	0.00	321	42.299	311	4.580	322	7.142	314	0.000	322	6.888	314	0.000
		351	10.211	351	13.790	321	39.697	342	0.002	323	0.467	313	0.000	385	0.347	324	0.010	390	0.271	324	0.004
		353	4.800	353	5.199	323	2.099	352	0.705			342	0.002	390	0.369	331	0.001			331	0.001
		369	0.013	369	0.009			381	0.140			352	0.872			332	0.000			332	0.000
		371	0.892	371	0.692			383	2.530			381	0.075			354	0.000			354	0.001
		372	0.096	372	0.085			384	7.214			383	2.366			355	0.053			355	0.060
												384	5.822			356	0.004			356	0.005
																361	0.000			361	0.000
																362	0.006			362	0.008
																382	16.648			382	16.088
																				385	0.206
Normalized Weighted Total Trade Share			*16.28*		*19.98*		*48.55*		*10.59*		*42.77*		*13.72*		*7.86*		*16.72*		*7.16*		*16.37*

Notes: (1) Analysis is based on ISIC data at 3-digit level of 56 closed sample countries out of 67 total

(2) Data Source: World Bank: Production and Trade Data:2006

(3) For "Most Pollutive Industry" category no industry had RCA>1 for the period 1984-88 and 2000-04

Table 6.7

BangladeshTrade Specialization Pattern: Comparative Analysis of 1984-88 Versus 1994-98

Most Pollutive Industries

	1984-88 RCA < 1 Ind.code	1984-88 RCA < 1 Normalized trade share	1984-88 RCA < 1 RCA <1	1984-88 RCA > 1 Ind.code	1984-88 RCA > 1 Normalized trade share	1984-88 RCA > 1 RCA >1	1994-98 Ind.code	1994-98 RCA <1 Normalized trade share	1994-98 RCA <1 RCA <1
	3411	0.145	0.189	3512	0.60	4.16	3411	0.134	0.189
	3412	0.001	0.001				3412	0.001	0.001
	3419	0.007	0.000				3419	0.022	0.000
	3511	2.423	0.001				3511	1.160	0.001
	3512	1.381	0.550				3513	1.275	0.003
	3513	1.711	0.003				3530	3.032	0.518
	3530	7.299	0.518				3691	0.001	0.079
	3691	0.001	0.079				3692	1.057	0.000
	3692	1.247	0.000				3699	0.001	0.007
	3699	0.001	0.007				3710	3.090	0.003
	3710	5.250	0.003				3720	0.305	0.002
	3720	0.505	0.002						
alized Weighted Total Trade Share		*19.972*			*0.6*			*10.076*	

Some What Pollutive Industries

	1984-88 RCA > 1 Ind.code	1984-88 RCA > 1 Normalized trade share	1984-88 RCA > 1 RCA >1	1984-88 RCA < 1 Ind.code	1984-88 RCA < 1 Normalized trade share	1984-88 RCA < 1 RCA <1	1994-98 RCA > 1 Ind.code	1994-98 RCA > 1 Normalized trade share	1994-98 RCA > 1 RCA >1	1994-98 RCA < 1 Ind.code	1994-98 RCA < 1 Normalized trade share	1994-98 RCA < 1 RCA <1
	3111	0.041	1.675	3112	1.269	0.041	3114	0.237	5.133	3111	0.005	0.066
	3114	0.643	7.763	3113	0.000	0.001	3121	0.062	1.567	3112	0.259	0.003
	3121	0.342	6.233	3115	4.918	0.006	3211	32.969	2.749	3113	0.000	0.150
	3211	21.486	7.265	3116	0.249	0.322	3212	0.612	11.728	3115	2.452	0.001
	3212	3.698	46.549	3117	0.000	0.006	3213	1.878	10.905	3116	0.111	0.018
	3214	0.008	6.279	3118	0.192	0.237	3214	0.001	1.428	3117	0.000	0.003
	3215	0.014	7.443	3119	0.000	0.000	3215	0.050	44.918	3118	0.055	0.000
	3231	2.475	31.506	3122	0.000	0.000	3231	0.651	12.132	3119	0.000	0.000
				3131	0.000	0.000				3122	0.000	0.000
				3132	0.000	0.000				3131	0.000	0.039
				3133	0.000	0.000				3132	0.000	0.000
				3134	0.000	0.000				3133	0.000	0.027
				3213	0.194	0.884				3134	0.000	0.000
				3219	0.031	0.269				3219	0.142	0.012
				3232	0.000	0.000				3232	0.000	0.000
				3233	0.000	0.019				3233	0.000	0.073
				3420	0.012	0.113				3420	0.014	0.004
				3521	0.001	0.004				3521	0.001	0.004
				3522	0.169	0.013				3522	0.095	0.007
				3523	0.000	0.296				3523	0.000	0.036
				3529	0.093	0.010				3529	0.076	0.003
				3811	0.007	0.274				3811	0.003	0.020
				3812	0.000	0.004				3812	0.000	0.004
				3813	0.289	0.101				3813	0.149	0.159
				3819	0.283	0.044				3819	0.165	0.018
				3831	1.402	0.016				3831	0.437	0.051
				3832	0.243	0.001				3832	0.199	0.001
				3833	0.008	0.007				3833	0.007	0.005
				3839	0.128	0.020				3839	0.068	0.137
				3841	0.033	0.169				3841	0.019	0.092
				3842	0.027	0.000				3842	0.010	0.000
				3843	0.738	0.010				3843	0.478	0.007
				3844	0.057	0.001				3844	0.035	0.192
				3845	0.066	0.000				3845	0.040	0.001
				3849	0.000	0.000				3849	0.000	0.000
alized Weighted Total Trade Share		*28.707*			*10.410*			*36.459*			*4.819*	

Less Pollutive Industries

	1984-88 RCA > 1 Ind.code	1984-88 RCA > 1 Normalized trade share	1984-88 RCA > 1 RCA >1	1984-88 Ind.code	1984-88 RCA < 1 Normalized trade share	1984-88 RCA < 1 RCA <1	1994-98 RCA > 1 Ind.code	1994-98 RCA > 1 Normalized trade share	1994-98 RCA > 1 RCA >1	1994-98 RCA < 1 Ind.code	1994-98 RCA < 1 lormalized trade shar	1994-98 RCA < 1 RCA <1
	3220	37.339	11.307	3140	0.004	0.298	3220	45.611	20.236	3140	0.002	0.150
	3312	0.000	2.056	3240	0.000	0.002	3610	0.002	1.718	3240	0.004	0.943
				3311	0.000	0.001	3903	0.006	4.543	3311	0.002	0.359
				3319	0.000	0.126				3312	0.000	0.838
				3320	0.000	0.004				3319	0.000	0.004
				3540	0.008	0.926				3320	0.000	0.001
				3551	0.053	0.000				3540	0.003	0.001
				3559	0.032	0.014				3551	0.035	0.000
				3560	0.169	0.002				3559	0.012	0.001
				3610	0.000	0.079				3560	0.153	0.169
				3620	0.015	0.006				3620	0.014	0.003
				3821	0.164	0.073				3821	0.097	0.062
				3822	0.011	0.080				3822	0.015	0.022
				3823	0.021	0.042				3823	0.034	0.013
				3824	2.092	0.050				3824	1.391	0.125
				3825	0.010	0.001				3825	0.015	0.000
				3829	0.791	0.159				3829	0.464	0.088
				3851	0.165	0.045				3851	0.112	0.004
				3852	0.002	0.005				3852	0.001	0.144
				3853	0.000	0.000				3853	0.000	0.000
				3901	0.000	0.000				3901	0.000	0.000
				3902	0.000	0.000				3902	0.000	0.000
				3903	0.001	0.000				3909	0.073	0.180
				3909	0.031	0.132						
alized Weighted Total Trade Share		*37.340*			*3.572*			*45.619*			*2.427*	

Notes: (1) Analysis is based on ISIC data at 4-digit level of 56 closed sample countries out of 67 total
(2) Data Source: World Bank: Production and Trade Data:2001
(3) For "Most Pollutive Industry" category no industry had RCA>1 for the period 1984-88

Table 6.7.1

BangladeshTrade Specialization Pattern: Comparative Analysis of 1984-88 Versus 2000-2004

Most Pollutive Industries						Some What Pollutive Industries								Less Pollutive Industries							
Ind.code	Trade Share (%) 1984-88 with XRCA>1	Ind.code	Trade Share (%) 1984-88 with XRCA<1	Ind.code	Trade Share (%) 2000-04* with XRCA<1	Ind.code	Trade Share (%) 1984-88 with XRCA>1	Ind.code	Trade Share (%) 1984-88 with XRCA<1	Ind.code	Trade Share (%) 2000-2004 with XRCA>1	Ind.code	Trade Share (%) 2000-2004 with XRCA<1	Ind.code	Trade Share (%) 1984-88 with XRCA>1	Ind.code	Trade Share (%) 1984-88 with XRCA<1	Ind.code	Trade Share (%) 2000-2004 with XRCA>1	Ind.code	Trade Sha 2000-2004 with XRCA<
353	4.232	341	0.212	341	0.308	321	21.751	311	10.453	321	21.536	311	7.136	322	30.898	314	0.001	322	47.267	314	0.001
		351	5.276	351	4.360	323	5.842	313	0.001	323	1.020	313	0.001			324	0.000	324	0.003	331	0.001
		369	0.982	353	1.922			342	0.009			342	0.015			331	0.001	361	0.001	332	0.000
		371	3.237	369	0.686			352	0.361			352	0.407			332	0.000			354	0.000
		372	0.350	371	2.201			381	0.490			381	0.205			354	0.000			355	0.057
				372	0.254			383	2.132			383	1.937			355	0.135			356	0.035
								384	2.706			384	2.480			356	0.045			362	0.011
																361	0.001			382	8.000
																362	0.011			385	0.058
																382	10.770			390	0.098
																385	0.070				
Normalized Weighted Total Trade Share	***4.23***		***10.06***		***9.73***		***27.59***		***16.15***		***22.56***		***12.18***		***30.90***		***11.03***		***47.27***		***8.26***

Notes: (1) Analysis is based on ISIC data at 3-digit level of 56 closed sample countries out of 67 total

(2) Data Source: World Bank: Production and Trade Data:2006

*: In 2004 for most pollutive category non of the product had RCA > 1

6.5 Conclusion

The analysis in this chapter used Balassa comparative advantage model and a further extension to that model to compute sectoral changes in trade specialization pattern of pollutive manufacturing industry over time across three South Asian countries. The main aim was to examine the impact of environmental regulations on different pollutive industrial trade specialization patterns and competitiveness over three South Asian countries during 1984-2004. The results for inter-country and intra-country comparison of various pollutive industries group produced a variety of outcomes. Firstly, the study found that both Pakistan and Bangladesh have lost trade competitiveness in most pollutive industries trade during end sample period compared to beginning sample period whereas, India gained its competitiveness position in end period. Therefore, India, due to gaining comparative advantage in the world's most pollutive industries, shows some evidence of pollution haven effects. Also, the South Asia region's export structure is dominated by low technology and low sophistication products.

While most research on the subject just focused on most pollutive industries' production and trade specialization patterns, this study, in addition to analyzing trade specialization patterns of most pollutive industries, also concentrated on somewhat pollutive and less pollutive industries. For somewhat pollutive industries, both India and Bangladesh improved their trade competitiveness in 1994-98 compared to the beginning period, whereas Pakistan seemed to have maintained its competitiveness position- if not increased- to some extent for the same category during the end to the beginning period. However, Bangladesh reduced its trade share in the same category in 2000-04, and so did Pakistan, while India maintained its industrial trade specialization shares when compared 1984-88 with 2000-04 periods. Therefore, the impacts of environmental regulations on pollutive industrial trade in South Asian countries are industry/ pollutive-group sensitive. The results also vary from most pollutive industries to least pollutive industries. There are further signs of pollution haven effect for most pollutive industries especially for India. For other two countries there seemed to be a shift of the locus of production and trade specialization pattern to least pollutive industries. At the same time, South Asian countries provide evidence for shifting normalized trade shares within and between pollutive industries and pollutive industries' movements from specialized groups to non-specialized groups and vice versa. Overall, there seemed to be less systematic trends emerging over time regarding the impact of environmental regulations on pollutive industries trade specialization patterns for South Asian countries.

Chapter 7

Searching for Pollution Haven Effect: Evidence from South Asia Region

7.1 Introduction

One of the main research objectives of this study is to examine whether due to differences in environmental regulations between stringent North-OECD- and laxer South-the South Asian countries have become a haven for pollutive industrial trade flows to the North. The literature reviewed in chapter 3 indicates that gap in environmental regulations between rich North and poor South will lead the pollutive industrial relocation towards developing countries, assuming other things constant and developing countries can develop a comparative advantage in most pollutive industries and become repository for pollutive industrial production and trade (McGuire, 1982; Baumol and Oates, 1988; Copland and Taylor, 1994). Earlier empirical literature focusing on trade data have traced the evidence of pollutive heaven effect (Tobey, 1990; Low and Yeats, 1992; Sorsa, 1994; Van Beers and Van den Bergh, 1997&2000; XU, 1999; Grether and de Melo, 2004 Cole and Elliott, 2003).

The comparative advantage-based modeling results explained in chapter 6 provide in-depth information towards competitiveness position and trade specialization patterns of pollutive industrial trade for South Asian countries and shed light on the pollution haven hypothesis. The analysis on pollution haven hypothesis further demands that whether the difference in environmental regulations between stringent North and laxer South has allowed the latter to become a haven for pollutive industrial exports to OECD. Such a sort of analysis requires adopting a methodology that incorporates bilateral level pollutive industrial trade data while keeping some control on geography. Grether and de Melo (2004) offered that methodology, and the present study tends to adopt it to examine whether the South Asia region has become a haven for pollutive industrial exports to OECD countries. They also argued that detection of pollution haven might depend on the level of industrial data aggregation; hence, this chapter analyses bilateral industrial trade data at the highest dis-aggregation 4-digit and 3-digit levels, explaining why previous studies that focus on aggregate level data have failed to find pollution haven effect. Furthermore, no efforts have been made before to examine if the South Asia region has become a pollution haven for industrial exports to OECD and other countries, and this study will fill the gap in the literature by first computing the composition and structural effects of different pollutive industries group and later estimating a bilateral level revealed comparative advantage (RCA) exports of South Asia with OECD and rest of the world (REW). The chapter further examines whether a comparative analysis between most pollutive with relatively cleaner industrial trade provides some insight into the pollution haven effects in the South Asia region.

In section 7.2 study explains first the choice of countries and data to examine pollution haven hypotheses in the North-South framework. Then it explains in detail the Grether and de Melo (2004) model that would allow a time series analysis on bilateral export flows between South Asia and OECD and the rest of world countries. The RCA model will pave the way for computing both technique and composition effects and total effects for all pollutive industries. In section 7.3, the study will explain the effectiveness of the composition effect, structural and total effect for pollutive industries trade in South Asia over time. After that, bilateral exports RCAs between South Asia with OECD and REW countries are analyzed, and results for pollution haven effect are explored. Section 7.4 concludes this chapter.

7.2 Data and Modeling Choices to Pollution Haven Hypothesis- South Asia vs OECD

This study has identified the seventeen high-income OECD countries to examine the hypothesis of whether South Asian economies over time have become a haven for pollutive industrial exports to OECD countries. These countries include Australia, Austria, Canada, Denmark, Spain, Finland, France, United Kingdom, Germany, Ireland, Italy, Japan, Netherlands, Norway, New Zealand, Sweden, and United States. The three South Asian countries are India, Pakistan and Bangladesh. The study used the same data sources elaborated in chapter 5. Also, for comparative analysis of South Asia, bilateral pollutive industrial exports with OECD and rest of the world countries a closed sample of 56 countries trade data has been split between high-income OECD and reset of the world countries. The study used the same periods it chose for trade data analysis in chapter 6. The sample periods are 1984-88, 1994-98, and 2000-2004 and three pollutive industrial groups. Therefore, again, to avert or minimize any random factors that might influence the results of single year, five years averaged pollutive industrial trade data have been chosen at the analysis stage.

Some earlier empirical work on whether developing countries are becoming a haven for the most pollutive industrial export has already been summarized in literature survey chapter 4 and in section 4.4.2. It is, however, worth indicating here that it is difficult to draw a clear distinction on separating the literature on the impact of environmental regulations and trade competitiveness and pollution haven hypothesis as both notions to some extent have relevancy to explain each other in developing countries context. For example, if South Asia shares in most pollutive industry exports going towards OECD countries is increasing over the years, then this would imply that on the one hand, South Asian countries are becoming a haven for the most pollutive industries and on the other latter are gaining competitiveness in those industries too. Grether and de Melo (2004) have argued to control for geography aspects is imperative to elucidate the pollution haven effect and offered in what followed a research methodology.

Keeping in view the high and low-income countries RCA weighting issues around the globe, the importance of composition, technique effects as well geographical controlled bilateral RCAs, this study adopted Grether and de Melo (2004) and provided a process of extensions in Balassa via equations 7.1-7.7, as below:

$$RCA_i^P = \frac{S_{wp}^{ip}}{S_{wa}^{ia}} \div \frac{S_{ia}^{ip}}{S_{wa}^{wp}} \tag{7.1}$$

Where $\frac{S_{wp}^{ip}}{S_{wa}^{ia}}$ is country *i*'s share in world exports of polluting products (of all products)

and $\frac{S_{ia}^{ip}}{S_{wa}^{wp}}$ is the share of polluting products in total exports of county *i*(of the world).

Based on equation (7.1) and using the World Production and Trade Data (2001) at 3-digits ISIC level for five most pollutive industries and dividing sample countries in low- and high-income groups based on per capita GNP, Grether and de Melo (2004) found puzzling outcomes. Firstly, global trends towards the higher value of export revealed comparative advantage (RCA) values were observed for both high- and low-income groups, whereas, more intuitively, an increase in one group of RCAs should be accompanied by a decrease of other groups at a particular point in time. The answer to this query is provided through the weighted sum, which though totaled to one but can vary, i.e., if from equation (7.1) the world is consisting of two countries n and s , then one gets as under:

$$S_{sw}^{sa} RCA_s^P + S_{wa}^{na} RCA_n^P = 1 \tag{7.2}$$

Therefore, following equation (7.2), the simultaneous increase in both RCA indices can happen when a large weight is placed on smaller values. Their empirical results also supported that argument as developed countries depicted low RCA but their share in world export increased. That was one of the reasons that, unlike earlier work such as Low and Yeats (1992), Sorsa (1994), and XU (1999), this study has not just relied on the Balassa index alone to witnessing pollution haven effects in South Asia.

The second contradiction they witnessed in their results was that in group (LDCs) most RCA (Balassa index) is increasing while aggregate RCA of the group is declining. They sought answer of this contradictory outcome again through the shares, i.e., the composition effect, with the share of lowest-RCA countries rising at the cost of highest RCA countries. By elaborating the equation (7.1), this notion can be easily verified, and this study, in what follows, attempts to make use of this methodology for South Asian analysis to compute composition and structural effect based on the beginning and end data sample period.

$$RCA_S^P = \sum_{I=1}^{ns} S_{sa}^{ia} RCA_i^p \qquad (7.3)$$

Where group for South is assumed to be composed of n_s countries (India, Pakistan and Bangladesh) and S_{sa}^{ia} is the share of country *i* in total exports of groups.

Following equation (7.3) the change in the aggregate RCA index (Balassa index) can be decomposed in the following terms. For the current analysis, a bar over a variable implies the average over both periods, i.e., beginning period 1984-88 and end periods (1994-98) for 4-digit ISIC level trade data and (2000-2004) using trade data on 3-digits ISIC level for pollutive industries.

$$\Delta RCA_S^P = \sum_{i=1}^{ns} \Delta S_{sa}^{ia} \overline{RCA_i^p} + \sum_{i}^{ns} \overline{S}_{sa}^{ia} \Delta RCA_i^p \qquad (7.4)$$

First-term in equation (7.4) is the composition effect: it is the part of the aggregate RCA change that is attributable to the changes in countries' exports share i.e., the share of one country in a specific industry of the country say Pakistan is falling and that of saying India is increasing. The second part of equation (7.4) reveals the pure structural effect that reflects just the opposite of the composition effect. It provides information on structure shift in pollutive industrial exports at the highest dis-aggregated level of South Asia region through the impact of change in exports RCAs while keeping the three selected South Asian countries' industrial export share constant at their average value.

Next, after controlling for geography, the study computes bilateral exports RCA of South Asia region with environmental stringent OECD and REW, which is what pollution haven effect has called for. To accomplish this task, again following mainly (Grether and de Melo (2004), with a slight change, a new decomposition is introduced in what follows that isolates the impact of geography on the RCA index. From equation (7.1), again, the RCA of country i in product p (RCA_p^i) can be decomposed as under:

$$RCA_i^P = \sum_{j=1}^{N} RCA_{ij}^p S_{iwa}^{ija} \qquad (7.5)$$

Where bilateral RCA (RCA_{ij}^p) is defined as the ratio between the share of product p in total exports of country i to country j (S_{ija}^{ijp}) and the share of product p in total world exports (S_{wa}^{wp}). This share is weighted by share of country j in total exports country i to world (S_{iwa}^{ija}). For analysis purpose, this study divides trade data into two groups of countries: n_S is the South Asian group of countries bilateral exports going to high-income OECD countries, and n_N is the South Asian bilateral exports link with REW countries during the sample period and that $n_S + n_N = N$. The equation (7.5) can be rewritten as under:

$$RCA_i^P = S_i^p + N_i^p \equiv \sum_{j=1}^{n_s} RCA_{ij}^p S_{iwa}^{ija} + \sum_{j=1}^{n_N} RCA_{ij}^p S_{iwa}^{ija} \qquad (7.6)$$

Where S_i^p is the OECD contribution in changing selected South Asian countries bilateral RCA_i^P and N_i^p is the rest of world (REW) contribution regarding changing bilateral RCA_i^P patterns of the region. Therefore, in terms of variation between analysis periods i.e. ending periods (1994-98) and (2000-2004) and the beginning period (1984-88), equation (7.6) will be changed as below:

$$\Delta RCA_i^p = \Delta S_i^p + \Delta N_i^p \qquad (7.7)$$

Where Δ indicates a change between periods, the study has accordingly computed equations (7.4), (7.6), and (7.7), and the results are discussed in section 7.3 next.

7.3 Results: Pollution Heaven Effects for South Asia Region: Statistical Analysis

In this section, the study based on the methodological approach described in section 7.2 attempts to present results ascertained by applying the equations (7.4), (7.6), and (7.7) to three different pollutive industrial categories export data at 4-digit ISIC level of totaled 81 industries covering the periods 1984-1988 and 1994-1998 and at 3-digit ISIC level for 28 pollutive industries covering the periods 1984-1988 and 2000-04. The results are reported in tables 7.1, 7.1.1, and 7.2, 7.2.1 respectively.

The results in tables 7.1 and 7.1.1 show that the export composition of a number of industries within the category of most pollutive industries of the South Asia region has changed towards a positive direction. So did the structural changes, which in the group of most pollutive industries exports, showed more of positive effects. Nevertheless, the structural effect for the majority in most pollutive industries group is stronger than the composition effect. It implies that the impact of change in export revealed comparative advantage, keeping the share of the respective commodities constant around mean value during two sample periods, is stronger than the change in exports share of these countries (keeping RCA constant around an average of two periods). Therefore, the composition effect has reinforced the structural effect in most pollutive industrial exports for the South Asian countries, due to which the total effect is positive. By definition, the total effect is the sum of composition and structural effect. The study finds positive effects for most pollutive industrial exports except containers, boxes of paper & paperboard in 1994-98 at 4-digits ISIC level. The structural effect among the category of most pollutive industries was consistently more substantial compared to composition effect during1984-2004 leading total effects to be positive.

Table 7.1, for somewhat pollutive industries exports group, which constitutes about 43 industries of 81 industries, depicts a stronger structural effect than the composition effect during 1984-98. For some industries, both effects reinforce each other in positive and negative directions. Whereas, in other cases, they depicted an opposite sign making total effect either positive or negative. Using counting positive and negative processes, pollutive industries with positive total effects are more than negative effects. For example, in the industry preparing and preserving meat (3111), the negative structural effect outweighs the positive composition effect making the total South Asian region total effect of the same pollutive industry negative. The notable high structural transformed industries, in the somewhat pollutive category, are grain mills products (3116), sugar factories and refineries (3118), knitting mills (3213), cordage rope and twine industries (3215), textile nes (3219). In these industries, the positive structure effect outweighs the negative composition effect, thus making the total pollutive industrial trade effect positive. In the same somewhat pollutive industries export group, the results during 1984-2004 showed vivid positive effects and improvements in the pollutive industrial groups in almost all industrial trade cases, except leather products where the total effect is negative. The study finds mixed effects for the less pollutive industries group- both positive and negative industrial compositional and structural changes- during 1984-98. Nonetheless, within the less pollutive industries group, the study finds that structure effects are more substantial than composition effects.

Overall, the study finds that most pollutive industries group provides more consistent outcomes throughout the sample period. Within the same group, in most industries cases, both composition and structural effects moved in the same positive direction and paving the way for confirming the pollution haven hypothesis for South Asian countries. The analysis provides valued insight into the characteristics of various pollutive categories of industrial export patterns for the South Asia region based on three countries. Nonetheless, the results need to be supported by additional analysis on bilateral trade flows between South Asia and OECD countries and the rest of the world before drawing the conclusions of PHH for the South Asia region. The research conducted by computing equations (7.6) and (7.7) explain these results next.

Table-7.1 **Decomposition of Aggregate Change in RCA for South Asia (1984-98)**

		4-Digits ISIC	Composition effect	structural effect	total effect	total effect
			1	2	1+2	Signs
Most Pollutive Industries	3411	pulp paper and paper board	0.004	0.051	0.055	+
	3412	contaniers, boxes of paper & pap	-0.003	0.003	-0.001	-
	3419	pulp paper, paperboard aticle ne:	0.002	0.062	0.065	+
	3511	basic industrial chemical except	0.028	0.611	0.639	+
	3512	fertilizers and pesticides	0.042	0.708	0.750	+
	3513	synthetic resins plastic, man-mad	0.001	0.285	0.286	+
	3530	petroleum products	0.030	-0.470	-0.440	-
	3691	structural clay products	0.007	0.138	0.145	+
	3692	cement lime and plaster	0.033	1.291	1.324	+
	3699	non-metallic mineral products ne:	0.022	1.058	1.080	+
	3710	iron and steel basic industries	0.019	0.644	0.663	+
	3720	non-ferrous metal basic industries	0.012	0.145	0.157	+
Somewhat Pollutive Industries	3111	preparing and preserving meat	0.026	-0.130	-0.104	-
	3112	dairy products	0.001	0.028	0.028	+
	3113	preserving of fruits & vegetables	0.006	-0.507	-0.501	-
	3114	preserving & processing fish crus	0.122	0.142	0.265	+
	3115	vegetable, animal oils & fats	0.099	1.355	1.454	+
	3116	grain mill products	-0.970	3.275	2.304	+
	3117	bakery products	-0.010	-0.077	-0.088	-
	3118	sugar factories & refineries	-0.314	2.164	1.849	+
	3119	cocoa chocolate & sugar confecti	-0.014	0.043	0.029	+
	3121	food prodcuts nes.	0.229	-3.836	-3.606	-
	3122	manfucture of prepared animal fe	-0.004	-0.002	-0.006	-
	3131	distilling rectifying and blending s	0.001	0.145	0.147	+
	3132	wine industires	0.000	-0.002	-0.002	-
	3133	malt liquors and malt	0.002	0.032	0.034	+
	3134	soft drinks and carbonated waters	-0.003	-0.028	-0.031	-
	3211	spinning weaving and finishing te	-0.593	1.299	0.706	+
	3212	made-up textile goods except w.	-0.534	-3.653	-4.187	-
	3213	knitting mills	0.009	2.440	2.449	+
	3214	manufacture of carpets and rugs	-0.579	-5.574	-6.153	-
	3215	cordage rope and twine industrie:	0.507	3.979	4.487	+
	3219	textiles nes.	-0.164	1.602	1.438	+
	3231	tanneries and leather finishing	-0.005	-11.069	-11.074	-
	3232	fur dressing and dyeing	0.000	-0.024	-0.023	-
	3233	leather, leather subst. except foo	0.090	0.313	0.402	+
	3420	printing publishing and allied ind	0.004	-0.034	-0.030	-
	3521	paints varnishes and lacquers	0.022	-0.988	-0.966	-
	3522	drugs and medicines	0.054	0.014	0.068	+
	3523	soap, cleaning preparation perfu	0.036	-0.726	-0.690	-
	3529	chemical products nes.	0.010	0.077	0.086	+
	3811	cutlery hand tolls and general ha	0.016	-0.050	-0.034	-
	3812	furniture and fixtures primarily of	0.004	-0.056	-0.053	-
	3813	structural metal products	0.015	0.023	0.037	+
	3819	facribated metal prod. except ma	0.015	0.138	0.153	+
	3831	electrical ind. Machinery & appa	0.006	0.026	0.032	+
	3832	radio t.v. communication equip.&	0.003	0.024	0.028	+
	3833	electrical appliances and housew	0.003	-0.016	-0.013	-
	3839	electrical apparatus, supplies ne:	0.016	-0.332	-0.316	-
	3841	shipbuilding and repairing	-0.002	0.023	0.021	+
	3842	railroad equipment	0.012	-0.216	-0.204	-
	3843	motor vehicles	0.005	0.047	0.052	+
	3844	motorcycles and bicycles	0.057	0.119	0.176	+
	3845	aircraft	-0.004	-0.051	-0.055	-
	3849	transport equipment nes.	0.001	0.022	0.022	+
Less Pollutive Industries	3140	tobacco manufacture	0.034	-1.906	-1.872	-
	3220	wearing apparel except footwea	0.188	1.010	1.198	+
	3240	footwear except vulcanized rubb	0.068	-0.617	-0.549	-
	3311	sawmills planing and other wood	0.006	0.019	0.025	+
	3312	wooden and cane containers	0.034	-0.013	0.021	+
	3319	wood and cork products nes.	0.000	-0.073	-0.073	-
	3320	furniture and fixtures except prin	-0.001	0.008	0.007	+
	3540	miscellaneous porudcts of petrol	0.002	-0.024	-0.023	-
	3551	tyres and tube industries	0.038	0.472	0.510	+
	3559	rubber products nes.	0.018	-0.023	-0.005	-
	3560	plastic products nes.	0.006	0.191	0.197	+
	3610	pottery china and earthenware	0.019	0.177	0.197	+
	3620	glass and glass products	0.008	0.153	0.161	+
	3821	engine and turbines	0.008	0.120	0.129	+
	3822	agriculture machinery and equipr	0.004	0.058	0.062	+
	3823	matal and woodworking machine	0.009	-0.132	-0.122	-
	3824	special ind. machinery except me	0.005	-0.067	-0.062	-
	3825	office computing and accounting	0.003	0.006	0.010	+
	3829	macinery & equipment except ele	0.008	-0.040	-0.032	-
	3851	prof. & scientific, equipments nes	-0.039	-0.016	-0.055	-
	3852	photographic and optical goods	0.006	-0.127	-0.121	-
	3853	watches and clocks	0.004	0.174	0.178	+
	3901	jewellery and related articles	0.719	-1.111	-0.392	-
	3902	musical instruments	0.001	0.061	0.062	+
	3903	sporting and athletic goods	-0.420	1.257	0.837	+
	3909	industries nes.	-0.007	0.274	0.267	+

Source: Author's calculation based on Trade and Production Data(2001)

Notes: (1) Analysis is based on ISIC data at 3-digit level of 56 closed sample countries out of 67 total

(2) South Asian Countries Included: Pakistan, India, Bangladesh

Table-7.1.1 **Decomposition of Aggregate Change in RCA for South Asia (1984-2004)**

	3-Digits ISIC		Composition effect	structural effect	total effect	total effect
			1	2	1+2	signs
Most Pollutive Industries	341	paper& product	0.001	0.067	0.068	+
	351	industrial chemical	0.081	0.895	0.976	+
	353	petrloeum refineries	0.273	0.537	0.810	+
	369	other non-metallic mineral	0.147	1.275	1.421	+
	371	iron & steel	0.261	1.671	1.931	+
	372	non-ferrous metals	0.036	0.430	0.466	+
Somewhat Pollutive Industries	311	food products	0.028	0.233	0.261	+
	313	Beverages	0.000	0.013	0.013	+
	321	Textiles Industry	0.646	5.277	5.923	+
	323	Leather products	-0.289	-11.539	-11.828	-
	342	printing &publishing	0.008	0.037	0.045	+
	352	other chemicals	0.015	0.174	0.190	+
	381	fabricated metals	0.059	0.360	0.420	+
	383	machinery electric	0.006	0.053	0.059	+
	384	transport equipments	0.013	0.057	0.070	+
Less Pollutive Industries	314	tobacco producs	0.016	0.113	0.129	+
	322	wearing apparel	2.243	4.276	6.519	+
	324	footwear cept rub.plstic	0.054	0.819	0.874	+
	331	wood prod. Excpet furniture	-0.006	-0.033	-0.039	-
	332	furniture except mtl	0.016	0.336	0.351	+
	354	misc.petrol. &coal prods	0.022	0.265	0.287	+
	355	Rubber products	0.016	0.330	0.346	+
	356	plastic products	0.032	0.255	0.287	+
	361	pottery	0.220	0.506	0.726	+
	362	glass	0.031	0.145	0.176	+
	382	machinery electric	0.024	0.014	0.038	+
	385	porf.&scientific equipments	-0.251	-0.271	-0.522	-
	390	others industires	0.089	-7.942	-7.853	-

Source: Author's calculation based on Trade and Production Data(2001) and (2006)

Notes: (1) Analysis is based on ISIC data at 3-digit level of 56 closed sample countries out of 67 total

(2) South Asian Countries Included: Pakistan, India, Bangladesh

For bilateral RCA analysis, the sample of 56 countries has been divided into two groups- first, environmentally stringent North 17 OECD countries and a second group including 39 sample countries henceforth termed as rest of world (REW). Table 7.2 provides the results on bilateral RCAs for the period 1984-98 and table 7.2.1 for 1984-2004. In addition to the changing in export shares at the bilateral level, the study also reports the average annual percentage growth rates of these shares based on beginning and end sample periods.

In the table 7.2, in most pollutive industries group, the bilateral exports RCAs growth rates of South Asia with high-income OECD countries are positive for all industries except petroleum products (3530). The high bilateral exports RCA growth rates of South Asia with OECD are among others mainly found in pulp paper, paperboard article nes (20.57 %), fertilizers and pesticides (18.16 %), structural clay products (13.17 %), cement lime and plaster (21%). The positive change in share at bilateral level and conspicuously high growth rates for most pollutive industries both provide convincing evidence for confirming the hypothesis that South Asian countries have become a safe haven for most pollutive industries exports to the OECD the 1990s compared to the 1980s. Some of the earlier studies, such as Mani and Wheeler (1999) and Low and Yeats (1992), based on trade data, find evidence consistent with the pollution haven hypothesis. Lucas et al. (1992), based on production data for most pollutive industries, found that growth in pollution-intensive industries was highest in the South region when OECD economies were pursuing stringent environmental regulations. Furthermore, Grether and de Melo (2004), for a group of developing countries sample as a whole, find some evidence consistent with pollution haven hypothesis, i.e., South as a whole is becoming a haven for the dirtiest industrial exports to North. Sawhney and Rastogi (2015), for most pollutive industries trade of India with the USA, has found evidence of pollution haven effects.

In most pollutive industry group, the study also found positive bilateral exports RCAs shares and growth rates of South Asian trade with REW during 1984-2004. This phenomenon lights the fact that pollutive industries in South Asia as region are gaining a bilateral comparative advantage with environmental stringent OECD countries and the rest of the world. Therefore, in addition to the differential of environmental regulations compliance between South Asia and the OECD, other comparative advantage sources might be of paramount importance for South Asia region in explaining bilateral trade pattern, trade competitiveness, and pollution haven effects.

Most of the research conducted in this area has not attempted before to analyze whether or not a similar and or somewhat different scenario can emerge for relatively less pollutive industries compared to what this study finds for most pollutive industries for the North-South bilateral RCA framework. In table 7.2, the results for somewhat pollutive industries category, following the criteria of changing bilateral RCAs and RCA growth rates of South Asia with OECD for 43 industries do not provide conclusive outcomes for South Asia pollutive industries bilateral

RCAs with OECD as estimates are positive for some industries and negative for others. The study finds a similar result for South Asia bilateral RCAs analysis with REW in the somewhat pollutive industrial category during 1984-98. Nonetheless, these results in table 7.2.1 changed when the study computed bilateral RCAs during 1984-2004 wherein almost all somewhat pollutive industries group show a positive change in growth rates in bilateral RCA exports of South Asia with the OECD, expect leather industries. The study finds a mix of positive and negative changes in bilateral exports RCAs of South Asia with REW during 1984-2004. These results confirmed that pollution haven effects for somewhat pollutive industries were more pronounced between South Asia and OECD than with REW countries.

Lastly, less pollutive industries results as reported in tables 7.2 and 7.2.1 show the bilateral RCAs of South Asia with OECD and REW and growth rates of bilateral exports RCAs. Following the counting process of industries with positive and negative sectoral change and growth rates between two periods of industries, positive number of growth rates of South Asia less pollutive exports group with stringent environmental OECD are more than its bilateral RCA exports with REW. The trend of positive bilateral RCA of South Asia with OECD among majority industries continued for less pollutive industry group during 1984-2004. In the same pollutive industries category, the results are mixed for South Asia bilateral RCA exports flows with REW during 1984-2004. The buoyant bilateral exports RCA in relatively most cleaner industries further confirm the assertion that, in addition to pollution haven hypothesis phenomena, other comparative advantage and trade competitiveness sources are vital in South-North pollutive industrial trade.

Table-7.2. **Bilateral RCA of South Asia with OECD and Rest of World: "pollution haven effect"(1984-98)**

	4-Digits ISIC		South Asia's Change in RCA Share with OECD(17)	South Asia's Change in RCA with OECD (Growth Rates)	South Asia's Change in RCA Share with REW*	South Asia's Change in RCA with REW* (Growth Rates)	Total Change
			1	2	3	4	5=(1+3)
			84-98	84-98	84-98	84-98	RCA
Most	3411	pulp paper and paper board	0.0001	12.296	0.0007	8.584	0.0008
Pollutive	3412	contaniers, boxes of paper & pap	0.0000	6.278	0.0000	0.816	0.0000
Industries	3419	pulp paper, paperboard aticle ne	0.0001	20.568	0.0003	12.773	0.0004
	3511	basic industrial chemical except	0.0102	10.379	0.0100	8.463	0.0202
	3512	fertilizers and pesticides	0.0019	18.155	0.0000	-0.076	0.0018
	3513	synthetic resins plastic, man-mad	0.0033	13.904	0.0047	14.689	0.0079
	3530	petroleum products	-0.0002	-8.757	-0.0211	-10.772	-0.0213
	3691	structural clay products	0.0001	13.177	0.0003	8.919	0.0004
	3692	cement lime and plaster	0.0000	21.001	0.0013	22.948	0.0013
	3699	non-metallic mineral products ne	0.0022	12.124	0.0012	8.316	0.0034
	3710	iron and steel basic industries	0.0051	7.624	0.0107	14.806	0.0158
	3720	non-ferrous metal basic industries	0.0003	2.988	0.0021	4.710	0.0024
Somewhat	3111	preparing and preserving meat	-0.0028	-10.486	-0.0013	-2.360	-0.0041
Pollutive	3112	dairy products	0.0001	14.951	0.0000	-0.319	0.0001
Industries	3113	preserving of fruits & vegetables	0.0003	1.887	-0.0020	-7.991	-0.0017
	3114	preserving & processing fish crus	-0.0040	-3.481	0.0031	5.579	-0.0009
	3115	vegetable, animal oils & fats	0.0032	10.866	0.0054	3.659	0.0086
	3116	grain mill products	0.0004	1.319	-0.0027	-0.723	-0.0023
	3117	bakery products	0.0000	6.849	-0.0001	-3.910	-0.0001
	3118	sugar factories & refineries	0.0002	1.060	0.0027	11.802	0.0029
	3119	cocoa chocolate & sugar confecti	0.0000	3.017	0.0001	2.836	0.0001
	3121	food prodcuts nes.	-0.0066	-7.363	-0.0250	-11.047	-0.0316
	3122	manfucture of prepared animal fe	0.0000	11.098	0.0000	-0.082	0.0000
	3131	distilling rectifying and blending s	0.0001	10.584	0.0003	15.741	0.0004
	3132	wine industires	0.0000	-4.891	0.0000	-6.072	0.0000
	3133	malt liquors and malt	0.0000	4.135	0.0000	24.248	0.0000
	3134	soft drinks and carbonated waters	0.0000	7.361	0.0000	-9.003	0.0000
	3211	spinning weaving and finishing te	-0.0280	-3.738	0.0058	0.580	-0.0222
	3212	made-up textile goods except w.	0.0023	1.064	-0.0174	-10.237	-0.0150
	3213	knitting mills	0.0378	15.744	0.0012	1.294	0.0391
	3214	manufacture of carpets and rugs	-0.0123	-4.951	-0.0065	-13.042	-0.0188
	3215	cordage rope and twine industrie	0.0005	15.231	0.0010	17.124	0.0015
	3219	textiles nes.	0.0036	30.804	0.0021	11.890	0.0057
	3231	tanneries and leather finishing	-0.0262	-12.233	-0.0103	-7.896	-0.0365
	3232	fur dressing and dyeing	0.0000	-33.011	0.0000	-100.000	0.0000
	3233	leather, leather subst. except foo	0.0033	4.822	-0.0004	-2.504	0.0030
	3420	printing publishing and allied ind	0.0001	1.968	-0.0004	-3.393	-0.0003
	3521	paints varnishes and lacquers	0.0000	-0.538	-0.0021	-22.115	-0.0021
	3522	drugs and medicines	0.0022	3.891	0.0043	3.569	0.0065
	3523	soap, cleaning preparation perfu	0.0003	5.334	-0.0016	-5.251	-0.0013
	3529	chemical products nes.	0.0007	2.332	0.0009	3.653	0.0016
	3811	cutlery hand tolls and general ha	0.0001	0.196	0.0000	-0.061	0.0000
	3812	furniture and fixtures primarily o	0.0001	12.018	-0.0001	-6.705	-0.0001
	3813	structural metal products	-0.0002	-3.181	0.0000	-0.105	-0.0002
	3819	facribated metal prod. except ma	0.0021	4.474	0.0012	2.415	0.0033
	3831	electrical ind. Machinery & appa	0.0009	8.272	0.0010	3.982	0.0019
	3832	radio t.v. communication equip.&	0.0042	20.055	0.0010	2.462	0.0052
	3833	electrical appliances and housew	0.0001	11.180	-0.0002	-3.571	-0.0001
	3839	electrical apparatus, supplies ne	0.0011	15.143	-0.0041	-9.466	-0.0030
	3841	shipbuilding and repairing	0.0003	23.716	-0.0004	-3.989	-0.0001
	3842	railroad equipment	0.0000	10.918	-0.0004	-9.557	-0.0004
	3843	motor vehicles	0.0048	14.329	-0.0002	-0.236	0.0046
	3844	motorcycles and bicycles	0.0010	10.840	0.0006	1.473	0.0016
	3845	aircraft	-0.0009	-12.812	-0.0004	-9.948	-0.0014
	3849	transport equipment nes.	0.0000	29.553	0.0000	24.885	0.0000
Less	3140	tobacco manufacture	-0.0015	-12.172	-0.0064	-17.229	-0.0079
Pollutive	3220	wearing apparel except footwea	0.0406	3.294	-0.0017	-0.715	0.0390
Industries	3240	footwear except vulcanized rubb	0.0012	0.965	-0.0081	-12.790	-0.0069
	3311	sawmills planing and other wood	0.0002	4.201	0.0001	1.331	0.0002
	3312	wooden and cane containers	0.0000	-0.445	0.0000	2.565	0.0000
	3319	wood and cork products nes.	0.0000	-1.852	-0.0001	-9.520	-0.0001
	3320	furniture and fixtures except prin	0.0001	9.824	0.0000	-1.012	0.0001
	3540	miscellaneous porudcts of petrol	0.0000	-5.564	-0.0001	-6.078	-0.0001
	3551	tyres and tube industries	0.0007	4.174	0.0017	5.663	0.0023
	3559	rubber products nes.	0.0009	19.659	-0.0005	-3.348	0.0005
	3560	plastic products nes.	0.0023	25.688	0.0017	9.701	0.0040
	3610	pottery china and earthenware	0.0004	17.318	0.0000	1.104	0.0004
	3620	glass and glass products	0.0004	6.371	0.0008	6.355	0.0011
	3821	engine and turbines	0.0006	6.121	0.0000	0.332	0.0006
	3822	agriculture machinery and equipr	0.0003	24.626	-0.0002	-3.903	0.0001
	3823	matal and woodworking machine	0.0002	2.059	-0.0023	-8.133	-0.0021
	3824	special ind. machinery except me	0.0008	6.622	-0.0034	-4.528	-0.0027
	3825	office computing and accounting	0.0022	17.148	-0.0002	-0.808	0.0020
	3829	macinery & equipment except ele	0.0007	4.066	-0.0020	-5.048	-0.0013
	3851	prof. & scientific, equipments ne	-0.0010	-2.491	0.0002	0.981	-0.0008
	3852	photographic and optical goods	0.0002	10.638	-0.0015	-16.044	-0.0013
	3853	watches and clocks	0.0001	18.332	0.0005	28.234	0.0006
	3901	jewellery and related articles	-0.0212	-2.814	0.0110	1.884	-0.0103
	3902	musical instruments	0.0000	-2.354	0.0000	1.433	0.0000
	3903	sporting and athletic goods	0.0016	3.065	0.0005	3.305	0.0021
	3909	industries nes.	0.0012	10.195	0.0018	12.209	0.0030

Source: Author's calculation based on Trade and Production Data(2001)

Notes: (1) Analysis is based on ISIC data at 3-digit level of 56 closed sample countries out of 67 total

(2) South Asian Countries Included: Pakistan, India, Bangladesh

*RES: REST OF WORLD

Table-7.2.1 Bilateral RCA of South Asia with OECD and Rest of World: "pollution haven effect"(1984-2004)

	3-Digits ISIC		South Asia's Change in Bilateal RCA Share with OECD(17) 1	South Asia's Change in Bilateral RCA with OECD (Growth Rates) 2	South Asia's Change in Bilateral RCA Share with REW* 3	South Asia's Change in Bilateral RCA with REW* (Growth Rates) 4	Total Change 5=(1+3)
			1984-2004	1984-2004	1984-2004	1984-2004	RCA
Most	341	paper& product	0.036	11.02	0.043	4.72	0.079
Pollutive	351	industrial chemical	0.377	5.49	0.432	6.65	0.809
Industries	353	petrloeum refineries	0.387	15.02	1.017	12.22	1.404
	369	her non-metallic minera	0.835	6.88	0.323	6.07	1.159
	371	iron & steel	0.672	6.39	0.794	11.81	1.466
	372	non-ferrous metals	0.036	2.30	0.326	8.66	0.361
Somewhat	311	food products	0.001	0.02	0.209	1.90	0.211
Pollutive	313	Beverages	0.003	1.66	0.009	7.68	0.012
Industries	321	Textiles Industry	0.602	0.66	1.155	4.86	1.757
	323	Leather products	-10.702	-7.00	-0.459	-1.32	-11.161
	342	printing &publishing	0.089	2.90	-0.039	-1.83	0.051
	352	other chemicals	0.080	1.17	0.105	2.35	0.186
	381	fabricated metals	0.254	2.44	0.073	2.38	0.327
	383	machinery electric	0.059	5.30	-0.010	-1.12	0.050
	384	transport equipments	0.056	4.46	-0.004	-0.35	0.052
Less	314	tobacco producs	0.114	7.50	-0.012	-0.90	0.102
Pollutive	322	wearing apparel	1.040	0.86	0.162	4.78	1.202
Industries	324	footwear cept rub.plstic	0.844	2.65	0.024	2.84	0.868
	331	ood prod. Excpet furnitu	-0.011	-0.95	-0.004	-0.94	-0.015
	332	furniture except mtl	0.251	13.49	0.012	4.31	0.263
	354	misc.petrol. &coal prods	0.212	9.22	0.041	5.19	0.253
	355	Rubber products	0.133	1.71	0.178	3.38	0.311
	356	plastic products	0.206	9.77	0.041	3.75	0.247
	361	pottery	0.240	8.52	-0.007	-0.62	0.233
	362	glass	0.091	2.19	0.046	1.17	0.137
	382	machinery electric	0.056	2.95	-0.044	-2.13	0.012
	385	prf.&scientific equipmen	-0.116	-2.75	0.010	1.06	-0.106
	390	others industires	-5.364	-4.30	-0.092	-0.19	-5.456

Source: Author's calculation based on Trade and Production Data(2001) and (2006)

Notes: (1) Analysis is based on ISIC data at 3-digit level of 56 closed sample countries out of 67 total

(2) South Asian Countries Included: Pakistan, India, Bangladesh

*RES: REST OF WORLD

7.4 Conclusion

This chapter examined the key research question of tracing the pollution haven effect evidence in South Asia region. The study deployed bilateral level trade methodology to different pollutive industries groups of South Asia region trade flows with OECD and rest of world countries during 1984-2004. For accomplishing the task, the study firstly computed technique and composition effects for pollutive industrial trade groups. An in-depth analysis was conducted to determine whether the change in comparative advantage over time attributes more to productivity/technologies improvement via technique effects or to change in industrial composition. Secondly, to comply with the demand of the pollution haven hypothesis, the study by controlling for geography examined the bilateral RCA changes with OECD and REW countries groups for three pollutive industries categories. The comparative static analysis aimed at finding evidence of pollution haven effects between environmentally stringent North and relatively lax South.

The study finds that structural effects for most pollutive and other pollutive groups, in general, are more substantial than the compositional effect. The compositional effects of pollutive industrial trade reinforce technique effects, making total effects for pollutive industrial exports to move in a positive direction. The results further revealed that the structural transformation mechanism worked for pollutive industrial trade competitiveness. The impacts are more visible among the most pollutive industries where, except for few exceptions, total effects are positive for all most pollutive industrial exports. The results for the somewhat pollutive industries group further confirm this conclusion wherein majority industries showed total positive effects. That is one of the vital contributions of the study towards the pollution haven effect. The findings revealed that confining the research analysis to just most pollutive industry trade could provide incomplete information on environmental policy impact on pollutive industries trade flows. That was especially true for South Asian countries where environmental regulations were equally or perhaps more important for industries other than most pollutive as large volume bilateral industrial trade flows of South Asia region with OECD and REW countries fall in somewhat pollutive industry group.

The study, in this chapter, finds that bilateral RCA's exports of South Asia with OECD's in most pollutive industries and somewhat pollutive industries groups are positive among the majority industries, especially in most pollutive industries that showed positive bilateral RCAs with OECD over time in almost all industries, except one. These findings confirm that South Asia has become a haven for pollutive exports to stringent environmental OECD. Nonetheless, the South Asia region's bilateral exports share and RCAs growth rates in the same pollutive groups have also risen over time with REW group, relatively environmentally laxer countries. The trend witnessed the strongest for most pollutive industries compared to other groups. For less pollutive or relatively cleaner industries group, this study results inter alia found that bilateral RCA of South Asia with the OECD is stronger and more positive than REW, confirming more of pollution halo hypothesis instead of pollution haven effect.

The analysis between comparative pollutive industries group and between regional groups has depicted somewhat puzzling results. Because, if the difference of environmental policy was a key factor in bilateral exports flows between South Asia and OECD, then the study could have seen improved bilateral RCA of South Asia with OECD in most pollutive industries only and not in other pollutive industries groups, and nor a consistent rise of South Asia bilateral exports with REW and OECD in relatively cleaner industries. Few plausible reasons could help explain this phenomenon. Firstly, based on competitiveness indicators, results produced in chapter 6 inter alias concluded that the South Asia region, in general, gained competitiveness both in most pollutive industries and less pollutive industries. Second, results produced for compositional and structural effects for industrial exports suggest that, not for all but most industries, the structural and composition effects reinforced each other across pollutive groups. Thirdly, which is appealing in the light of comparative advantage theory, that in addition to the difference of environmental regulations between North and South as theory predicted, other traditional sources of comparative advantages such as labor cost differential between South and OECD and industrial and trade policies facilitating competitiveness might contributing to determine bilateral trade flows. Controlling for other unobservable factors requires adopting an econometric technique that, keeping other things constant, measures a specific environmental policy impact on bilateral trade flows for pollutive industries in the South-North pollutive industrial trade framework.

To find the specific effects of the environmental regulatory variable on trade flows and competitiveness and to explore possibilities of whether South Asian countries have become pollution haven for pollutive industrial bilateral trade flows with environmental stringent OECD countries, the study used econometric based gravity modeling techniques in chapter 8 that provide further insights into this study research questions/hypothesis. The chosen research methods should control other factors influencing trade flows while elucidating the impact of environmental policy on trade competitiveness.

Chapter 8

Application of Gravity Model to Environmental Regulations and trade Competitiveness analysis: Modeling and Data Analysis

8.1 Introduction

This study in chapters 6-7 have empirically examined the environmental policies' impacts on trade competitiveness both by using multilateral and bilateral pollutive industrial trade flows for South Asian countries and their trade flows with OECD and the rest of the world by deploying comparative static international trade models. The results produced and conclusions drawn in those chapters drew attention on few vital outcomes. The author of this study believed that a further investigation regarding the confirmation and rejections of this study hypothesis on the likely impact of environmental regulations on pollutive industrial trade competitiveness is vital. Firstly, the analysis in chapter 6 revealed that some South Asian countries improved trade competitiveness in most pollutive industries and least pollutive industries over time. However, theory predicted the negative competitiveness impacts of environmental regulations on most pollutive industries trade comparative advantage and positive on cleaner industries due to shifting in the locus of production in later industries from stringent environmentally regulated to least environmental regulated industries. Second, the study results produced in chapter 7 provided evidence for pollution haven effects in South Asia among the group of most pollutive and somewhat pollutive industrial bilateral trade with stringent environmental OECD. However, South Asia bilateral exports RCA with environmental laxer countries REW were also growing over time in same pollutive industries groups during the same period. And third, less pollutive or relatively cleaner industries group inter alias showed that bilateral exports RCA of South Asia with the OECD are stronger and more positive than REW, confirming more of pollution halo hypothesis instead of pollution haven effect. The answer to all these three somewhat puzzling outcomes lies in the need to control for unobserved factors influencing trade competitiveness other than environmental regulations to measure true policy impact. This process requires regression analysis by deploying an appropriate model. The adopted model should be theoretically sound and control other variables that influence manufacturing commodity trade flows but fit best to test the study research hypotheses on associations between environmental regulations and pollutive industrial trade.

After critically reviewing literature in chapter 4 indicated the superiority of the gravity model over the HOV trade model to examine the study's main research questions/hypotheses. The study in this chapter, therefore, will use an extended gravity model wherein bilateral trade-export and imports- depends on countries size and wealth, the geographical distance that allows to *inter alias* measure the natural obstacles to trade between trading partners such as transportation cost and transaction cost and host of other variables. The gravity model then has been extended to incorporate the variable of interests like environmental stringency and commodity tariffs for pollutive manufacturing trade. As reviewed in chapter 4, that earlier empirical work also adopted the conventional H-O-V modeling approach wherein net export of manufacturing commodities regressed on determinants of trade in factor flows model (Tobey, 1990; Ratnayake, 1998; Wilson et al., 2002; Busse, 2004; Sawhney and Rastogi, 2015). The problem with the HOV approach is that it is based on multilateral trade flows. It meant to say that differential effects of environmental policy on various trade flows might cancel out due to aggregation of bilateral trade flows to multilateral trade flows (Van Beers and Van den Bergh, 1997 and 2000; XU, 2000). The gravity model averts this problem well and allows for undertaking dis-aggregated industrial bilateral trade flow analysis. Also, the gravity modeling approach is more appropriate for trade flows between North and South (Grether and de Melo, 2004, Cantore and Cheng, 2018). This study contributes to the research debate by advocating that finding results for environmental regulations impacting trade competitiveness and tracing evidence of pollution haven effects are sensitive to the choice of methodology deployed. Therefore, the study hypotheses are best examined in a cross methodological framework.

Given the above backgrounds, the study in section 8.2 after historical background on gravity model will provide the theoretical derivation of the model based on traditional classical trade theory and new trade theories. The model is derived under certain restrictive assumptions like both in homothetic preference and non-homothetic preferences, further bifurcating what the final model looks like under frictionless trade and trade with impediments. The literature reflects the gravity model's usefulness for trade flows data analysis and its reliability discussed in this section. In section 8.3, the study will specify the empirical models for analysis. The study also discusses variables' choices, their sources/descriptions, and their relevance to the model specifications. Moreover, a comparative analysis on the choice between cross-sectional and panel data techniques based on their strengths and weaknesses is assessed in this section. Some issues regarding data estimation for econometric analysis are shared in section 8.4.1. The specific research questions and hypotheses for econometric analysis are described in section 8.4.1.1 and 8.4.1.2, respectively. Descriptive analysis and correlation matrix and detecting multicollinearity via variance inflation factor (VIF) techniques are explained in section 8.4.2. In section 8.4.3, the study measures the gravity model using panel data to examine environmental regulations' impact on different categories of pollutive industries trade flows: total industrial trade flows, most pollutive industries trade flows, and relatively less pollutive industries trade flows. To accomplish this task and to avert endogeneity issues in the model and data robustness, the study has deployed OLS and Hausman and Taylor criteria (1980) regarding the choice between FEM and REM data estimation techniques. The study further cross-examined the data by deploying Newey-West estimator techniques to ascertain time series heteroskedasticity and autocorrelation corrected (HAC) estimates. In section 8.4.4, the study estimates the pollution haven hypotheses using South Asian industrial trade flows with OECD countries by applying the same estimation techniques. After that, in section 8.5, the gravity model used cross-section data analysis at 4-digit ISIC pollutive industries trade groups for 1990 and 1998. In this context, at the model specification and estimation process, the use of variables and their descriptions and scope of data has been explained, and estimation results for the year 1990 and 1998 are examined in sections 8.5.1 and 8.5.2, respectively. The argument that countries create tariff walls to offset environmental regulations impact is also empirically examined in sections 8.5.1-2 for 1990 and 1998 data sets. Section 8.6 concludes this chapter.

8.2 Does Gravity model captures what Traditional and New Trade Theories propose?

Trade is expected to take place when domestic production is not equivalent to domestic demand. Essentially, certain fields of production have an advantage in certain regions or countries that result in specialization of production and a division of labor. In trade theory, this specialization of production explains why trade occurs in terms of comparative advantage in production. In the light of various theoretical approaches, trade occurs due to differences across countries in technologies (Ricardian theory). Heckscher-Ohlin theory says that different countries have different factor endowments. Others argued that trade takes place not only due to the differences in technologies across counties but due to continuing their transfer to other countries (Posner, 1961 and Vernon, 1966 in Mathur, 1999) and quoting from Dreze (1961) Mathur (1999) say that country size and scale economies are vital determinants of trade.

Small industrial countries can enjoy a comparative advantage in those sectors where demand is standardized. At the same time, the small countries will be at a disadvantage in highly differentiated goods trade because the domestic market is not sufficiently large to enable scale economies to be fully exploited. Nevertheless, while most of classical trade theories explain why countries trade in different products or roots of international trade, they failed to explain completely underlying factors that elucidated the trade pattern, direction, and growth rate. This explains the limited applicability of trade theory in explaining the size and extent of trade flows. The gravity model allows more factors to explain the trade patterns at bilateral level. Among the New Trade Theories advocated by those of Krugman and Helpman (1985) and Deardorff

(1995), attention is drawn to explaining international trade empirically and theoretically. These theories are generally based on the assumption of monopolistic competition and economies of scale. The assumption of similar technologies and factor endowments across countries is implicit in their theoretical models.

The gravity Model explains the size of bilateral international trade between countries and analogues to Newton's Law that states that the attraction forces between two entities are proportional to their respective masses and inversely proportional to the square distance. In economic modeling, bilateral trade flows between two regions are directly related to their income, i.e., GDP or GNP (masses**),** and inversely related to the distance between them (Rose, 2002a). The gravity model though pioneered by Tinbergen (1962) and Linnemann (1966) in a partial equilibrium framework of export supply and import demand its theoretical basis were elaborated and justified by, among others, Anderson (1979), Bergstrand (1985), Evenett and Keller (2002) and Deardorff (1998) in both perfect and imperfect market structures.

Linnemann (1966) advocated that the gravity model reduced form equations of export supply and import demand wherein price plays a negligible role as they merely adjust to equate supply and demand. He put forward the following three-fold key determinants of bilateral trade flows, which still to date are applied in most of the empirical and theoretical literature:

(1): bilateral trade flows are determined by the factors indicating the total potential supply of exporting countries i.e., exporting countries' income and population.

(2): factors that reveal total potential demand of importing countries such as importing countries income and population and

(3): factors depicting the impediments to bilateral trade flow from potential suppliers to the potential buyer such as geographical distance-transportation, transaction costs, and other trade obstacles such as tariffs and environmental regulations (Linnemann, 1966, Van Beers and Van den Bergh, 1997 and 2000; XU, 2000, Grether and de Melo, 2004). For illustrative purpose, two models in what follows are explained to shed light on the derivation of gravity equations.

8.3 Gravity Modeling: From Theoretical Approaches to Empirical Modeling

Anderson (1979) developed an economic foundation for gravity-type equations using a Cobb-Douglas expenditure system. Under the assumption of monopolistic competition, each country is assumed to specialize in different products and to have identical homothetic preferences. The model implicitly assumed the zero balance of trade in each period and kept prices constant at cross-sectional. Then the equilibrium trade volume from country *i* to *j* (X^*_{ij}) at any time period *t* in its simple form can be written as:

$$X^*_{ij} = \theta_i Y_j \, or \, \theta_i = X^*_{ij} / Y_j , \tag{1}$$

Where θ_i denotes the fraction of income spend on country *i's* products (the fraction is identical across importers) and Y_j denotes real GDP in importing country *j*. Since production in country *i* must be equal to the sum of exports and domestic consumption of goods, country *i's* GDP is expressed in what follows:

$$Y_i = \sum_{j=1}^{N} X^*_{ij} = \sum_{j=1}^{N} \theta_i Y_j = \theta_i \left\{ \sum_{j=1}^{N} Y_j \right\} or \, \theta_i = Y_i \Big/ \left\{ \sum_{j=1}^{N} Y_j \right\} = Y_i \Big/ Y_w , \tag{2}$$

Where $Yw = \sum_{j=1}^{N} Y_j$ is world real GDP that is constant across country pairs. Rearranging equation (2) produces:

$$X^*_{ij} = Y_i Y_j \Big/ \left\{ \sum_{j=1}^{N} Y_j \right\} = Y_i Y_j \Big/ Y_w \tag{3}$$

This is a simple gravity equation that relies only upon the adding-up constraints of a Cobb-Douglas expenditure system with identical homothetic preferences and specialization of each country in one good. For the empirical quest, the basic gravity model is ascertained by taking a natural logarithm of both sides of (3) in what follows:

$$\ln X_{ij} = \alpha + \beta \ln Y_i + \gamma \ln Y_j + \phi Z_{ij} \tag{4}$$

Where $\alpha = (-\ln Y_w)$ and Z_{ij} is a vector of time-invariant variables such as distance and border effect. As in real world, the countries do not have exactly identical and homothetic taste, the coefficient should not be unity but are not significantly different from unity in aggregate trade either (Anderson, 1979).

Bergstrand (1985) argued that despite the empirical success of the gravity model in explaining trade flows the absence of strong theoretical foundation has inhibited the model's predictive ability. He criticized the earlier approach by Linnemann (1966) of the gravity model for omitting the certain price variables and thus model misspecification. He derived gravity model equation using micro-level general equilibrium model of world trade originated through utility and profit maximization agent behavior in N countries, single factor of production in each country with product differentiated nationally by monopolistic competition and other assumptions including perfect international product substitutability, homothetic preferences and, identical technology across countries. The reduced form equation model produces the generalized gravity model of bilateral trade relations between exporting and importing countries, including price variables in addition to standard income variables. Bergstrand (1985) argued that as reduced form generalized gravity model eliminates all endogenous variables out of the explanatory part of each equation, income and price can be used as exogenous explanatory variables of bilateral trade.

Deardorff (1998), building upon earlier work such as Anderson (1979), has provided theoretical justification of gravity model both in the spirit of H-O type factor flow model and New Trade Theory that allows for product differentiation, increasing return to scale, and monopolistic competition phenomenon. According to Jakab (2001), Deardorff (1998) main contribution is to justify that H-O trade theory is consistent with the gravity equation. If trade is frictionless and producers and consumers are indifferent with markets settled randomly among all possibilities, then trade flows would follow a gravity equation with distance and prices playing no role. Deardorff (1998) further goes on to prove that when trade is impeded, and each good is produced by only one country, the H-O model would result in produce the same bilateral trade pattern as the model with differentiated goods, and cases, where transaction costs of trade involve then distance, should be included in the gravity equation.

To develop a gravity equation from H-O trade theory author considers two cases. First, frictionless trade wherein zero barrier to trade, including tariffs and transport costs, is presumed to allow the market to settle randomly among all possibilities, including producers and consumers to face indifferent behaviour. Given this scenario, trade flows at a bilateral level will generally be large and fall in the configuration of the gravity equation, ignoring any role that distance can play between countries. Second, the case is to allow for the presence of trade impediments and the Factor Price Equalization (FPE) theorem does not hold unless it is assumed that all countries face identical prices, and neither could overcome the positive barrier on its exports to the other. Assuming that the number of goods in the world is extremely large compared to the number of factors then for almost all goods, only one country will be the least cost producer. He further assumed that bilateral impeded trade works when each good is produced only one country for analytical purposes. Deardorff (1998), therefore, given the assumptions, argued that bilateral trade patterns in the H-O model are the same as in other models with differentiated products hence gravity equations can easily be derived within this framework of H-O model. Following the earlier interpretation of the gravity model, Deardorff (1995) specified the standard gravity model as under:

$$T_{ij} = A\frac{y_i y_j}{D_{ij}} \quad (1)$$

Where T_{ij} is the value of exports from country *i* to country *j*, the *Y's* are their respective national incomes, D_{ij} is the measure of the distance between them, and *A* is the constant of proportionality.

Homothetic Preferences:

Let xi be country I's vector of production and c_i is its consumption in frictionless trade equilibrium with world price vector *p*. The income is therefore, $Y_i = \boldsymbol{p}^{/} x_i = p^{/} c_i$, with assumption of balanced trade and expenditure equals income. The volume of export from country *i,* to country j is defined as T_{ij}. Given identical, homothetic preferences all countries will spend same fraction, β_k ,of their income on good *k*, so that country *J*'s consumption of good *k* is $c_{jk} = \beta_k y_j / p_k$. Drawing randomly from the world pool of goods k to which country *i* has contributed the fraction $\gamma_{ik} = x_{ik} / \sum_h x_{hk}$, country *j*'s purchases of good k from country *i* will be $c_{ijk} = \gamma_{ik}\beta_k y_j / p_k$. Let $x_k{}^w = \sum_i x_{ik}$ be world output of good k. Given the identical fractions of income being spent on good k by all countries, that fraction should also equal the share of good k in world income $Y^w : \beta_k = p_k x_k^w / y^w$. The value of j's total imports from i, is therefore can be shown as below:

$$Tij = \sum_k pkcijk = \sum_k \gamma_{ik}\beta_k y_j$$
$$= \sum_k \frac{x_{ik}}{x_k{}^w}\frac{p_k x_k{}^w}{y^w} y_j = \sum_k p_k x i_j \frac{Y_j}{y^w} \quad (2)$$
$$= \frac{Y_i y_j}{Y^w}$$

Arbitrary Preferences:

When the preferences are not identical or not homothetic, then equilibrium may have each country spending a different share of its income on each good and the derivation above does not work. Let β_{ik} now be the share of its income that country *i*'s income that it derives from producing good *k*. While the first and second equalities of (2) still holds but we need to replace β_{ik} with β_k. The value of world output of good *k* is $P_k x_k{}^w = \sum_i \alpha_{ik} Y_i$ and therefore the fraction of world output of good k that is produced by country *i*, is $\gamma_{ik} = \alpha_{ik} Y_i / \sum_h \alpha_{hk} Y_h$. Country *j* again drawing randomly from pool for good k an amount equal to its demand $\beta_{jk} Y_J$, it will get that fraction from county i, and therefore, the value of sales by country I, to country j of good k will be:

$$T_{ijk} = \frac{\alpha_{ik} Y_i}{\sum_h \alpha_{hk} Y_h} \beta_{jk} Y_j \tag{3}$$

Summing across goods *k* we get

$$T_{ij} = \sum_k T_{ijk} = \sum_k \frac{\alpha_{ik} Y_i}{\sum_h \alpha_{hk} Y_h} \beta_{jk} Y_j = Y_i Y_j \sum_k \frac{\alpha_{ik} \beta_{jk}}{P_k x_k{}^w} \tag{4}$$

This is not a gravity equation as summation could be different for different values of *i, and j*. In extreme cases, if country *i*, tended to specialize completely in a good that country *j* does not demand at all, then T_{ij} will be zero regardless of Y_i and Y_j. Nonetheless, it is possible to simplify (4) further if one can assume that the fractions that exporters produce, and those importers consume are in some sense unrelated. Let $\lambda_k = pkxk^w / Y^w$ be the fraction of world income accounted for by production of good *k*. Then the equation (4) can be re-written as under:

$$T_{ij} = Y_i Y_j / Y^w \sum_k \frac{\alpha_{ik} \beta_{jk}}{\lambda_k} \tag{5}$$

The equation (5) depicts that as each country good shares of both production (α_{ik}) and consumption β_{jk} sum to one, this will reduce to the simple frictionless gravity equation (2) if either the exporter produces goods in the same proportions as the world ($\alpha_{ik} = \lambda_k$) or if the importer consumes good in the same proportion as the world ($\beta_{jk} = \lambda_k$), as it is true in the case of homothetic preferences) but not in general. If the λ_k, were equal for all *k* the each being 1/n is the number of goods, it would also get back to (2) if α_{ik} *and* β_{jk} were uncorrelated. With goods having unequal shares of the world market, one can still get this weight by defining correlations on a weighted basis using the λ_k as weights as under: that is lets,

$\alpha ik = \frac{\alpha_{ik} - \lambda_k}{\lambda_k}$, $\tilde{\beta}_{jk} = \frac{\beta jk - \lambda k}{\lambda k}$ be the proportional deviation of country is production shares and of country j's consumption shares from world averages. Then

$$\sum_k \lambda_i \tilde{\alpha}_{ik} \tilde{\beta}_{jk} = \sum_k \frac{1}{\lambda_k} (\alpha_{ik} \beta_{jk} - \lambda_k \alpha_{ik} + \lambda_k^2) = \sum_k \frac{\alpha_{ik} \beta_{jk}}{\lambda_k} - 1 \tag{6}$$

,and one can re-write (5) as follows:

$$T_{ij} = Y_i Y_j / Y^w (1 + \sum_k \lambda_k \tilde{\alpha}_{ik} \tilde{\beta}_{jk}) \tag{7}$$

The sign of the summation of in (7) is the same as the sign of the weighted covariance between $\tilde{\alpha}_{ik}$ and $\tilde{\beta}_{jk}$. Therefore, when these deviations of exporter production share and importer consumption shares from world averages are uncorrelated, then once again the simple frictionless gravity equation (2) will hold.

$$\begin{aligned}\sum_{ij}\left[T_{ij} - \frac{Y_i Y_j}{Y^w}\right] &= \sum_{ijk} \frac{Y_i Y_j}{Y^w} \lambda_k \tilde{\alpha}_{ik} \tilde{\beta}_{jk} \\ &= \sum_{ik} \frac{Y_i}{Y^w} \tilde{\alpha}_{ik} \sum_j (Y_j \beta_{jk} - Y_j \lambda_k) \\ &= \sum_{ik} \frac{Y_i}{Y^w} \tilde{\alpha}_{ik} (\sum_j c_{jk} - \lambda_k Y^w) \\ &= 0\end{aligned} \tag{8}$$

In a nutshell, with frictionless trade the values of bilateral trade are on average given by the simple, frictionless gravity equation. If expenditure fractions differ across countries because preferences are not identical and or not homothetic, individual bilateral trade flows will vary around this frictionless gravity value.

Deardorff (1998) also brought trade impediments issue under theoretical debate about the derivation of gravity equation and assumed in his simple model that not only barriers to trade exist such as transportation costs, but these costs exist for every good and further assumed those barriers to be strictly positive on all international transaction. It is further assumed that every country produces and exports different goods. While in general, the H-O model allows equilibria with both FPE and non-FPE among the group of countries, no two countries that have the same factor prices can trade with each other. The author further develops the analytical model in the light of a real-world scenario by relaxing one of the H-O model assumptions where, instead, equal the unequal factor prices in each pair of traded countries are assumed. Also, it is assumed that there are more goods than there are factors. With frictionless trade having unequal factor price equalization the possibility that number of goods that any two countries could produce in common is severely limited. Having introduced the trade impediments, this is not the case as goods can become non-traded, and countries can also compete in the same market if the difference in transport costs exactly equals the difference in production costs. Nonetheless, assuming that transportation costs for a given good are constant between any pair of countries then the case can be made that only a negligible small subset of all goods will be sold by any two countries to the same market. Further, assuming that every good is produced by a different country in an international trade equilibrium, one can identify each good with the country that produces it and enter them into a utility function as imperfect substitutes. Given this background, let's define the transportation cost to be a transport factor (one plus the transport cost) between countries *i* and *j* being t_{ij}. This is a fraction (t_{ij} -1) of the good shipped from country *i* is used up in transport to country *j*. With perfect competition, sellers from country *i* will receive a single price p_i, for their products in all markets. Buyers are expected to pay the transportation cost, and the buyer price in market *j* will be $t_{ij}\, p_i$.

The pattern of bilateral trade flows would depend on preferences which initially Deardorff (1995) assumes to be identical and Cobb-Douglas. Consumers in each country spend on fixed share β_i of their income on the product of country *i*. Lets x_i be out output of country *i*. The country *i*'s income, Y_i is

$$Yi = p_i x_i = \sum_j \beta_i Y_j = \beta_i y^w \qquad (9)$$

from which $\beta_i = {Y_i}/{Y^w}$. The trade can be valued as either exclusive of transport costs (f.o.b.) or inclusive of transport cost (c.i.f). On c.i.f. basis one get immediately

$$T_{ij}^{cif} = \beta_i Y_j = \frac{Y_i Y_j}{Y^w} \qquad (10)$$

Given the model's assumption, the study has been able to drive again frictionless gravity equation for c.i.f. trade with no role for transport cost or distance. Nonetheless, on fob basis trade flows should be reduced by the amount of transportation cost as under:

$$T_{ij}^{fob} = \beta_i Y_j = \frac{Y_i Y_j}{t_{ij} Y^w} \qquad (11)$$

As the bilateral expenditures on international trade do not decline with distance, therefore, the author also considered alternate to Cobb-Douglas formulation viz. CES preferences model by assuming that consumers in country *j* maximize the following CES utility function defined on the products of all countries *i* including their own.

$$U_j = \left(\sum_i \beta_i\, c_{ij}^{(\frac{\sigma-1}{\sigma})} \right)^{\frac{\sigma-1}{\sigma}} \qquad (12)$$

where $\sigma>0$ is the common elasticity of substitution between any pair of countries' products. Facing c.i.f. prices $t_{ij}\, p_i$ of the goods, *j's* consumer's maximizing this function subject to their income $Y_j=p_j x_j$ from producing x*j*, will consume

$$Cij = \frac{1}{t_{ij}\,p_i} Y_j \beta_i \left(\frac{t_{ij}\,p_i}{p_j^I} \right)^{1-\sigma} \tag{13}$$

where p_j^I is a CES price index of landed prices in country *j*:

$$p_j^I = \left(\sum_i \beta_i t_{ij}^{1-\sigma}\, p_i^{1-\sigma} \right)^{1/(1-\sigma)} \tag{14}$$

Therefore the f.o.b. value of exports from country *i* to country *j* is

$$T_{ij}^{fob} = \frac{1}{t_{ij}} Y_j \beta_i \left(\frac{t_{ij}\,p_i}{p_j^I} \right)^{1-\sigma} \tag{15}$$

From above equation the c.i.f. value of trade in this same expression multiplied by t_{ij}, which is decreasing in t_{ij} if $\sigma>1$.

The parameters β_i is no longer country's *i's* share of world income, as it was in the Cobb-Douglas case, so that does not reduce as easily to the standard gravity equation. To solve the above expression of β_i lets θ_i be a country *i's* share of the world income and one can relate it to β_i as under:

$$\theta_i = \frac{Y_i}{Y^w} = \frac{p_i x_i}{Y^w}$$

$$= \frac{1}{Y^w} \sum_j \beta_i\, p_j x_j \left(\frac{t_{ij}\,p_i}{p_J^I} \right)^{1-\sigma}$$

$$= \beta_i \sum_j \theta_i \left(\frac{t_{ij}\,p_i}{p_J^I} \right)^{1-\sigma} \tag{16}$$

from above equations

$$\beta_i = \frac{Y_i}{Y^w} \frac{1}{\sum_j \theta_j \left(\frac{t_{ij}\,p_i}{p_j^I} \right)^{1-\sigma}} \tag{17}$$

Combining equation (17) with equation (16) gives:

$$T_{ij}^{fob} = \frac{Y_i Y_j}{Y^w} \frac{1}{t_{ij}} \left[\frac{\left(\frac{t_{ij}}{p_J^I} \right)}{\sum_h \theta_h \left(\frac{t_{ih}}{p_h} \right)^{1-\sigma}} \right] \tag{18}$$

For interpretative purpose Deardorff (1998) product price, p_i, is normalized at unity and thus p_j^I becomes a CES index of country *j's* transport factors as an importer, what he called it as an average distance from suppliers δ^S :

$$\delta^S = (\sum_i \beta_i t_{ij}^{1-\sigma})^{\left(\frac{1}{1-\sigma}\right)} \quad (19)$$

The vital aspect for demand along a particular route is the transport factor t_{ij} relative to this average distance from suppliers which he coined as the relative distance from suppliers ρ_{ij}:

$$\rho ij = \frac{t_{ij}}{\delta_j^S} \quad (20)$$

With this notion, trade flow in equation (18) can be written as under

$$T_{ij}^{fob} = \frac{Y_i Y_j}{Y^w} \frac{1}{t_{ij}} \left[\frac{\rho_{ij}^{1-\sigma}}{\sum_h \theta_h \rho_{ih}^{1-\sigma}} \right] \quad (21)$$

Deardorff (1998) has described equation (21) as the main result of his paper. It conveys that when importing country *j* relative distance from exporting country *i* is the same as an average of all the demanders relative distances from *i* then exports from *i* to *j* will be the same as in Cobb-Douglas case. That is c.i.f. exports will be given by the simple, frictionless gravity equation, while f.o.b. exports will be reduced by the transport factor from *i*, to *j*, much as in the standard gravity equation with the transport factor (one plus transport cost) measuring distance. If country *j* relative distance from *i* is greater than this average the c.i.f. (and respectively f.o.b.) trade along this route will be correspondingly less than simple, frictionless gravity equation, and if country *j* relative distance from *i* is less than this average, then trade will correspondingly more. The results also show that the greater the elasticity of substitution among goods, the more trade between distance countries falls short of the gravity equation, and the more the trade will among close countries exceed it. Moreover, the reduction in transport factor due to technological improvement in transport area will pull trade closer the amounts predicted by the simple frictionless gravity equation.

Evenett and Keller (2002) showed that the gravity equation could be derived from the traditional neo-classical H-O model with both perfect and imperfect product specialization. They advocated that increasing return to scale model rather than the perfect specialization version of the H-O model is a more likely candidate to explain the success of the gravity model.

After a comprehensive survey on the theoretical foundation of gravity models in explaining trade flows, Evenett and Keller (1998 in 2002) proposed the three significant findings:

1- little production perfectly specialized due to factor in endowments differences, making perfect specialization version of Heckscher-Ohlin model an unlikely candidate to explain the empirical success of gravity equations;
2- increasing returns are important causes for perfect specialization and gravity equation, especially among industrialized countries.

3- to the extent that production is not perfectly specialized across countries, it is possible to find support for both Heckscher-Ohlin and increasing Returns models. Both models explain different components of the international variation of production pattern and trade volume, with important implications for productivity growth and labor.

The gravity model has proved successful in predicting the pattern of trade and assessing the effects of commercial and monetary policies (Longo and Sekkat, 2001). The gravity modeling is less data demanding, produces robust results, and more applicable for developing countries whose price data are less reliable and complete (Wilson et al., 2003).

8.4 Empirical Gravity Modeling for Environmental Regulation and Trade Competitiveness: From Modeling Choice to Data Description and Estimation Methods.

In the light of theoretical literature, the empirical gravity models since the 1960s to-date have extensively been used to accomplish various study objectives such as to examine the role of international blocks on trade (Tinbergen, (1962); Linnemann (1966); Rose, (2002a), the role of the institution in trade flows (Álvarez et al., 2018) and in recent past to assessing the impact of environmental regulations on trade flows (Grether and de Melo (2004); Van Beers and Van den Bergh, 1997 and 2003; XU, 2000; Jayawardane and Edirisingh, 2014; Cantore and Cheng, 2018). Most of the standard empirical research typically leads to a specification where-all in natural logarithms form- the volume of trade is related to the levels of incomes in the exporting and importing countries, and distance is always added, of course, usually with adhoc references to the importance of transportation and communications costs and some extended capture tariff and non-tariff barriers. This standard model is augmented by incorporating the host of variables depending on study research objectives. Most of earlier research conducted using cross-sectional level data have used the following classical gravity model without bringing time element into the equation and aimed at controlling for heterogeneity using the country paired effects such as common language, border effect, colonial links etc.

$$X_{ijk} = \beta o(Y_i)^{\beta_1}(N_i)^{\beta_2}(Y_j)^{\beta_3}(N_j)^{\beta_4}(D_{ij})^{\beta_5}\ (Z_{ij})^{\beta_6}\ \varepsilon_{ij} \qquad (1)$$

Anderson and Wincoop (2003) argued that controlling for relative trade cost is of paramount importance for a well-specified gravity model. They showed that bilateral trade cost is an outcome of relative trade cost i.e., the propensity of country j to import from county i is determined by country j's trade cost toward i relative to its overall resistance to imports (weighted average trade costs) and to the average resistance facing exporters in country i ; and not just by absolute trade costs between county i and country j. The justification of including what the authors coined as 'multi-lateral trade resistance' (MRT) is that keeping other thing constant, two countries surrounded by other large trading economies, say Belgium and the Netherlands bordered by France and Germany respectively as well as by each other, will trade less between themselves than if they were surrounded by the oceans (such as Australia and New Zealand) or by vast stretches of deserts and mountains such as the Kyrgyz Republic and Kazakhstan. They proposed functional form as under:

$$X_i = \frac{Y_i Y_j}{Y_j}\left[\frac{t_{ij}}{\pi_i \; p_j}\right]^{1-\sigma} \qquad (1.1)$$

Where Y shows the world GDP and Y_i and Y_j are the GDP's of country i and country j, respectively. t_{ij} is (one plus tariff equivalent of the overall trade cost) cost in *j* of importing good from i, $\sigma > 1$ is the elasticity of substitution and , $\pi_i \; p_j$ depicts exports and imports ease of market access or county *i* outward and county *j* inward multilateral resistance terms(MRTs). They are low if country is remote from the world market; remoteness is determined by both physical factors i.e., physical distance from the large market and policy factors such as tariff barriers and other trade-related costs. These results, according to the authors, highlights the server mistakes made in the estimation of gravity model like in equation (1) above by earlier researchers of just focusing on GDP and population variable and standard distance on both exporting and importing countries and not augmenting the model of controlling for MRTs (Anderson and Wincoop, 2003, in UNCTAD, 2012). Nonetheless, the problem at the estimation level of bringing these MRTs is that later are not directly observable. There seemed to be consensus in the literature that the simple and most widely alternate proxy for MRTs is to use country-fixed effects for both importers and exports, especially for panel data. (Feenstra, 2004; Baldwin and Taglioni, 2006, in UNCTAD, 2012).

For empirical analysis equation **(**1) is expressed in natural logs on both sides of equations and resulting estimated equations are log linear as follows:

$$ln(X_{ijkt}) = \alpha_0 + \beta_1 \, ln(Y_{it}) + \beta_2 \, ln(N_{it}) + \beta_3 \, ln(Y_{jt}) + \beta_4 \, ln(N_{jt}) + \beta_5 \ln{(D_{ij})} + \beta_6 \ln{(Z_{ij})} + \varepsilon_{ijkt} \qquad (2)$$

where X_{ijkt} variable has generally been used in literature for total trade flows from country *i* to country *j* of industrial good *k* for respective pollutive categories at time period *t* (Rose, 2002a; Van Beers and Van den Bergh, 1997; Jakab et al., 2001), export flows from country *i* to country *j* of industrial good *k* at time *t* (Cantore and Cheng , 2018; Jayawardane and Edirisinghe, 2014) and or imports or mirror exports of country *i* to country *j* of good *k* at time period *t* (Rahman, 2003; Grether and de Melo, 2004; Ederington, Levinson and Minier, 2005). Dhar and

Panagariya (1999) (in Kandogan, 2009) argued that total trade should not be the dependent variable, because it imposes equality of coefficients for imports and exports. This criticism is widely accepted. In fact, most authors estimate the gravity equation using import data on the assumption that countries tend to monitor their imports more carefully than their exports (Grether and de Melo, 2004). However, others suggested using export flows data to capture the competitiveness impact of the explanatory variables, including environmental policy (XU, 2000; Cantore and Cheng, 2018). Whereas Rahman (2003) argued that since the gravity model theoretically can be derived for both exports and imports trade flows as a dependent variable, a careful research in gravity modeling framework should examine the impact on both dependent variables separately. The present research endeavors are focused on examining both export and import trade flows for South Asia and selected 17- OECD countries at 4-digit ISIC-level for two periods- 1990 and 1998 in cross-sectional framework and at 3-digit ISIC level covering panels of 1990,1998 and 2004 by deploying extended gravity modeling approach. A brief introduction to the explanatory variables for gravity modeling is what follows.

Among the list of explanatory variables in equations (1) and (2), Y_i and Y_j show the income of exporters and importers countries, respectively, which for present research are termed as GDP of exporting and importing countries or per capita GDP of exporting and importing countries where appropriate. The GDP of the exporting country measures productive capacity, while that of the importing country measures absorptive capacity (Martínez-Zarzoso et al., 2017). The higher level of income in exporting countries reveals a high level of production, which increases the availability of goods for exports. Similar reasons could be applied for importing country as a higher level of income suggests higher demand for imports. These two variables are expected to be positively related to trade (Cantore and Cheng, 2018; Jayawardane and Edirisinghe, 2014). However, it is worth sharing that alternative explanatory variables of income have been used to explain bilateral trade flows depending on scope and study objectives. For example, some empirical literature used the product of GDP exporter and importer countries and the product of per capita of exporters and importer countries (Glick and Rose, 2001). The studies also used the difference of per capital incomes as an explanatoy variable in the gravity model to test the effect of economic similarity between countries. The variable of difference in Per capita income examines the applicability of the Linder Hypothesis, which states that countries with similar living standards may have a high level of intra-industry trade given that they share a broader range of goods to trade (Longo and Sekkat, 2001).

As pointed out by Linnemann (1966), the choice of GDP as an explanatory variable instead of GNP is more appropriate for trade data analysis. In respect of exports, GDP is preferred for analysis because all domestically produced goods leaving a country are counted as exports whether they are produced by national factors of production or by foreign factors of production. However, with regards to imports data, it was opined that imports of current producer goods and capital are related to the domestic product, while those of consumer goods probably relate more to national product (in Voicu and Horsewood, 2006). The present research, following most of literature including Van Beers and Van den Bergh (1997, 2000), Rahman, 2003), XU (2000), Glick and Rose (2001), Cheng and Cantore, (2018), and Jayawardane and Edirisinghe, (2014) will choose variables of GDP and GDP per capita for cross-sectional and panel data analysis.

Population variable is used as a measure of country size. Since larger countries have more diversified production and tend to be more self-sufficient, population variable is normally expected to be negatively related to trade i.e. the country will export less when it is big-absorption effect (Martinez-Zarzoso et al., 2017). Prewo (1978) found an inconsistency in this argument, as larger populations allow for economies of scale and, therefore, promote specialization, which are translated into higher exports. Therefore, the sign of the coefficient β_2 of the exporting country in the bilateral trade flow model would be indeterminate. The coefficient β_4 of importing country population would also be undetermined, i.e., positive or negative for similar reasons (Kandogan, Y, 2009). However, depending on data robustness checks like multicollinearity, the population variable might be replaced with GDP per capita as explanatory variables, which is expected to have a positive association with trade flows (Helpman and Krugman, 1985)

One vital variable included in equation (2) to explain the trade flows is the geographic distances, D_{ij}, which proxies for three elements of natural trade obstacles viz. transport costs, transport time and economic horizon (or physical distance) (Linnemann, 1966, XU, 2000). Economic geography theory (Grossman and Krueger, 1991) highlights the role of distance in determining the pattern and direction of international trade flows. Two fundamental forces are at work to guide the location of firm: (1) economies of scale at factory level and (2) trade costs. Geographical distances are calculated following the great circle formula, which uses latitudes and longitudes of geographic coordinates of the capital cities (CEPII, 2006). The distance coefficient β_5 is expected to be negatively associated with trade flows since it is a proxy for the sources of trade costs, and there is a general consensus in the literature on the expected negative sign of coefficient β_5 in equation (2) (Kandogan, Y, 2009; Longo and Sekkat, 2001; Van Beers and Van den Bergh, 2000).

It is well known that determined of trade flows are further to the just income, population and distance variables and therefore, literature on gravity modeling guide to incorporate a host of extra conditioning variables that might affect trade which among others include variables such as commodity tariffs (Wall, H.J., 1999; Glick and Rose, 2001, XU, 2000; Wilson et al., 2003), environmental regulations, land areas of exporting and importing countries (Van Beers and Van den Bergh, 1997 and 2003), and other dummy variables covering the cultural phenomena (e.g., whether the countries share a common language), the geographic nature of the countries (e.g., whether none, one or both are landlocked), and the historical nature of the relationship between the countries (e.g., colonial links between countries) and RTA's(regional trade agreements). *The idea is to control for as many important effects on trade as possible so that whatever is left over is mostly the result of artificial barriers to trade* (Rose, 2002a:3). The key variable pertaining to research objectives, i.e., environmental regulatory variable and some of those controlled variables, are explained below.

One of this study research objectives is to examine whether tariff walls created by the countries to offset the loss of trade competitiveness due to compliance with stringent environmental regulations in the countries. It is common to bring commodity or industrial tariff as an explanatory variable in the import side equation of gravity model. However, some studies have also used tariff variables to explain bilateral industrial exports by deploying gravity model to examine whether bilateral tariff barriers on manufacturing products reduce bilateral exports (Wilson et al., 2003; XU, 2000; Linnemann and Verbruggen ,1991). Linnemann and Verbruggen (1991) defined manufacturing tariff levels as trade control measures (TCM) i.e., higher the TCM are lesser the trade flows would be. They further explained that higher TCM would reduce imports and increase the domestic-market orientation of manufacturing productions, thus reducing the country's manufacturing exports. Therefore, tariff levels entering export or import equations will leave a negative effect on trade flows. Therefore, the study expects negative sings of bilateral average tariff coefficients for both exports and imports equations for cross-sectional analysis. It has been noted in the empirical literature of gravity modeling that at disaggregated ISIC level commodity tariff data for bilateral trade flows has hardly been used in the literature about environmental regulation and trade flows and generally the regional agreements dummies (Glick and Rose, 2001) or other proxies such as trade index scores (Wall, 1999) have been used to capture the protectionist policies effects on trade flows.

To examine the impact of tariffs on pollutive export competitiveness in the gravity model, XU (2000) added a proxy for tariff variables as an explanatory variable to determine the pollutive industrial export flows. He used the ratio of tariff revenue share in total imports rather than using actual bilateral tariff data for respective pollutive commodity/country. One plausible issue of using the tariff proxy could be the lack of true reflection of protectionist policy, especially in the countries where the variation in ratios (tariff revenue/import) in individual countries might not be due to change in tariff level and or levies but due to other factors such as variation in exchange rates, in-efficiencies in the customs port system, corruptions in revenue system in general and or other structural factors linked to imported commodities.

This study, accordingly, for trade data analysis following Wilson et al. (2003) augments the standard gravity model by ($100+Tariff_{ijkt}$) by using bilateral tariff data from World Production and Trade (Nicita and Olarreaga, 2001). The term $Tariff_{ijkt}$ denotes effectively applied tariff rate (AHS) in the percent ad valorem term specific to the trading partners *i* and *j* and at 4-digits ISIC bilateral level commodity *k* at period *t* for cross-sectional level in sample periods -1990 and 1998. The inclusion of this variable in the model will help avert omitting variable bias in the data. However, for panel data analysis, this variable has not been included as (a) in panel data with its country-specific effects and time effect have had the inherent ability to capture country-specific effects; hence, most of the literature in this area has not incorporated this variable. Furthermore, the distance variable tends to capture tariff barriers, along with country-specific effects for both exporters and importers. The lack of tariffs data at industrial levels restricted the study to use it for full study period as tariffs data set at highest dis-aggregated ISIC 4-digit level was not available after 1998 in World Production and Trade data sources. The study, therefore, includes tariff variables for cross-sectional data analysis for the period 1990 and 1998.

This study has transformed the data on tariff variables (AHS tariff category) for the individual industry to three industrial groups: total bilateral trade, most pollutive industrial trade, and relative less pollutive industrial trade at a bilateral level for 17 OECD and 3 South Asian countries for 1990 (average 1986-90) and 1998 (average 1994-98) periods. For few countries where exact sample year data was not available, the study linearly interpolated or extrapolated the applied rates over the period under analysis. This process averts a significant loss of observations in a data set. The incorporation of tariffs as an explanatory variable is particularly important for OECD and South Asian countries bilateral exports flows associations since, unlike the EU whose tariff policies are harmonized, as revealed from this study tariffs data South Asian countries, applied tariff rates generally vary across the member countries and across their exporting partners. Therefore, inclusion of tariff variables to explain trade flows is also vital. In literature, it is argued that protectionist attitude-both tariff and non-tariffs barriers-of the OECD countries prevented full market access by developing countries, including South Asia to OECD markets (Majad, N., 1995).

The gravity model has widely been used for regional trade analysis, and numbers of dummies as explanatory variables are incorporated to explain trade flows and the most important regional trade agreements (RTAs). In the regional/geographical economics subject, the spectacular growth of regional trade blocs has been a significant development in international relations in recent years. Virtually all countries are members of a bloc, and many belong to more than one. Over a third of world trade occurs within such agreements- nearly two-thirds when Asia-Pacific Economic Cooperation (APEC) is included. Regional agreements vary widely, but all have virtually a common objective of reducing barriers to trade between member countries (Schiff and Winters, 2003). Keeping that in mind, the effects of regional trading arrangements on trade flows are estimated using a dummy variable approach that measures a country's participation in RTA. By including the dummy variables in a gravity model equation, a consensus has emerged among researchers that regional trading arrangements are trade-creating (Ghosh and Yamarik, 2004). A positive sign of the coefficient attached to the RTA variable is expected. RTA_{ij} depicts value 1 if both countries are members of the same regional trading arrangement and 0 otherwise. The source of this variable and other dummies is CEPII: website: http://www.cepii.fr/anglaisgraph/bdd/distances.htm.

The present study adds a few more following dummy variables in the augmented gravity model to examine the impact on bilateral trade flows of other geographical factors and historical ties between countries,

Contiguity (border/adjacency): A dummy variable is included to identify a pair of countries that are adjacent or contiguous or share a border. This dummy is in addition to the inclusion of the distance variable to account for the possibility of center- to- center distance overstating the effective distance of neighboring countries that may often engage in a large volume of border trade. The dummy variable is 1 if countries i, and j share a common border and 0 otherwise. The positive sign is again expected from contiguity coefficient at regression level analysis (Batra, A., 2004);

Common Language ($CLANG_{ij}$): Common language is expected to reduce transaction cost as speaking the same language help facilitate trade negotiation. The dummy variable is equal to 1 if countries i, and j share a common language and 0 otherwise (Batra, 2004).

Colonial Links (Col_{ij}): The history sharing is likely to reduce the transaction cost caused by the cultural differences between countries and can positively affect trade flows. So dummy is added to explain that phenomenon between a pair of countries. It will be 1 when countries *i*, and *j* share colonial links and 0 otherwise (Batra, 2004).

Land area ($land_i$ and $Land_j$): The land area of a country can positively or negatively affects trade flows. Land area exerts a negative influence on trade flows as the larger the country's total area is, the small the fraction of its economic activities expected to cross the borders. Nevertheless, the land area can positively affect trade flows when a country with a large land availability area can expand in the external sectors and provide a push factor for the exports of that sector (Van Beers and Van den Bergh,1997 and 2000). Land variables, therefore, can have a positive or negative impact on bilateral pollutive trade flows.

Environmental Regulation variables: As reviewed in chapter 4, there is a dearth of data on environmental regulations at the pollutive industrial level. Therefore, empirical literature in the past aimed at analyzing the environmental regulations on trade competitiveness has suffered from a lack of adequate and comprehensive comparative data on environmental stringency across countries (Busse, M., 2004). In view of the data deficiencies issues, the present research focuses on two sets of data sources available covering periods: 1990;1998; 2004. For the year 1990, the study will use the Environmental Regulatory Index developed by Dasgupta et al. (1995), the team from the World Bank who mustered information from the individual 31 countries and compiled data in the light of UNCED guidelines. Their survey assessment report for these 31 selected countries uses identical 25 questions to classify and compile information on (1) state of environmental awareness; (2) scope of environmental policies adopted; (3) scope of environmental legislation enacted; (4) environmental control mechanisms in place and (5) the degree of success in implementation. The status in each category is graded as high, medium, low, with an assigned value of 2, 1 and 0, respectively, for the year 1990. All 25 questions for UNCED report are answered for agriculture, industry, energy, transport, urban and environment side elements, including air, water, land, and living resources. Dasgupta et al. (1995) developed a scoring index of stringency for environmental regulations for the four-dimensional environmental policy analysis viz. air, water, land, and living resources and the resulting environmental regulatory index is a composite index of these four environmental dimension indices. The higher the index number is, the higher the country's stringency is in the country for respective indices. The results for cross-section analysis show that countries with higher per capita income are the ones pursuing stringent environmental regulatory policies. The environmental performance index is found to be positively correlated with a host of variables, including per capita income, freedom of information, security of property rights, and one that most relevant to the current research is the positive association of environmental performance index and development of the legal and regulatory system. The income elasticity of environmental policy was found to be positive and highly statistically significant in all environmental dimensions. This environmental policy index serves well to accomplish present study objectives and has been used by other researchers like XU (2000) for similar research inquiry lines. Eliste and Fredriksson (2001), using the same methodology of Dasgupta et al. (1995), extended the environmental stringency index from 31 countries to 60 countries, which covers all sample countries chosen for analysis, including 17 OECD and three South Asian countries. On the request of this study researcher, Eliste and Fredriksson (2001) provided environmental scoring index data set to the author to use for research endeavors.

For the sample periods of 1998 and 2004, this study chooses a new comprehensive database made available by the Centre for International Earth Science Information Network (CIESIN). It is a non-governmental organization and the outcome of collaboration among the World Economic Forum's Global Leaders for Tomorrow Environment Task Force, the Yale Centre for Environmental Law and Policy and the Earth Institute at Columbia University (CIESIN, 2006; Busse, 2004: 288). The most vital indicator the institutions have developed is called Environmental Sustainability Index, henceforth ESI, which measures overall progress towards environmental sustainability for 142 countries. The ESI goes well with environmental regulations and environmental stringency expectations. The analysis conducted based on the ESI scoring index clearly shows its positive association with country per capital income, i.e., the higher the per capita income of the country, is higher the ESI would be. The ESI has been used in the literature on the assumption that high ESI in a country's economy is, higher environmental stringency in that country will be (Emerson et al., 2012 in Jayawardane and Edirisingh, 2014).

The ESI during the period 2000-2004 is, on average, constructed by integrating sixty-eight to seventy-six data sets tracking natural resource endowments, past and present pollution level, environmental management efforts, and society capacity to improve its environmental performance. These are then aggregated to construct around 20 core indicators of environmental sustainability. These include air quality, water quantity, biodiversity, land, reducing air pollution, reducing water stress, reducing eco-system stress, reducing waste and consumption pressures, reducing population growth, basic human sustenance, environmental health, science and technology, capacity for debate, environmental governance, private sector responsiveness, eco-efficiency, participation in international collaborative efforts, reducing greenhouse gas emissions, reducing trans-boundary environmental pressures. Several variables are used to capture each of these variables, and their effect was classified according to their coverage and variable relevancy. This process of ESI construction then aggregates the 20 core indicators into five broad indicators of sustainability. These broad indicators are: 1) environmental system; 2) reducing environmental stress; 3) reducing human vulnerability; 4) social and institutional capacity component; and 5) global stewardship. These indicators are then collapsed into a single ESI variable (CIESIN, 2006; Jha and Murthy, 2003).

According to (Busse, 2004), for the empirical analysis on the association between environmental regulations and trade patterns two of the CIESIN core indicators are more appropriate: environmental governance and participation in international collaborative efforts. Other studies have chosen the overall ESI considering the importance of the composite index and its impact on trade flows and competitiveness (Jayawardane and Edirisingh, 2014). Present research tends to use overall compositive index ESI data to maintain the analysis symmetry of 1998 and 2004 with 1990 compositive environmental stringency index. It is worth mentioning here that the key underlying assumption for the construction of both ESI by CIESIN (2006) and ERI by Dasgupta et al. (1995) was the same i.e., positive and statistically significant income elasticity of environmental performance and their links to the stringency of environmental regulatory regimes for countries around globe.

In the light of the importance of all variables elucidated in forgoing paragraphs, the study extends equation (2) to develop an augmented gravity model for total manufacturing export and total manufacturing import flows; most pollutive manufacturing export and import flows and relatively less pollutive manufacturing export and import flows. The study examines cross-sectional data at 4-digit ISIC level (revision-2) for the years 1990 and 1998. For panel data analysis study uses at 3-digit ISIC level(revision-2) pollutive trade data covering the years 1990, 1998 and 2004. All panel years- 1990, 1998 and 2004- reflect five-year average data from preceding years so that any single-year macro-economic distortions could be taken care of. It is also important to mention that the final functional form will be chosen once data's robustness analysis is carried out in the estimation section. The equations (3), (3a), and (4) would measure data using cross-section gravity models given below:

Augmented Gravity model for Exports and Environmental Regulation:

$$\begin{aligned} ln(X_{ijkt}) = \alpha_0 &+ \beta_1\, ln(Y_{it}) + \beta_2\, ln(Y_{jt}) + \beta_3\, (N_{it}) + \beta_4\, ln(N_{jt}) + \beta_5\, ln(D_{ij}) \\ &+ \beta_6\, ln(ENV_{it}) + \beta_7\, ln(ENV_{jt}) + \beta_8 (Border_{ij}) + \beta_9 (CLANG_{ij}) \\ &+ \beta_{10}\left(COLLINK_{ij}\right) + \beta_{11}\left(RTA_{ij}\right) \\ &+ \beta_{12}\, ln(LAND_i) + \beta_{13}\, ln(LAND_j) + (\varepsilon_{ijkt}) \qquad (3) \end{aligned}$$

Augmented Gravity model for Exports Environmental Regulations and Tariffs:

$$ln(X_{ijkt}) = \alpha_0 + \beta_1\, ln(Y_{it}) + \beta_2\, ln(Y_{jt}) + \beta_3\, ln(N_{it}) + \beta_4\, ln(N_{jt}) + \beta_5\, ln(D_{ij})$$
$$+\beta_6\, ln(ENV_{it}) + \beta_7\, ln(ENV_{jt}) + \beta_8 (Border_{ij}) + \beta_9 (CLANG_{ij})$$
$$+\beta_{10} (COLLINK_{ij}) + \beta_{11} (RTA_{ij}) + \beta_{12}\, ln(LAND_i) + \beta_{13}\, ln(LAND_j)$$
$$+\beta_{14}\, ln(100 + Tariff_{ijkt}) + (\varepsilon_{ijkt}) \quad (3a)$$

Augmented Gravity model for imports:

$$ln(M_{ijkt}) = \alpha_0 + \beta_1\, ln(Y_{it}) + \beta_2\, ln(Y_{jt}) + \beta_3\, ln(N_{it}) + \beta_4\, ln(N_{jt}) + \beta_5\, ln(D_{ij})$$
$$+\beta_6\, ln(100 + Tariff_{ijt}) + \beta_7 (ENV_{it}) + \beta_8 \big(ENV_{jt}\big)$$
$$+ \beta_9 (Border_{ij} + \beta_{10} (CLANG_{ij}) + \beta_{11} (COLLINK_{ij}) + \beta_{12} (RTA_{ij})$$
$$+\beta_{13}\, ln(LAND_i) + \beta_{14}\, ln(LAND_j) + (\varepsilon_{ijkt}) \quad (4)$$

Where *i* denotes the exporters and *j* denotes the importers for augmented gravity export model while *i* and j denotes for importers and exporters for augmented gravity import model at time period *t.*

X_{ijkt} denotes the real exports in manufacturing products, at 4-digits ISIC level (revision-2) and at 3-digits ISIC level (revision-2) from country *i*, to country *j* of product group *k* at time period *t* (in 000 US$).

M_{ijkt} denotes the real imports in manufacturing products, at 4-digits ISIC level (revision-2) and at 3-digits ISIC level (revision-2) of country *i*, from country *j* at time period *t* (in 000 US$).

Y_{it} and Y_{jt} are the real GDP of exporting and importing countries at time period *t* or it will represent GDP per Capita depending final model choice: PPP[25] (constant 1995 international (in 000 US$) for augmented export model and vice a versa for augmented import model.

N_{it} and N_{jt} denote population of exporting and importing countries (in 000) for augmented-export model and vice a versa for augmented-import model.

D_{ij} is the distance between the official capital cities of country *i* and country *j*.

ENV_{it} and ENV_{jt} are the environmental stringency variables of country *i* and country *j* at time period *t* as described above. The environmental variables are expressed in natural logs for the time period selected for the year 1990 and to distinguish the environmental regulatory variable

[25] In the literature for empirical analysis of gravity modelling approach GDP and GDP per capita variables have been chosen at current exchange rates as well as purchasing power parity rates (PPP). In theory however, PPP rates are preferable as large temporary swings in the nominal exchange rate can distort the comparison of incomes across countries (Batra, A., 2004)

for 1998 the study uses ES_{it} and ES_{jt} , all expressed in logs. For panel analysis, it will be ES_{it} and ES_{jt} for three selected panel years, 1990; 1998; 2004.

$BORDER_{ij}$ is dummy variable included to identify a pair of countries that or adjacent or contiguous or share border. The dummy variable is 1 if countries *i*, and *j* share a common border and 0 otherwise.

$CLANG_{ij}$ is the binary dummy variable which is unity when country *i* and country *j* share a common language and 0 otherwise.

$COLLINK_{ij}$ is a binary dummy variable which is unity if country *i* and country *j* share a colonial link and 0 otherwise.

RTA_{ij} is a binary variable that is unity if country *i* and country *j* belong to same regional trade block and 0 otherwise.

$LAND_i$ and $LAND_j$ are land area (000 hectares) of country *i* and country *j*.

$Tariffs_{ijkt}$ is a simple average bilateral tariff (AHS) applied by country *i* to country *j* of commodity *k* at time period *t* at 4digit ISIC-level of country *i* and country *j*. Technically the tariff variable values being at bilateral level data used for both import and export equations will remain the same following Wilson et al. (2003) and Linnemann and Verbruggen (1991).

ε_{ijkt} is defined to take account of all the possible measurement error andε_{ijkt} is assumed to be independently and identically distributed.

$\alpha_o$is a constant term that accounts for the average effect of all the variables omitted from the sample to the dependent variable. In cross-sectional analysis, constant term accounts for the effects of unmeasured trade distortions on exports and imports flows for respective gravity equations (3); 3(a) and (4).

The gravity model has been estimated originally using cross-sectional level data only. While cross-section data analysis permits to have valued information across countries on a particular industry during a specific year, panel data estimation technique allows analysis for more than a year. Some researchers prefer analysis using cross-sectional data as values of the model variables are averaged over the period of analysis (Wang and Winters, 1991). They argued that averaging minimizes the temporary disequilibria and shocks but at the same time data averaging has an econometric consequence as it forces the parameters of the model to be the same for every year. While working on India's global trade potential Batra (2004) used the gravity model for India bilateral and regional trade analysis. He argued for choosing cross-section over panel data because aggregation did not add any value to the estimation over time. He, nonetheless, admits that panel data has advantages in capturing the relevant relationships over time and that panels monitor unobservable trading partner pairs individual effects. Another criticism on cross-section data is that standard cross-sectional methods produce biased results due to its inability to control heterogenous trading relationships and issues pertaining to endogeneity. If research endeavours require data analysis over time, cross-sectional data analysis does not help infer intra-individual changes over time. Panel data techniques help address these issues of heterogeneity and endogeneity for gravity modelling in trade sectors. OLS estimates will be biased when individual effects are omitted as individual effects are correlated with the regressors. The panel data has been analyzed using different techniques, but two of them that have received considerable attention in empirical literature are, viz: fixed-effect and random-effect (Cheng and Wall, 2005).

In fixed-effects models (FEM), according to Allison (2009), the analysis facilitates for unobserved variables are allowed to have any associations whatsoever with the observed variables. Fixed effects models control for, or partial out, the effects of time-invariant variables with time-invariant effects. On the other hand, the Random Effects Models (REM) have an inherent tendency wherein unobserved variables are expected to be uncorrelated with (or, more strongly, statistically independent of) all the observed variables. Random effect models estimate for time-invariant variables, and that random effect models can be assessed via Generalized Least Squares (GLS). If there is enough information to believe that omitted variables are not correlated with explanatory variables included in this study gravity model. In that case, REM will probably perform best as it will produce unbiased estimates of the coefficients. Nonetheless, in the presence of omitted variables, correlation with the explanatory variables in the model FEM can better control omitted variable bias. The expectation is that whatever effects the omitted variable has on the subject at one time, they will also have the same effect over time, thence, their effects will remain constant or fixed. However, to hold this condition, the omitted variable must have time-invariant values with time-invariant effects *(*in Williams, 2018, p:2).

The proponent of FEM in panel data analysis advocates that FEM allows for unobserved or misspecified factors that simultaneously explain trade volume between two countries. Some researchers tend to agree on using fixed-effect models to address the issues pertaining to un-observed heterogeneity, but they differ in the specification of the fixed-effect model at the estimation level (Mátyás, 1997; Cheng and Wall, 2005; Millimet and Osang, 2004). For example, Cheng and Wall (2005) propose two fixed effects for each pair of countries, one for each direction of trade. In Glick and Rose (2001), each pair of countries has only one fixed effect. In Mátyás (1997), each country has two fixed effects: an exporter and one as an importer.

Baltagi et al. (2003) challenged earlier work regarding the specification of panel model for FEM using gravity framework. They argued that earlier work has focused on what he called the main effect, including exporter, importer and time effects, and that earlier trade work analysis missed the interaction effects as explanatory variables that include a country-pair effect, i.e., an interaction effect between the unobserved exporter and importer characteristics. The two additional interaction terms include: first, time-variant effects, such as the exporter country's business cycle, its cultural, political, or institutional characteristics, and unobserved factor endowment variables; and second, the other interaction term that accounts for these influences from the importer's perspective. A model that fails to incorporate one or more interaction terms is exposed to significant risks of omission bias and inconsistency of the regression coefficients (Baltagi et al., 2003). Mátyás (1997) argues that the correctly specified gravity models are indeed three-fold. One dimension is time, reflecting the common business cycle or globalization process, and the other two dimensions represent the effects of group variables related to time-invariant exporters and importers. Baltagi et al. (2003) new form of the specification is an improvement over Mátyás (1997), Chen and Wall (2004), and Glick and Rose (2002), who mainly focused on the main effects in the model specification (Kabir et al., 2017).

The problem in using FEM at the analysis level is that it does not directly estimate variables that do not change over time as the inherent transformation wipes out such variables like distance, land, contiguity, common language, etc. Recent work regarding the impact of environmental regulation on trade competitiveness for panel data analysis leaned towards random effect specification for gravity modeling framework. In this context, Jayawardane and Edirisingh (2014) used the country pairing effect by generating country pair dummies and modelled as random instead of FEM as this approach allowed the researcher to preserve the possibility of estimating separately the impact of bilateral factors such as distance, common borders, etc. that would otherwise be puzzled with fixed effect. Cantore and Cheng (2018), in their recent work on environmental regulation and trade competitiveness, have focused both on FEM and REM and choose Hausman test criteria for data estimation.

Regarding the choice of estimation technique between FEM and the random effect, it is now well documented in the literature to first implement a Hausman test due to Hausman (1978). If the Hausman pre-test rejects the pre-test null hypothesis that random effect specification is correct, inference based on fixed effect estimator is used in the second stage and vice versa (Guggenberger, Partik, 2009). Hausman's empirical test normally determines whether REM is more efficient or FEM. This study, therefore, following the debate on alternate estimation models and, keeping in view the importance of both cross-section and time series analysis in the gravity model and for sensitivity/robustness perspectives, will cover the analysis at both cross-sectional and panel levels. Accordingly, the equation (5) below will follow the estimation technique based on the above literature survey and the recent work on trade and environmental regulation using panel data by Cantore and Cheng (2018).

$$ln(X_{ijkt}) = \alpha + \beta_1\, ln(Y_{it}) + \beta_2\, ln(Y_{jt}) + \beta_3\, ln(N_{it}) + \beta_4\, ln(N_{jt}) + \beta_5\, ln(D_{ij}) + \beta_6\, ln(ENV_{it}) + \beta_7\, ln(ENV_{jt}) + \beta_8 (Border_{ij}) + \beta_9 (CLANG_{ij}) + \beta_{10} (COLLINK_{ij}) + \beta_{11} (RTA_{ij}) + \beta_{12}\, ln(LAND_i) + \beta_{13}\, ln(LAND_j) + \mu_i + \mu_j + F_t + (\varepsilon_{ijkt}) \quad (5)$$

The model presented in equation (5) is extended to incorporate the country effects (μ_i) and (μ_j) which are unobservable components and time annual effects F_t, the later time effect capture cyclical influence commonly shared by all the country under analysis and or technological effects etc. and that of (ε_{ijkt}) is the idiosyncratic random effects. The random effect model in equation-5 will assume that all the covariates are un-correlated with $(\mu_i,\ \mu_j)$ $and\ (\varepsilon_{ijkt})$. It will be empirical quest using Hausman test to determine if FEM or REM is more appropriate. The next sections will discuss the data measurements and empirical estimations.

8.4.1 Data Estimation for Environmental Regulations and Trade Competitiveness

This section estimates the data on bilateral trade flows for total exports flowers, most pollutive exports flows, and relatively less pollutive trade flow for cross-sectional and for panel data analysis covering 17 OECD countries and 3 South Asian countries, -totaling 20. The panel data covers three data set periods viz, 1990, 1998, 2004 at 3-digit ISIC level. The reasons for choosing these panel periods were primarily the availability of corresponding period environmental performance/regulatory data[26] across the countries. The data on trade variables (exports and imports) are in current prices, which is generally subject to a number of distortions such as macro-economic imbalances and inflation. To overcome this issue, firstly, the data at bilateral level trade for each country with rest 19 countries and then all data series at commodity level are deflated using respective country export and import price index for the period 1984-2004. The data on export price index (EPI) and import price index (IPI) for each country are obtained through IFS annual series. Among OECD countries, export price index for Austria and France was not available for the entire period and therefore, EPI for industrial countries is

[26] The available data nearest to the year 1998 through Centre for International Earth Science Information Network (CIESIN) was for the year 2000 but the building blocks for constructing these two selected and other variables for overall Environmental Sustainability index as highlighted in reports (CIESIN, 2001, 2002) are based on information ascertained between 1997-2000 and most of them are from the year 1998 and therefore it would give somewhat upper bound environmental stringency effect on trade flows.

used as a proxy to deflate bilateral exports at the commodity level. The data are then averaged over five-year periods covering pre-dated data to take into account the cyclical fluctuation in time series data and second to minimize macroeconomic distortions in bilateral trade flows for a particular period. The data on real GDP (constant, PPP), population, and land variables for all selected countries are available through World Development Indicators (2006). The data on distance and some dummies are obtained from CEPII website: http://www.cepii.fr/anglaisgraph/bdd/distances.htm , CIA fact book. The data dummies for RTAs have been created based on information provided by (Batra, 2004). The regional trade agreements in the light of the coverage of countries, including APEC, EEA, SAPTA, and NAFTA, have been used based on their year of commencement and their applicability to the analysis periods. For data compilation and analysis, the study used software such as Eview-10-11 and Excel.

The study examines various versions of the gravity equations 3-5. Firstly, using panel data analysis techniques in estimating equation (5), the augmented gravity models are estimated for three periods-1990,1998,2004- for 20 sample countries (17 OECD and 3 South Asian). There is total of 380 (20x19) observations for an individual year, and for three panels, the total number of observations is 1140. For cross-sectional data analysis, Ordinary Least Square (OLS) estimation techniques applied to equations (3) (3a) and (4). The empirical models specified in equations (3), (3a) and (4) will examine the environmental stringency impact on trade flows-exports and imports- for total trade flows, most pollutive industrial trade flows, somewhat pollutive trade (henceforth less pollutive industrial trade) less pollutive industrial trade flows at 4digit- ISIC level for periods 1990 and 1998. The third pollutive industrial group, which is the most cleanest one, will be part of total trade flows for comparative analysis purposes. There are 380 observations for each year panel in cross-section data. The research will first cover the analysis for full sample countries and later split the data to examine South Asian countries' bilateral pollutive trade flows with OECD countries.

Another econometric issue was the handling of cases with zero bilateral trade. The literature identified three approaches to zero observations: discard such bilateral flows from the sample, substitute small values for zeros, or use the Tobit estimation technique. Most studies show that the resulting estimates are not substantially affected by choice of approach (Wang and Winters, 1991; Baldwin, 1994) (in Kandogan, 2009) and use the first approach. There are only five values for most pollutive category in export only for the year 1990 for Bangladesh, which is around one percent of the total sample. All three approaches have been considered at the analysis level for cross-checking the results. However, the final results are reported based on assigning the constant factor to the data set as most of these values as indicated in data sources by Nicita and Olarreaga (2001; 2006) can be the result of ‘rounding off small values’ instead of actual zero values.

8.4.1.1 Key Research Questions

What is the impact of environmental regulation on export flows of various categories of pollutive industrial, during the period covered 1990-2004 for the selected sample OECD and South Asian countries? Whether environmental regulations affect the most polluted manufacturing export industries differently as compared to relatively less pollutive industrial exports. Whether South Asia region (selected South Asian countries) has become a pollution haven for manufacturing exports to high income and most environmentally stringent OECD countries during the period under analysis. Whether tariffs created by the countries to offsets environmental regulation impact benefits or hurts trade competitiveness.

8.4.1.2 Research Hypotheses:

- Environmental regulations reduce total bilateral trade flows[27], the bilateral trade flows of most pollutive industries, and bilateral trade flows of relatively less pollutive industries.

- Relative stringent environmental regulations in OECD countries as compared to South Asian countries increase South Asian pollutive industrial exports to OECD- a pollution haven hypothesis.

- Tariffs on pollutive industrial trade negatively affect to the pollutive industrial trade and export competitiveness.

8.4.2 Descriptive Statistics for Panel Data Analysis

Descriptive statistics provide useful information and features about the data. Table 8.1 depicts some descriptive statistics computed in natural logs about the panel data covering the period with intervals 1990-2004. The statistics cover the median, maximum, and minimum values, standard deviation, skewness, kurtosis, and Jarque-Bara tests for all variables of interest in gravity model. The mean and median values vary considerably between the variables and those of standard deviation, indicating the dispersion from mean also shows a variation among the

[27] The terms trade flows would represent exports and imports separately at analysis level.

variables. The median is generally considered a better indicator than the mean being averting the extreme values and seemed to be higher than mean values for most of the variables. Table 8.1 shows a negative skewness for those variables and tail to the left, while for others where mean is greater than median, the distribution is positively skewed to the right. For example, policy variables such as environmental stringency LOGESI and LOGESJ are positively skewed and those of bilateral exports variables LOGMPEX, LOGTOTEXP, LOGLPEXP are negatively skewered hence tailed to the left, and mean values are greater than median too. Kurtosis provides the visual estimate of the sample's variance and gives more insight if data is peak or flat relative to its normal distribution. Most of the model variables outcomes are indicating asymmetrical data distribution and showing a peaked curve-Leptokuritic. The outcomes of the Jarque-Bera test designed to check for normality in the data further confirm the results received from skewness and kurtosis that the data is not normally distributed. The values of explanatory variables are far away from zero. As goodness of fit test, the results show that probabilities of almost all of the model variables tend to reject the null hypothesis: data is normally distributed. The study examined the correlation matrix and conducted variance inflation factor analysis to detect the early signs of multicollinearity in the data.

table 8.1- Descriptive Statistics

stats/variables	LOGDIJ	LOGESI	LOGESJ	LOGGDPCAPITAI	LOGGDPCAPITAJ	LOGGDPI	LOGGDPJ	LOGLANDI	LOGLANDJ	LOGLPEXP	LOGMPEXP	LOGPOPI	LOGPOPJ	LOGTOTEXP	COL	COML	CONTG	RTA
Mean	8.31	4.40	4.40	103.92	9.92	28.83	28.83	10.66	10.66	102.12	10.79	18.91	18.91	12.93	0.06	0.16	0.07	0.42
Median	8.69	4.21	4.21	104.36	10.36	30.26	30.26	10.40	10.40	102.28	11.39	19.70	19.70	13.16	0.00	0.00	0.00	0.00
Maximum	9.88	5.22	5.22	105.03	11.03	34.29	34.29	13.73	13.73	108.16	17.35	24.84	24.84	18.80	1.00	1.00	1.00	1.00
Minimum	5.84	3.68	3.68	100.98	6.98	21.71	21.71	8.13	8.13	94.67	1.48	12.15	12.15	5.54	0.00	0.00	0.00	0.00
Std. Dev.	1.11	0.49	0.49	1.02	1.02	3.82	3.82	1.61	1.61	2.37	3.04	3.65	3.65	2.31	0.24	0.37	0.26	0.49
Skewness	-0.48	0.55	0.55	-1.68	-1.68	-0.59	-0.59	0.58	0.58	-0.31	-0.80	-0.49	-0.49	-0.29	3.59	1.82	3.26	0.31
Kurtosis	2.03	1.87	1.87	4.55	4.55	1.83	1.83	2.65	2.65	2.96	3.16	1.97	1.97	2.73	13.90	4.32	11.65	1.10
Jarque-Bera	87.52	116.96	116.96	648.99	648.99	131.71	131.43	70.69	70.69	18.74	123.45	96.57	96.47	19.27	8095.39	714.83	5578.55	190.43
Probability	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum	9470.10	5012.03	5012.03	118463.60	11303.63	32861.28	32864.95	12154.41	12154.41	116411.60	12297.22	21561.72	21560.82	14735.72	72.00	186.00	84.00	483.00
Sum Sq. Dev.	1411.78	271.17	271.17	1194.28	1194.28	16633.78	16660.39	2938.75	2938.75	6419.47	10538.16	15212.51	15209.89	6061.94	67.45	155.65	77.81	278.36
Observations	1140.00	1140.00	1140.00	1140.00	1140.00	1140.00	1140.00	1140.00	1140.00	1140.00	1140.00	1140.00	1140.00	1140.00	1140.00	1140.00	1140.00	1140.00

Notes: **All variables are in natural logarithm form except country paired variables and regional cooperation variables including; COL; COML; CONTG; RTA (Panel period:** 1990; 1998; 2004)

Table-8.2: Correlation Matrix

	LOGMPEXP	LOGLPEXP	LOGTOTEXP	LOGDIJ	LOGESI	LOGESJ	LOGGDPCAPITAI	LOGGDPCAPITAJ	LOGGDPI	LOGGDPJ	LOGLANDI	LOGLANDJ	LOGPOPI	LOGPOPJ	COL	COML	CONTG	APEC	RTA	DSASIA	EEA	DOECD
LOGMPEXP	1.00																					
LOGLPEXP	0.87	1.00																				
LOGTOTEXP	0.90	0.97	1.00																			
LOGDIJ	-0.48	-0.43	-0.46	1.00																		
LOGESI	-0.07	-0.08	-0.09	-0.05	1.00																	
LOGESJ	0.07	-0.08	-0.08	-0.05	0.81	1.00																
LOGGDPCAPITAI	0.58	0.45	0.43	-0.16	-0.28	0.08	1.00															
LOGGDPCAPITAJ	0.24	0.40	0.41	-0.16	0.08	-0.28	0.04	1.00														
LOGGDPI	0.25	0.34	0.34	0.01	-0.85	-0.87	0.30	0.27	1.00													
LOGGDPJ	0.23	0.32	0.34	0.02	-0.87	-0.85	0.27	0.30	0.88	1.00												
LOGLANDI	0.06	0.05	0.04	0.31	0.00	-0.01	-0.08	0.00	0.18	-0.01	1.00											
LOGLANDJ	0.09	0.11	0.11	0.31	-0.01	0.00	0.00	-0.08	-0.01	0.18	-0.05	1.00										
LOGPOPI	0.10	0.23	0.24	0.06	-0.81	-0.93	0.03	0.27	0.96	0.85	0.21	-0.01	1.00									
LOGPOPJ	0.17	0.22	0.24	0.06	-0.93	-0.81	0.27	0.03	0.85	0.96	-0.01	0.21	0.81	1.00								
COL	0.11	0.14	0.14	0.04	0.00	0.00	0.01	0.01	0.04	0.04	0.09	0.09	0.04	0.04	1.00							
COML	0.00	0.03	0.01	0.16	-0.02	-0.02	-0.08	-0.08	0.01	0.01	0.28	0.28	0.04	0.04	0.41	1.00						
CONTG	0.26	0.27	0.27	-0.46	0.01	0.01	0.01	0.01	0.01	0.01	-0.02	-0.02	0.01	0.01	0.09	0.15	1.00					
APEC	-0.36	-0.33	-0.32	0.21	0.00	-0.04	-0.15	0.01	-0.16	0.01	-0.22	0.01	-0.12	0.01	-0.05	0.09	-0.09	1.00				
RTA	0.50	0.45	0.47	-0.79	0.09	0.09	0.26	0.26	-0.03	-0.02	-0.24	-0.22	-0.10	-0.09	-0.14	-0.08	0.33	-0.08	1.00			
DSASIA	-0.54	-0.38	-0.37	0.15	0.02	-0.36	-0.94	0.05	-0.02	0.00	0.12	-0.01	0.24	-0.01	-0.02	0.09	-0.01	0.08	-0.27	1.00		
EEA	0.37	0.24	0.26	-0.22	0.00	0.07	0.22	-0.01	0.10	-0.01	-0.03	0.00	0.04	0.00	0.01	-0.16	0.09	-0.71	0.15	-0.23	1.00	
DOECD	0.54	0.38	0.37	-0.15	-0.02	0.36	0.94	-0.05	0.02	0.00	-0.12	0.01	-0.24	0.01	0.02	-0.09	0.01	-0.08	0.27	-1.00	0.23	1.00

Notes: **All variables are in natural logarithm form except country paird variables and regional cooperation variables including; COL; COML; CONTG; APEC; RTA;DSASIA; EEA;DOECD (Panel period:** 1990; 1998; 2004**)**

Table 8.3 Variance Inflation Factor (VIF)

Variable Name	VIF (GDP variables)	VIF (GDP/CAPITA Variables)
COL (Colonial links)	1.25	1.21
COML (Common language)	1.54	1.47
CONTG (Contiguity)	1.39	1.39
LOG Dij (Distance)	1.86	1.80
LOG ESi (Environmental performance of exporters)	20.05	10.90
LOG ESj (Environmental performance of importers)	20.19	10.90
LOG GDPi (GDP of exporters)	36.81	
LOG GDPj (GDP of importer country)	36.84	
LOG GDP CAPITAi (GDP/Capita of exporters)		2.59
LOG GDP CAPITAj (GDP/Capita of importers)		2.60
LOG Landi (Land area of exports)	2.02	1.28
LOG Landj (Land area of importers)	2.01	1.28
LOG POPi (Population of exporters)	53.56	
LOG POPj (Population of importers)	53.36	

Notes:1- All variables are in natural logarithm form except country paired variables and regional cooperation variables including COL; COML; CONTG; RTA (Panel period: 1990;1998;2004, full sample 20 countries)
2- Author's calculation based on World Production and Trade (1998, 2006) for trade variables; data on dummy variables from CEPII; data on economic variables; GDP, population, land area, GDP per capita etc. are from World Development Indicators, CD-ROM (2004); data on environmental variable from Centre for International Earth Science Information Network (CIESIN)

For multiple regressions analysis models, wherein the explanatory variables are likely to have a strong association with each other's the phenomenon of multicollinearity[28] exists in data analysis. The study examines the presence of multicollinearity in data by firstly computing the correlation matrix as reported in table 8.2 and secondly, the Variance-inflation factor (VIF), which is reported in table 8.3. The larger the value of VIF, the more collinear the regressors are. VIF is defined as $1/(1-R_j^2)$ where R_j^2 is obtained through the auxiliary regression analysis. The tolerance level, on the other hand, would be $(1-R_j^2)$. The higher the tolerance level is lower the collinearity between the explanatory variables is and vice versa. As a rule of thumb, if the VIF of a variable exceeds ten, which one expects to observe when R2 exceeds .90 then that

[28] Multicollinearity is a statistical phenomenon whereby two or more predictor variables in a multiple regression model are strongly statistically associated. During such circumstances, the coefficient estimates may depict un-predictable change in response to small changes in the model or the data. Multicollinearity does not reduce the predictive power or reliability of the model as a whole; it only affects calculations regarding individual predictors (Gujarati, 2003)

variable is highly collinear. However, while VIF analysis s good insights into the problem of multicollinearity, it is not free from criticism either as high VIF can be counterbalanced by a low variance or high $\sum x_j^2$ (square value of the difference of actual and mean values of regressors). Therefore, high VIF is neither a necessary nor a sufficient condition to get a high variance and high standard errors (Gujarati, 2003).

Table 8.2 provide the correlation matrix for manufacturing export flows and a host of explanatory variables, including variables of GDP, population variables, land variables, and environmental performance variables included in the gravity model equation (5). The correlation matrix for the manufacturing export model shows the expected sign and strong association with explanatory variables, including GDP, GDP Per capita, distance variable and population variables and some dummy variables. The different groups of pollutive bilateral trade variables such as most pollutive trade, total and relatively less pollutive trade flows depict a weak correlation with environmental regulations of both exporters and importers. There seemed to be a strong degree of association or correlation between GDP and population as theoretically, income and population re-enforce each other. XU (2000) pointed out that a high correlation between GDP and population might not be a severe problem since one can test the restriction that the coefficients of GDP and population are the same but opposite sign. Accordingly, on the validity of this restriction, the GDP per capital variable can be used to avert collinearity in data rather separately, including those two variables in the analysis.

The high degree of association between GDP and population variables and high correlation coefficient between environmental variables and population variables of both exporters and importers countries is a cause of concern and shows multicollinearity in the data. Therefore, in regression analysis, an alternate form, i.e., the variable addition or deletion analysis, can be conducted to have a consistency check in the results. The exclusion of those variables in the model might create specification bias for model estimation. However, it is quite difficult first to detect multicollinearity in practice, which can be an outcome of multifaceted reasons, including the data collection procedure, later sometimes beyond the scope of secondary data users like present research. Secondly, the removal methods available for high or strong collinearity between variables are not free from limitations either (Gujarati, 2003). Nevertheless, "if regression equations have low estimated standard errors and high t-ratios, we should not spend too much time worrying about any multicollinearity that might be present ….as OLS estimation [still] retain their desirable properties and estimated errors remain unbiased (Thomas, 1997:23 in Gujarati, 2003). The correlation matrix in table 8.2 for export also depicts that in addition to what the classical gravity model predicted regarding the trade determinants, including income, population, and distance, a considerable variation in the dependent variables of trade flows is inter alias due to some dummy variables. The correlation matrix shows that the signs of environmental stringency variables with regards to their degree of association with trade flows are negative for most of the pollutive trade categories, except one. That is in line with what theory reviewed in chapter 3 predicted that environmental regulations negatively affect pollutive commodity trade.

This study computed VIF for explanatory variables by using alternate variables of GDP and GDP per capita given the high correlation between environmental regulatory variables and population variables for both exporters and imports and those of GDP variables and population variables. Comparative statistical results on measured VIF show a very high score for the variables of environmental performance, population, and GDP for exporters and importers countries. In VIF analysis, when GDP was used as an explanatory variable, the score went as high as 53.36 for population variables. For those of environmental variables, the measured scores were around 20. These scores are far higher than the expected upper limit score for VIF, which is under 10, and results are indicating the presence of high multicollinearity in the data. These results changed drastically when the explanatory variable of GDP was replaced with GDP per capita. The measured VIFs of all variables are in the range of the lowest 1.21 for colonial links variable to the score of 10.90 for environmental performance variables of exporters and importers countries. Accordingly, GDP per capita is a more appropriate income variable for both exports and importers countries to be used in the gravity model so that presence of multicollinearity in data is ruled out the best or at least minimized.

However, this study will run regressions using the GDP variable for data robustness and report the results appendix 8.1-2 to the thesis.

8.4.3 Impact of Environmental Regulations on Trade Flows of OECD's and South Asian Countries: Estimation of Augmented Gravity Model- Panel Data Analysis

This section presents results ascertained from the estimation of augmented gravity model equation (5) with different pollutive categories of export flows covering 17 OECD and 3 South Asian countries totaling 20 country data using panel data analysis. The total observations for three panels, 1990, 1998, 2004 total number of observations will be 1140. As discussed in previous modeling design sections, it will be an empirical quest using the Hausman test to determine if FEM and REM are more appropriate. The Hausman test guided this study to accept the null hypothesis that random effect is more appropriate. Therefore, this study has deployed random effect model henceforth REM to gravity model estimation. The adoption of REM technique also helps avert data orthogonality, heteroscedasticity, and simultaneity bias (Cantore and Cheng, 2018). The expected signs in gravity equation (5) for the GDP and Per Capita GDP variables of both exporters and importers countries are positive. The distance variable is expected to have a negative effect on bilateral trade flows. Dummy variables including $BORDER_{ij}$ (border association), $CLANG_{ij}$ (common language), $COLLINK_{ij}$ (colonial link) will have a positive effect on manufacturing commodities trade flows. The dummy variable variables of lands are dropped in the final model in panel data, especially when country fixed effects are added in the analysis. As the latest research guided, the study's final results for panel data analysis are reported using country-specific dummies- both exporters and importers- levels and time dummies. Following the study hypothesis, parameters β_6 (environmental regulation in exporting country) and β_7 (environmental regulation in importing country) are expected to have a negative and positive value, respectively[29].

The analysis produced in tables 8.4-8.5 shows inter alias the relationship between environmental policy and different categories of pollutive manufacturing exports competitiveness using both pooled OLS and REM techniques. In table 8.4, a comparative analysis is provided between pooled regression analysis (OLS technique) and REM. However, the study in this chapter already highlighted that Hausman criteria is preferred over OLS as later estimation technique does not capture country-specific effects and produce the biased result (Cagatay and Mihci, 2006). The data examination reveals a violation of the statistical hypothesis of homoscedasticity as the sample countries under analysis differ mainly in terms of income and country size. Therefore, the error terms associated with large countries will have variances higher than the error terms associated with small countries. This is likely to be the case with GDP and GDP per capita as well. The study, therefore, conducted heteroscedasticity tests- White (1980) tests- which rejects the homoscedasticity assumption in estimation. Thus, the study reports results using White (1980) heteroscedasticity-consistent covariance matrix.

The regression results of the gravity model for pollutive bilateral trade flows reported in table 8.4 do not provide drastically different outcomes when it comes to examining the effect of environmental policy variables on different categories of pollutive exports for selected sample

[29] Literature reviewed in the theoretical chapter provided far more complex results regarding the impact of environmental policy on trade flows especially when it is examined in static and or dynamic as well as whether within or between countries analysis. One of worth mentioned discussions on the subject and mostly cited in literature as reviewed by the present study was the one presented by Palmer, Oates and Portney (1995) and Porter and Van der Linde (1995) which guided through to determine the sign regarding environmental policy consequences for trade competitiveness. This study following neo-classical orthodoxy concluded in chapter 3 that negative impact of environmental regulations on country trade competitiveness seemed and positive sign for pollution haven effects seemed more plausible.

countries using both pooled and REM. The estimated coefficients reflect the elasticities for both pooled and REM. Both pooled and REM results show that, as expected, the income variables in the current case GDP per capita of both exporters and importers countries exert statistically significant and positive effects on export flowers of all pollutive categories. The distance variable is generally regarded as a stumbling block to exports due to increased transaction costs involved in trade with distance countries and, therefore, expected to affect pollutive industrial export flows negatively. As predicted, the distance variable has negative and statistically significant effects on export flow for all pollutive categories in full sample countries in table 8.4.

Table 8.4 depicts that environmental regulations introduced by the exporters in full 20 selected countries have a significant negative impact on most pollutive exports and those of relatively less pollutive exports. This implies that domestic environmental regulations have played a vital role in the country's pollutive manufacturing exports competitiveness in both selected OECD and South Asian countries during the period under analysis. These results are in line with some of the earlier work in this area for OECD and other countries (Jug and Mirza, 2005; Martínez-Zarzoso et al., 2017; Jayawardane and Edirisingh, 2014) who found a negative impact of environmental policies on most pollutive industrial trade. Stringent environmental regulations introduced in the model for importer county are expected to increase the demand for pollutive commodities exports from exporting countries. Hence, the expected sign between exporting countries' pollutive industrial exports supply and environmental regulations introduced in importing countries is positive. This argument is mainly cited for most pollutive manufacturing traded goods in the light of pollution/production displacement and pollution haven effects. Nonetheless, the competing porter hypothesis envisaged the negative association between stringent environmental regulation by importing countries and the pollutive industrial export supply by exporting countries.

The results in table 8.4 for REM reveal a positive and statistically insignificant association between environmental regulations of importing country on pollutive industries and the demand of foreign exports of different categories of pollutive exports from exporting country. Whereas OLS based pooled technique tended to confirm the porter hypothesis i.e., more stringent domestic environmental regulations are on pollutive categories of manufacturing sectors products in imported country less would be the demand of pollutive industrial import from the exporting country.

Table 8.4 Environmental Regulation and pollutive Exports: Random vs Pooled Effects

	Random effects Model		**Pooled- OLS effects**	
Variables /pollutive category	**Most pollutive Exports**	**Relative less pollutive exports**	**Most pollutive Exports**	**Relative less pollutive exports**
Log exporting country GDP Per Capita	1.31^{***} (5.44)	1.19^{***} (3.22)	1.72^{***} (10.96)	1.60^{***} (12.79)
Log importing country GDP per Capita	0.91^{***} (5.89)	$.53^{***}$ (3.10)	$.90^{***}$ (4.28)	$.54^{***}$ (2.80)
Log Distance	-1.26^{***} (-20.58)	$-.74^{***}$ (-9.19)	-1.32^{***} (-69.25)	$-.78^{***}$ (-19.48)
Env. regulation exporting country (ENV_{it})	$-.93^{***}$ (-5.42)	$-.37^{**}$ (-2.34)	-1.04^{***} (-6.25)	$-.55^{***}$ (-2.90)
Env. Regulation importing country (ENV_{jt})	.01 (.01)	-1.06 (-1.59)	-1.52^{***} (-3.05)	-4.21^{***} (-7.28)
Dummy Contiguity ($CONTG_{ij}$)	$.45^{*}$ (1.82)	$.75^{***}$ (6.91)	$.44^{***}$ (5.14)	$.76^{***}$ (10.15)
Dummy Common Language ($COML_{ij}$)	$.66^{**}$ (2.04)	$.63^{***}$ (4.81)	$.42^{***}$ (3.90)	$.48^{***}$ (6.06)
Dummy Colonial links (COL_{ij})	$.80^{***}$ (3.52)	$.57^{*}$ (1.70)	$.79^{***}$ (6.62)	$.59^{***}$ (3.64)
Constant	-117.35^{***} (-5.14)	12.82^{***} (3.04)	-150.01^{***} (-11.61)	-37.91^{***} (-3.95)
Reporter dummy	Yes	Yes	Yes	Yes
Partner dummy	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes
Observations	1140	1140	1140	1140
Adjusted R-Squared	.55	.62	.71	.72

*Notes: (1) *** denotes significance at the 1% level, ** denotes significance at the 5 % level, * denotes significance at the 10 % level*

: (2) t- statistics are in parentheses.

: (3) *Estimation uses White (1980) heteroscedasticity-consistent covariance matrix estimator.*

:(4) All variables both regressand and regressors in estimation of equations (3) are expressed in natural logarithm form, except dummies. Total exports, most pollutive exports and relative less pollutive exports are dependent variables.

:(5) Analysis based on full 20 sample countries panel data (1990, 1998,2004) including three South Asian and 17 OECD countries.

Table 8.5 Environmental Regulations and Trade Competitiveness: A Comparative Analysis of pollutive Industrial Exports: All Sample Countries

Random effects Model

Variables /pollutive category	All Sample Countries: Total Exports	All Sample Countries: Most pollutive exports	All Sample Countries: Relative Less pollutive Exports
Log exporting country GDP Per Capita	.65 ***: (6.08)	1.31***: (5.44)	1.19 ***: (3.22)
Log importing country GDP per Capita	0.62 *** (3.05)	0.91 *** (5.89)	0.53 *** (3.10)
Log Distance	-.84 *** (-12.39)	-1.26 *** (-20.58)	-.74 *** (-9.19)
Env. regulation exporting country (ENV_{it})	-.40* (-1.90)	-.93 *** (-5.42)	-.37** (-2.34)
Env. Regulation importing country (ENV_{jt})	.02 (.03)	.01 (.01)	-1.06 (-1.59)
Dummy Contiguity ($CONTG_{ij}$)	.52*** (2.93)	.45* (1.82)	.75*** (6.91)
Dummy Common Language ($COML_{ij}$)	.44*** (2.76)	.66** (2.04)	.63*** (4.81)
Dummy Colonial links (COL_{ij})	.71** (2.41)	.80*** (3.52)	.57* (1.70)
Constant	-51.41*** (-4.13)	-117.35*** (-5.14)	12.82*** (3.04)
Reporter dummy	Yes	Yes	Yes
Partner dummy	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes
Observations	1140	1140	1140
Adjusted R-Squared	.67	.55	.62

Notes: *(1) *** denotes significance at the 1% level, ** denotes significance at the 5 % level, * denotes significance at the 10 % level*
: (2) t- statistics are in parentheses.
: (3) *Estimation uses White (1980) heteroscedasticity-consistent covariance matrix estimator.*
:(4) All variables both regressand and regressors in estimation of equations (3) are expressed in natural logarithm form, except dummies.
:(5) Analysis based on full 20 sample countries panel data (1990, 1998,2004) including three South Asian and 17 OECD countries.

The estimated coefficients signs of controlled dummy variables are generally in line with expectation and variables of border link(contiguity), common language, and colonial links exert positive effects on export flows for most of the pollutive category for full sample country and with varied level of statistical significance.

In table 8.5, the study based on REM reports augmented gravity model results for full sample countries and three export categories, including total bilateral exports, most pollutive bilateral exports and, relative less pollutive bilateral exports flows. The comparative analysis between three categories of exports will help examine if environmental regulation leaves different impacts for different pollutive categories of export flows. Also, if somewhat different results could be ascertained for different pollutive categories of manufacturing exports of sample countries during the period under study. The values of adjusted R^2 that measure the degree of association between independent variables and dependent variables show that more than 50 percent of the variation in different categories of export flows is explained by the independent variables chosen for the model. As expected, the variables related to exporter and importer incomes are positive and statistically significant at one percent level of significance for all manufacturing export categories viz, total exports, most pollutive exports, and relatively less pollutive exports. The other controlled variables like distance, border link(contiguity), common language, and colonial links depict a positive association with all three manufacturing exports flows and trade competitiveness for sample country and period.

In table 8.5, the estimated variables **(**ENV_{it}) and (ENV_{jt}) reflect the environmental stringency measures introduced by exporting and importing countries, respectively. The results show that environmental regulation imposed on exporting countries negatively affects total manufacturing exports, most pollutive manufacturing exports, and relatively less pollutive exports for selected 20 nation countries. All estimated coefficients regarding environmental stringency variable effect on exports flow had a prior expected negative sign, and export elasticity with respect to environmental regulations for most pollutive exports category is negative and statistically highly significant at 1 percent level, indicating the negative impact of environmental regulations on pollutive industries exports competitiveness. The impact of environmental regulation on relatively less pollutive exports is also negative. Still, negative export elasticity with respect to environmental regulation is relatively lower compared to the effects environmental regulations have for most pollutive export for the exporting country. The environmental regulatory variable introduced for importing country for total export flows and most pollutive exports categories shows positive but statistically insignificant results. Those for relatively less pollutive exports are negative but statistically insignificant.

This study has applied robustness checks prior to data estimation using alternate multicollinearity tests as well as produced results using White (1980) heteroscedasticity-consistent covariance matrix by deploying REM estimation technique. Nonetheless, it still cannot be denied that results reliability could be affected due to issue of endogeneity when the explanatory variable depicts correlation with error terms and likely routes of endogeneity could be the presence of autocorrelation in the data, time series heteroscedasticity and simultaneity bias. The endogeneity test revealed that the variable of GDP and Per capita GDP of both importer and exporter countries is the prime suspect. It is likely to observe the simultaneity issues between export flows and income variables. Furthermore, environmental regulations and export flows can be endogenous to each other hence can cause simultaneity problems in the analysis i.e., causality can run in both directions (Zarzoso et al., 2017). However, endogeneity tests, except GDP and Per capita GDP, for all variables including environmental stringency, the study does not reject the null hypothesis that the explanatory variables are exogenous in the chosen gravity model.

While Hausman-Taylor estimations-based on REM would take care of simultaneity bias and heteroscedasticity and would correct the REM in case of any suspect violation of orthogonality between some of the covariates and the unobservable components (μ_i) and (μ_j), the study aims to apply further robustness checks to correct the presence of autocorrelation and time series heteroscedasticity in panel data. For this to accomplish, it followed Cantore and Cheng (2018) and used Newey-West standard error model by assuming first and second-order autocorrection (in Wooldridge, 2013). Accordingly, the study presents results for up to two lags based on HAC (Heteroscedasticity and Autocorrelation Consistent) standard error model.

Table 8.6 gives valuable insights into the analysis. The per capita income variables of both exporters and importers country leave a positive effect on export flows of all categories of pollutive industries trade, and a more noticeable feature is that income elasticities with all categories of pollutive exports are much higher with HAC models when compared the results with REM (table 8.5). The estimated coefficients of income variables are statistically significant as well, showing consistent results under different lag periods. The geographical variable distance is also showing the expected negative and statistically significant impact on different pollutive manufacturing exports for the full sample countries data covering the period under review. The other controlled variables covering border link(contiguity), common language, and colonial links depict a positive association with all three categories of manufacturing exports flows and trade competitiveness for sample country and period, but contiguity variable though positive but statistically insignificant for the most pollutive manufacturing exports.

The results for environmental stringency imposed on both exporting and importing countries after applying the HAC model on the data reveal that environmental costs/regulations variable is vital determinants of different groups of pollutive industrial export competitiveness. The estimated coefficients of environmental stringency variable for all pollutive exports categories for exporting countries are consistent in both lag periods, statistically significant, and negatively associated with industrial export flows. The study expected that environmental regulation might leave different effects for different pollutive categories of manufacturing exports. It is generally the most pollutive manufacturing industry that comes under stringent compliance to environmental regulations both at national and international levels viz-a-viz relative cleaner manufacturing industrial production and exports. The results in table 8.6 clearly show that HAC-based regression analysis produces stronger negative effects of environmental regulations on export flows for all categories of manufacturing commodities in both exporting and importing countries compared to REM technique (table 8.5) without correcting for autocorrelation and time series heteroscedasticity. The negative relationship between the stringency of environmental regulation and export flows for both the OECD and South Asian countries means that there can be a possible trade-off between efforts towards trade expansions and improving environmental quality at the economic policy level. Especially estimated elasticity coefficients of environmental policy variable introduced for importing countries showing a positive and statistically insignificant effect on total manufacturing exports and most pollutive exports flow categories in the REM (table 8.5) now depicted strong negative and statistically significant effect on all categories of manufacturing exports. The results also indicate that environmental regulations negatively affect the most pollutive industrial exports and relative less pollutive and total industrial exports in both the OECD and South Asian countries, thus confirming the neo-classical orthodoxy of adverse impacts of environmental policy on pollutive industries trade flows. These results further reject the New Trade Theorists' assertion of the porter hypothesis. The study findings echoed some empirical research that found a negative and statistically significant impact of environmental regulations on most pollutive industrial trade (Wilson et al., 2002; Jug and Mirza, 2005; Zarzoso et al., 2017). Table 8.6 also reveals that environmental regulations introduced in partner importing countries would not encourage the demand of manufacturing exports from the exporting country hence less evidence of pollution haven effects. It is worth mentioning here that the pollution haven hypothesis can be well detected by applying the geographically controls and reconstructing the North-South trade flows framework, especially given the current study research hypothesis, South Asia pollutive industrial exports flows to OECD countries. By doing that process, this study can better understand how environmental policy influences pollutive industries trade of countries between lax environmental regulations with those facing stringent ones.

This is what the study examines in the next section, 8.4.4. The environmental regulations introduced in partner importing country would not encourage the demand of manufacturing exports from the exporting country hence less evidence of pollution haven effects.

Table 8.6 Environmental Regulations and Trade Competitiveness: A Comparative Analysis of pollutive Industrial Export- Newey-West Model with lags (1)-(2).

Variables /pollutive category	All Sample Countries: Total exports		All Sample Countries: Most pollutive exports		All Sample Countries: Relative less pollutive exports	
	Lag (1)	Lag (2)	Lag (1)	Lag (2)	Lag (1)	Lag (2)
Log exporting country GDP Per Capita	1.22 ***: (11.09)	1.22 ***: (11.31)	1.71*** (10.69)	1.71*** (11.34)	1.60 *** (13.70)	1.59 *** (14.23)
Log importing country GDP per Capita	0.62** (2.07)	0.62** (2.15)	.90** (2.43)	.90*** (2.62)	.54* (1.70)	.54* (1.78)
Log Distance	-.88 *** (-11.05)	-.87 *** (-11.51)	-1.32*** (-12.55)	-1.32*** (-12.55)	-.78 *** (-9.88)	-.77 *** (-10.44)
Env. regulation exporting country (*ENV_{it}*)	-.56 * (-1.88)	-.56 ** (-2.14)	-1.04** (-2.37)	-1.04** (-2.56)	-.54* (-1.65)	-.55* (-1.88)
Env. Regulation importing country (*ENV_{jt}*)	-2.78 *** (-8.50)	-2.78 *** (-8.72)	-1.52*** (-3.54)	-1.52*** (-3.73)	-4.21*** (-12.01)	-4.21*** (-12.39)
Dummy Contiguity (*$CONTG_{ij}$*)	.54* (1.79)	.54* (1.87)	.44 (1.28)	.44 (1.28)	.76** (2.42)	.76** (2.60)
Dummy Common Language (*$COML_{ij}$*)	.33 (1.40)	.33 (1.52)	.42 (1.40)	.42 (1.53)	.48** (2.14)	.47** (2.34)
Dummy Colonial links (*COL_{ij}*)	.70*** (2.76)	.70*** (2.76)	.79 ** (2.54)	.79 *** (2.81)	.59** (2.33)	.59** (2.48)
Constant	-95.07 *** (-8.53)	-95.06 *** (-8.52)	-117.39 (-5.14) ***	-150.01*** (-9.25)	-37.91*** (-3.22)	-37.91*** (-3.36)
Reporter dummy	Yes	Yes	Yes	Yes	Yes	Yes
Partner dummy	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1140	1140	1140	1140	1140	1140

Notes: *(1) *** denotes significance at the 1% level, ** denotes significance at the 5 % level, * denotes significance at the 10 % level*
: (2) t- statistics are in parentheses.
: (3) *Estimation uses: Newey-West Model with lags (1)-(2).*
:(4) All variables both regressand and regressors in estimation of equations (3) are expressed in natural logarithm form, except dummies. Total exports, most pollutive exports and relative less pollutive exports are dependent variable.
:(5) Analysis based on full 20 sample countries panel data (1990, 1998,2004) including three South Asian and 17 OECD countries.

8.4.4 Estimating Pollution Haven Hypothesis for South Asia: Panel Data Analysis

In this section, the study examines whether South Asian countries with relatively lax environmental regulatory regimes as compared to environmentally stringent OECD countries have become a haven for pollutive industrial export flows to OECD countries. One of the main hypotheses in this study research endeavours is to examine the pollution haven hypothesis (PHH). The PHH claims that difference in the stringency of environmental regulation between developed North (in this case OECD countries) and developing South(in this case South Asian countries) can provide later countries to have a comparative advantage in pollution-intensive industries production and exports (Grether and de Melo, 2004; Cole et al., 2005). The theoretical literature reviewed in chapter 3 indicates that gap in environmental regulations between advanced North and poor South will lead the pollutive industrial relocation towards developing countries, assuming other things constant (Baumol and Oates, 1988), and developing countries can develop a comparative advantage in pollutive industries trade and become a repository for pollutive industrial production and trade (Copland and Taylor, 1994).

The literature reviewed in chapter 4 indicated that most of the trade takes place among the world's richest countries that share a similar level of environmental regulations. Therefore, drawing any conclusion for delocalization or relocation of production and trade for developing countries based on advanced countries' data analysis might not give accurate information unless trade data is analyzed between developed and developing countries. The analysis on PHH requires pollutive industrial trade data examination between developed and developing countries. Furthermore, the detection of pollution havens may depend on aggregation level, which could explain why previous studies that focused on aggregate level data had failed to find pollution haven effects (Azhar and Elliott, 2007; Cole et al., 2005). This study, therefore, for South Asia analysis re-constructed the data for bilateral exports of selected three South Asian countries viz, India, Pakistan and Bangladesh with 17 OECD countries during the panel periods -1990, 1998, 2004- and three pollutive industrial categories- total bilateral exports, most pollutive industries exports and relatively less pollutive industrial exports. The total number of observations, in this case, would be (19x3x3) 171.

Again, to examine the bilateral trade relationship between developed OECD countries and developing South Asia, the extended gravity modeling approach is adopted using equation (5) by deploying both REM and Newey-West with lags (HAC) estimation, and results are reported in tables 8.7 and 8.8, respectively. The results ascertained using REM for all key variables as well as controlled variables are not dissimilar to the outcomes of gravity model estimation using

Newey-West (HAC). The study explains the autocorrelation corrected estimates of South Asia pollutive industrial trade flows with the OECD for brevity and robustness.

The results in table 8.8 show that the variable of per capita income for both exporter and importer country depicting expected positive and statistically significant signs at 1 % level and high elasticities for all categories of manufacturing export flows but trade elasticities with respect to income for most pollutive manufacturing trade flows are higher compared to the rest of manufacturing export categories for both exporting and importing countries during 1990-2004. These results, therefore, provide good evidence regarding the importance of per capita income variable in determining the trade flows for South Asian region exports flows with OECD. The distance variable representing transaction cost and proxy for trade cost is expected to negatively affect exports due to transportation cost involved in trade flows. As expected, the distance variable is negative and statistically insignificant for total manufacturing export and relatively less pollutive exports and negative and significant at 1% level for most pollutive manufacturing exports. The weaker effect of distance variable on external trade and especially on bilateral exports is not surprising given that South countries trade more with other regions around the world than with their neighboring countries. Another possible reason for distance variable to show insignificant association with export flows could be the one explained by Pitigala Nihal (2005), who, after in-depth analysis on commodity level trade data, concludes that evidence of South Asian trade pattern does not support the hypothesis that characterizes 'natural trading partner' on the basis of geographical proximity. These countries rather demonstrate an increasing tendency to trade relatively intensively with partners outside the region due to either pure endowment differences-that is vis-à-vis high-income industrial countries-or due to long-standing cultural ethnic and or religious affiliation.

While South Asian countries have not been able to reap much trade benefits of contiguity i.e., border linkage due to low intra-regional trade the countries in this region do not show any biased towards colonial linkages nor common language. Some researchers for South Asian trade flows with the rest of the world dropped variables like border, contiguity, and common language from gravity model estimation and find less effects of distance variable on trade flows (Moinuddin, 2013; Bhattacharyya and Tathagata, 2006). This is also being witnessed in this study findings produced in table 8.8, wherein, apart from distance variable, the variables of contiguity and colonial links are statistically insignificant for total manufacturing exports flows, most pollutive manufacturing exports, and relatively less pollutive manufacturing exports. Nonetheless, the independent variable common language seemed to have good relevancy in explaining pollutive industrial exports expansion and showing statistically significant and positive association with most pollutive manufacturing exports group.

With regard to the pollution haven hypothesis and in order to maintain the symmetry with the results in previous sections of this chapter, the study used the same environmental stringency variables for both exporting countries and importing countries and applied them to all pollutive industrial groups. The environmental stringency variable introduced for exporting South Asian countries will give environmental regulations impact on South Asian exports flows competitiveness in the South Asia-OECD framework. At the same time, the environmental regulatory variable introduced for importer countries provides detail on whether South Asian countries have become pollution haven for North- OECD countries. Accordingly, the study expects the environmental stringency introduced in importing OECD countries to be positively associated with South Asian export flows to OECD.

The estimated results in tables 8.7 using REM and 8.8 deploying HAC estimation techniques show that trade elasticity regarding environmental regulations for exporting countries in South Asia is negative and statistically significant for all pollutive categories of manufacturing exports during the sample period. However, the magnitude of those elasticities for pollutive manufacturing export categories was higher when robustness analysis was done using Newey-West Model with lags as reported in table 8.8. The estimated coefficients of environmental policy variables for all three pollutive exports categories show the loss of export competitiveness due to the introduction of environmental policies and the level of effect is negative and consistent across three pollutive industries groups. However, the impact of environmental regulation is more on most pollutive manufacturing industrial exports due to higher elasticity figures than relatively less pollutive export industries and overall manufacturing exports of South Asia region trade flows with the OECD and results remained consistent up to two lag periods for HAC estimations. The study does not find any evidence of whether relatively cleaner industries are gaining any form of export competitiveness due to the introduction of stringent environmental policy as observed through results of negative trade elasticity with respect to environmental regulation for relatively less pollutive manufacturing exports.

This research strongly implies that environmental regulations do have a significant impact on developing countries' pollutive industries production and exports competitiveness flows with OECD countries, and this loss of pollutive industrial trade is just not a phenomenon of developed countries only. There are strong possibilities that developing countries as compared with developed countries, do get affected harder while being embarking on the route to the compliance of stringent domestic environmental regulations. This is primarily due to additional challenges developing countries facing from developed countries regarding environmental regulation compliance whereby process and production methods (PPMs) can act as non-tariff trade barriers against environmentally laxer-regulated countries. The developing countries are much more concerned that their traded products could be denied access to developed markets or have to incur high adjustment costs to maintain access to advanced nations who are pursuing stringent environmental regulations and demanding harmonization of environmental standards between countries. Therefore, the negative impact of compliance with environmental regulations on competitiveness could be different and even more challenging in LDCs than what could be observed for advanced countries (Pearson, 2000). The results for South Asian countries again confirm this study hypothesis that the negative impact of environmental policy on country pollutive industrial trade flows and competitiveness cannot be rejected for South Asian trade flows with OECD countries. These findings also confirm the theoretical argument put forward by Palmer, Oates and Portney (1995) that *there is no free lunch in this world*, and following the conventional neo-classical approach, some negative effects of environmental regulations are out there to be borne by firms and industry in terms of cost in order to get benefits that environmental regulation ultimately brings to firm(s).

For PHH, the environmental stringency introduced in importing countries depicts the impact of the policy on South Asian pollutive industries exports to OECD (tables 8.7 and 8.8). In table 8.7, the trade elasticities with environmental regulations are negative and statistically insignificant for total manufacturing exports and relatively less pollutive exports categories. However, the sign of the estimated coefficient of environmental stringency variable for most pollutive manufacturing export is positive but statistically insignificant. Therefore, results do not provide clear evidence of pollution displacements and or South Asia to become pollution haven for OECD industrial exports. The results in table 8.8 based on Newey-West Model show that estimated coefficients of trade elasticities regarding the environmental stringency of importing countries are negative and statistically significant for all manufacturing export, thus rejecting PHH for South Asia. Moreover, most pollutive export groups' elasticity magnitude and significance are weaker than the results with estimated elasticities coefficients of total export flows and relatively less pollutive manufacturing exports groups.

The above results suggest that finding the empirical evidence of the pollution haven effect in South Asia for different categories of pollutive manufacturing trade is less as there is a lack of empirical support to PHH for South Asia bilateral pollutive industrial trade with the OECD. A number of reasons can be attributed to this empirical finding. Grether and de Melo (2004), using gravity model in North-South most pollutive industrial bilateral trade find little and week evidence for South (developing countries) to become pollution haven for most pollutive manufacturing industrial trade as a statistically insignificant environmental regulatory variable did not provide support to this hypothesis. They find that compared to other industries, most pollutive industries had higher barrier-to-trade as seen in the form of large elasticities of bilateral trade with respect to transport costs measured via distance variable. If not all, the present research for most pollutive industries trade confirms high negative trade elasticities with respect to distance (proxy for transport costs, etc.). The pollutive industries can be geographically less mobile due to transport cost but high plant fixed costs and or agglomeration economies. As a result, these fewer mobile industries will not be sensitive to the differential in regulatory stringency between countries hence unable to relocate easily. Furthermore, most pollutive industries are the least footloose making pollution haven effect particularly difficult to detect (Ederington, Levinson and Minier, 2005). The study by Jaffe et al. (1995), based on a large literature survey and data analysis, concludes that although environmental regulations are responsible for having a significant cost impact on pollutive industries and trade competitiveness, there is less evidence to believe that these costs are substantial enough to affect the pattern of trade.

In light of this research findings and some earlier work in this area, finding the negative impact of importing country environmental regulation on exporting countries' pollutive industries trade flows are not startling but a first effort to find PHH evidence between South Asia and the OECD pollutive industrial trade nexus. The study, therefore, rejects PHH for South Asian pollutive industrial exports flows with OECD. This research has contributed to empirical literature to provide a more detailed analysis on the subject for specific regions and provided an added value to reserach by bringing a comparative analysis regarding the impact of environmental regulations for different categories of pollutive manufacturing exports of South Asian countries with the OECD countries.

Table 8.7 Environmental Regulation and Exports Competitiveness: South Asia Pollution Haven Analysis

Random effects Model

Variables /pollutive category	South Asian vs OECD Total exports	South Asian vs OECD Most pollutive exports	South Asian vs OECD Relative less pollutive exports
Log exporting country GDP Per Capita	1.28 (1.15)	1.84 * (1.65)	1.60 (1.61)
Log importing country GDP per Capita	1.78 *** (3.09)	1.89 *** (3.24)	1.98 *** (4.12)
Log Distance	-.30 * (-1.64)	-.85 * (-1.71)	-.25 (-1.29)
Env. regulation exporting country	-2.63 ** (-1.98)	-4.09 * (-1.80)	-3.21 ** (-2.21)
Env. Regulation importing country	-.69 (-.36)	1.23 (.87)	-2.22 (-1.35)
Dummy Contiguity ($CONTG_{ij}$)	.67 (.67)	.37 (.31)	.81 (1.28)
Dummy Common Language ($COML_{ij}$)	.84 *** (6.05)	1.28 *** (3.69)	1.02 *** (64.70)
Dummy Colonial links (COL_{ij})	.83 (1.24)	1.02 (1.41)	.62 (1.22)
Constant	-117.34 (-.92)	-176.71 (-1.34)	-54.17 (-.47)
Reporter dummy (South Asia)	Yes	Yes	Yes
Partner dummy	Yes	Yes	Yes
Year Dummy	Yes	Yes	no
Observations	171	171	171
Adjusted R-Squared	.53	.51	.55

*Notes: (1) *** denotes significance at the 1% level, ** denotes significance at the 5 % level, * denotes significance at the 10 % level*
: (2) t- statistics are in parentheses.
: (3) *Estimation uses White (1980) heteroscedasticity-consistent covariance matrix estimator.*
:(4) All variables both regressand and regressors in estimation of equations (3) are expressed in natural logarithm form, except dummies. Total exports, most pollutive exports and relative less pollutive exports are dependent variable.
:(5) Analysis based on 3- South Asian countries exports with 17 OECD's countries panel data (1990, 1998,2004).
:(6) To avert singularity issue in the data we have used South Asia region dummies for reporting countries. data

Table 8.8 Environmental Regulation and Exports Competitiveness: South Asia Pollution Haven Analysis - Newey-West Model with lags (1)-(2).

Variables /pollutive category	South Asian vs OECD Total exports		South Asian vs OECD Most pollutive exports		South Asian vs OECD Relative less pollutive exports	
	Lag (1)	Lag (2)	Lag (1)	Lag (2)	Lag (1)	Lag (2)
Log exporting country GDP Per Capita	1.86 **: (2.21)	1.85 **: (2.45)	2.89*** (3.63)	2.89*** (4.44)	2.46 *** (3.12)	2.46 *** (3.01)
Log importing country GDP per Capita	2.83*** (7.85)	2.83*** (8.89)	3.01*** (7.43)	3.01*** (7.44)	2.78*** (7.99)	2.78*** (8.11)
Log Distance	-.41 (-1.39)	-.41 (-1.39)	-1.02 *** (-3.24)	-1.02 *** (-3.16)	-.38 (-1.33)	-.38 (-1.25)
Env. regulation exporting country	-7.14*** (-4.67)	-7.14 *** (-5.44)	-9.38 *** (-5.23)	-9.38 *** (-5.21)	-6.87 *** (-4.52)	-6.87 *** (-4.67)
Env. Regulation importing country	-4.91 *** (-4.11)	-4.91 *** (-4.23)	-2.94* (-1.77)	-2.94* (-1.93)	-5.23*** (-4.03)	-5.22*** (4.62)
Dummy Contiguity (*CONTG*$_{ij}$)	.89 (.81)	.89 (.71)	.33 (.28)	.33 (.29)	.77 (.73)	.76 (.65)
Dummy Common Language (*COML*$_{ij}$)	.84 (1.61)	.84 (1.54)	1.25* (1.79)	1.25* (1.94)	.97** (2.07)	.97** (2.04)
Dummy Colonial links (*COL*$_{ij}$)	.41 (.73)	.41 (.79)	.65 (.97)	.66 (1.22)	.43 (.68)	.43 (.75)
Constant	-142.81 (-1.63)	-142.81 * (-1.83)	-246.89*** (-2.93)	-246.87*** (-3.63)	-115.68 (-1.41)	-115.68 (-1.38)
Reporter dummy (South Asia Dummy)	Yes	Yes	Yes	Yes	Yes	Yes
Partner dummy	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Observations	171	171	171	171	171	171

Notes: *(1) *** denotes significance at the 1% level, ** denotes significance at the 5 % level, * denotes significance at the 10 % level.*
: (2) t- statistics are in parentheses.
: (3) *Estimation uses new-west model with lags (1)-(2).*
:(4) All variables both regressand and regressors in estimation of equations (3) are expressed in natural logarithm form, except dummies. Total exports, most pollutive exports and relative less pollutive exports are dependent variable.
:(5) Analysis based on 3- South Asian countries exports with 17 OECD's countries panel data (1990, 1998,2004).
:(6) To avert singularity issue in the data we have used South Asia region dummies for reporting countries. data

8.5 Environmental Regulation and Trade Flows: Cross-Sectional Analysis

In this section, as opposed to the panel the study results for cross-section data analysis for both exports and imports flows of 20 selected countries and using 4-digit ISIC data for period 1990 and 1998. As explained in chapter 5, World Production and Trade Data sources offer bilateral trade flows data on 4-digit ISIC level till 1998 only and therefore, it is worth examining if gravity modeling analysis on highest dis-aggregated data provides somewhat different results the cross-sectional level. A controlled variable named bilateral level industrial tariffs at 4-digit ISIC level has been incorporated in gravity model equations (3), (3a), (4) described in section 8.4 of this chapter. First the data on tariffs are transformed for each pollutive trade category viz total bilateral industrial tariffs, tariff on most pollutive industries and tariffs levied on relatively less pollutive industries using same 4-digit ISIC level for each period 1990 and 1998. This will show whether tariff barriers created in the countries affecting the different pollutive industries group of trade flows in two comparative static periods. The study does not explicitly capture the effect of non-tariff barriers (other than environmental regulations) in the analysis, nor the scope of current study requires that as measuring non-tariff barriers requires data sets that are not in the purview of this study. This study, therefore, following other studies, will presume that the effect of non-tariff barriers is accounted for in the intercept term in regression analysis (Tamirisa,1998 and XU, 2000 made the same assumption). The study will make use of the GDP per Capita variable to avert multicollinearity problems, and the same has been used by many other cross-section studies (Tamirisa,1998 and Kalirajan and Shad,1998).

The analysis is conducting by computing augmented gravity model equations (3), (3a) and (4). The variables of Per capita GDP of both exports and importers countries are expected to positively impact trade flows. The distance variable is expected to have a negative effect on bilateral trade flows in the estimation of equations (3) (3a) and (4). Due to reasons explained before in section 8.4 of this chapter, import tariffs variables are expected to have a negative association with pollutive industrial categories of bilateral exports and imports flows. Other controlled variables included in the gravity equations (3), (3a) and (4), are BORDERij (border association), $CLANG_{ij}$ (common language), $COLLINK_{ij}$ (colonial link) will have a positive effect on industrial trade flows. The dummy variable viz., RTA_{ij} (regional trade agreements) and South Asia dummy are trade-creating hence included in export equations to exert a positive influence on pollutive industrial export flows. The controlled variables of land for exports and importers are expected to exert either a negative or positive impact on trade flows for reasons already explained in section 8.4 of this chapter.

The environmental regulation variables included in equations (3), (3a) and (4) following research hypotheses will measure whether stringent regulations exert a negative influence on competitiveness. Accordingly, the parameters β_6 and β_7 in equation (3) and (3a) are expected to have a negative and a positive value, respectively. Considering similar reasons, the parameters β_7 and β_8 in equation (4), are expected to have a positive and a negative value, respectively.

The augmented gravity models are estimated by applying OLS technique to cross-sectional data for the period 1990 and 1998 of 20 sample countries- 17 OECD and 3 South Asian. Therefore, the total number of observations for each cross-section period are (20x19) 380. The study constructed the data for three manufacturing trade categories viz. most pollutive manufacturing bilateral trade flows, relatively less pollutive bilateral trade flows and total manufacturing trade flows. Therefore, the empirical models the study specified will examine the environmental stringency impact on bilateral trade flows- export and imports. All variables, both regressand and regressors in the estimation of export equations (3), (3a), and import equation (4), are expressed in natural logarithm form, except dummies and the analysis is done for each period 1990 and 1998.

This study's vital aim is to examine the environmental regulations impacts on pollutive industrial trade for South Asia region in the cross-sectional data set. The number of observations will reduce to 57 only from 380 if the study just considers bilateral trade flows of South Asia with OECD countries. This would imply a serious loss of a degree of freedom and model estimate with small observation and significant explanatory variables, including dummies and other variables that cause issues of singularity in data. This outcome is more visible while estimating the model especially when additional dummies as control variables are added in model specification. The study has introduced interaction variables in gravity model specification to avert these issues in data estimation and maintain the total number of observations to 380. The interaction variables include South Asia dummy with environmental regulations variables and South Asia dummy with tariff variables so that, apart from finding the outcome of sample data, a true environmental stringency and tariffs impacts on pollutive trade for South Asian countries are found. The interaction variables approach will also help draw a comparative analysis regarding the impact of the policy on South Asian region with full sample countries. That is a superior technique for analysis as Jug and Mirza (1995) also used an interaction variable approach for environmental regulations and trade flows associations. They among others used interaction variables such as environmental stringency with the EU and dirty and cleaner sectors and examined their impact on most pollutive industrial trade flows.

Therefore, the present research has applied these interaction variables analysis technique to both 1990 and 1998 periods.

The regression results in general, exhibits the violation of the statistical hypothesis of homoscedasticity as the sample countries under analysis differ largely in terms of income and country size. The study, therefore, conducts a heteroscedasticity test[30] which tends to reject the homoscedasticity assumptions of OLS. Thus, this study computes White (1980) heteroscedasticity-consistent covariance matrix and calculates the t-value based on the corrected standard errors. The descriptive statistics, correlation matrix for the year 1990 period is reported in appendixes 8.3.1A-4A. The correlation matrix table shows a very high degree of association between environmental variables and tariffs variables. Therefore, this study presented results with and without tariff variables in the analysis. Correlation coefficients are also high between GPD per capita and environmental variables which could be due to a high degree of association between population and environmental regulatory variables. However, for model specification and study hypothesis, both variables are vital to retaining at the analysis stage.

8.5.1 Cross-Section Data Estimation for 1990

The results in table 8.9 for total industrial exports show that coefficients such as GDP per capita of both exporters and importers countries revealed an expected sign for three pollutive industrial groups. Income variable in exporting country shows the potential export supply and that of importing country potential import demand. These variables for both exporters and partner countries are positive and statistically significant at a 1% level, showing that country per capita GDP variables are vital determinants of bilateral exports for all sample countries in 1990. As expected, the parameter of distance variable shows a negative impact on export competitiveness, and the estimated coefficient is significant for 1 percent for all pollutive industrial groups. The estimated coefficient of RTA with the positive and statistically significant sign is found in most pollutive industrial trade categories and insignificant for the other groups. The results show that regional trade efforts are export-creating for the most pollutive sectors compared to total exports and less pollutive industrial exports. The South Asia dummy for 1990 shows a strong and statistically significant positive impact on all

[30] The study conducted White (1980) heteroscedasticity tests which is based on the regression of squared residuals on squared fitted values.

manufacturing exports categories. Other's countries paired dummies in the model broadly showing expected positive signs.

The environmental stringency variable in table 8.9 for exporting country shows its negative and statistically significant impact on less pollutive industrial exports group. The impact of policy on total industrial exports and most pollutive industries is negative but statistically insignificant in 1990. The stringent environmental regulations introduced by the partner country is also discouraging home country pollutive industrial exports going to partner countries as estimated coefficient signs are negative and statistically significant at 1 % level for all pollutive industrial groups. Therefore, again there is less evidence of pollution and industrial de-localization and pollution haven effects owing to stringency of environmental regulations in 1990. The estimated model fits well as adjusted R^2 values for all three sets of regression results reported in table 8.9 range from .49 to .64. Also, the overall model significant tests-F-statistics- are significant at one percent level and range from 37.95 to 69.81 for three categories of pollutive manufacturing export flows.

In table 8.10, again, most of the model-controlled variables are showing expected signs. The variable of income for both exporting and importing countries is positive and significant at 1% level, distance is negative and statistically significant for all pollutive categories. The coefficients of land variables are positive and statistically insignificant for exporting countries but positive and statistically significant for importing countries for all pollutive manufacturing export categories and for total exports. These results suggest that partner country with large size land availability area have the ability for production activity to expand in the external sectors and provide a push factor for the total manufacturing exports, most pollutive manufacturing sectors and less pollutive manufacturing exports (Van Beers and Van den Bergh, 1997, 2003).

The study variables of interest in table 8.10 show the negative impact of environmental stringency measures on both exporting and importing countries in full sample country data. The research interest here is to examine the outcome of the interaction variable, which is the product of the environmental regulation of exporting country and South Asia dummy. The estimated coefficients result of this interaction variable show a positive impact of environmental regulations on total exports, most pollutive exports and less pollutive exports in South Asia, and elasticities are greater than one and statistically significant at 1% level. The results seemed to suggest a win-win situation for South Asian countries i.e., environmental regulations are good for export competitiveness for the 1990 sample period. However, the net effects of regulations on exporting country for all manufacturing exports are important to investigate which are negative for total exports (-2.03+1.21= -.82) and less pollutive exports (-3.44+1.13= -2.31) but positive for most pollutive manufacturing exports (-.15+1.45= 1.3). Therefore, the results show that environmental regulatory measures have a positive impact on most pollutive manufacturing exports competitiveness in 1990 when environmental regulations were relatively less stringent in South Asia than in succeeding years.

The theoretical chapter 3 and empirical endeavours on the subject reviewed in chapter 4 have provided a wealth of information on pollution haven effects. The plausible reasons included differential of environmental regulations between rich North and developing South as well as lack of well-designed property rights in South and absence of harmonization of environmental laws between developed and developing countries. To examine whether South Asin countries have become pollution haven for pollutive industrial exports to the OECD in 1990 the study has constructed an interaction variable that is the product of environmental regulation of partner country with South Asia dummy. The study expects a positive impact of this joint variable on the home country's pollutive industrial exports. In table 8.11, the estimated coefficients of this product variable showed a positive impact of the policy on pollutive industries exports, but the net effects for this product variable are negative for all pollutive industrial export groups. This study, therefore, again rejects PHH for South Asian pollutive industrial export flows in all three groups. Moreover, the study does not find any stark difference whether environmental regulations in importing countries triggers varied impacts for three different pollutive industrial exports groups in South Asia in 1990. The other controlled variables in the model are broadly depicting the expected signs and adjusted R^2 range between .53 to .68 for three categories of export flows. The model fits the data well, as F-statistics are highly significant for all categories of pollutive exports.

One possible reason for finding the positive impact of domestic environmental regulation on export competitiveness in South Asia for 1990 period could be due to use of cleaner technologies as a result of environmental regulation as advocated by Porter[31] and Van der Linde (1995). As reviewed in theoretical chapter 3, trade and environmental policies are mutually supporting and complement each other. The thrust of their argument is that there is no trade-off between environmental-related social benefits and private costs. However, this framework

[31] Murty and Kumar (2003), studied the effect of environmental regulation relating to water pollution by the Indian industry on the productive efficiency of firms. The panel data of 92 water- polluting firms related to sugar industry for the three years 1996-97, 1997-98, and 1998-99 are used to test the porter hypothesis of having win-win opportunities for the firms subjected to environmental regulation. The key finding was that the technical efficiency of firms increases with the intensity of environmental regulation and the water conservation efforts thus supporting the porter hypothesis.

applies more in a dynamic framework allowing productivity to change over time and compliance with more stringent environmental regulations. But developing countries are still in the process of compliance with those regulations. Therefore, more plausible reasons for finding a positive association of home country environmental policy and most pollutive industry trade competitiveness in 1990 data are what follows.

First, in countries with relatively strict environmental policies, the expected negative effect on export can be counterbalanced by the subsidies to the pollutive industries as compensation for increased production costs. Depending on the magnitude of industrial subsidization, if the counterbalance effect is strong enough, it can produce the positive effect of environmental regulation on export flows and export competitiveness. The second possibility is that other non-environmental factors like available labour skills and the political instability of countries might have influenced plant relocation and export decisions. If this is the case, the regressions analyses do not capture enough information. To accomplish that task, the explanatory variables need to be extended with appropriate indicators reflecting these additional influences, which is difficult due to limited data availability (Van Beers and Van den Bergh, 1997, 2003). Other possible reasons of finding positive impact of environmental regulation on exports in South Asia could be the one that recent literature has picked up frequently and cited most regarding the choice of methodology, and that is that cross-sectional level regression analysis in cross-country and commodity framework might not capture country fixed effect and face issues pertaining to capturing the un-observed effects in the analysis. This is what has been advocated among others by Brunnermeirer and Levison (2004). According to them, unobserved heterogeneity can refer to unobserved industry or country characteristics which can be correlated with country's strict environmental regulations and the production and export of pollution-intensive goods. As a result of that country will export a lot of that good and will cause creating a lot of pollution, ceteris paribus, it will impose strict regulation to control pollution output. If these unobserved variables are omitted in a simple cross-sectional model, which is the case in most cross-sectional models, this will produce inconsistent results, which cannot be meaningfully interpreted. Therefore, the cross-section model-based results will find a positive relationship between strict environmental regulations and exports. They advocated that a simple solution to that is to conduct panel data analysis with time variation and incorporate country and or industry-specific fixed effects. This could be one reason for finding a positive impact of environmental regulation on export competitiveness in cross-sectional data analysis by Tobey (1990) and XU (2000) and present research.

Table 8.9 Extended Gravity Model(s) Regression results for Industrial Exports versus Environmental Regulations (OECD and South Asia: 1990)

DEPENDENT VARIABLE: LOG INDUSTRIAL EXPORTS 1990	TOTAL INDUSTRIAL EXPORTS	MOST POLLUTIVE INDUSTRIAL EXPORTS	LESS POLLUTIVE INDUSTRIAL EXPORTS
Right Hand Side Variables	(1)	(2)	(3)
Log Exporter's Per Capita GDP 1990	3.64*** (6.64)	4.22*** (6.71)	3.72 *** (6.52)
LOG Importer's Per Capita GDP 1990	1.71 *** (4.33)	1.28 *** (2.98)	1.91*** (4.44)
Log Distance between exporter and importer country Log D_{ij}	-.53*** (-3.47)	-.70 *** (-4.55)	-.43 *** (-2.70)
Log Composite Env. Stringency in exporter's country ($LENVT_i$ 90)	-1.99 (-1.32)	-.38 (-.23)	-3.38 ** (-2.13)
Log Composite Env. Stringency in partner's county ($LENVT_j$ 90)	-3.85*** (-2.39)	-3.19 * (-1.84)	-4.60*** (-2.63)
Dummy Contiguity ($CONTG_{ij}$)	.67 * (1.87)	.70 ** (1.94)	.88 *** (2.40)
Dummy Common Language ($COML_{ij}$)	.47 * (1.83)	.42 (1.45)	.59 ** (2.25)
Dummy Colonial links (COL_{ij})	1.39 *** (4.60)	1.30*** (3.42)	.1.41*** (4.55)
Regional Trade Agreements ($RTA's_{ij}$)	.33 (1.0)	.56* (1.68)	.42 (1.17)
Dummy South Asia	6.10*** (5.13)	6.73*** (4.78)	5.61*** (4.59)
Adjusted R^2	.54	.64	.49
Constant term	-10.12 (-1.22)	-23.72 *** (-2.63)	-3.69 (-.42)
F-Statistics	45.09 ***	69.81***	37.95***
Number of Observations	380	380	380

*Notes: (1) *** denotes significance at the 1% level, ** denotes significance at the 5 % level, * denotes significance at the 10 % level*
: (2) t- statistics are in parentheses.
:(3) F-critical values at 1% level of significance with (10,370) degree of freedom is 3.93
: (4) *Estimation uses White (1980) heteroscedasticity-consistent covariance matrix estimator.*
:(5) All variables both regressand and regressors in estimation of equations (3) are expressed in natural logarithm form, except dummies.

Table 8.10 Effects of Environmental Regulation on South Asian Pollutive Industry Exports with OECD Countries -1990

DEPENDENT VARIABLE: LOG SOUTH ASIA INDUSTRIAL EXPORTS 1990	**TOTAL INDUSTRIAL EXPORTS**	**MOST POLLUTIVE INDUSTRIAL EXPORTS**	**LESS POLLUTIVE INDUSTRIAL EXPORTS**
Right Hand Side Variables	(1)	(2)	(3)
Log Exporter's Per Capita GDP_i *1990*	3.40*** (6.69)	4.03*** (7.16)	3.53*** (6.45)
LOG Importer's Per Capita GDP_j *1990*	1.78 *** (4.73)	1.35 *** (3.34)	1.97*** (4.75)
Log Distance between exporter and importer country Log D_{ij}	-.70*** (-4.91)	-.89*** (-5.88)	-.60 *** (-3.92)
Log Composite Env. Stringency in exporter's county ($LENVT_i$ 90)	-2.03 (-1.50)	-.15 (-.09)	-3.44** (-2.42)
Log Composite Env. Stringency in partner's county ($LENVT_j$ 90)	-4.25*** (-2.76)	-3.64** (-2.23)	-4.96*** (-2.94)
Dummy Contiguity ($CONTG_{ij}$)	.49* (1.41)	.51* (1.42)	.72** (2.01)
Dummy Common Language ($COML_{ij}$)	.15 (.60)	.04 (.17)	.29 (1.14)
Dummy Colonial links (COL_{ij})	1.40 *** (5.13)	1.31*** (3.99)	1.42*** (4.98)
Log Env. Stringency in exporter county (*LENVTi* 90) *Dummy South Asia	**1.21*** (4.55)**	**1.45*** (4.86)**	**1.13*** (4.02)**
Regional Trade Agreements ($RTA's_{ij}$)	.30 (.93)	.53* (1.61)	.39 (1.14)
Log $Land_i$	.09 (1.62)	.02 (.37)	.09* (1.66)
Log $Land_j$	.34*** (6.38)	.38*** (6.62)	.31*** (5.74)
Adjusted R^2	.59	.69	.54
Constant term	-9.22 (-1.18)	-24.09 *** (-2.86)	-3.13 (-.38)
F-Statistics	46.25***	69.68***	37.83***
Number of Observations	380	380	380

*Notes: (1) *** denotes significance at the 1% level, ** denotes significance at the 5 % level, * denotes significance at the 10 % level*
: (2) t- statistics are in parentheses.
:(3) F-critical values at 1% level of significance with (12,368) degree of freedom is 2.18
: (4) *Estimation uses White (1980) heteroscedasticity-consistent covariance matrix estimator.*
:(5) All variables both regressand and regressors in estimation of equations (3) are expressed in natural logarithm form, except dummies

Table 8.11 Pollution Haven Effects in South Asia for OECD Countries -1990

DEPENDENT VARIABLE: LOG SOUTH ASIA INDUSTRIAL EXPORTS 1990	TOTAL INDUSTRIAL EXPORTS	MOST POLLUTIVE INDUSTRIAL EXPORTS	LESS POLLUTIVE INDUSTRIAL EXPORTS
Right Hand Side Variables	(1)	(2)	(3)
Log Exporter's Per Capita GDP_i *1990*	3.34^{***} (5.99)	3.86^{***} (6.66)	3.35^{***} (6.09)
LOG Importer's Per Capita GDP_j *1990*	1.79^{***} (4.70)	1.36^{***} (3.34)	1.98^{***} (4.74)
Log Distance between exporter and importer country Log D_{ij}	$-.69^{***}$ (-4.79)	$-.89^{***}$ (-5.79)	$-.59^{***}$ (-3.86)
Log Composite Env. Stringency in exporter's county ($LENVT_i$ 90)	-1.99 (-1.47)	-.13 (-.09)	-3.45^{**} (-2.42)
Log Composite Env. Stringency in partner's county ($LENVT_j$ 90)	-4.42^{***} (-2.86)	-3.84^{***} (-2.34)	-5.12^{***} (-3.01)
Dummy Contiguity ($CONTG_{ij}$)	$.56^{*}$ (1.64)	$.60^{*}$ (1.65)	$.78^{**}$ (2.19)
Dummy Common Language ($COML_{ij}$)	.15 (.61)	.05 (.19)	.29 (1.18)
Dummy Colonial links (COL_{ij})	1.40^{***} (5.07)	1.30^{***} (3.86)	1.41^{***} (4.88)
Log Env. Stringency in partner's county ($LENVT_j$ 90) *Dummy South Asia	**1.04^{***} (4.31)**	**1.19^{***} (4.31)**	**$.90^{***}$ (3.54)**
Regional Trade Agreements ($RTA's_{ij}$)	.36 (1.11)	$.59^{**}$ (1.72)	.42 (1.20)
Log $Land_i$	$.09^{*}$ (1.67)	.03 (.48)	$.10^{*}$ (1.78)
Log $Land_j$	$.33^{***}$ (6.40)	$.38^{***}$ (6.59)	$.31^{***}$ (5.72)
Adjusted R^2	.59	.68	.53
Constant term	-8.11 (-1.04)	-21.64^{***} (-2.59)	-.74 (-.08)
F-Statistics	45.88^{***}	68.57^{***}	37.21^{***}
Number of Observations	380	380	380

*Notes: (1) *** denotes significance at the 1% level, ** denotes significance at the 5 % level, * denotes significance at the 10 % level*
: (2) t- statistics are in parentheses.
:(3) F-critical values at 1% level of significance with (12,368) degree of freedom is 2.18
: (4) *Estimation uses White (1980) heteroscedasticity-consistent covariance matrix estimator.*
:(5) All variables both regressand and regressors in estimation of equations (3) are expressed in natural logarithm form, except dummies.

The study further examined the impact of tariff barriers for different categories of pollutive industrial trade to test whether tariff barriers created by the countries negatively affect pollutive industrial trade flows. The results in table 8.12 show that higher tariffs are trade reducing and leave a significant negative impact on pollutive industrial export flows and competitiveness. The negative elasticities are greater than one and statistically significant at 1% level for all export categories for a full sample of 20 countries. Previous studies conducted in this area also found negative impacts of tariffs on industrial export flows (Wilson et al., 2003; Linnemann and Verbruggen,1991).

The interaction variable that is product of tariffs and South Asia dummy differs from the over sample tariffs results and depicts a positive and statistically significant impact on bilateral pollutive industrial trade. Nonetheless, the net effects of tariff barriers on export flows are still negative and large for all manufacturing trade categories, total exports (- 6.93+1.35= -5.58), most pollutive exports (-4.36+1.46= -2.9), less pollutive exports (-5.13+1.15= -3.98). The income variables of both exporting and importing countries show trade creation effects while that of distance is affecting negatively to exports flows. As depicted in F-tests results, the model is overall statistically significant for all manufacturing exports at 1% level and the coefficient of determination adjusted R^2 values range between .55 to .69. The estimated coefficients of other dummies variables such as colonial links, common languages, and contiguity all show expected signs.

The estimated results ascertained using the imports model for all categories of trade and tariff walls impact imports are reported in appendixes 8.3.5A-7A. The results just mirror images of the bilateral exports model. Next, the study shows the empirical results based on 1998 cross-sectional data.

Table 8.12 Impact of Tariffs to Exporting Country's Competitiveness-1990

DEPENDENT VARIABLE: LOG SOUTH ASIA INDUSTRIAL EXPORTS 1990	**TOTAL INDUSTRIAL EXPORTS**	**MOST POLLUTIVE INDUSTRIAL EXPORTS**	**LESS POLLUTIVE INDUSTRIAL EXPORTS**
Right Hand Side Variables	(1)	(2)	(3)
Log Exporter's Per Capita GDP_i *1990*	2.98*** (5.78)	3.80*** (6.28)	3.16 *** (5.73)
LOG Importer's Per Capita GDP_j *1990*	1.79 *** (4.99)	1.50 *** (3.79)	2.02*** (5.10)
Log Distance between exporter and importer country Log D_{ij}	-.67*** (-7.21)	-1.01*** (-9.71)	-.62 *** (-6.40)
Log Composite Env. Stringency in exporter's county ($LENVT_i$ 90)	-2.51** (-1.95)	-.51 (-.35)	-3.98*** (-2.89)
Log Composite Env. Stringency in partner's county ($LENVT_j$ 90)	-3.92*** (-2.66)	-3.90*** (-2.48)	-4.73*** (-2.92)
Log Applied tariff (100+TARIFF$_{ij}$) in percent ad valorem	-6.93*** (-4.23)	-4.36*** (-2.02)	-5.13*** (-3.21)
Dummy Contiguity ($CONTG_{ij}$)	.58** (1.78)	.52* (1.47)	.75** (2.19)
Dummy Common Language ($COML_{ij}$)	.11 (.48)	.16 (.64)	.30 (1.26)
Dummy Colonial links (COL_{ij})	1.35 *** (5.13)	1.12*** (3.64)	1.32*** (4.90)
Log Applied tariff (100+TARIFF$_{ij}$) in percent ad valorem 90) *Dummy South Asia	**1.35*** (5.30)**	**1.46*** (5.05)**	**1.15*** (4.34)**
Log $Land_i$	.06 (1.51)	.02 (.35)	.08 (1.51)
Log $Land_j$	.35*** (6.55)	.38*** (6.59)	.33*** (5.93)
Adjusted R^2	.60	.69	.55
Constant term	27.93 *** (2.61)	1.45 (.01)	26.0** (2.42)
F-Statistics	49.18***	70.15***	38.95***
Number of Observations	380	380	380

Notes: (1) *** denotes significance at the 1% level, ** denotes significance at the 5 % level, * denotes significance at the 10 % level

: (2) t- statistics are in parentheses.

:(3) F-critical values at 1% level of significance with (12,368) degree of freedom is 2.18

: (4) *Estimation uses White (1980) heteroscedasticity-consistent covariance matrix estimator.*

:(5) All variables both regressand and regressors in estimation of equation (3a) are expressed in natural logarithm form, except dummies.

8.5.2 Cross-Section Data Estimation for 1998

After providing an in-sight to the empirical endeavours for the years 1990 on the subject, the present research shed some light on the trade and environmental data set in the sample year 1998 for three pollutive categories of trade flows of 20 sample selected sample countries. The gravity models based on equations (3), (3a) and equation (4) again are estimated for the data set of the period 1998.

Firstly, the study estimates the descriptive statistics of the critical variables of the model, and then in order to check the presence of multicollinearity in data, it examines the correlation matrix of key variables results of which are reported at appendix 8.4.1A-4A. The study, like in the 1990 period, chose 20 sample countries, and there are 380 observations in the data set. The diagnostic test applied to the gravity model for homoscedasticity exhibits a violation of the statistical hypothesis of homoscedasticity in the OLS technique. Therefore, the study computes White (1980) heteroscedasticity-consistent covariance matrix and calculates the t-value based on the corrected standard errors.

In table 8.13, results for the export model in gravity modeling estimates are presented. The estimated coefficients of income variables for exporting and importing countries contribute to export supply and demand for all pollutive industrial trade categories at 4-digits ISIC level for overall sample countries. Distance variable again found negative and statistically significant associated with the export of manufacturing commodities for all pollutive categories and overall exports. The dummy variables are also showing expected signs, and the model overall fits well and statistically significant as F-statistics range from 80.87 to 97.78. The adjusted R^2 values range from .70 to .74 for all three categories of pollutive manufacturing exports. For full sample countries in 1998, the trade elasticities with respect to environmental regulations for exporter countries' pollutive categories of exports, including total exports, most pollutive exports, less pollutive exports are negative and statistically significant at the 1% level. The findings show that environmental regulations were causing a negative impact on competitiveness, regardless of the pollutive industrial exports categories. The environmental regulatory measures introduced by the partner country have not paved the way for the home country to increase its export supply to those countries either as estimated elasticity coefficients of partner country environmental regulations with home country exports supply was negative and statistically significant at 1 % level. These results indicate the reverse of industrial or pollution delocalization/ haven hypothesis hence rejects PHH effect for overall sample countries in1998.

Table 8.13 Effects of Environmental Regulation on South Asian Pollutive Industry Exports with OECD Countries -1998

DEPENDENT VARIABLE: LOG SOUTH ASIA INDUSTRIAL EXPORTS 1998	**TOTAL INDUSTRIAL EXPORTS**	**MOST POLLUTIVE INDUSTRIAL EXPORTS**	**LESS POLLUTIVE INDUSTRIAL EXPORTS**
Right Hand Side Variables	(1)	(2)	(3)
Log Exporter's Per Capita GDP_i *1998*	1.12*** (3.27)	1.06*** (2.76)	1.32*** (3.70)
Log Importer's Per Capita GDP_j *1998*	1.93*** (15.51)	1.85*** (12.41)	1.93*** (14.45)
Log Distance between exporter and importer country Log D_{ij}	-.91*** (-9.10)	-1.28*** (-11.29)	-.79*** (-7.47)
Log Env. Stringency in exporter's county (ES_i)	-7.17*** (-12.21)	-5.90*** (-8.41)	-7.85** (-12.64)
Log Env. Stringency in partner's county (ES_j)	-6.43*** (-11.46)	-7.23*** (-10.89)	-6.31*** (-10.61)
Dummy Contiguity ($CONTG_{ij}$)	.29 (1.10)	.06 (.21)	.42* (1.41)
Dummy Colonial links (COL_{ij})	.98*** (4.44)	.84*** (3.30)	1.05*** (4.87)
Log Env. Stringency in exporter's country ((ES_i) *Dummy South Asia	**-.63** (-2.34)**	**-1.01*** (-3.29)**	**-.57** (-2.03)**
Regional Trade Agreements ($RTA's_{ij}$)	.15 (.62)	.29 (1.11)	.23 (.91)
Log $Land_i$	.38*** (9.88)	.56*** (11.13)	.38*** (9.52)
Log $Land_j$	.46*** (11.04)	.57*** (10.96)	.42*** (9.95)
Adjusted R^2	.71	.74	.70
Constant term	32.33*** (7.71)	30.42*** (6.61)	32.05*** (7.09)
F-Statistics	85.71***	97.78***	80.87***
Number of Observations	380	380	380

Notes: *(1) *** denotes significance at the 1% level, ** denotes significance at the 5 % level, * denotes significance at the 10 % level*
: (2) t- statistics are in parentheses.
:(3) F-critical values at 1% level of significance with (11,369) degree of freedom is 2.18
: (4) *Estimation uses White (1980) heteroscedasticity-consistent covariance matrix estimator.*
:(5) All variables both regressand and regressors in estimation of equation (3) are expressed in natural logarithm form, except dummies.

Thus, in line with the earlier 1990 data study for 1998, data analysis finds negative effects of environmental regulations on manufacturing export competitiveness for all categories of pollutive exports for full sample countries.

Table 8.14 Pollution Haven Effects in South Asia for OECD Countries: Manufacturing Exports Cross-Section Data-1998

DEPENDENT VARIABLE: LOG SOUTH ASIA INDUSTRIAL EXPORTS 1998	TOTAL INDUSTRIAL EXPORTS	MOST POLLUTIVE INDUSTRIAL EXPORTS	LESS POLLUTIVE INDUSTRIAL EXPORTS
Right Hand Side Variables	(1)	(2)	(3)
Log Exporter's Per Capita GDP_i *1998*	1.23*** (3.52)	1.18*** (3.08)	1.41*** (3.73)
Log Importer's Per Capita GDP_j *1998*	1.93 *** (15.61)	1.85 *** (12.47)	1.93*** (14.55)
Log Distance between exporter and importer country Log D_{ij}	-.90*** (-9.03)	-1.28*** (-11.40)	-.78 *** (-7.48)
Log Env. Stringency in exporter's county (ES_i)	-7.13*** (-12.15)	-5.86*** (-8.37)	-7.81** (-12.60)
Log Env. Stringency in partner's county (ES_j)	-6.36*** (-11.33)	-7.11*** (-10.62)	-6.24*** (-10.50)
Dummy Contiguity ($CONTG_{ij}$)	.27 (1.03)	.03 (.09)	.40* (1.35)
Dummy Colonial links (COL_{ij})	.99*** (4.43)	.85*** (3.30)	1.05*** (4.85)
Log Env. Stringency in exporter's country ((ES_j) *Dummy South Asia	**-.49** (-1.99)**	**-.84*** (-3.25)**	**-.45* (-1.77)**
Regional Trade Agreements ($RTA's_{ij}$)	.14 (.59)	.26 (1.01)	.22 (.89)
Log $Land_i$	.38*** (9.63)	.56*** (10.94)	.37*** (9.31)
Log $Land_j$	.45*** (10.87)	.57*** (10.79)	.41*** (9.81)
Adjusted R^2	.71	.74	.70
Constant term	31.56 *** (7.26)	28.83 *** (6.53)	30.81*** (6.63)
F-Statistics	84.95***	96.97***	80.40***
Number of Observations	380	380	380

*Notes: (1) *** denotes significance at the 1% level, ** denotes significance at the 5 % level, * denotes significance at the 10 % level*
: (2) t- statistics are in parentheses.
:(3) F-critical values at 1% level of significance with (11,369) degree of freedom is 2.18
: (4) *Estimation uses White (1980) heteroscedasticity-consistent covariance matrix. estimator.*
:(5) All variables both regressand and regressors in estimation of equations are expressed in natural logarithm form, except dummies.

To find out whether South Asia region's competitiveness outcomes for environmental policy measures are the same as the overall sample countries or if estimated results show a divergent picture, the study constructed an interaction variable using the product of environmental regulation and South Asia dummy. The study finds that estimated coefficients of these product variables for pollutive industrial categories are negative and statistically significant in 1998 for

South Asian countries. These results are in line with the overall sample conclusion drawn for 20 sample countries data.

The study computed the gravity model to examine environmental policy introduced in the partner country and its impact on home country pollutive industrial trade flows and reported the results in table 8.14. The estimated coefficient of income, distance, land, exports and importer countries variables, and some dummies show an expected signs in full sample data. Also, environmental stringency variables introduced both in exporting and importing countries leave a negative and statistically significant impact on all pollutive industries exports groups in 1998. The estimated coefficients of the interaction variable- environmental stringency of partner country with South Asia region- are showing negative and statistically significant impact on home export flows and competitiveness. Therefore, stringency environmental policy introduced by partner countries is not encouraging South Asia to expand its pollutive exports supply to those countries. A comparative analysis between different categories of pollutive manufacturing exports does not provide any divergent outcomes either, except export elasticity regarding environmental regulations for most pollutive industrial category is higher than other pollutive industrial groups. The model is statistically significant at 1 percent level, and adjusted R^2 values range between .70 to 74 for three sets of regressions depict good explanatory powers of independent variables to explain pollutive industrial trade flows.

To investigate the impact of tariff walls introduced by the countries aimed at offsetting trade effects of stringent environmental regulations as well as to separate the effect of environmental regulation on trade flows from those of border distortion created via tariff walls the study has incorporated the bilateral industrial tariffs variable at 4-digits ISIC level in gravity model as estimated equation (3a) for 1998 data. The estimated models again compute White (1980) heteroscedasticity-consistent covariance matrix and calculate the t-value based on the corrected standard errors and results are reported in table 8.15. The F-statistics for all categories of export flows are statistically significant at 1 percent level and range from 87.66 to 110.62 and the power of independent variables to explain the three groups of pollutive industrial trade flow of the model is reasonably well as seen in adjusted R^2 values of three categories of manufacturing exports and range from .70 to .74. The variables of GDP per capita of exporting and importing countries and distance show the expected positive signs and statistically significant at 1% level. The environmental stringency variable for both exporter and importer countries was found to be negatively and statistically significant. The dummy variables are also showing expected signs.

In table 8.15, the results of bilateral industrial tariffs introduced in all sample countries show a negative impact of all categories of pollutive manufacturing exports, but estimated coefficients are statistically significant for total exports and most pollutive exports only and turned out to be insignificant for less pollutive exports. The result indicates that border distortions in form of tariff barriers could be biased against most pollutive manufacturing exports to some extend compared to less pollutive manufacturing export flows and total industrial exports in 1998.

The study further examines the specific effects that tariff barriers have on South Asian pollutive categories of manufacturing exports, which has been reported in table 8.16. The results of interaction variable of South Asia dummy with tariff barriers are in line with generally held belief that tariff walls created by the countries are reducing pollutive industries exports in South Asia. The estimated coefficients of interaction variables are negative for three categories of export and statistically significant at leave 5 % level. The values range from .44 for less pollutive export to .79 the most pollutive manufacturing exports. The estimated model overall statistically significant at 1 % level with F-values range from 88.54 to 106.87. The adjusted R^2 values range from .70 to .74. The overall results for the tariff variable for both developed and developing countries in full sample and South Asian countries clearly show that tariff barriers created to offset trade effect of environmental regulations are paving the way for reducing pollutive industries' manufacturing exports and competitiveness. The estimated results for import equations covering the impact of environmental regulations on imports as well as tariffs impact on export flows are reported to the appendixes 8.4.5-6A as most of these results are the mirror images of what the study found using export data and confirming the robustness of research.

The overall empirical results regarding the impact of environmental regulations on trade flows for the periods 1990 and 1998 seemed to suggest that generally held theoretical studies belief that environmental regulations lower the pollutive industries trade flows cannot be rejected for the selected OECD and South Asian countries. The research did find some weak evidence for pollution haven effects in most pollutive industrial category for South Asia region in 1990 data only. Also, one of the research objectives was to analyze whether environmental stringency variables have had a different impact for relatively less pollutive trade as compared to most pollutive industries. The comparative analysis between three groups of pollutive industries trade flows did not depict many different outcomes regarding environmental stringency measures impact on trade flows, especially for full sample countries data years of 1990 and 1998.

Table 8.15 Impact of Tariffs to Exporting Country's Competitiveness-1998

DEPENDENT VARIABLE: LOG SOUTH ASIA INDUSTRIAL EXPORTS 1998	**TOTAL INDUSTRIAL EXPORTS**	**MOST POLLUTIVE INDUSTRIAL EXPORTS**	**LESS POLLUTIVE INDUSTRIAL EXPORTS**
Right Hand Side Variables	(1)	(2)	(3)
Log Exporter's Per Capita GDP_i *1998*	1.65*** (9.77)	1.82*** (9.05)	1.85*** (10.34)
Log Importer's Per Capita GDP_j *1998*	1.97 *** (15.48)	1.91 *** (13.00)	1.97*** (14.61)
Log Distance between exporter and importer country Log D_{ij}	-.90*** (-12.01)	-1.28*** (-13.91)	-.81 *** (-10.61)
Log Env. Stringency in exporter's county (ES_i)	-7.09*** (-12.01)	-5.99*** (-8.23)	-7.67** (-12.65)
Log Env. Stringency in partner's county (ES_j)	-6.46*** (-11.39)	-7.20*** (-10.93)	-6.32*** (-10.53)
Log Applied tariff (100+TARIFF$_{ij}$) in percent ad valorem	**-3.53** (-2.12)**	**-6.85*** (-3.86)**	**-2.40 (-1.53)**
Dummy Contiguity ($CONTG_{ij}$)	.32 (1.22)	.08 (.29)	.45* (1.50)
Dummy Colonial links (COL_{ij})	.99*** (4.65)	.83*** (3.37)	1.03*** (4.89)
Log $Land_i$	.46*** (11.20)	.58*** (11.48)	.43*** (9.58)
Log $Land_j$	.45*** (10.87)	.57*** (10.79)	.43*** (10.03)
Adjusted R^2	.71	.74	.70
Constant term	43.08 *** (4.83)	53.61 *** (5.59)	36.76*** (4.44)
F-Statistics	94.00***	110.62***	87.66***
Number of Observations	380	380	380

Notes: *(1) *** denotes significance at the 1% level, ** denotes significance at the 5 % level, * denotes significance at the 10 % level*
: (2) t- statistics are in parentheses.
:(3) F-critical values at 1% level of significance with (10,370) degree of freedom is 2.32
: (4) *Estimation uses White (1980) heteroscedasticity-consistent covariance matrix estimator.*
:(5) All variables both regressand and regressors in estimation of equations are expressed in natural logarithm form, except dummies

The tariff barriers introduced by the countries to offset the trade effects of environmental regulation are proving counter-productive to export flows and trade competitiveness both in South Asia and all sample countries. The results produced using bilateral data on imports are re-confirming the results ascertained via estimating the export data.

Table 8.16 Extended Gravity Model(s) Regression results for Industrial Tariffs Effects on South Asian Manufacturing Exports:1998

DEPENDENT VARIABLE: LOG SOUTH ASIA INDUSTRIAL EXPORTS 1998	**TOTAL INDUSTRIAL EXPORTS**	**MOST POLLUTIVE INDUSTRIAL EXPORTS**	**LESS POLLUTIVE INDUSTRIAL EXPORTS**
Right Hand Side Variables	(1)	(2)	(3)
Log Exporter's Per Capita GDP_i *1998*	1.13*** (3.41)	1.07*** (2.82)	1.34*** (3.84)
Log Importer's Per Capita GDP_j *1998*	1.94*** (15.80)	1.85*** (12.79)	1.95*** (14.81)
Log Distance between exporter and importer country Log D_{ij}	-.96*** (-13.90)	-1.38*** (-15.82)	-.87*** (-12.45)
Log Env. Stringency in exporter's county (ES_i)	-7.16*** (-12.20)	-5.86*** (-8.35)	-7.84** (-12.63)
Log Env. Stringency in partner's county (ES_j)	-6.45*** (-11.45)	-7.22*** (-10.88)	-6.32*** (-10.57)
Log Applied tariff (100+TARIFF$_{ij}$) in percent ad valorem*Dummy South Asia	**-.49** (-2.47)**	**-.79*** (-3.58)**	**-.44** (-2.16)**
Dummy Contiguity ($CONTG_{ij}$)	.29 (1.09)	.05 (.17)	.42* (1.40)
Dummy Colonial links (COL_{ij})	.94*** (4.37)	.77*** (3.12)	.99*** (4.67)
Log $Land_i$	.39*** (9.95)	.57*** (11.13)	.38*** (9.54)
Log $Land_j$	.46*** (11.02)	.57*** (10.96)	.42*** (9.97)
Adjusted R^2	.72	.74	.70
Constant term	33.46*** (8.09)	31.59*** (7.09)	32.43*** (7.40)
F-Statistics	94.19***	106.87***	88.54***
Number of Observations	380	380	380

Notes: *(1) *** denotes significance at the 1% level, ** denotes significance at the 5 % level, * denotes significance at the 10 % level*
: (2) t- statistics are in parentheses.
:(3) F-critical values at 1% level of significance with (10,370) degree of freedom is 2.32
: (4) *Estimation uses White (1980) heteroscedasticity-consistent covariance matrix estimator.*
:(5) All variables both regressand and regressors in estimation of equations (3) are expressed in natural logarithm form, except dummies. Data is covering again three South Asian and 17 OECDs countries.

8.6 Conclusion

The study in this chapter, by choosing environmental regulatory policy variables, has examined the impact of policy on pollutive industrial trade flows for both OECD and South Asian countries as well as South Asian bilateral exports flows with OECD countries. The principal objective of conducting research in this chapter was to examine the study hypotheses by controlling for all un-observed variables so that a true impact of environmental regulations on pollutive industrial trade flows and competitiveness is measured. In this context, the choice of the methodology should be theoretically sound but empirically testable and compatible with this study's research hypotheses. The study accordingly signified the importance of gravity modeling both at theoretical and empirical levels. Consequently, the theoretical derivation of the gravity bilateral trade model and development in that model on the design that fit best to test the empirical bilateral trade data have been critically reviewed in neo-classical orthodoxy and new trade theory perspectives.

Development in both gravity model specifications at the empirical level and the latest development on measurement techniques were adopted to examine the research questions/hypotheses reviewed for accurate data estimation. In this context, the significance of both panel and cross-sectional measurement techniques have been discussed. While the superiority of panel data methodology over cross-sections has been highlighted for robustness results, both cross-section and panel data analysis were considered at measurement stages. Moreover, the study discussed the significance of key research variables in gravity model and controlled variables as guided by earlier empirical literature. After that, the data sources of variables incorporated in the gravity model, especially the environmental stringency variables and data transformation process, are assessed in detail. The study further conducts descriptive data analysis and some diagnostic tests such as multicollinearity that help the formation of final gravity modeling specifications. For cross-methods checks and data robustness, Hausman-Taylor estimations based on REM took care of simultaneity bias and heteroscedasticity and corrected any suspect violation of orthogonality between some of the covariates and the unobservable components. The Newey-West standard error technique to gravity model estimation further authenticated the estimated outcomes by correcting the presence of autocorrelation and time series heteroscedasticity in panel data.

The study hypothesized the negative effects of environmental regulations on total trade flows, most pollutive trade flows and less pollutive trade flows. The research using panel data methodology for the periods 1990, 1998, and 2004 confirmed the hypothesis both for overall sample countries as well for South Asian countries. The study found a negative impact of environmental regulations on pollutive industrial trade flows for most pollutive, less pollutive and total trade flows in a cross- methodological framework and results remained consistent. The elasticities generally turned out to higher in the case of HAC methods with lags compared to REM and pooled data. The study further examined whether environmental regulations tend to leave different impacts for different pollutive industrial export flows. The research findings showed that environmental regulations negatively affected the most pollutive industries and less pollutive industries and total industries trade groups. Nonetheless, a higher value of negative trade elasticities with respect to environmental regulations for most pollutive industries compared to other pollutive industrial groups in the home country showed that the impact of the policy on most pollutive industrial trade competitiveness was more pronounced. Therefore, there seemed to a clear trade-off between the introduction of stringent environmental regulations in pollutive manufacturing exports and trade competitiveness for the sample countries and period under study. Furthermore, the environmental stringency introduced in importing country negatively affects the home country's pollutive industrial export flows, and the impact of the policy was stronger on relatively less pollutive industries trade group as compared to other industrial groups. The findings, therefore, indicated that importing countries' environmental regulatory policies were more biased toward exporting countries less pollutive industries exports. These findings remained consistent for full sample countries data analysis and when analysis was conducted for South Asian countries exports flows to the OECD.

The second hypothesis set in for this study was to examine whether South Asian countries have become a pollution haven for different categories of pollutive manufacturing exports to OECD countries. The panel data analysis showed that finding evidence of pollution haven effect in South Asia for different categories of pollutive manufacturing trade was less as there was a lack of empirical support to PHH. The study attributed several reasons for the absence of support to PHH for South Asia, which inter alia included most pollutive industrial trade had higher barrier-to-trade in terms of distance costs, pollutive industries being geographically less mobile due to high plant fixed costs and or agglomeration economies and that pollutive industries were least footloose thus making pollution haven effects difficult to detect.

The study further conducted analysis for cross-section data using 4-digit ISIC trade data for the period 1990 and 1998. The impact of environmental policy for full sample countries on trade competitiveness in cross-sectional data periods 1990 and 1998 was broadly in line with the study found in panel data analysis. The study applied a variable interaction approach to examine a specific impact of environmental policy on pollutive industrial trade competitiveness. The study found that the impact of the policy on South Asian countries exports competitiveness for all pollutive industrial groups was negative during both periods, except most pollutive industry group in 1990, where the impact of the policy on industrial export flows was positive. The study provided various reasons for that outcome, including the confirmation of the porter hypothesis, higher subsidies for pollutive industries to counterbalance the environmental regulations in South Asia, and what seemed more plausible that weakness in OLS-based cross-sectional methodology to capture country fixed/un-observed effects. On PHH for South Asia using cross-sectional data 1990 and 1998, the study findings were consistent with panel analysis and again rejected the presence of pollution haven effects in South Asia for all pollutive industrial groups.

One of the hypotheses in cross-sectional data analyses stated was to examine whether tariff walls created by the countries affected negatively to pollutive manufacturing trade. This was because of the debated issue in literature that countries had created a tariff wall to counteract the loss of trade competitiveness they faced due to increased environmental regulatory compliance costs. In light of estimated results for periods 1990 and 1998 and for whole sample country and interaction variable analysis for South Asian countries, the study found the negative effects of tariffs barriers on all categories of pollutive industrial trade flows and export competitiveness.

The study also found that key variables, including exporters and importers incomes, distance variables, and a host of dummy variables including regional dummies played a significant role in elucidating the pollutive industrial trade flows and competitiveness for both OECD and South Asian countries.

Chapter 9

Concluding Discussions and Some Policy Recommendations

9.1 Introduction

The association between environmental regulations and trade competitiveness in an economic liberalization era has received considerable attention within developed countries and between developed and developing countries. The economies around the world have seen rapid reductions in trade and tariff barriers in the liberalization era, combining with increased demand for the compliance of environmental regulations by the rich North for the developing South in the wake of fear of loss of trade competitiveness and industrial delocalization. On the other hand, Southern countries have raised serious concerns on competitiveness challenges the environmental regulations would inflict on their pollutive industries production and international trade. Given this background, this study examined the impact of environmental regulations on pollutive industrial trade competitiveness for South Asian countries. Further, it investigated whether South Asian countries have become a pollutive haven of pollutive industrial exports to OECD countries during 1984-2004. In addition to that, it examined whether tariff walls created by the countries to offsets stringent environmental regulations negatively affect pollutive industrial trade flows.

In the light of an in-depth examination of existing theoretical literature covering both neo-classical trade theory and new trade theory and subsequently, empirical research conducted regarding trade competitiveness impacts on pollutive industries of environmental regulations, this study has identified a number of gaps in the literature. Firstly, most of the empirical literature on the subject has focused on developed countries while ignoring less developed regions like South Asia. Second, studies in the area concluded trade competitiveness effects of environmental policy following a single estimation model when results were sensitive to the choice of the method deployed; hence for vigorous findings, a cross-methodological analysis was imperative. Thirdly, existing literature on the subject chooses only the five most pollutive industries trade for analysis. Nonetheless, for better understanding regarding environmental regulations' impact on industrial trade competitiveness, the analysis on relatively less pollutive and least pollutive industrial traded groups and comparative analysis between them was of paramount importance. The comparative analysis between different pollutive industrial groups was more imperative when vital traded pollutive industries such as textile and leathers and other industries in South Asia fall in the category of less pollutive industries but are subject to stringent environmental regulations. The current study has contributed to the literature by filling these gaps.

The present study has deployed a cross-methodological approach to find environmental regulations impacts for pollutive industrial trade flows and competitiveness to address study objectives, research questions, and study hypotheses. One of the key study findings is that environmental regulations impact on pollutive industrial trade of South Asia region are sensitive to the choice of methods the study chooses.While statistical modeling approaches provide less systematic results regarding the impact of environmental regulations on pollutive industrial trade specializations patterns and competitiveness, the econometric based modeling results inter alia vividly showed the negative impact of environmental regulations on most pollutive industrial exports, total industrial exports, and less pollutive industrial exports in both South Asia and OECD countries during the period under study. There was further lack of support on finding evidence of pollution haven effects for pollutive industrial exports flows of South Asian countries with OECD countries. Also, this study has provided a better understanding of the dynamics of environmental policy impacts on trade competitiveness both for South Asia regions and their trade flows with environmental stringent OECD countries by broadening the research definition of pollutive industries from just most pollutive industries group to somewhat pollutive and less pollutive industries group and provides a comparative analysis between those industrial groups. This study has also looked into the debated issues of whether tariffs walls created by the countries to counterbalances environmental compliance costs in pollutive industries helped or hurt the trade competitiveness. The study concluded that industrial tariffs negatively affected total industrial trade flows, most pollutive industrial trade flows, and less pollutive industrial trade flows and, thus, competitiveness to South Asian and OECD countries during 1990 and 1998 periods.

This chapter, therefore, in forging paragraphs concludes this study by summarizing conceptual frameworks and research process-from theory to empirics-, methodological choices to data source and examination of this study research questions/ hypotheses, reporting key study findings, arriving on some policy implications as well as sharing this study’s main contributions to the knowledge and highlighting limitations of the study.

9.2 Summary and Conclusions

The starting point of this thesis was to explain how environment being a free public good can be brought into mainstream economic activities and then linking the environmental regulations and trade aspects in the realm of dynamics of the environment and international trade. In chapter two, the study explained in the terms environmental regulations, which is usually defined in the framework of command and control (CAC) and or market-based or incentive-based instruments aimed at correcting the externalities after assigning the appropriate price to the typical public good, environment. The latter is usually described as input to the production process, and control of environmental pollution necessitates environmental regulatory policy. After that, the study provided some reflections on different environmental regulatory instruments available to correct environmental externalities and their likely advantages/disadvantages, the outcomes of which was sensitive to the instrument chosen to correct the externality. The association between environmental quality, environmental regulations, and trade is multi-dimensional and complex. Therefore, the current study attempted to provide a cursory look at overall debated research endeavours/hypotheses surrounding trade and environmental policy dynamics. The dynamic links cover a variety of areas from economic growth to environmental regulations and trade and those of environmental quality aspect to FDI, geographical aspects, and trade competitiveness effects of environmental regulations. There are further competing theories which this study critically reviewed on the association between environmental regulations and trade, such as industrial delocalization/pollution displacements, pollution haven hypothesis, and porter hypothesis. The discussions in chapter two concluded that research areas and issues surrounding trade and environmental relationship are multidimensional that involved linkages of pollutive industrial trade flow with economic growth, FDI, product structure, ecological governance and stringency /community pressure /geographical factors, and a host of other factors that led to the emergence of competing theories/hypothesis pertaining to trade and environmental policy linkages. Therefore, there was no general equilibrium model that could capture all those theories under one umbrella. And present research is no exception either. Therefore, it just focused its research endeavours on environmental regulations and pollutive industrial trade associations following theoretical and empirical research surrounding the environmental policies impact on pollutive commodities/industrial trade. Accordingly, the current study provided an in-depth analysis of theoretical and empirical debate regarding the channels via which environmental policy and pollutive industries' trade competitiveness could effectively be understood and measured.

To accomplish those tasks, the study in chapter 3 adopted methodological research design following the dominant mainstream Neo-classical orthodoxy path, which holds that proper methodology should positivistic, quantitative, and empirical based on which it elucidated the research design covering the complete process from theory to empirical results and drawing conclusions. The first step, in which case, was to seek guidance from theory on broad research questions about the possible impacts of environmental policy on pollutive commodities trade competitiveness. Theoretical literature reviewed in chapter 3, especially under new-classical assumptions, advocated that environmental regulations could influence production costs, trade pattern, industry comparative advantage and location, and gains from trade and thus competitiveness of the economy and relaxing one or few assumptions of the model(s) could produce quite complex results. The literature reviewed in light of neo-classical comparative advantage theory for environmental regulations and trade competitiveness perspective produced various possibilities depending on theoretical model assumptions and policies levied but maintained generally held belief that environmental management efforts will leave negative effects on country's trade comparative advantage and industrial competitiveness. Therefore, given the limited economic productive resources, there was a trade-off between environmental regulations and trade competitiveness. Nonetheless, the final outcomes regarding environmental policy impact on trade flows found inter alias depend on combinations of factor intensities of productive goods, income and demand elasticities, preferences for export and non-exports goods, and country size/price diffusions effects.

The competing new trade theory followers that inter alia believed in economies of scale/product innovation/market imperfections, on the other hand, argued that there was no trade-off between compliance of environmental regulations and trade competitiveness due to cost-savings achieved via innovative environmental technology, which promotes a race to the top. The study further reviewed literature wherein neo-classical orthodoxy challenged race to the top hypothesis, especially in the wake of poor records of property rights and lax environmental regulations in developing and developing countries and argued that race to the top hypothesis could not exist, especially in developing countries economic. Theoretical debate conducted in chapter 3 also reflected on one of this study hypothesis: PHH- and concluded that differential of environmental standards between rich North and relatively poor South as well as due to poor records of property rights in South had created the possibilities for South to become a haven for world pollutive commodities exports to North. Therefore, a difference of environmental regulations between stringent high-income North and laxer lowered income South would allow dirties industries to relocate from North to South and pave the way for South to develop a comparative advantage in pollutive industrial trade. Accordingly, this study developed a synthesis in chapter 3 that while neo-classical theories seemed to be more relevant to the quest of current study research endeavours and for setting study research hypotheses but in the light of limitations among competing theories to produce conclusive outcomes, the impact of the environmental regulations on pollutive industrial trade could best be examined via empirical quest.

The thesis clarified the definitional aspects of environmental regulation and trade competitiveness and surveyed the relevant literature in chapter 4. Since the study focuses on pollutive industrial trade, for statistical/empirical research analysis, the concept of pollutive industrial trade competitiveness had been seen through the lenses of trade specialization pattern and, to be more specific industrial exports comparative advantage/specialization of pollutive industrial trade over time. In a cross-methodological analysis framework, the competitiveness in pollutive industrial trade for South Asian and overall sample countries, including OECD, would be judged based on environmental policy impact-positive and or negative- on different categories of pollutive industrial trade flows. To quantify environmental regulations, the researchers used pollution abatement control costs as a proportion of manufacturing total costs for which data were generally available for only selected advanced countries. Others, for comparative cross-country pollutive industrial trade analysis, developed environmental stringency indexes. There is a paucity of time series data on environmental control costs at the industrial level in developed countries and seriously lacking for developing countries. And for the countries where environmental control costs data are available, there are further complex issues involved in contradictory methodologies adopted on measurement of environmental control costs between countries. Therefore, contemporary empirical literature regarding environmental regulations' effects on pollutive industrial trade competitiveness followed two-pronged strategies regarding the pollution-intensive industry definition. The first approach identifies those industries which constitute relatively high pollution abatement costs in total costs or relative to their turnover as pollution intensive. The second approach is to pick those industries which rank high on actual emission intensity i.e., emission per unit of output or value-added or per person employed. Both methods identified the same most pollutive manufacturing industries. This study embraced the definition offered by UNIDO (2000) of pollutive industries that ranked those industries by their high and low emission intensity per unit of output and identified three categories of pollutive industries at disaggregated ISIC level viz. most pollutive industries, somewhat pollutive industries and less pollutive industries.

For the current research, the methodological choices for empirical analysis were made following critically reviewing previous research regarding pollutive industrial trade and environmental regulations associations. The present study has examined both direct and indirect methods in chapter 4 that were deployed to trade and environment regulations data to find a measurable impact of environmental regulation policies on pollutive industrial trade and competitiveness. Most of the research conducted in the 1970s and 1980s tended to choose an indirect method of estimation, and the focus of attention was on measuring environmental control costs for most pollutive industrial traded sectors. The research was predominantly focused on US pollutive industrial traded sectors. Several studies found an insignificant impact of environmental regulatory costs on pollutive industries trade patterns as environmental control costs on average remained around 2 percent in overall manufacturing costs. Nevertheless, other carefully assessed empirical findings showed that environmental control cost for pollution abatement in manufacturing sectors could leave considerable negative effects for industrial trade flows and the country’s balance of trade and payments. Among the direct empirical methods the mainstream empirical research in this area has been broadly dominated by three trade modeling approaches including industrial comparative advantage model developed by Balassa (1965), Heckscher-Ohlin-Vanek model (in Murrell, 1990, 237-239) that allow to regress net trade on factor abundance variables including environment and, gravity trade modelling approach pioneered by Tinbergen (1962) and Linnemann (1966), which is a bilateral trade flow model wherein industrial flows are determined by home and partner countries income, distance between countries and host of geographical dummy and policy variables. And presented research reviewed a good number of studies covering all three trade models (see chapter 4).

Studies that adopted comparative advantage Balassa based indexes have analysed the impact of environmental regulations on trade via changing trade patterns and comparative advantage of most pollutive industries over time. These studies conducted a comparative static analysis of pollutive industries trade between beginning and end study periods. The expectation was that the countries facing increasingly stringent environmental regulations in pollutive industries over time would lose comparative trade advantage in those industries in the end period. The underlying assumption in choosing this methodology was that environmental stringency on pollutive manufacturing production and trade sectors had risen over time in the country. Some studies found that environmentally stringent developed countries' trade shares and comparative export advantages in most pollutive industries were reducing over time. Whereas the developing countries with lax environmental standards were gaining their export share in most pollutive industries of world total and export comparative advantages in most pollutive manufacturing sectors over the years. Based on these results, the researchers concluded for pollutive industries displacement/delocalization hypotheses and developing countries to become pollution haven for industrial production and trade for environmental stringent developed countries. Nonetheless, rigorous analysis by employing extensions in comparative advantage models like normalized competitiveness index study found less evidence of change in pollutive industries trade specialization patterns over time in developed countries (see chapter 4).

The direct approach to examining the environmental regulation impact on trade competitiveness commenced in 1990 after the seminal work by Tobey (1990), who deployed the HOV factor flow model and found an insignificant impact of environmental regulations on pollutive industries in both OECD and non-OECD countries. His work was, among others, challenged on the methodological grounds as HOV was more of multilateral trade flows, which meant to say that differential effects of environmental policy on various trade flows might cancel out due to aggregation of bilateral trade flows to multilateral trade flows. Therefore, an alternate methodology of bilateral trade flows-based gravity modeling was considered to be a preferred choice to examine environmental regulations' impact on bilateral pollutive industrial trade flows (Van Beers and Van den Bergh, 1997).

Most of the empirical work conducted regarding environmental policy impacts on pollutive industrial competitiveness did focus on the developed part of the world and less attention was given to LDCs. The empirical outcomes based on both bilateral trade flows like gravity models and multilateral trade flows- H-O-V models- depicted that the impact of environmental regulations on trade competitiveness was positive as well negative, and these results were sensitive to the choice of methodology, estimation techniques deployed and pollutive industries and geographical coverage and period selected. Especially recent development in literature indicted that cross-sectional data analysis and simple OLS methods might not be able to control for the unobserved effects and issues surrounding endogeneity in data. Subsequently, panel data estimation techniques could produce more accurate results regarding the impact of environmental policy on pollutive industrial trade. Moreover, regarding tracing effects of PHH, some studies indicated the possibilities for developing countries to become a haven for world dirty production and trade. In contrast, others failed to find any systematic evidence for the pollution haven hypothesis. Also, this study observed while reviewing the literature on PHH in chapter 4 that number of studies concluded for developing countries to be in a state of PHH based on declining pollutive industries trade share in world total and changing specialization pattern in developed countries data only, which provide incomplete information on PHH. Also, this approach seemed to be a violation of the pollution haven hypothesis as PHH demands the analysis between developed and developing countries with differential stringencies in environmental regulations. Related to the competitiveness issues of environmental regulation on exporting countries, the literature reviewed in chapter 4 drew attention that import tariffs are either an artificial barrier to trade or new trade barriers that have emerged to offset stringent environmental regulations. The results showed that industrial tariff barriers created by the countries negatively affect different categories of pollutive exports and trade competitiveness.

Instead of using actual data on pollutive industrial trade, the study reviewed used proxies of tariff barriers that lose results' efficacy.

In a nutshell, the outcome of the critically reviewed literature by this study inter alia depicted that the impact of environmental regulations on trade competitiveness was positive for some countries and for selected most pollutive industries and negative for other countries and selected pollutive industries/commodities and period. The results of environmental policies on pollutive industrial trade competitiveness found to be sensitive to the type of empirical model chosen/estimation technique employed, country (s) / period selected, and the nature of pollutive commodities/ types of environmental regulations. There were also clear measurement problems in the earlier studies reviewed, especially in comparing the environmental laws in different countries and assigning numbers that quantify environmental regulations. Also, issues pertaining to the definition of pollutive sectors and data quality required due attention. Some studies lack a theoretical basis regarding the choice of model others failed to report or perform diagnostic tests/sensitivity and endogeneity analysis, thus leaving the issue regarding the effect of environmental regulations on trade competitiveness at the global level still unresolved.

The critical examination of literature reviewed in chapters 2-4 enabled this study to point out other notable issues/research gaps. Firstly, the large body of literature ignored the significance of drawing a comparative analysis between most pollutive and relatively less pollutive industries' export patterns over time. It was worth examining if somewhat similar or different conclusions could be drawn for most pollutive industrial trade to least pollutive industrial trade due to the introduction of stringent environmental regulations. Secondly, there was a dearth of literature regarding the impact of environmental regulations on trade wherein the same data set was placed to scrutinize cross-methodological analysis, especially when the results were sensitive to the choice of method deployed. Furthermore, the author of the present research did not find any comprehensive study for South Asian countries that analyzed the possible impact of environmental regulations on industrial trade competitiveness using the most pollutive to least pollutive industry trade at the highest available dis-aggregated data at 3-digit and 4-digit ISIC level nor their existed any study which examined pollutive industrial trade flows of South Asia with OECD and rest of world (REW) countries. Present research filled these gaps in the literature.

Given the gaps highlighted, this study examined the four key research questions. Firstly, whether South Asian countries, due to internal and external environmental regulations, lost trade competitiveness in most pollutive industrial trade, a somewhat pollutive industrial trade, and relatively less pollutive industrial trade during 1984-2004. Secondly, the study examined whether, due to the difference in environmental regulations compliance between stringent OECD countries and lax South Asia, South Asian countries had become a haven for most pollutive manufacturing exports to OECD countries. Thirdly, where the first two research questions are linked, whether the impact of environmental regulations on relatively less pollutive industries' trade competitiveness would be the same as literature predicts for the most pollutive industrial trade. Fourthly, the study examined whether tariff walls created by the countries against pollutive industries trade negatively affect the different groups of pollutive industrial trade competitiveness.

Accordingly, as guided by theoretical models and empirical literature, this study used a number of methods to assess the impact of environmental policies on pollutive industrial trade specialization patterns and competitiveness. Firstly, for statistical analysis, the study employed the comparative advantage model offered by Balassa (1965, 1979, 1986) and advancement in Balassa model to developing competitiveness index by (XU, 1999) and bringing geographically based measuring bilateral RCA and weighted pollutive industrial trade flows between North and South as offered by Grether and de Melo (2004). Secondly, this study estimated the extended gravity model to examine the impact of environmental regulations on bilateral industrial trade flows, especially total industrial export flows, most pollutive industrial export flows and relatively less pollutive industrial export flows between selected South Asian countries and seventeen most stringent high-income OECD countries and full 20 sample countries. To support the study’s research methods, this study used and transformed available Trade and Production Data (2001,2006) on 3-digit and 4-digit ISIC levels first for a closed sample of 56 countries which also included the three selected South Asian countries viz. India Pakistan and Bangladesh and 17 environmentally stringent OECD countries. The choice of three South Asian countries had also been made in the light of recent research conducted by the team of world bank on the state of environmental performance that showed that while environmental performance score for India and Pakistan was almost the same Bangladesh was a bit behind in its efforts towards effective pursuit of environmental performance compared to former countries (see chapter 5).

The data analysis in chapter 5, among others, showed that manufacturing exports share of most pollutive industrial group for the OECD in world total receded over time and those of developing economies such as ASEAN-4, Latin America, and South Asia regions it increased during 1984 2004. Moreover, the average annual growth rates depicted in table-5.1.1 at the regional level for both most pollutive and somewhat pollutive industrial sectors exports during

1984-2004 further shed some light on time series export patterns of various regions around globe. South Asia region showed the highest growth rate of 8.7 percent during period 1984-2004 for most pollutive industrial group amongst all world regional group followed by ASEAN4 with a growth rate of 3.8 percent, East Asia .48 percent and highest concentrated export industrial group OECD with a negative growth rate of 0-.78 percent during the period 1984-2004, giving some indication of changing pattern of export flows of most pollutive industrial group. For the other two categories of pollutive industries groups growth rate of OECD and East Asia economies showed a negative trend and those of North American, ASEAN-4, Latin America, South Asia regions were indicating a positive trend during the period 1984-2004.

To trace evidence on the comparative advantages positions of different categories of pollutive industries and their trade specialization patterns, the study employed the comparative advantage model offered by Balassa (1965) and advancement in Balassa model to developing competitiveness index by XU (1999) in chapter 6. The likely expectation was that due to the introduction of relatively stringent environmental regulation in the 1990s onwards compared to 1980s environmental pollutive industries with higher export performance in the beginning of the sample period would become less competitive in the end sample period. The Balassa XRCA measured the competitiveness of each pollutive industry of selected South Asian countries- India, Pakistan and Bangladesh- in three different periods- 1984-88 and 1994-98 and 2000-04 by separating the specialized and non-specialized pollutive industries. A specialized industry is the one where XRCA for the industry is greater than one, and vice versa is true for non-specialized industry. Second, in order to examine how trade share of those commodities revealed both XRCA and XRCDA during the period under study, another competitiveness indicator following XU (1999) was calculated. The study, accordingly, separated the percentage trade share of those environmental sensitive goods that indicated a specialization (i.e., XRCA greater than one) from those trade shares that indicated non-specialization pattern (XRCA less than one) out of a total of three categories of pollutive industrial traded good for each period and three selected South Asian countries. The competitiveness indicator could help reveal that If industries trade share for a specific pollutive industries category such as the most pollutive industries group showed a decline in trade share from total in end period compared to beginning period, then one could argue that industries trade competitiveness position for that specific industries group had deteriorated over time. The competitiveness indicator provided valued information on the movements of pollutive industries trade share both within and between pollutive industries groups over time.

The study findings based on the Balassa RCA model deployed to pollutive industries trade groups of South Asian countries inter alia produced a number of outcomes. Firstly, for the most pollutive industrial group, India gained its competitiveness position in export for the number of pollutive industries and her comparative disadvantage in most industries of the same pollutive industries category reduced in late 1990s and during 2000-04 as compared to early 1980s. Therefore, Indian industries witness structure transformation mechanisms within most pollutive industries exports during the period 1984-2004. Pakistan did not gain a comparative advantage in most pollutive industries exports and that her XRCDA increased in the same industrial category during 1994-98 and 2000-04 compared to the early 1980s. In most pollutive industrial exports categories, Bangladesh also failed to enjoy XRCA in 2000-2004 compared to 1984-88 and faced with XRCDA over time in most pollutive industrial group.

For somewhat pollutive industries, both India and Bangladesh improved their trade competitiveness in 1994-98 as compared to the beginning period whereas, Pakistan seemed to have maintained its competitiveness position- if not increased- to some extent for the same category during the end period compared to the beginning period. In the somewhat pollutive industries group, the study found that all three South Asian countries maintained their comparative advantage position in wearing apparel and footwear industries. Among the less pollutive industries group other industries were the ones where both India and Pakistan depicted XRCA in the world market during 2000-2004. Therefore, the present study observed some if not drastic structural changes in pollutive industries trade patterns of South Asian countries due to among others introduction of stringent environmental regulations in the 1990s onwards compared to 1980s. Moreover, among South Asian countries, the more common result that emerged was that all three countries, to some extend, enjoyed revealed comparative advantage in- non-footloose industries- resource-based and low technology or labour-intensive manufacturing industries such as textile and leather wherein South Asian economies depicted a consistence exports comparative advantage performance during 1984-2004 (see chapter 6).

The study findings based on XU (1999) competitiveness indicator for India in most pollutive industries category showed that industries trade share in the specialized group (XRCA>1) remained the same till 1994-98 but rose in end period 2000-04. The significant change witnessed during the end period in most pollutive industries category was the rise in the number of pollutive industries that moved from non-specialized groups to specialized groups. However, the normalized percentage trade share of non-specialized industries -within most pollutive industries group- which did not change significantly until 1994-98 dropped drastically by 2000-2004. These findings indicated that in the end period, the trade share of non-specialization industries being shifted either to specialized industries group within the same pollutive category and or to other two pollutive industries groups. Following the XU (1999) model for most pollutive industry groups, these findings led this study to conclude that exports comparative advantage position and industrial trade specialization trends in most pollutive industries group of India improved over the years.

India in somewhat pollutive industries category, also maintained her normalized trade share in specialized group for almost 30 years of this study and thus seemed to have less been affected due to the rise in the stringency of environmental regulation in that country over the years. The notable industry that captured the highest trade specialization share for India within somewhat pollutive industry group was that of textile industry, which maintained its trade specialization trend during the study period. There was further evidence in the movement of some industries from non-specialization group to specialized group such as food products fabricated metals over the years; hence those pollutive industries increased their trade competitiveness position in world market. Turning to a non-specialized group of industries for the same pollutive industry category, trade share slightly dropped to 1994-98 compared to the beginning period 1984-88 but rose drastically in 2000-2004, the significant contributors to this share were industries such as machinery electric, and transport equipment industry. India broadly speaking maintained its specialization patterns over time in somewhat pollutive industries group.

Among three pollutive industrial categories for Indian trade the less pollutive industries category accounted for the largest percentage share in total trade flows in sample periods. However, the trade share in the specialized group was concentrated on a selected few industries and not seen widely dispersed within these relatively cleaner industries. The normalized weighted trade share of less pollutive industries in a position of specialization in the beginning period maintained that share in the end period 2000-04. The most significant contributing industries in this pollutive category were wearing apparel except footwear and jewelry and related articles. A further comparison of industries movement between specialized and non-specialized during periods 1984 till 2004 showed that industries which were in a specialized group in 1984-88 remained specialized in 2000-2004, but industries such as rubber industry which was in a non-specialized group in 1984-88 moved to a specialized group in 2000-2004. The competitiveness position of India, for the least pollutive category, strengthened over time in light of the rising weighted trade share in total trade flows and an increase in the number of industries moving to the trade specialization category within the same pollutive group (chapter 6).

The comparative analysis between less pollutive industrial category with most pollutive industrial category of trade flows of India depicted that country improved her competitiveness gains in both pollutive industries groups which contrary to what theory predicted, i.e., the stringency of environmental regulations should increase trade share of less pollutive industries and decrease those of most pollutive industries group. Therefore, the study finding suggested that in addition to compliance with environmental standards, other conventional sources of comparative advantage such as skills and productivity could be a vital determinant of industrial production and trade competitiveness. In terms of environmental regulation's impact on time series pollutive industrial trade patterns, the findings for Indian pollutive trade industries have concluded that environmental regulations have not had any tangible impact on most pollutive to least pollutive industries trade specialization patterns overtime. And in the light of gains witnessed in most pollutive industries both in terms of comparative advantage and trade specialization pattern over 30 years period, the phenomena of pollution haven effect seemed more relevant for Indian pollutive manufacturing trade.

The trade specialization patterns for the same three pollutive industries groups for Pakistan's economy covering the period 1984 till 2004 produced different results from India, especially in most pollutive industries, as reported in chapter 6. For most pollutive industries group the results show that Pakistan's trade share in the specialized group was just around 1 percent in total trade flows in 1984-88 that was in chemical industries and for remaining most pollutive industries the country was in a non-specialized group in 1984-88 and remained non-specialized till 2000-2004. For the same most pollutive industrial category the trade share of the non-specialized group increased in 1994-98 compared to1984-88 and remained almost same in 2000-2004. Pakistan, therefore, in most pollutive industries group remained non-specialized in end periods compared to beginning one. However, it is the somewhat pollutive industries category that depicts the highest weighted trade share in total trade flows for Pakistan manufacturing sectors where country broadly maintained its trade specialization position over the years. The most significant contributing industry in trade specialization share was that of textile industry whose share in the specialized group remained conspicuously high in somewhat pollutive trade category during full sample period 1984-2004. The commodity that moved from non-specialized group to specialized group was Ind code-3219 (textiles nes.), and also the country's food industry (ind code 311) that was in the specialized group in 1984-88 moved to the non-specialized group in 1994-98 and remained in the non-specialized group in 2000-2004. For the same industrial category, the weighted trade shares of non-specialized group reduced over time which could be explained through the third category of pollutive industries viz. less pollutive industries whose weighted trade share for the specialized industries group rose in

1994-98 and remained almost the same till end period. In Pakistan's less pollutive industry group, which was relatively the most cleaning industry category, the normalized weighted trade shares of non-specialized groups reduced over time. A further look at the movement of industries from specialized group to non-specialized group the results in cleaner sector showed that other industries (Ind. code 390) which were in a specialized group in 1984-88 moved to the non-specialized group in 2000-2004. These results based on XU(1999) model for Pakistan concluded that firstly, Pakistan lost its industrial trade specialization in most pollutive industries group; secondly, it was the somewhat pollutive industries category that captured the large chunk of weighted trade shares from total trade flows and broadly maintained its industrial trade share over time and thirdly, less pollutive industries group had to some extend maintained its trade specialization trend over the period 1984-2004. Last but not least, key manufacturing sectors of Pakistan that made a vital contribution to international trade with the relatively largest trade specialization shares were textile, leather, and wearing apparel.

The competitiveness indicator for Bangladesh pollutive industries groups depicted that the country was less concentrating in terms of weighted trade share for the most pollutive industries category to be in the specialized group. All industries in the most pollutive group category were in non-specialized trade regions in end periods. Hence, like Pakistan, Bangladesh witnessed a loss in trade specialization and competitiveness over the years in most pollutive industrial trade. The trade share of a somewhat pollutive industry specialized group rose in 1994-98 compared to the beginning period 1984-88 but dropped in 2000-04. Also, most of the industries that were in a specialized group in 1984-88 remained in the specialized group in 1994-98 except industry viz. preparing and preserving meat which was in the specialized group became non-specialized in 1994-98 and ind. code 3213(knitting mills) that was in non-specialized trade share group in 1984-88 moved to specialized group 1994-98. The share of non-specialized industries for the same category of industries also reduced in 1994-98 from the initial period but depicted an increasing trend in 2000-04. In 1994-98, the reduction of trade share in somewhat pollutive industry partly shifted to the specialized industries group within less pollutive industries. The specialized group within less pollutive industry depicted a consistent rise during sample period 1984-2004. There was further evidence on the movement of industries within the same category from non-specialized to specialized group which included industries such as ind. code 324 (footwear) and 361(pottery) which were in non-specialized group in 1984-88 moved to specialized trade group in 2000-04. Bangladesh, therefore, strengthen her trade specialization position in relative cleaner products over the years (see chapter 6).

The study in the light of using XU (1999) trade competitiveness indicator can conclude for Bangladesh that the country lost industrial trade specialization in most pollutive industries over the years, increased its industrialization specialization trade in somewhat pollutive industries in 1990s but dropped in 2000-04 and improved the country trade specialization pattern for less pollutive industries during end sample periods compared to beginning period. One plausible reason for gaining competitiveness in less pollutive industries could be what theory predicted that stringent environmental regulations imposed to the most pollutive sectors, keeping other things constant could shift the locus of production and trade specialization towards relatively cleaner sectors (Krutilla, 1999).

The results for inter-country comparison based on Balassa (1965) and XU (1999) methodologies deployed to three pollutive industrial trade categories have produced various outcomes. Firstly, the study found that both Pakistan and Bangladesh lost trade competitiveness in most pollutive industries trade during the end sample period compared to the beginning sample period. In contrast, India gained its competitiveness position in the end period. For somewhat pollutive industries, both India and Bangladesh improved their trade competitiveness in 1994-98 as compared to the beginning period whereas, Pakistan seemed to have maintained its competitiveness position- if not lost- to some extent for the same category during 1994-98 compared to 1984-88. However, Bangladesh reduced its trade share in the same category in 2000-04, and so did Pakistan, while India maintained its specialized industrial trade share when compared 1984 with 2000-04 periods. For the less pollutive industry group, all three South Asian countries seemed to have strengthened their trade specialization pattern during the period under review. Therefore, the likely impacts of environmental policies introduced in South Asia regions are mix and sensitive to the choice of industries, and results vary for different pollutive industrial groups from most pollutive industries to least pollutive industries. The findings for most pollutive industries signaling the presence of pollution haven effect on India. There are shifts of locus of production and trade specialization pattern to least pollutive industries for other countries. At the same time, results for each South Asian countries provide evidence for shifting of normalized trade shares within and between pollutive industries and pollutive industries movements from specialized group to non-specialized group and vice versa. Overall, there seemed to be less systematic trends emerging over time regarding the impact of environmental regulations on pollutive industries trade specialization patterns for South Asian countries.

In terms of commodity specialization technological aspect, for all three countries of South Asia region, the export structure broadly speaking is dominated by low technology and low sophistication products and the region's economies have not tapped the mainsprings of export dynamism in a globalizing era. Pakistan and Bangladesh in manufacturing exports have largely concentrated on selected few low-technology-based products such as textiles and clothing. In India, which is relatively experiencing diversified exports, the jewelry industry is added in the list of commodities concentrations in their endeavor towards export specialization. Such concentration is inherently risky, and the nature of products makes it even less desirable as these are not dynamic products and are listed among the slowest growing industries activities in the world (Weiss and Lall, 2004).

One of this study objectives was to examine whether differences in environmental regulations between stringent North-OECD- and laxer South-South Asia- have caused South Asian countries to become haven for pollutive industrial trade flows to the North. Theoretical literature reviewed in chapter 3 indicated that a gap in environmental regulations between rich North and poor South could lead to the pollutive industrial relocation towards developing countries, assuming other things constant and developing countries can develop a comparative advantage in most pollutive industries and become a repository for pollutive industrial production and trade. Accordingly, the second vital hypothesis of this study in statistical modeling was that the difference in environmental regulations between South Asia and OECD countries would increase different categories of pollutive industrial bilateral exports from South Asia to the OECD countries-pollution haven hypothesis (PHH).

This study reviewed some of the earlier literature on PHH and the number of studies that drew conclusions for developing countries to become PHH by finding the reduced pollutive industries exports share of developed countries over time, which seemed to violate PHH. The competitiveness indicator computed in chapter 6 for all three pollutive industries groups and for each South Asian country has provided an in-depth understanding of pollutive industrial competitiveness and trade specialization pattern over time and reflected on pollution haven effect. Nevertheless, as this study argued in chapter 7, the examination of PHH demanded further control on geography so that the bilateral trade flows of pollutive industrial over time could be analysed between environmentally stringent OECD and environmental laxer South Asia. Such sort of analysis requires adopting a methodology that enables to measure the bilateral RCAs in the North-South framework. Grether and de Melo (2004) offered that methodology and study deployed it to trace evidence of PHH in the South Asia region. The literature also argued that detection of PHH could depend on the level of industrial data aggregation. Hence this study analysed pollutive industries bilateral trade data at the highest dis-aggregation i.e., 4-digit and 3-digit ISIC levels. Furthermore, no efforts were made in the literature before to examine if the South Asia region had become a pollution haven for different groups of industrial exports to OECD. The study further examined whether a comparative analysis between most pollutive with relatively cleaner industrial trade groups provided further insights into the pollution haven effects for the South Asia region.

Following Grether and de Melo (2004) methodology, the study first computed composition effect: it is the part of the aggregate RCA change that is attributable to the changes in countries exports share i.e., the share of one country in a specific industry of the country say Pakistan is falling and that of say India is increasing. Then it focused on computing structural effect that provides information on structure shift in industrial exports measured through bilateral RCAs by keeping composition effect constant around its average. The estimation of composition and techniques effects during the period 1984-2004 reflected whether the change in comparative advantage over time attributed more to productivity/technologies improvement via technique effect or due to change in industrial composition. Then based on 56 closed sample export data, it computed South Asian bilateral weighted exports RCAs for all three pollutive categories with 17 environmentally stringent high-income OECD countries and with rest of world (REW) during 1984-2004. These new geographically controlled bilateral exports analysis provided a better understanding on whether South Asian countries had become pollution haven of dirty exports to most environmentally stringent OECD countries. Also, for comparative analysis, the study examined whether somewhat different results could be drawn from the analysis of South Asia bilateral pollutive industries export with REW, later group of countries was not necessarily environmentally stringent. For most pollutive industrial group, the findings revealed that structural effects within the same groups were stronger than the compositional effect and that compositional effects of pollutive industrial trade were reinforcing to technique effects making total effects move in a positive direction. The results further revealed that structural transformation mechanism worked for pollutive industrial trade competitiveness as impacts were more visible among the most pollutive industries group where except few exceptions total effects found to be positive for all most pollutive industrial exports. The results for the somewhat pollutive industries group further confirmed this conclusion wherein majority industries showed total positive effects. For less pollutive industries, the study finds a mix of results in terms of positive and negative changes in industrial compositional and structural changes.

Further analysis on measuring bilateral RCA exports of South Asia region with OECD region in both most pollutive and somewhat pollutive industries groups depicted positive bilateral RCA shares and their growth rates in majority industries. These results were consistent, especially in most pollutive industries that showed positive bilateral RCA with the OECD over time in almost all industries. That is one of the vital contributions of this study towards the pollution haven effect. This conveys that by confining the research analysis to just most pollutive industry trade could give incomplete information on trade flows when environmental regulations are equally or perhaps more important for industries other than most pollutive industries in the South Asian region. Because the large volume of pollutive industrial trade flows both with OECD and REW falls in the category of somewhat pollutive industry group. The findings based on the bilateral RCA model confirmed that South Asia had become a haven for pollutive exports to environmental stringent OECD. Nonetheless, South Asia regions bilateral exports share and RCA growth rates in same pollutive industries groups also rose overtime with REW group, relatively laxer environmentally stringent countries. The pollution haven effects found to be stronger in most pollutive industries groups, but the study found a vivid evidence of PHH in somewhat pollutive industries. Also, for the last category of pollutive industries that are less pollutive or relatively cleaner industrial group, the study inter alia found that bilateral RCA of South Asia with the OECD was stronger and more positive than the REW countries group, confirming more of pollution halo hypothesis instead of pollution haven effect.

A comparative analysis of bilateral exports RCA in pollutive industries groups between the South Asia region and the OECD and REW regions depicted somewhat puzzling results. Theoretically, the difference in environmental stringency between OECD and South Asian countries should be seen in the rise of South Asia bilateral RCA with the OECD in most pollutive industries and not in less pollutive industries groups. Few plausible reasons could be attributed to these results. Firstly, this study findings based on competitiveness indicator in chapter 6 concluded that while India improved her trade specialization pattern and competitiveness in most pollutive industries and less pollutive industries, the other two South Asian countries broadly maintained their trade specialization and comparative advantage in somewhat pollutive and less pollutive industries. Second, this study findings on compositional and structural effects for pollutive industrial exports as concluded in chapter 7 suggested that -if not for all- for most of industries both effects-structural and composition- reinforced each other across all pollutive industrial groups for total effects to be positive. Thirdly, which is also appealing in the light of comparative advantage theory that in addition to the difference of environmental regulations between North and South, other traditional sources of comparative advantages such as labor cost differential between South Asia and OECD and industrial and trade policies facilitating could be contributing factors in determining in South Asian pollutive industrial trade competitiveness. Given that the study witnessed somewhat puzzling results in cross-methodological analyses conducted in chapter 6 and chapter 7, a further investigation to test this study's hypotheses of the likely impact of environmental regulations on pollutive industrial trade competitiveness was imperative. One direct method to find the environmental regulations impact on pollutive industrial bilateral trade flows by controlling all other factors explaining trade flows was to deploy the gravity model which could provide an empirical estimate on specific environmental policy impact on bilateral trade flows in South-North industrial trade framework.

The research analysis via chapter 8 accordingly signified the importance of gravity modeling both at theoretical and empirical levels to test the research hypothesis, which mainly focused on determining the impact of environmental regulations on different categories of pollutive trade flows. It also reviewed the literature on development over time both in gravity model specifications and estimation techniques deployed to the gravity model. In a nutshell, while the superiority of panel data methodology over cross-sections was highlighted but for robust results, this study conducted both cross-sectional and panel data analysis, ensuring that all diagnostic tests were carried out in final model specifications/estimations. Moreover, the significant of key variables used in the gravity model especially justifying the choice of environmental regulations variables and controlled variables, data sources, and data transformation process, also elucidated during research endeavours. At the gravity model estimation stage, while Hausman-Taylor estimations-based on REM technique took care of simultaneity bias and heteroscedasticity and would correct any suspect violation of orthogonality between some of the covariates and the unobservable components the study aimed at correcting the presence of autocorrelation and heteroscedasticity in panel data made use of Newey-West standard error (HAC) model.

Due to dearth of data on environmental regulations for pollutive industries, the literature in the past aimed at analyzing the environmental regulations on trade competitiveness has suffered from a lack of adequate and comprehensive comparative data on environmental stringency across countries. While some efforts have been made in the advanced part of the world to measure the abatement costs of environmental regulations, one of the major problems the countries confronted with is measuring the exact abatement cost that regulation imposes on manufacturers, which is not straightforward. This is because many costs associated with pollution abatement also generate a certain amount of cost-saving, normally termed as cost offsets. Moreover, enforcement of existing regulations could vary across countries that might reflect a misleading picture of the stringency of environmental regulations in practice.

Given the data deficiencies issues, the present research focused on two sets of data sources available to estimate panel data periods: 1990,1998, 2004. For the year 1990, the set of environmental stringency variables, which is termed as Environmental Regulatory Index (ERI), was chosen from Dasgupta et al. (1995), the team from World Bank developed a 'scoring index' of the stringency for environmental regulations for 31 countries for four-dimensional environmental policy analysis viz. air, water, land and living resources and the resulting environmental regulatory index is a composite index of these four environmental dimension indices. The higher the index number, the higher the stringency of environmental policy in country for respective indices and index further revealed that countries with higher per capita income also pursued stringent environmental regulatory policies. The environmental performance index is positively correlated with a host of variables, including per capita income; freedom of information; security of property rights, and the most relevant to the current research: the positive association of environmental performance index and development of the legal and regulatory system. The income elasticity of environmental policy was found to be positive and highly statistically significant in all environmental dimensions. This environmental policy index served well to accomplish these study objectives and has also been used by other researchers for similar research inquiry (XU, 2000). Eliste and Fredriksson (2001), using the same methodology adopted by Dasgupta et al (1995) extended the stringency index for the sample from 31 countries to 60 countries, which covered all countries selected for current research- 17 OECD and three South Asian (see chapter 8).

For the sample periods of 1998 and 2004, the study chooses a newly comprehensive database that has been made available by the (CIESIN), which is a non-governmental organization and the outcome of collaboration among the World Economic Forum's Global Leaders for Tomorrow Environment Task Force, the Yale Centre for Environmental Law and Policy and the Earth Institute at Columbia University (CIESIN, 2006; Busse, 2004: 288). The most vital indicator the institutions have developed is called The Environmental Sustainability Index, henceforth ESI, which measures overall environmental sustainability for 142 countries. The ESI goes well with environmental regulations and environmental stringency expectations. The analysis conducted based on ESI scoring index clearly shows its positive association with country's per capital income i.e., higher the per capital income of the country is higher the ESI/stringency of the regulatory regime would be (see chapter 8).

This study, accordingly, estimated the data on bilateral trade flows for total exports flowers, most pollutive exports flows and relatively less pollutive trade flow for cross-sectional and for panel data analysis covering 17 OECD countries and 3 South Asian countries, -totaled 20. The study conducted descriptive data analysis and some diagnostic tests such as multicollinearity that guided in the formation of final gravity modeling specifications. The panel data covers three periods viz, 1990, 1998, 2004, and the study used trade data at 3-digit ISIC level for panel data estimation. The reason for choosing these panel periods was primarily the availability of corresponding period environmental performance/regulatory data across the countries. The study hypothesized the negative effects of environmental regulations on total trade flows, most pollutive trade flows and less pollutive trade flows. The findings confirmed the hypothesis for full sample countries, including South Asia and OECD countries and South Asian countries. The results found a negative impact of environmental regulations on pollutive industrial trade flows for most pollutive, less pollutive, and total trade flows in cross-econometric methodologies. The elasticities generally turned out to be higher in HAC methods with lags compared to the one ascertained using REM and pooled data analysis methods. The study further expected that environmental regulations might leave different effects for different pollutive categories of manufacturing exports as it was generally the most pollutive manufacturing group as compared to less pollutive industry group production and trade that come under the stringent compliance of environmental regulations both at national and international levels.

As reported in chapter 8, the gravity model results based on HAC-as compared to REM-technique found strong negative effects of environmental regulations on export flows for all categories of pollutive industries both in exporting and importing countries of South Asia and OECD. The statistically negative association between the stringency of environmental regulations and pollutive industrial export flows means that there can be a possible trade-off between efforts towards trade expansions and improving environmental quality at the economic policy level. This study also contributed to research by finding that environmental regulations negatively affect the world's most pollutive industrial exports and relative less pollutive and total industrial exports in both the OECD and South Asian countries. Nonetheless, the higher value of negative trade elasticities with respect to environmental regulations levied on the home country for most pollutive industries group compared to other pollutive industrial groups seemed to suggest that the impact of the policy on most pollutive industrial trade competitiveness was more pronounced. Furthermore, the environmental regulations introduced in importing countries negatively affect the home countries' pollutive industrial export flows. The policy's impact was more substantial on relatively less pollutive industries trade groups than other groups. These findings, therefore, indicated that importing countries' environmental regulatory policies were more biased against exporting countries less pollutive industries exports group. These findings remained consistent for full sample countries data analysis, and when the analysis was conducted for South Asian countries, exports flow with the OECD. The study, therefore, confirmed the neo-classical orthodoxy of negative environmental policy impact on pollutive industries trade flows and rejected the new trade theorists' assertion of the porter hypothesis. These findings also echoed the conclusions from related studies on the impact of environmental regulations on trade competitiveness reviewed in chapter 4, which found the statistically significant negative impact of environmental policies on most pollutive industrial trade.

This study also examined whether South Asian countries with relatively lax environmental regulatory regimes compared to environmentally stringent OECD countries have become haven for pollutive industrial export flows to OECD countries. One of the main hypotheses in course of this study research endeavours was to examine the pollution haven hypothesis (PHH). PHH claimed that differences in the stringency of environmental regulation between developed North (in this case OECD countries) and developing South (in this case South Asian countries) could provide South Asian countries to develop a comparative advantage in pollution-intensive industries export flows to environmentally stringent countries. The analysis on PHH requires pollutive industrial trade data examination between developed and developing countries. This study, therefore, for South Asia analysis re-constructed the data for bilateral exports of selected three South Asian countries viz, India, Pakistan and Bangladesh with 17 OECD countries covering the same times period- 1990, 1998, 2004 panels- and three pollutive industrial categories- total bilateral exports, most pollutive industries exports and relatively less pollutive industrial exports. The extended gravity modeling approach adopted, and study deployed both REM and Newey-West with lags (HAC) techniques to gravity model estimation (see chapter 8).

In chapter 8, the study results based on panel data analysis suggested that finding evidence of pollution haven effect in South Asia for different categories of pollutive manufacturing trade was bleak. There was a lack of empirical support to PHH in South Asia regions, especially for most pollutive industries. The study attributed several reasons for the dearth of support to PHH in especially most pollutive industries trade group that inter alia included pollutive industrial trade had higher barrier-to-trade in terms of distance costs, pollutive industries being geographically less mobile due to high plant fixed costs, and or agglomeration economies and that pollutive industries were least footloose thus making pollution haven effects challenging to detect. Based on negative and statistically significant importing country environmental regulations impact on exporting countries pollutive industries bilateral exports, the results suggest that partner country is less likely to increase its demand for pollutive imports from exporting countries after the introduction of stringent environmental regulations on its own country. Therefore, there seemed to be less empirical support to pollutive industrial trade displacement/delocalization effects due to the introduction of stringent environmental regulations introduced in importing countries in South Asia and the OECD countries' trade nexus.

To examine the environmental policy impact on dis-aggregated 4-digit ISIC level pollutive trade data, the study further performed gravity modeling analysis to cross-sectional industrial trade data for the 1990 and 1998 periods. The impacts of environmental policy on pollutive industries' trade competitiveness in 1990 and 1998 for full sample countries were generally in line with the study found in panel data analysis. To examine the environmental policy impact on South Asian countries bilateral pollutive industries trade flows within full sample countries the study incorporated the interaction variables in the gravity model. The study found that the impact of environmental regulations on South Asian countries bilateral exports competitiveness for all pollutive industrial groups were negative during both periods, except most pollutive industry group in 1990 where the impact of the policy on industrial export flows was positive. The study provided various reasons for that outcome, including the confirmation of the porter hypothesis, higher subsidies for pollutive industries to counterbalance the environmental regulations in South Asia, and what seemed more plausible was the weakness in OLS-based cross-sectional methodology to capture country fixed/un-observed effects. Regarding the tests on PHH for South Asia using 1990 and 1998 data, the study findings were consistent with results found in panel data analysis and this study again rejected the presence of pollution haven effects in South Asia at cross-sectional level data for across pollutive industrial groups in 1990 and 1998, except for most pollutive industry group in 1990. Also, one of the research objectives was to analyze whether environmental stringency variables have had a different impact for relatively less pollutive trade as compared to most pollutive industries. The comparative analysis between three group of pollutive industries trade flows did not depict many different outcomes regarding environmental stringency measures' impact on trade flows. For robust analysis, the study cross-examined the research hypothesis by using bilateral data on pollutive industrial imports in the gravity model, which re-confirmed the findings ascertained via estimating the export data.

The third hypothesis of this study set in chapter 1 and chapter 8 for empirical analysis was that the countries' tariff walls negatively affect pollutive industrial trade. Because of the debated issue in literature, countries had created tariff walls to counteract the loss of trade competitiveness they faced due to increased environmental regulatory compliance costs. In light of estimated results for periods 1990 and 1998 using cross-sectional data in gravity model, the study found statistically significant and negative effects of tariff barriers on all categories of pollutive industrial trade flows and exports competitiveness in South Asia for both periods. These findings remained consistent for full sample data analysis, including OECD and South Asian countries across all pollutive industries groups during both periods-1990 and 1998. The study also found that key variables, including exporters and importers incomes, distance variables, and a host of dummy variables including regional dummies played a significant role in determining the pollutive industrial trade flows for both OECD and South Asian countries.

By controlling for other variables' impact on pollutive industrial trade flows, the findings in the gravity modeling framework solved the puzzle this study observed in statistical modeling analysis both regarding competitiveness impact of the policy and PHH. Firstly, the gravity modeling-based results concluded that the impact of environmental regulations across all pollutive industries groups was negative for both South Asia and full sample countries. Secondly on PHH, the results clearly showed that differential in environmental regulations between OECD and South Asian countries was less likely to be the main reason obtaining a comparative advantage in pollutive industrial exports by South Asia in increasing bilateral export RCA with OECD. The study also found a negative impact of domestic environmental regulations on export competitiveness for South Asian countries for different categories of pollutive exports, including most pollutive exports. Although there was no direct comparison that one could draw between statistical model outcomes with econometric findings, but there seemed to be some support to this finding that study can relate to competitiveness index results on industrial trade patterns in chapter 6 that inter alias revealed that except India for most pollutive industrial trade Pakistan and Bangladesh lost trade competitiveness over time. The gravity model results using panel data re-confirmed the negative impact of domestic environmental regulations on most pollutive export competitiveness for South Asia. These findings further confirmed one of the study’s research argument that detecting the environmental regulatory impact on pollutive industrial trade pattern are sensitive to the choice of methodology used hence the impact of the policy produce robust results when data are examined in cross-methodological framework.

Overall, the study can conclude that the impact of environmental regulations on trade flows for South Asian countries is sensitive to the chosen methodology. The statistical modeling analysis does provide varied impact on pollutive industries groups competitiveness of environmental regulations in South Asian countries. The bilateral RCA model vividly provides evidence on South Asian countries to become a pollution haven for OECD countries in most pollutive and less pollutive industries, but this study cautioned on robustness on the conclusion in the wake of finding a pollution halo effect for South Asia among the least pollutive industries with OECD countries. Accordingly, based on statistical modeling results, the study concludes that there seemed to be less systemic results/conclusions drawn for the impact of environmental regulations on different categories of pollutive manufacturing trade in South Asian countries and their bilateral trade flows with the OECD countries. On the other hand, econometric methodology-based results can lead the study to conclude that environmental regulations leave a significant and negative impact on exports flows and competitiveness across all pollutive industries groups both for South Asian countries and overall sample countries. In addition, there are less possibilities of finding a pollution haven effect in South Asian countries for pollutive industries exports to OECD on account of difference in the stringency of environmental regulations between these two regions. The study found weak support to PHH in 1990 data only. The study can further conclude that tariff walls created by countries to offsets the impact of environmental regulations can reduce pollutive industrial export flows across all pollutive groups and negatively affects the competitiveness of both South Asian and OECD countries. Lastly, the consistency of findings across empirical methods and pollutive industries groups this study undoubtedly suggests that environmental regulations play a vital role in shaping pollutive industrial trade patterns and competitiveness.

9.3 Policy Implications

The study findings show that a careful comparative analysis between most pollutive and relatively less pollutive industries is essential for environmental policy impacts on export and trade competitiveness as the impact of the policies is sensitive to the choice of different pollutive industrial categories and within each pollutive industry group. Therefore, environmental policy designed to achieve social benefits with industrial objectives should carefully be weighted to incorporate more dis-aggregated level sectors impact by bringing in the diversity of measurements needed for each pollutive industrial sectors rather than framing the policy on the belief that 'one size fits all'. Related to that, the findings also show that environmental regulations impact on pollutive industrial exports are sensitive to the methodology adopted, and therefore, any policy-making endeavours to achieve both industrial competitiveness and environmental management should be based on rigorous cross-methodological research analysis.

The study concluded that while controlled variables such as income and others are of paramount importance in explaining bilateral export flows and competitiveness for environmentally sensitive industries, the strong significant negative impact of environmental regulations on trade flows cannot be ignored. Therefore, the country's economic and trade policies, especially for South Asia regions, should have the right weight to address the negative impact environmental regulation would cause to accomplish overall economic growth and environmental quality objectives.

Based on research findings with some positive and negative impacts on different categories of pollutive industries of environmental policies, the policymaking efforts towards the alliance between environmental and competitiveness objectives should carefully be weighed on all different positive and negative channels connecting environmental policy to competitiveness.

The study findings both for full sample countries and South Asian countries concluded the negative impact of environmental regulations on export flows. There is thus a trade-off between environmental and industrial competitiveness objectives. Trade-offs are the most challenging situations for policymaking. Therefore, this research conveys that sustainable production and trade policies combining with innovative and cost-effective environmental policies are needed to be designed to achieve both economic gains in terms of industrial competitiveness and environmental benefits for society. Also, development in environmental policy in trade-off situations like the current study findings demands that environmental benefits obtained are carefully weighed against the adverse effect it might cause to economic activities and export competitiveness.

The research output showed that tariff walls created by the countries to offset the environmental regulations compliance costs by the countries would prove counterproductive in light of the negative effects of tariffs on all pollutive groups of industrial trade flows. This is because the demand for protectionism will be less likely to solve trade competitiveness issues of pollutive industries when the root cause of poor performance lies somewhere else. Therefore, at the policy level, instead of lobbing for protectionism to avert compliance with environmental regulations, the industrial/trade organizations should lobby for better environmental policies. And those environmental policies should aim at enhancing productivity, growth, and competitiveness without compromising the overall environmental benefits the society expected to gain.

9.4 Contribution to the Knowledge

The study efforts regarding the impact of environmental regulations and trade flows for South Asia in particular and in the North-South framework in general have allowed making some contribution in the literature.

Firstly, the research in environmental policies and trade competitiveness association has given less attention to developing countries and a large body of literature focused on developed countries and research has neglected South Asia regions to provide a comprehensive count on the impact that environmental regulations would leave for pollutive industrial trade. The current study has contributed to the literature by filling some of these gaps and offering the analysis of environmental regulation impact on different categories of pollutive industrial trade competitiveness.

Secondly, the current research-in view of limitations of a single methodology applied by many researchers- focused on a cross methodological approach to address the impacts of the environmental regulation for export flows and trade competitiveness for South Asian countries and their bilateral pollutive industries exports flows with stringent environmental regulated partners OECD countries. One of the key findings of this research - a pre-requisite for policy-making level- is that the pollutive industrial trade data should be scrutinized in a cross-methodological framework for robust results. It showed that while statistical modeling approaches provide less systematic results on industrial trade specialization patterns and competitiveness of environmentally sensitive industries, the econometric modeling-based findings inter broadly found the negative impact of environmental regulations on different categories of pollutive industries' trade competitiveness.

Thirdly, in the literature survey, the study highlighted that some studies have failed to report or perform diagnostic tests/sensitivity and endogeneity analysis. Therefore, the present study has employed sound theoretically driven empirical models and ensured that all appropriate diagnostics tests are employed for robust findings.

Fourthly, by employing the comparative advantage model and further development in that of competitiveness indicator methodology, the study for South Asian countries has provided a detailed analysis not only on trade pattern of different categories of pollutive industries changed over time but also within those pollutive categories how environmental regulations effected the different groups of pollutive industries trade specialization patterns within each group and between groups. In the light of the study findings regarding the impact of environmental policy on trade competitiveness on industries other than the most pollutive, this study contributed to the literature by highlighting why the scope of pollutive industry group was imperative to expand from just most pollutive industries– focused by many researchers- to somewhat pollutive and less pollutive sectors

Fifthly, while some earlier research concluded for pollution haven effects in developing countries by examining the pollutive industrial trade patterns of developed countries over time only, PHH hypothesis demanded looking at bilateral trade flows between developed and developing countries. Therefore, the present research contributed to the literature by adopting a cross-methodological approach and ensuing those methods-statistical and econometric allowed for geographical controls to examine three pollutive industrial groups trade flows between South Asia and the OECD produced robust conclusions on PHH.

Sixthly, this study clearly conveys the message that there is trade-off between accomplishing environmental regulatory objectives and enhancing trade competitiveness not only for environmentally stringent OECD countries but also environmentally laxer South Asian countries. The study rejected the generally held belief that negative impacts on pollutive industrial competitiveness due to environmental compliance measures were just a phenomenon of developed countries. The strong negative impact of environmental regulations on pollutive exports for South Asian countries clearly showed the industrial trade competitiveness challenges the developing countries are facing.

Finally, by transforming the tariffs data for each pollutive industry group level for South Asian and OECD countries, the study contributed to the research quest on whether tariffs walls created by the countries leave negative impact on different categories of industrial export flows in both South Asia and OECD countries. It concluded that regardless of the country's environmental stringency level, the countries' tariffs walls will negatively affect the pollutive industrial exports and competitiveness. Therefore, policy-making efforts should be devoted more to adopting innovative environmental policies rather than creating an artificial barrier to trade.

9.5 Some Areas for Future Research

The study findings have guided the research on future research on environmental policy and trade competitiveness.

First, the study examined the environmental policy impact on different categories of pollutive industrial trade and analysed how their specialization pattern changed over time. A further data examination on individual sector-specific effects of environmental regulations on competitiveness by applying appropriate methodology can provide more insights into pollutive trade sectors of South Asia region as well as region's trade flows with environmental stringent North economies.

Second, while the current study has focused on South Asian trade flows and competitiveness and their export flows with OECD countries, the study in chapter 5 broadly touched upon how other developing and emerging regions worldwide are progressing with different categories of pollutive industrial trade. It would be desirable if the cross-methodological framework of this study extended to examine the impact of environmental regulations on pollutive industrial trade competitiveness impacts on those developing and emerging regions.

Thirdly, the study indicated the dearth of environmental regulatory data over time. Therefore, concerted efforts are required to collect and compile the time series data on environmental control costs at the industry/firm levels for South Asian countries and other developing countries. The availability of environmental regulation data at the highest dis-aggregated level will pave the ways to conduct more refined industry-specific research on environmental policy and trade linkages.

Fourthly, while pollution haven effects act as promoting arguments for lax environmental regulation being adopted in developing countries including South Asia, further empirical research on individual pollutive industry-specific -instead of pollutive group-bilateral trade flows of South Asia with OECD countries can be conducted so that the direct impact of environmental policy on each pollutive industry could be assessed.

Fifth, which is related to a few of the above, is about the moving from general to specific questions: general question to be examined is the relationship between environmental policy and competitiveness and at the intermediate level of detail, what is studied are the competitiveness impacts per policy measure, per industry, or per environmental issue. Examining these questions can be expected to aid in devising a more transparent policy guideline in achieving trade competitiveness with improving environmental quality.

9.6 Study Limitations

There is a dearth of data on environmental regulations. Therefore, empirical literature in the past aimed at analyzing the environmental regulations on trade competitiveness has suffered from a lack of adequate and comprehensive comparative data on environmental stringency across countries. While some efforts have been made in the advanced part of the world to measure the abatement costs of environmental regulations in terms of environmental expenditure at industry level, they are not free from errors. One of the major problems the countries face is measuring the exact abatement cost that regulation imposes on manufacturers, which is not straightforward. This is because many costs associated with pollution abatement also generate a certain cost-saving amount, normally termed as cost offsets. The enforcement of existing regulations may vary across countries that might depict a somewhat misleading picture of the stringency of regulations in practice.

Given these data deficiencies, the current study focused on environmental stringency indexes widely accepted in mainstream research. There is a dire need for time series cross-countries comparable environmental controlled cost data at individual industry/firm levels from most pollutive industries to least pollutive industrial for developing countries like South Asia and other regions. Moreover, there should be uniformity in data collection methodology for both developed and developing countries, allowing the researcher to have better insights into the environmental regulation and trade competitiveness links within developing countries and between developed and developing countries.

The time covered for the current study was up to 2004, which was in the light of trade and tariffs and environmental data available at the time of present research commencements. While this is deemed to be a first effort regarding the detailed analysis of environmental policy and trade competitiveness issues for South Asian countries and their bilateral trade flows with OECD countries, further research with updated data will shed more light on the subject. This study has not focused on political economy aspects nor strategic issues of environmental policies and trade. The debate on non-tariff measures' roles to protect public health and environment and their impact on trade and issues relating to the association between transboundary pollutions and international trade were not in the main purview of present research either.

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Appendix 4.1. Summary of the Selected Empirical Studies on Environmental Regulations Impact on Trade

Author/ Study year	Main Study Objective (s)	Model Type	Dependent Variable in (regression models)	Environmental Regulation Variable (in regression Model)	Data / Period/ Country(s)	Key Finding(s)
Walter (1973)	To examine impact of environmental control costs on trade pattern. Whether exports good of US economy are more pollutive than those of import goods.	Partial equilibrium (input-output)	Not applicable	Not applicable	Input-output tables for US for 83 goods /1966 / US	Environmental control costs for US exports are higher than those of imports. Environmental control cost overall is trade neutral.
Evans (1973)	To examine pollution control policies effects on macroeconomic indicators and on pollutive industrial sectors.	Partial/ General equilibrium modeling/regression model-OLS	Price elasticities	Industrial pollution control costs	Input-output tables for 81 industries/macro variable of US economy/ 1972-1980/ USA	Environmental control costs could be absorbed on aggregate level without significantly affecting macroeconomic indicators. Some individual industry would hit by environmental control cost but cost is not high enough to alter the investment decisions.
Mutti and Richardson (1977)	Analyze the effects of unilateral environmental control costs on output and trade	General equilibrium model	Not applicable	Not applicable	Input-output tables for 81 industries;/macro data/ 1967 / US	Negative impact of environmental control on Industry's output through **loss of trade competitiveness.**
Robison (1988)	To examine impact of marginal change in pollution abatement cost on U.S trade balance in general and U.S balance of trade with Canada in particular.	Partial equilibrium model (input-output)	Not applicable	Not applicable	Input-output table for 78 industries; macroeconomi	Environmental control costs increased sharply from 1973 to 1982. This cost rise would reduce US

Author/ Study year	Main Study Objective (s)	Model Type	Dependent Variable in (regression models)	Environmental Regulation Variable (in regression Model)	Data / Period/ Country(s)	Key Finding(s)
					c data/ 1973, 1977, 1982	trade balance overall and with Canada.
Tobey (1990)	To empirically examine the impact of environmental policy on trade pattern of most polluting industries.	Heckscher-Ohlin Vanek Model (HOV), regressions analysis	Net exports of pollutive sectors.	Index of environmental stringency (7=strict; 1=tolerate) based on **input** cost on abatement measures.	Pollutive industries and controlled variables/1975 /23 countries :14 OECD and 9 non-OECD	Stringent environmental regulations **did not** change the trade pattern of polluting industry for selected countries and period.
Van Beers and Van den Bergh (1997) & Van den Bergh (2003)	Tobey (1990) revisited: impact of environmental regulations on trade patterns	Gravity model: regression analysis, OLS: analysis.	Total bilateral trade flows; dirty sectors trade flows and five most pollutive sectors trade flows.	Index based on output-oriented data from OECD environmental indicators covering: -recycling rate -energy intensity -protected area -unleaded gas market share - population with sewerage -environmental group indices -state enforcement budget. -PAOC, adjusted for states	Pollutive sectors and gravity model variables/1975 ,1992/14-OECD and 9 developing for 1975 and 14-21 OECDs countries for 1992-year analysis	Among others, stringent environmental regulations have **significant** and **positive** /**negative** impact on trade flows depending on type of trade flows and sectoral industry used for regression analysis. Dirty sector overall found insignificantly associated with environmental regulations Overall, evidence or not enough to draw any specific conclusions. Generally environmental effects are more significant in 1992 as compared to 1975.

Author/ Study year	Main Study Objective (s)	Model Type	Dependent Variable in (regression models)	Environmental Regulation Variable (in regression Model)	Data / Period/ Country(s)	Key Finding(s)
				-Industrial compositions - PAOC Per dollar of value added		
XU (2000)	To provide the time series analysis of ESG industries and to empirically examine the impact of environmental regulation and tariff barriers on export flows and competitiveness	Balassa and competitiveness index; Gravity model/ OLS method	Bilateral Industrial export flows of total exports and ESG industries and footloose industries	Environmental Performance Index developed by Dasgupta et al. (1995)	Industrial trade SITC 3-digits UNIDO and gravity variables from world bank/1990, 1965-90/developed/ developing 31&134	The trade pattern of ESG remained unchanged between 1965-90. The impact of environmental stringency on bilateral exports is positive for ESG and that tariff is negatively effecting export flows.
Harris et al. (2002)	Van Beers and van den Bergh (1997) revisited: impact of environmental regulations on trade flows.	Gravity model: different versions of F.E. panel models	Bilateral industrial imports flow of most pollutive sectors & footloose sectors.	Energy supply and energy consumption based environmental stringency index in line with Van Beers and van den Bergh (1997)	Panel data for gravity model variables; sectoral imports, environmental indexes/ 1990-96 / 24 OECD	Environmental costs do not have any real impact - neither positive not negative - on trade flows.
Wilson et al. (2002)	To analyse the impact of environmental regulations on export of pollution intensive industries.	multifactor HOV model	Net pollutive industrial exports.	Dasgupta et al. (2001) index on environmental legislation enacted in manufacturing and other sectors	Pollutive industries and other HOV model-based data/1994-98/24 OECD	Stringent environmental regulations do have consequences for pollutive goods exports for OECDs and non-OECDs countries

Author/ Study year	Main Study Objective (s)	Model Type	Dependent Variable in (regression models)	Environmental Regulation Variable (in regression Model)	Data / Period/ Country(s)	Key Finding(s)
					& Non-OECD countries	
Cole and Elliott (2003)	To examine the effect of environmental regulations on trade flows within international comparative advantage-based model. Whether environmental regulations like other factor endowments influence the composition of trade?	H-O-V model Intra-Industry Trade Model (Grubel and Lloyd,1975) index based HOV model extension.	Net exports: and intra-industry exports flows at sectoral level covering most pollutive industries.	Dasgupta et al. (2001) index on environmental legislation enacted in manufacturing sector extended by Eliste and Frederickson (2001) for 60 OECD and Non-OECD countries; change in energy intensity (energy use/GDP)	HOV model based economic ad endowments data/1995/60 OECD and non-OECD countries	For H-O-V framework the stringent environmental regulations did not have any impact on net export of dirty commodities in the sample countries. For intra-industry trade model, the outcome among others showed that share of intra and inter-industry flows of pollutive goods are indeed motivated by the differences in environmental regulations. Found evidence of "pollution haven affects".
Ederington, Levinson and Minier (2005)	Finding underlying factors on why it is difficult to detect the impact of environmental regulation on pollutive industrial trade.	Panel; industry and time fixed effect, analysis on small and large industry costs	Net US industrial imports with OECDs and Non-OECDs at SIC dis-aggregation level	Ration of Pollution abatement Costs and Expenditure (PACE)/total costs; environmental stringant index developed by Eliste and Fredriksson (2002)	US industrial trade and factor abundance; 1978-92/ developed and developing total 53 countries	The stringency of environmental regulations can leave discernible impact on net imports to US pollutive industries once issues of industrial characteristics and environmental costs, data heterogeneity and industrial mobility factors are effectively examined.

Author/ Study year	Main Study Objective (s)	Model Type	Dependent Variable in (regression models)	Environmental Regulation Variable (in regression Model)	Data / Period/ Country(s)	Key Finding(s)
Levinson and Taylor (2004)	To re-examine the link between pollution abatement cost and trade flows	Panel fixed effect; 2SLS industry/time effect	Net US industrial imports with Canada, Mexico	Ratio: Pollution abatement Costs and Expenditure (PACE) as fraction of value added	US Industrial trade and other variables data/1974-86/US, Mexico, Canada, OECD, Non-OECD	The environmental stringency leave significant and positive impact on US net imports flows but results are more robust in 2SLS compared to fixed effect alone.
Busse (2004)	Empirically examine the relationship between environmental regulation and trade competitiveness	HOV factor abundance model Cross-section	Net exports of five pollutive industries	Environmental Sustainability Index; ESI; two key regulatory variables	Industrial trade data and other variables/2001 /109 countries	Impact of env regulations on all sectors insignificant, except iron and steel which is negative/significant.
Babool and Reed (2010)	To examine impact of environmental regulations on six selected OECDs countries	HOV factor abundance model Panel data	Net exports of most pollutive/less pollutive industries including food industry	Environmental Sustainability Index; ESI; two key regulatory variables with data extrapolation/interpolation-7 years data	Industrial trade and factor abundance/1987-2003/6 OECDs countries.	Environmental regulations affecting negatively to most pollutive industries of OECDs countries but positively to food industries hence confirming for Porter Hypothesis for food sector.
Jug and Mirza (2005)	To examine the impact of environmental regulation on trade flows between EU and Eastern European countries.	Panel; F.E. Model; OLS; GMM; structural gravity model	Relative industrial imports of pollutive and clean industries	Current environmental expenditure at industrial level	Eurostat's and other sources industrial trade and other variable data/1996-199/EU and non-EU countries	Environmental regulation is negatively associated with bilateral trade flows of pollutive industries and impact is more pronounced on homogeneous products and trade between EU and not EU countries. Pollution haven effects not found.

Author/ Study year	Main Study Objective (s)	Model Type	Dependent Variable in (regression models)	Environmental Regulation Variable (in regression Model)	Data / Period/ Country(s)	Key Finding(s)
Ratnayake (1998)	To examine the impact of environmental policy on export competitiveness of New Zealand's manufacturing industry.	Revealed Comparative Advantage and H-O-V model	Net sectoral exports as ratio of total industrial trade based on industrial classification .	Dummy variable approach for environmental sensitive industries.	109 manufacturing Industries export data SITC-2 and 3 digits level and other economic variables / 1980-93/New Zealand with Trading partners	Stringency of environmental regulations do not affect the trade pattern of New Zealand with its trade partners.
XU (1999)	Impact of stringent environmental regulations on the competitiveness on environmental sensitive goods	Revealed Comparative Advantage Model & Competitive Index	Not Applicable	Not Applicable	SITIC trade data/ 1965-95/34 OECD and Non-OECD countries.	Export patterns of environmental sensitive goods remained unchanged after the introduction of stringent environmental regulation in advanced countries.
Low and Yeats (1992)	To look for the evidence of *Industrial flight hypothesis*	Revealed Comparative advantage model (RCA)	Not applicable	Not applicable	United Nations /1965-88/ LDCS	Found evidence of *industrial flight hypothesis* and shift in location was inter alia due to differences in environmental policy
Sorsa (1994)	To examine trade patterns of selected OECD countries and impact of environmental expenditure on trade flows	RCA model Regression analysis.	Not applicable	Not applicable	UNIDO: industrial level trade data; OECD Env. environmental control data/ 1970-1990.	OECD countries maintained their competitiveness in most pollutive industries during period-1970-90

Author/ Study year	Main Study Objective (s)	Model Type	Dependent Variable in (regression models)	Environmental Regulation Variable (in regression Model)	Data / Period/ Country(s)	Key Finding(s)
Grether and de Melo (2004)	To examine environmental regulation impact on changing bilateral trade patterns on pollutive industries between rich North and developing South.	Modified version of RCA Model, Gravity model, panel data analysis	Mirror exports flows of pollutive industries	Differences in GNP per capita across countries to capture regulatory gaps between North and South.	Industrial trade data and other gravity model variable/1981-98-level/56 developed and developing countries	Week possibility for 'South' to become haven for world most pollutive industries trade of rich North countries.
Zhaohua Wang et al. (2016)	To analyze the impact of environmental regulation on aggregate trade and sectoral level trade for Chinese economy	Econometric model using both feasible generalized least squares (FGLS) and seemingly unrelated regression (SUR) are used to examine panel data	Exports, imports and net exports of aggregate trade and sectorial level SITC data	Environmental Regulation level (ERL) measured by the rates of pollution abatement.	SITC total export and import data and nine sectors data of China economy covering both primary and manufacturing trade for the period 1985-2010	The environmental regulations in China except few exceptions have positive impact of both imports and exports and encouraging the manufacturing of pollutive industries to migrate to cleaner production process.
Sawhney and Rastogi (2015)	To find pollution haven effect for India-US pollutive manufacturing trade.	RCA, SRCA and Michaely statistics model; Panel data/instrumental variables	Net exports of pollutive industries	PACE US survey-based data/pollution abatement and control costs.	SIC/NAIC dis-aggregated level data/ 1991-2005 with gaps/ India-US.	Pollution haven effects are not found in overall industrial trade. Some evidence of PHH found in most pollutive industries.

Author/ Study year	Main Study Objective (s)	Model Type	Dependent Variable in (regression models)	Environmental Regulation Variable (in regression Model)	Data / Period/ Country(s)	Key Finding(s)
Martínez-Zarzoso et al. (2017)	Study examines two key hypotheses. First, whether the stringency of a country's environmental regulations can result in pollution havens. Second, if empirical outcomes differ by industry and for old and new EU member countries.	Augmented time- varying Gravity model with specific industry-time effect. Instrumental variable approach/ Panel data	Total exports; dirty industrial exports, exports of specific footloose industries for comparative analysis.	Total environmental tax revenues as a percentage of GDP; second variable is the current environmental protection expenditures of the public and the private sectors.	Eurostat data for trade and other sources variables/1996 to 2008/ old and new EU countries data.	The study finds that environmental stringency variables used for European country analysis are vital determinants of total exports at bilateral level and for the exports of dirty industry and export flows of footloose industries and thus support for "Porter Hypothesis". Authors finds some evidence of CEECs becoming *pollution haven* for European *footloose* industrial exports.
Cantore and Cheng (2018)	To examine the impact of environmental tax and environmental innovation efforts on bilateral export flows and competitiveness of environmental sensitive goods for developed and developing.	Gravity model/ Panel F.E/R.E. New-West models	Bilateral export flows of environmental sensitive goods in developed and developing countries.	Environmental tax in importing country/ patent ratio at bilateral level to capture innovation impacts on exports	UN Comtrade data on bilateral exports; Green data OECD and other sources/2000-2014/ 38-LDCs and 33-DCs data	Environmental tax and green innovation policies are good for export competitiveness both for developed and developing countries thus confirming porter hypothesis.

Appendix 6.1

Comparative Advantages (disadvantages)in Manufacturing Sectors Exports of Pakistan

			Balassa Index			Vollrath Index		
	ISIC Code	industrial Classifica	1984-88	1989-93	1994-98	1984-88	1989-93	1994-98
Most Pollutive Industry	341	paper& product	0.017	0.002	0.005	0.017	0.002	0.005
	351	industrial chemical	0.136	0.074	0.126	0.126	0.069	0.118
	353	petrloeum refineries	0.255	0.137	0.113	0.249	0.134	0.111
	369	other non-netallic min	0.253	0.305	0.205	0.251	0.303	0.203
	371	iron & steel	0.174	0.008	0.009	0.168	0.007	0.009
	372	non-ferrous metals	0.001	0.003	0.002	0.001	0.003	0.002
Some What Pollutive Industries	311	food products	**1.982**	**1.423**	**1.695**	**2.137**	**1.464**	**1.772**
	313	Beverages	0.031	0.057	0.037	0.031	0.057	0.037
	321	Textiles Industry	**11.927**	**12.750**	**13.504**	**27.471**	**32.950**	**34.510**
	323	Leather products	**8.920**	**5.985**	**4.034**	**9.642**	**6.290**	**4.157**
	342	printing & publishing	0.132	0.110	0.103	0.131	0.109	0.102
	352	other chemicals	0.090	0.103	0.128	0.087	0.100	0.124
	381	fabricated metals	0.176	0.113	0.110	0.170	0.109	0.106
	383	machinery electric	0.014	0.011	0.007	0.012	0.009	0.006
	384	transport equipment	0.047	0.018	0.011	0.039	0.015	0.009
Less Pollutive Industries	314	tobacco products	0.842	0.223	0.094	0.841	0.221	0.093
	322	wearing apparel	**4.417**	**5.405**	**5.967**	**4.910**	**6.344**	**7.029**
	324	footwear cept rub.pls	0.632	0.555	0.697	0.630	0.552	0.695
	331	wood prod.except furn	0.010	0.024	0.020	0.010	0.024	0.019
	332	furniture except mtl	0.033	0.025	0.040	0.033	0.025	0.039
	354	misc.petrol&coal prods	0.132	0.371	0.212	0.131	0.370	0.211
	355	Rubber Products	0.082	0.028	0.014	0.081	0.028	0.014
	356	plastic products	0.096	0.037	0.048	0.095	0.036	0.047
	361	pottery	0.222	0.050	0.039	0.221	0.050	0.039
	362	glass	0.137	0.049	0.039	0.136	0.048	0.039
	382	machinery xcept elect	0.064	0.035	0.034	0.055	0.030	0.029
	385	prf.&scientil equipment	0.496	0.453	0.462	0.487	0.444	0.453
	390	others Industries	0.965	**1.217**	**1.674**	0.964	**1.223**	**1.701**

Note: (1) Analysis is based on ISIC data at 3-digit level of 56 closed sample countries out of 67 total

(2) Revealed Comparative Advantages (RCA's) are depicted in **bold**

Appendix 8.1

Table A8.1. Environmental Regulation and Pollutive Exports: Comparative Analysis Random effects

Variables /pollutive category	Total Exports	Most Pollutive Exports	Less Pollutive Exports
Log exporting country GDP	1.23 (28.67) ***:	1.95 (15.53) ***	1.51 (24.92) ***
Log importing country GDP	0.62 (3.62) ***	.94 (7.52) ***	.65 (2.67) ***
Log exporting country population	-.44 (-5.42) ***	-.99 (-4.72) ***	-.71 (-11.27) ***
Log importing country population	-.14 (-.74)	-.26 (-.93)	-1.10 (-2.64) ***
Log Distance	-.97 (-34.29) ***	-1.41 (-17.57) ***	-.87 (-21.85) ***
Env. regulation exporting country	-.52 (-5.17) ***	-1.08 (-4.63) ***	-.20 (-6.43) ***
Env. Regulation importing country	.56 (1.76) *	1.34 (2.52) **	-.46 (-3.22) ***
Dummy Contiguity (*$CONTG_{ij}$*)	.18 (1.87) *	.02 (.32)	.39 (10.38) ***
Dummy Common Language (*$COML_{ij}$*)	.44 (3.16) ***	.63 (2.38) **	.62 (5.92) ***
Dummy Colonial links (*COL_{ij}*)	.17 (.83)	.10 (.83)	.03 (.13)
Constant	-14.54 (-1.51)	-28.21 (-2.78) ***	86.89 (8.65) ***
Reporter dummy	Yes	Yes	Yes
Partner dummy	Yes	Yes	Yes
Year Dummy	Yes	Yes	no
Observations	1140	1140	1140
Adjusted R-Squared	.83	.76	.59

*Notes: (1) *** denotes significance at the 1% level, ** denotes significance at the 5 % level, * denotes significance at the 10 % level*

: (2) t- statistics are in parentheses.

: (3) *Estimation uses White (1980) heteroscedasticity-consistent covariance matrix estimator.*

:(4) All variables both regressand and regressors in estimation of equations (3) are expressed in natural logarithm form, except dummies. Total exports, most pollutive exports, relatively less pollutive exports are dependent variables in regression analysis.

:(5) Analysis based on full 20 sample countries panel data (1990, 1998,2004) including three South Asian and 17 OECD countries.

In table A8.1, the study presents the results of three pollutive categories for the full sample countries using log GDP as explanatory variables instead of GDP per capita. The analysis is conducted to examine if replacing the log GDP per capita explanatory variable with the log GDP variable leaves any similar and or different effects on pollutive industrial export flows. This study has replaced the log GDP variable with GDP per capita following findings of the high multicollinearity in data due to the log GDP variable used for both exporters and partner countries. Table A8.1 presents the results for three pollutive export categories of full sample 20 countries data. The results inter alias show that domestic environmental regulations negatively affect total bilateral industrial exports, most pollutive bilateral industrial exports, and less pollutive bilateral industrial exports. These findings align with what this study found by using the log GDP per capita income as an explanatory variable in the gravity model.

APPENDIX 8.2

Table A8.2 Environmental Regulation and Exports Flows: *South Asia Pollution Haven Effects*

Random effects

Variables /pollutive category	Total Exports	Most Pollutive Exports	Less Pollutive Exports
Log exporting country GDP	1.16 ***: (2.32)	1.51*** (4.09)	1.62*** (4.36)
Log importing country GDP	1.91*** (6.90)	1.95*** (12.71)	1.90*** (12.37)
Log exporting country population	-.28 (-.55)	-.48 (-1.02)	-.73** (-1.99)
Log importing country population	-1.19*** (-3.42)	-1.02*** (-5.31)	-1.21*** (-7.04)
Log Distance	-.92*** (-4.47)	-1.77*** (-4.11)	-.71*** (-3.84)
Env. regulation exporting country	-2.01*** (-6.61)	-2.90*** (-106.15)	-1.91*** (-5.30)
Env. Regulation importing country	-.17 (-.19)	2.30** (2.35)	-.95 (-1.04)
Dummy Contiguity (*$CONTG_{ij}$*)	-.15 (-.23)	-.85 (-.89)	.02 (.06)
Dummy Common Language (*$COML_{ij}$*)	.59* (1.72)	1.06** (2.62)	.64*** (2.99)
Dummy Colonial links (*COL_{ij}*)	-.19 (-.40)	-.37 (-1.05)	-.12 (-.40)
Dummy Regional Trade Agreements (RTAs)	.21 (.56)	-.05 (-.23)	.50 (.09)
Dummy South Asia (DSASIA)	-1.30 (-.75)	-1.75 (-4.35)	-1.05 (-.77)
Constant	-20.86*** (-2.57)	-33.62*** (-11.47)	65.72*** (8.62) ***
Reporter dummy	no	no	no
Partner dummy	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes
Observations	171	171	171
Adjusted R-Squared	.85	.86	.87

*Notes: (1) *** denotes significance at the 1% level, ** denotes significance at the 5 % level, * denotes significance at the 10 % level*

: (2) t- statistics are in parentheses.

: (3) *Estimation uses White (1980) heteroscedasticity-consistent covariance matrix estimator.*

:(4) All variables both regressand and regressors in estimation of equations (3) are expressed in natural logarithm form, except dummies. Total exports, most pollutive exports, relatively less pollutive exports are dependent variables in regression analysis.

:(5) Analysis based on 3 south Asian countries exports with 17 OECDS sample countries panel data (1990,1998,2004).

Appendix 8.3 Descriptive Statistics/Correlation Matrix:1990 Data

Table 8.3.1A

Descriptive Statistics 1990: Exports Data

	LOG(TEXP)	LOG(LPE)	LOG(MPE)	LOG(TICT)	LOG(LPCT)	LOG(MPCT)	LOG(OGDPC1)	LOG(PGDPC1)	LOG(DIJ)	LOG(ENVTI)	LOG(ENVTJ)	CONTG	COML	COL	DSASIA	RTA	LOG(LANDI)	LOG(LANDJ)
Mean	8.27	7.47	6.27	4.72	4.73	4.71	9.50	9.50	8.31	5.02	5.02	0.07	0.16	0.06	0.15	0.42	10.66	10.66
Median	8.54	7.59	6.77	4.67	4.68	4.67	9.91	9.91	8.69	5.11	5.11	0.00	0.00	0.00	0.00	0.00	10.40	10.40
Maximum	13.68	13.24	12.19	5.30	5.35	5.30	10.19	10.19	9.88	5.22	5.22	1.00	1.00	1.00	1.00	1.00	13.73	13.73
Minimum	1.54	0.67	0.00	4.61	4.61	4.61	6.98	6.98	5.84	4.38	4.38	0.00	0.00	0.00	0.00	0.00	8.13	8.13
Std. Dev.	2.24	2.26	2.82	0.17	0.17	0.17	0.97	0.97	1.11	0.24	0.24	0.26	0.37	0.24	0.36	0.49	1.61	1.61
Skewness	-0.24	-0.21	-0.57	2.04	2.03	2.02	-1.87	-1.87	-0.48	-1.74	-1.74	3.26	1.82	3.59	1.96	0.31	0.58	0.58
Kurtosis	2.68	2.82	2.61	6.04	6.03	5.69	4.72	4.72	2.03	4.49	4.49	11.65	4.32	13.90	4.84	1.10	2.65	2.65
Jarque-Bera	5.44	3.18	23.09	411.39	405.81	373.23	267.62	267.62	29.17	226.28	226.28	1859.52	238.28	2698.46	297.19	63.48	23.56	23.56
Probability	0.07	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum	3141.18	2840.40	2381.94	1794.89	1796.56	1790.86	3611.12	3611.12	3156.70	1907.30	1907.30	28.00	62.00	24.00	57.00	161.00	4051.47	4051.47
Sum Sq. Dev.	1906.63	1933.33	3016.65	10.75	11.25	10.91	359.35	359.35	470.59	22.33	22.33	25.94	51.88	22.48	48.45	92.79	979.58	979.58
Observations	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00

Notes: All variables are in natural logarithm form except country paird variables and regional cooperation variables including; COL; COML; CONTG; RTA;DSASIA; (cross-section: 1990)

Table 8.3.2A

Descriptive Statistics 1990: Imports Data

	LOG(TIMP)	LOG(LPI)	LOG(MPI)	LOG(TICT)	LOG(LPCT)	LOG(MPCT)	LOG(OGDPC1)	LOG(PGDPC1)	LOG(DIJ)	LOG(ENVTI)	LOG(ENVTJ)	CONTG	COML	COL	DSASIA	RTA	LOG(LANDI	LOG(LANDJ)
Mean	8.35	7.53	6.45	4.72	4.73	4.71	9.50	9.50	8.31	5.02	5.02	0.07	0.16	0.06	0.15	0.42	10.66	10.66
Median	8.57	7.65	6.99	4.67	4.68	4.67	9.91	9.91	8.69	5.11	5.11	0.00	0.00	0.00	0.00	0.00	10.40	10.40
Maximum	13.80	13.35	12.26	5.30	5.35	5.30	10.19	10.19	9.88	5.22	5.22	1.00	1.00	1.00	1.00	1.00	13.73	13.73
Minimum	2.76	1.32	0.00	4.61	4.61	4.61	6.98	6.98	5.84	4.38	4.38	0.00	0.00	0.00	0.00	0.00	8.13	8.13
Std. Dev.	2.18	2.20	2.76	0.17	0.17	0.17	0.97	0.97	1.11	0.24	0.24	0.26	0.37	0.24	0.36	0.49	1.61	1.61
Skewness	-0.14	-0.09	-0.64	2.04	2.03	2.02	-1.87	-1.87	-0.48	-1.74	-1.74	3.26	1.82	3.59	1.96	0.31	0.58	0.58
Kurtosis	2.52	2.68	2.82	6.04	6.03	5.69	4.72	4.72	2.03	4.49	4.49	11.65	4.32	13.90	4.84	1.10	2.65	2.65
Jarque-Bera	4.99	2.18	26.73	411.39	405.81	373.23	267.62	267.62	29.17	226.28	226.28	1859.52	238.28	2698.46	297.19	63.48	23.56	23.56
Probability	0.08	0.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum	3171.93	2862.14	2449.29	1794.89	1796.56	1790.86	3611.12	3611.12	3156.70	1907.30	1907.30	28.00	62.00	24.00	57.00	161.00	4051.47	4051.47
Sum Sq. Dev.	1806.59	1839.13	2890.88	10.75	11.25	10.91	359.35	359.35	470.59	22.33	22.33	25.94	51.88	22.48	48.45	92.79	979.58	979.58
Observations	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00

Notes: **All variables are in natural logarithm form except country paird variables and regional cooperation variables including; COL; COML; CONTG; RTA;DSASIA; (cross-section: 1990)**

8.3.3A

Correlation Matrix 1990: Exports Data

VARIABLES	LOG(TEXP)	LOG(LPE)	LOG(MPE)	LOG(TMIT)	LOG(LPMIT)	LOG(MPMIT)	LOG(GDPCAPITAI)	LOG(GDPCAPITAJ)	LOG(DIJ)	LOG(ENVTI)	LOG(ENVTJ)	CONTG	COML	COL	DSASIA	RTA	LOG(LANDI)	LOG(LANDJ)
LOG(TEXP)	1																	
LOG(LPE)	0.98	1.00																
LOG(MPE)	0.91	0.85	1.00															
LOG(TMIT)	-0.47	-0.43	-0.65	1.00														
LOG(LPMIT)	-0.45	-0.41	-0.64	1.00	1.00													
LOG(MPMIT)	-0.44	-0.39	-0.64	0.97	0.97	1.00												
LOG(GDPCAPITAI)	0.44	0.40	0.64	-0.95	-0.95	-0.95	1.00											
LOG(GDPCAPITAJ)	0.38	0.38	0.21	0.08	0.10	0.08	-0.05	1.00										
LOG(DIJ)	-0.46	-0.43	-0.50	0.26	0.27	0.23	-0.16	-0.16	1.00									
LOG(ENVTI)	0.43	0.38	0.63	-0.94	-0.93	-0.94	0.98	-0.05	-0.17	1.00								
LOG(ENVTJ)	0.36	0.37	0.21	0.08	0.10	0.07	-0.05	0.98	-0.17	-0.05	1.00							
CONTG	0.26	0.27	0.26	-0.05	-0.06	-0.04	0.01	0.02	-0.46	0.02	0.02	1.00						
COML	0.00	0.02	-0.03	0.08	0.08	0.08	-0.10	-0.10	0.16	-0.05	-0.05	0.15	1.00					
COL	0.16	0.17	0.12	-0.01	0.00	-0.01	0.01	0.02	0.04	0.04	0.04	0.09	0.41	1.00				
DSASIA	-0.40	-0.36	-0.60	0.95	0.94	0.95	-0.98	0.05	0.15	-0.96	0.05	0.00	0.10	-0.02	1.00			
RTA	0.46	0.44	0.50	-0.34	-0.34	-0.31	0.26	0.27	-0.79	0.25	0.26	0.33	-0.08	-0.14	-0.27	1.00		
LOG(LANDI)	0.00	0.01	-0.10	0.25	0.24	0.26	-0.27	0.01	-0.04	-0.24	0.01	0.06	0.04	-0.01	0.32	-0.03	1.00	
LOG(LANDJ)	0.12	0.12	0.10	0.04	0.05	0.00	0.02	-0.02	0.32	0.01	-0.01	-0.04	0.27	0.11	-0.02	-0.22	-0.05	1.00

Notes: **All variables are in natural logarithm form except country paird variables and regional cooperation variables including; COL; COML; CONTG; RTA;DSASIA;** (cross-section: 1990)

8.3.4A

Correlation Matrix 1990: Imports Data

VARIABLES	LOG(TIMP)	LOG(MPM)	LOG(LPM)	TMIT	LOG(LPMIT)	LOG(MPMIT)	LOG(GDPCAPITAI)	LOG(GDPCAPITAJ)	LOG(DIJ)	LOG(ENVTI)	LOG(ENVTJ)	CONTG	COML	COL	DSASIA	RTA	LOG(LANDI)	LOG(LANDJ)
LOG(TIMP)	1.00																	
LOG(MPM)	0.90	1.00																
LOG(LPM)	0.98	0.83	1.00															
TMIT	-0.40	-0.21	-0.41	1.00														
LOG(LPMIT)	-0.39	-0.20	-0.40	0.99	1.00													
LOG(MPMIT)	-0.39	-0.20	-0.40	0.96	0.97	1.00												
LOG(GDPCAPITAI)	0.40	0.21	0.41	-0.95	-0.95	-0.95	1.00											
LOG(GDPCAPITAJ)	0.44	0.66	0.39	0.08	0.10	0.08	-0.05	1.00										
LOG(DIJ)	-0.44	-0.46	-0.41	0.24	0.27	0.23	-0.16	-0.16	1.00									
LOG(ENVTI)	0.38	0.20	0.39	-0.93	-0.93	-0.94	0.98	-0.05	-0.17	1.00								
LOG(ENVTJ)	0.43	0.65	0.38	0.07	0.10	0.07	-0.05	0.98	-0.17	-0.05	1.00							
CONTG	0.26	0.25	0.26	-0.04	-0.06	-0.04	0.01	0.02	-0.46	0.02	0.02	1.00						
COML	0.00	-0.02	0.03	0.06	0.08	0.08	-0.10	-0.10	0.16	-0.05	-0.05	0.15	1.00					
COL	0.17	0.12	0.18	-0.01	0.00	-0.01	0.01	0.02	0.04	0.04	0.04	0.09	0.41	1.00				
DSASIA	-0.37	-0.18	-0.38	0.94	0.94	0.95	-0.98	0.05	0.15	-0.96	0.05	0.00	0.10	-0.02	1.00			
RTA	0.45	0.49	0.43	-0.32	-0.34	-0.31	0.26	0.27	-0.79	0.25	0.26	0.33	-0.08	-0.14	-0.27	1.00		
LOG(LANDI)	0.04	0.06	0.03	0.24	0.24	0.26	-0.27	0.01	-0.04	-0.24	0.01	0.06	0.04	-0.01	0.32	-0.03	1.00	
LOG(LANDJ)	0.03	0.05	0.03	0.03	0.05	0.00	0.02	-0.02	0.32	0.01	-0.01	-0.04	0.27	0.11	-0.02	-0.22	-0.05	1.00

Notes: All variables are in natural logarithm form except country paired variables and regional cooperation variables including; COL; COML; CONTG; RTA;DSASIA; (cross-section: 1990)

Table 8.3.5A Extended Gravity Model(s) Regression results for Industrial Imports versus Bilateral Tariffs and Environmental Regulations (OECD and South Asia: 1990)

DEPENDENT VARIABLE: LOG INDUSTRIAL IMPORTS 1990	TOTAL INDUSTRIAL IMPORTS	MOST POLLUTIVE INDUSTRIAL IMPORTS	LESS POLLUTIVE INDUSTRIAL IMPORTS
Right Hand Side Variables	(1)	(2)	(3)
Log importer's Per Capita GDP 1990	1.05^{***} (2.70)	1.82^{***} (3.85)	1.56^{***} (3.83)
Log partner Per Capita GDP 1990	1.81^{***} (4.94)	1.48^{***} (3.60)	1.98^{***} (4.98)
Log Distance between exporter and importer country Log D_{ij}	$-.74^{***}$ (-7.91)	-1.08^{***} (-10.03)	$-.69^{***}$ (-7.21)
Log Composite Env. Stringency in importer's country ($LENVT_i$ 90)	-2.93^{**} (-2.19)	-.97 (-.65)	-4.28^{***} (-3.03)
Log Composite Env. Stringency in partner's county ($LENVT_j$ 90)	-4.12^{***} (-2.73)	-3.97^{***} (-2.38)	-4.74^{***} (-2.91)
Log Applied tariff (100+TARIFF$_{ij}$) in percent ad valorem	-4.04^{***} (-2.74)	-.85 (-.49)	-2.35 (-1.57)
Dummy Contiguity ($CONTG_{ij}$)	$.56^{*}$ (1.75)	.50 (1.45)	$.74^{**}$ (2.19)
Dummy Common Language ($COML_{ij}$)	.15 (.58)	.19 (.72)	.32 (1.27)
Dummy Colonial links (COL_{ij})	1.32^{***} (4.58)	1.09^{***} (3.32)	1.29^{***} (4.45)
Log $Land_i$	$.15^{***}$ (3.02)	$.10^{***}$ (1.64)	$.15^{***}$ (2.86)
Log $Land_j$	$.34^{***}$ (6.26)	$.38^{***}$ (6.40)	.32 (15.61)
Adjusted R^2	.57	.66	.52
Constant term	36.14^{***} (3.25)	7.33 (.59)	30.78^{***} (2.79)
F-Statistics	47.47^{***}	69.39^{***}	38.26^{***}
Number of Observations	380	380	380

Notes: *(1) *** denotes significance at the 1% level, ** denotes significance at the 5 % level, * denotes significance at the 10 % level*

: (2) t- statistics are in parentheses.

:(3) F-critical values at 1% level of significance with (11,369) degree of freedom is 3.93

: (4) *Estimation uses White (1980) heteroscedasticity-consistent covariance matrix estimator.*

:(5) All variables both regressand and regressors in estimation of equations (3) are expressed in natural logarithm form, except dummies.

Table-8.3.6A Extended Gravity Model(s) Regression results for Industrial imports versus Bilateral Tariffs and Environmental Regulations (OECD and South Asia: 1990)

DEPENDENT VARIABLE: LOG SOUTH ASIA'S INDUSTRIAL IMPORTS WITH 17 OECD COUNTRIES	TOTAL INDUSTRIAL IMPORTS	MOST POLLUTIVE INDUSTRIAL IMPORTS	LESS POLLUTIVE INDUSTRIAL IMPORTS
Right Hand Side Variables	(1)	(2)	(3)
Log importer's Per Capita GDP 1990	2.72*** (4.89)	2.95*** (4.60)	2.87*** (4.87)
Log partner's Per Capita GDP 1990	1.44*** (4.00)	1.94*** (4.91)	1.65*** (4.41)
Distance between exporter and importer country 1990: ($ln\ D_{ij}$)	-.60*** (-6.31)	-.92*** (-8.81)	-.55*** (-5.55)
Log Composite Env. Stringency in importer's country ($LENVT_i$ 90)	-3.74*** (-2.62)	-3.99** (-2.53)	-4.53*** (-2.93)
Log Composite Env. Stringency in partner's county ($LENVT_j$ 90)	-2.09 (-1.43)	-.85 (-.54)	-3.34** (-2.19)
Log Applied tariff (100+$TARIFF_{ij}$) in percent ad valorem	-2.16* (-1.44)	.22 (.10)	-1.05 (-.72)
Dummy Contiguity ($CONTG_{ij}$)	.61** (1.74)	.55* (1.54)	.77** (2.15)
Dummy Common Language ($COML_{ij}$)	.29 (1.24)	.35 (1.22)	.52** (2.17)
Dummy Colonial links (COL_{ij})	1.29*** (4.84)	1.00*** (2.98)	1.28*** (4.55)
Log Env. Stringency in importer county ($LENVT_i$ 90) *Dummy South Asia 90	**.77*** (2.76)**	**.82*** (2.63)**	**.60** (2.06)**
Log $Land_i$	.15*** (3.45)	.14*** (2.65)	.16*** (3.19)
Log $Land_j$	.17*** (3.32)	.27*** (4.93)	.14*** (2.62)
Adjusted R^2	.54	.65	.50
Constant term	9.03 (.81)	-14.19 (-.95)	9.82 (.87)
F-Statistics	38.77***	60.20***	32.11***
Number of Observations	380	380	380

*Notes: (1) *** denotes significance at the 1% level, ** denotes significance at the 5 % level, * denotes significance at the 10 % level*
: (2) t- statistics are in parentheses.
:(3) F-critical values at 1% level of significance with (12,368) degree of freedom is 2.18
: (4) *Estimation uses White (1980) heteroscedasticity-consistent covariance matrix estimator.*
:(5) All variables both regressand and regressors in estimation of equations (3) are expressed in natural logarithm form, except dummies.

Table-8.3.7A Finding Pollution Heaven Effects for South Asia's Industrial imports using Bilateral Tariffs and Environmental Regulations (OECD and South Asia:1990)

DEPENDENT VARIABLE: LOG INDUSTRIAL IMPORTS 1990	**TOTAL INDUSTRIAL IMPORTS**	**MOST POLLUTIVE INDUSTRIAL IMPORTS**	**LESS POLLUTIVE INDUSTRIAL IMPORTS**
Right Hand Side Variables	(1)	(2)	(3)
Log importer's Per Capita GDP 1990	2.74*** (4.80)	2.84 (4.34)	2.87*** (4.75)
Log partner's Per Capita GDP 1990	1.39 *** (3.74)	1.85 *** (4.51)	1.59*** (4.10)
Distance between exporter and importer country 1990: ($ln\ D_{ij}$)	-.49 *** (-3.00)	-.76 *** (-4.60)	-.43 *** (-2.52)
Log Composite Env. Stringency in importer's country ($LENVT_i$ 90)	-3.56** (-2.44)	-3.75* (-2.35)	-4.31 *** (-2.73)
Log Composite Env. Stringency in partner's county ($LENVT_j$ 90)	-2.06 (-1.38)	-.76 (-.47)	-3.26 (-2.10)
Log Applied tariff (100+TARIFF$_{ij}$) in percent ad valorem	-2.28 (-1.48)	.43 (.19)	-1.06 (-.72)
Dummy Contiguity ($CONTG_{ij}$)	.69** (1.98)	.64 ** (1.76)	.84 ** (2.32)
Dummy Common Language ($COML_{ij}$)	.22 (.87)	.25 (.81)	.43 (1.67)
Dummy Colonial links (COL_{ij})	1.39 *** (4.82)	1.15*** (3.08)	1.40*** (4.63)
Log Env. Stringency in partner's county ($LENVT_j$ 90) *Dummy South Asia 90)	**.74 *** (2.63)**	**.71 ** (2.31)**	**.59 ** (2.00)**
Log Land$_i$	.16*** (3.41)	.14*** (2.74)	.16*** (3.16)
Log Land$_j$	.16*** (3.32)	.27*** (4.93)	.51*** (7.53)
Adjusted R^2	.54	.66	.50
Constant term	7.83 (.66)	-16.58 (-1.07)	7.76 (.66)
F-Statistics	35.79 ***	55.32***	29.68***
Number of Observations	380	380	380

*Notes: (1) *** denotes significance at the 1% level, ** denotes significance at the 5 % level, * denotes significance at the 10 % level*

: (2) t- statistics are in parentheses.

:(3) F-critical values at 1% level of significance with (12,368) degree of freedom is 2.18

: (4) *Estimation uses White (1980) heteroscedasticity-consistent covariance matrix estimator.*

:(5) All variables both regressand and regressors in estimation of equations (3) are expressed in natural logarithm form, except dummies

Appendix 8.4 Descriptive Statistics and Correlation Matrixes: 1998 Data

Table 8.4.1A

Descriptive Statistics 1998: Exports Data

variables	LOG(TE98)	LOG(MPE98)	LOG(LPE98)	LOG(CTT98)	LOG(CTM98)	LOG(CTL98)	LOG(GDPPCAPITAI)	LOG(GDPPCAPITAJ)	LOG(DIJ)	LOG(ESI)	LOG(ESJ)	CONTG	COML	COL	LOG(LANDI)	LOG(LANDJ)	RTA	DSASIA
Mean	8.76	6.62	8.05	4.68	4.67	4.68	10.05	10.05	8.31	4.14	4.14	0.07	0.16	0.06	10.66	10.66	0.42	0.15
Median	9.00	7.12	8.24	4.65	4.63	4.65	10.42	10.42	8.69	4.19	4.19	0.00	0.00	0.00	10.40	10.40	0.00	0.00
Maximum	14.13	12.64	13.52	5.01	5.06	5.04	10.93	10.93	9.88	4.39	4.39	1.00	1.00	1.00	13.73	13.73	1.00	1.00
Minimum	3.76	0.01	2.41	4.61	4.61	4.61	7.35	7.35	5.84	3.68	3.68	0.00	0.00	0.00	8.13	8.13	0.00	0.00
Std. Dev.	2.13	2.75	2.14	0.10	0.11	0.11	0.99	0.99	1.11	0.20	0.20	0.26	0.37	0.24	1.61	1.61	0.49	0.36
Skewness	-0.15	-0.59	-0.12	2.03	2.31	1.95	-1.92	-1.92	-0.48	-1.12	-1.12	3.26	1.82	3.59	0.58	0.58	0.31	1.96
Kurtosis	2.52	2.69	2.66	6.22	7.41	5.91	5.01	5.01	2.03	3.35	3.35	11.65	4.32	13.90	2.65	2.65	1.10	4.84
Jarque-Bera	4.96	23.59	2.74	423.89	644.62	374.22	297.98	297.98	29.17	80.93	80.93	1859.52	238.28	2698.46	23.56	23.56	63.48	297.19
Probability	0.08	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum	3329.99	2515.49	3057.48	1777.13	1773.28	1779.37	3819.62	3819.62	3156.70	1573.04	1573.04	28.00	62.00	24.00	4051.47	4051.47	161.00	57.00
Sum Sq. Dev.	1724.34	2866.81	1728.07	3.95	4.37	4.29	374.12	374.12	470.59	15.35	15.35	25.94	51.88	22.48	979.58	979.58	92.79	48.45
Observations	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00

Notes: All variables are in natural logarithm form except country paired variables and regional cooperation variables including; COL; COML; CONTG; RTA;DSASIA; (cross-section: 1998)

Table 8.4.2A

Descriptive Statistics 1998: Imports Data

	LOG(TIMP98)	LOG(MPIMP98)	LOG(LPIMP98)	LOG(CTT98)	LOG(CTM98)	LOG(CTL98)	LOG(GDPPCAPITAI)	LOG(GDPPCAPITAJ)	LOG(DIJ)	LOG(ESI)	LOG(ESJ)	CONTG	COML	COL	LOG(LANDI)	LOG(LANDJ)	RTA	DSASIA
Mean	8.57	6.61	7.79	4.68	4.67	4.68	10.05	10.05	8.31	4.14	4.14	0.07	0.16	0.06	10.66	10.66	0.42	0.15
Median	8.75	7.10	7.90	4.65	4.63	4.65	10.42	10.42	8.69	4.19	4.19	0.00	0.00	0.00	10.40	10.40	0.00	0.00
Maximum	13.90	12.42	13.42	5.01	5.06	5.04	10.93	10.93	9.88	4.39	4.39	1.00	1.00	1.00	13.73	13.73	1.00	1.00
Minimum	2.98	0.00	1.61	4.61	4.61	4.61	7.35	7.35	5.84	3.68	3.68	0.00	0.00	0.00	8.13	8.13	0.00	0.00
Std. Dev.	2.14	2.73	2.14	0.10	0.11	0.11	0.99	0.99	1.11	0.20	0.20	0.26	0.37	0.24	1.61	1.61	0.49	0.36
Skewness	-0.13	-0.67	-0.05	2.03	2.31	1.95	-1.92	-1.92	-0.48	-1.12	-1.12	3.26	1.82	3.59	0.58	0.58	0.31	1.96
Kurtosis	2.53	2.88	2.63	6.22	7.41	5.91	5.01	5.01	2.03	3.35	3.35	11.65	4.32	13.90	2.65	2.65	1.10	4.84
Jarque-Bera	4.61	28.42	2.30	423.89	644.62	374.22	297.98	297.98	29.17	80.93	80.93	1859.52	238.28	2698.46	23.56	23.56	63.48	297.19
Probability	0.10	0.00	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum	3255.10	2510.40	2961.94	1777.13	1773.28	1779.37	3819.62	3819.62	3156.70	1573.04	1573.04	28.00	62.00	24.00	4051.47	4051.47	161.00	57.00
Sum Sq. Dev.	1733.60	2820.80	1733.60	3.95	4.37	4.29	374.12	374.12	470.59	15.35	15.35	25.94	51.88	22.48	979.58	979.58	92.79	48.45
Observations	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00

Notes: **All variables are in natural logarithm form except country paird variables and regional cooperation variables including; COL; COML; CONTG; RTA;DSASIA; (cross-section: 1998)**

Table 8.4.3A

Correlation Matrix 1998: Exports Data

VARIABLES	LOG(TE98)	LOG(MPE98)	LOG(LPE98)	LOG(CTT98)	LOG(CTM98)	LOG(CTL98)	LOG(GDPPCAPITAI)	LOG(GDPPCAPITAJ)	LOG(DIJ)	LOG(ESI)	LOG(ESJ)	CONTG	COML	COL	LOG(LANDI)	LOG(LANDJ)	RTA	DSASIA
LOG(TE98)	1.00																	
LOG(MPE98)	0.90	1.00																
LOG(LPE98)	0.99	0.86	1.00															
LOG(CTT98)	-0.33	-0.53	-0.31	1.00														
LOG(CTM98)	-0.33	-0.53	-0.31	0.98	1.00													
LOG(CTL98)	-0.34	-0.52	-0.32	0.99	0.96	1.00												
LOG(GDPPCAPITAI)	0.36	0.55	0.35	-0.86	-0.86	-0.85	1.00											
LOG(GDPPCAPITAJ)	0.41	0.25	0.41	0.07	0.09	0.07	-0.05	1.00										
LOG(DIJ)	-0.48	-0.50	-0.45	0.30	0.25	0.31	-0.17	-0.17	1.00									
LOG(ESI)	0.19	0.41	0.17	-0.76	-0.78	-0.74	0.89	-0.05	-0.11	1.00								
LOG(ESJ)	0.25	0.12	0.26	0.07	0.09	0.07	-0.05	0.89	-0.11	-0.05	1.00							
CONTG	0.27	0.26	0.27	-0.06	-0.06	-0.07	0.01	0.01	-0.46	0.01	0.01	1.00						
COML	0.00	0.00	0.02	0.17	0.15	0.17	-0.09	-0.09	0.16	-0.03	-0.03	0.15	1.00					
COL	0.14	0.11	0.15	0.02	0.00	0.01	0.00	0.00	0.04	0.01	0.01	0.09	0.41	1.00				
LOG(LANDI)	0.02	0.05	0.03	0.27	0.17	0.27	-0.10	0.01	0.31	0.01	0.00	-0.02	0.28	0.09	1.00			
LOG(LANDJ)	0.09	0.09	0.08	0.07	0.06	0.08	0.01	-0.10	0.31	0.00	0.01	-0.02	0.28	0.09	-0.05	1.00		
RTA	0.48	0.52	0.47	-0.40	-0.35	-0.41	0.27	0.28	-0.79	0.22	0.21	0.33	-0.08	-0.14	-0.24	-0.22	1.00	
DSASIA	-0.35	-0.54	-0.34	0.91	0.92	0.91	-0.98	0.05	0.15	-0.88	0.05	-0.01	0.09	-0.02	0.12	-0.01	-0.27	1.00

Notes: **All variables are in natural logarithm form except country paird variables and regional cooperation variables including; COL; COML; CONTG; RTA;DSASIA; (cross-section: 1998)**

Table 8.4.4A

Correlation Matrix 1998: Imports Data

VARIABLES	LOG(TIMP98)	LOG(MPIMP98)	LOG(LPIMP98)	LOG(CTT98)	LOG(CTM98)	LOG(CTL98)	LOG(GDPPCAPITAI)	LOG(GDPPCAPITAJ)	LOG(DIJ)	LOG(ESI)	LOG(ESJ)	CONTG	COML	COL	LOG(LANDI)	LOG(LANDJ)	RTA	DSASIA
LOG(TIMP98)	1																	
LOG(MPIMP98)	0.89	1.00																
LOG(LPIMP98)	0.99	0.84	1.00															
LOG(CTT98)	-0.35	-0.18	-0.36	1.00														
LOG(CTM98)	-0.35	-0.17	-0.37	0.98	1.00													
LOG(CTL98)	-0.36	-0.19	-0.37	0.99	0.96	1.00												
LOG(GDPPCAPITAI)	0.39	0.21	0.40	-0.86	-0.86	-0.85	1.00											
LOG(GDPPCAPITAJ)	0.38	0.60	0.34	0.07	0.09	0.07	-0.05	1.00										
LOG(DIJ)	-0.44	-0.47	-0.42	0.30	0.25	0.31	-0.17	-0.17	1.00									
LOG(ESI)	0.23	0.09	0.24	-0.76	-0.78	-0.74	0.89	-0.05	-0.11	1.00								
LOG(ESJ)	0.21	0.47	0.16	0.07	0.09	0.07	-0.05	0.89	-0.11	-0.05	1.00							
CONTG	0.27	0.26	0.27	-0.06	-0.06	-0.07	0.01	0.01	-0.46	0.01	0.01	1.00						
COML	0.01	-0.01	0.03	0.17	0.15	0.17	-0.09	-0.09	0.16	-0.03	-0.03	0.15	1.00					
COL	0.17	0.11	0.17	0.02	0.00	0.01	0.00	0.00	0.04	0.01	0.01	0.09	0.41	1.00				
LOG(LANDI)	0.13	0.13	0.12	0.27	0.17	0.27	-0.10	0.01	0.31	0.01	0.00	-0.02	0.28	0.09	1.00			
LOG(LANDJ)	0.04	0.06	0.03	0.07	0.06	0.08	0.01	-0.10	0.31	0.00	0.01	-0.02	0.28	0.09	-0.05	1.00		
RTA	0.46	0.49	0.44	-0.40	-0.35	-0.41	0.27	0.28	-0.79	0.22	0.21	0.33	-0.08	-0.14	-0.24	-0.22	1.00	
DSASIA	-0.38	-0.20	-0.40	0.91	0.92	0.91	-0.98	0.05	0.15	-0.88	0.05	-0.01	0.09	-0.02	0.12	-0.01	-0.27	1.00

Notes: **All variables are in natural logarithm form except country paird variables and regional cooperation variables including; COL; COML; CONTG; RTA;DSASIA; (cross-section: 1998)**

Table 8.4.5A Extended Gravity Model(s) Regression results for Industrial Imports versus Bilateral Tariffs and Environmental Regulations (OECD and South Asia: 1998)

DEPENDENT VARIABLE: LOG SOUTH ASIA INDUSTRIAL IMPORTS 1998	TOTAL INDUSTRIAL IMPORTS	MOST POLLUTIVE INDUSTRIAL IMPORTS	LESS POLLUTIVE INDUSTRIAL IMPORTS
Right Hand Side Variables	(1)	(2)	(3)
Log Exporter's Per Capita GDP_i *1998*	1.75^{***} (11.50)	1.53^{***} (8.17)	1.76^{***} (10.54)
Log Importer's Per Capita GDP_j *1998*	1.98^{***} (15.85)	2.35^{***} (17.05)	2.13^{***} (16.02)
Log Distance between exporter and importer country Log D_{ij}	$-.84^{***}$ (-12.04)	-1.24^{***} (-14.98)	$-.73^{***}$ (-10.01)
Log Env. Stringency in importer's county (ES_i)	-7.13^{***} (-12.14)	-7.23^{***} (-9.81)	-7.07^{**} (-11.54)
Log Env. Stringency in partner's county (ES_j)	-6.89^{***} (-11.59)	-4.60^{***} (-10.88)	-7.97^{***} (-12.67)
Log Applied tariff (100+TARIFF$_{ij}$) in percent ad valorem	**-3.65^{***} (-3.25)**	**-2.88^{***} (-2.37)**	**-3.82^{***} (-3.38)**
Dummy Contiguity ($CONTG_{ij}$)	.34* (1.44)	.16 (.59)	$.61^{***}$ (2.42)
Dummy Colonial links (COL_{ij})	1.14^{***} (6.34)	$.84^{***}$ (3.59)	1.19^{***} (6.32)
Log $Land_i$	$.53^{***}$ (12.44)	$.64^{***}$ (13.05)	$.50^{***}$ (11.01)
Log $Land_j$	$.38^{***}$ (10.69)	$.55^{***}$ (12.07)	$.37^{***}$ (9.93)
Adjusted R^2	.73	.75	.71
Constant term	43.01^{***} (6.65)	27.60^{***} (3.74)	45.45^{***} (7.09)
F-Statistics	102.59^{***}	116.98^{***}	95.40^{***}
Number of Observations	380	380	380

Notes: *(1) *** denotes significance at the 1% level, ** denotes significance at the 5 % level, * denotes significance at the 10 % level*

: (2) t- statistics are in parentheses.

:(3) F-critical values at 1% level of significance with (10,370) degree of freedom is 2.32

: (4) *Estimation uses White (1980) heteroscedasticity-consistent covariance matrix estimator.*

:(5) All variables both regressand and regressors in estimation of equations (3) are expressed in natural logarithm form, except dummies. Data is covering again three South Asian and 17 OECDs countries.

Table 8.4.6A **Pollution Haven Effects in South Asia for OECD's Countries: Manufacturing Imports Cross-Section Data-1998**

DEPENDENT VARIABLE: LOG SOUTH ASIA INDUSTRIAL IMPORTS 1998	**TOTAL INDUSTRIAL IMPORTS**	**MOST POLLUTIVE INDUSTRIAL IMPORTS**	**LESS POLLUTIVE INDUSTRIAL IMPORTS**
Right Hand Side Variables	(1)	(2)	(3)
Log Exporter's Per Capita GDP_i *1998*	1.19*** (3.15)	.36 (.97)	1.16*** (2.95)
Log Importer's Per Capita GDP_j *1998*	1.96 *** (15.42)	2.31*** (16.88)	2.11*** (15.60)
Log Distance between exporter and importer country Log D_{ij}	-.90*** (-11.39)	-1.33*** (-15.71)	-7.86 *** (-12.39)
Log Env. Stringency in importer's county (ES_i)	-7.22*** (-12.09)	-7.38*** (-9.94)	-7.24** (-11.43)
Log Env. Stringency in partner's county (ES_j)	-6.78*** (-11.34)	-4.44*** (-6.88)	-7.86** (-12.39)
Log Applied tariff (100+TARIFF$_{ij}$) in percent ad valorem	**-1.02 (-.50)**	**1.38 (.87)**	**-1.27 (-.63)**
Dummy Contiguity ($CONTG_{ij}$)	.20 (1.17)	.06 (.21)	.54** (2.12)
Dummy Colonial links (COL_{ij})	1.10*** (6.03)	.84*** (3.59)	1.19*** (6.32)
Log Env. Stringency in partner's county (ES_j)*Dummy South Asian	-.55 (-1.61)	-1.07*** (-3.37)	-.58 (-1.63)
Log $Land_i$	.53*** (12.44)	.66*** (13.20)	.50*** (11.01)
Log $Land_j$	.38*** (10.69)	.55*** (12.07)	.49*** (11.27)
Adjusted R^2	.74	.76	.72
Constant term	37.50 *** (5.06)	20.91 *** (3.04)	40.98*** (5.81)
F-Statistics	94.11***	109.95***	87.67***
Number of Observations	380	380	380

Notes: *(1) *** denotes significance at the 1% level, ** denotes significance at the 5 % level, * denotes significance at the 10 % level*

: (2) t- statistics are in parentheses.

:(3) F-critical values at 1% level of significance with (11,369) degree of freedom is 2.18

: (4) *Estimation uses White (1980) heteroscedasticity-consistent covariance matrix estimator.*

:(5) All variables both regressand and regressors in estimation of equations (3) are expressed in natural logarithm form, except dummies. Data is covering again three South Asian and 17 OECDs countries.