NORTH-SOUTH MIGRATION OF "DIRTY" INDUSTRIES AND THE "POLLUTION-HAVEN" HYPOTHESIS: A CROSS-COUNTRY STUDY

Dissertation submitted to Jawaharlal Nehru University in partial fulfilment of the requirements for The award of the Degree of

MASTER OF PHILOSOPHY

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CERTIFICATE

This is to certify that the dissertation entitled **NORTH-SOUTH MIGRATION OF "DIRTY" INDUSTRIES AND THE "POLLUTION-HAVEN" HYPOTHESIS: A CROSS-COUNTRY STUDY** submitted in partial fulfilment for the M.Phil degree of this university has not been previously submitted for this or any other university and is my original work.

(SANKHA MUKHERJEE)

We recommend that the dissertation may be placed before the examiners for evaluation.

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CHAPTER I

INTRODUCTION

Public awareness of the actual and potential threats to the environment has grown rapidly in recent years. Concerns about deteriorating ambient quality and natural resource depletion have raised the spectre of "irreversibility" – the fear that irreparable damage is being done to the planet through the exhaustion of natural and finite resources, the contraction of biodiversity and the cumulative destruction of air, land and water resources. This has resulted in severe pressures on governments, particularly in industrial countries, to develop policies to address environmental degradation. Choices have to be made from among alternative policy approaches, and these alternatives vary greatly as to their costliness and efficacy.

Trade and environment, and environmental issues more generally, may seem to have attracted widespread attention only recently. But this is illusory, since a similar debate raged some thirty years ago, only to die down again in the late 1970s. There are several reasons why these issues came and went, only to come back again more strongly, but what is important is that, much of the current agenda was debated and analyzed in the earlier years. Many of the insights gained through earlier work remain relevant today. In the 1990s, the issues concerning the relationship between trade liberalization and the environment in the world economy, re-emerged. While this work is still in its infancy, it has already produced a number of important insights. On the whole, however, this literature has been limited to a set of broad questions about the trade and environment relationship. How does economic growth affect the environment? How does trade liberalization affect environmental quality? And, how do environmental regulations affect trade and competitiveness?

The profession has not approached a consensus on these 3 questions. However, policy lessons can be drawn from this inconclusiveness.

The last decade of the twentieth century was similar to the end of the nineteenth century in that the world's economies were vigorously opening up themselves to international trade. One aspect of trade liberalization that did not concern society at the turn of the last century was how such openness might affect the earth's environment. Discussions in the 1990s, however, were saturated with questions regarding the environmental impact of trade liberalization. For almost three-quarters of the twentieth century, ecological concerns were not only absent from the international political arena, they were largely absent from economic thinking as well. The reason for this is that, many environmental problems that are now major concerns were either not problems at all or not recognized to be problems at that time. In fact, the economic rationale for the multitude of trade liberalization agreements that have been forged in the post-war period stem from two branches of economics: "growth theory" and "trade theory".

Awareness of the problems associated with environmental pollution and natural resource degradation did not become widespread until the 1960s and the 1970s. It is against this backdrop that the sub-field of environmental economics emerged. These economists surmised that environmental problems were prevalent because the market was not valuing the environment properly, sending mixed signals that gave firms the perverse incentive to pollute (Pearce and Turner, 1990). Environmental economists borrowed the concept of externalities from earlier welfare economists. An externality exists, when an activity by one economic agent causes an uncompensated gain or loss of welfare to another economic agent. In the environmental context, economists began seeing producers and consumers as not incorporating the full environmental costs (or externalities) of economic exchange into their transactions.

More recently, a sub-field called "ecological economics" has emerged, which views the economy as seminally intertwined with the ecological processes. Drawing on the natural sciences, these economists assert that the earth's ecology is inherently limited in its ability to both supply the economy with matter and energy and absorb the waste products created in the economic process. At some point, economic activity could cause catastrophic and irreversible ecological damage. Traditional environmental economic assumptions regarding marginal environmental costs and benefits of economic activity, do not square neatly with this approach (Harris, et al, 1995).

In the 1990s, tempers flared, when it was suggested that if the benefits of trade liberalization were not derived from transactions where the externalities related to trade had not been internalised, then perhaps the costs of trade liberalization could outstrip those benefits. Trade and environment discussions in economics dates back to the early and mid 1970s (d'Arge and Kneese, 1972; Grubel, 1975; Pethig, 1976), but attracted only scant attention. It was not until the early 1990s, in the midst of international negotiations on the "General Agreement on Tariffs and Trade" (GATT) and the "North-American Free Trade Agreement"

(NAFTA) that these issues came to a head. The most well-known forum for this debate occurred in the pages of "Scientific American" in 1993, where prominent trade economist Jagdish Bhagwati and ecological economist Herman Daly presented opposing views on the relationship between trade and environment in economics.

Drawing from the trade and growth theories, Bhagwati argued that trade liberalization is an efficient route to economic growth for nations. Economic growth, he added, enables governments to raise taxes necessary for environmental protection. Indeed, such raising incomes and freer trade could enable countries to import pollution-control technologies from countries that would be closed off from them, without trade. Daly, on the other hand, argued that the environmental costs of economic growth were outpacing its benefits and therefore trade-led growth was undesirable. Evoking environmental economics, Daly added that trade liberalization leads to inefficient allocation of resources, because it encourages trade between nations that do not internalize their costs. This could cause "pollution-havens", where companies move into nations with lower pollution-control standards. In fact, he went on to argue that nations that did internalize their costs should impose tariffs on those who did not.

These seemingly opposed views can, in fact, be reconciled in a broader theoretical perspective. While the "Scientific American" exchange was quite heated, neither Bhagwati nor Daly was necessarily wrong. This was revealed in another ground-breaking article in 1993 that synthesized these views into a framework that has largely characterized the trade and environment literature since then. Economists Gene Grossman and Alan Krueger identified 3 mechanisms by which trade and investment liberalization affect the environment: scale, composition and technique effects.

The "scale effect" occurs when liberalization causes an expansion of economic activity. If the nature of that activity is unchanged, but the scale is growing, then pollution and resource depletion will increase along with output. The "composition effect" occurs when increased trade leads nations to specialize in the sectors where they enjoy a comparative advantage. When comparative advantage is derived from differences in environmental stringency (i.e. the "pollution-haven" effect), then the composition effect will exacerbate existing environmental problems in the countries with relatively lax regulations. The "technique effects", or changes in resource extraction and production technologies, can potentially lead to a decline in pollution per unit of output for two reasons. First, the liberalization of trade and investment may encourage the transfer of cleaner technologies to developing countries. Second, if economic liberalization increases income levels, the newly affluent citizens may demand a cleaner environment.

Framing the interaction in this light shows that neither Bhagwati nor Daly was entirely wrong. Bhagwati was essentially arguing that trade could cause the technique effect to occur, while Daly feared the possibility of the negative scale and composition effects. Grossman and Krueger's framework is now considered to be the "standard way of thinking about the problem, and a helpful tool for analyzing the issues involved" (Frederikson, 1999).

One of the critical issues that has emerged as a result of recent globalization trends is the trade-environment competitiveness issue. Perhaps the most politically charged element of the trade and environment debate involves the so-called "pollution-haven" hypothesis. It is generally believed, based on classical economic thought, that free trade will open the floodgates for the migration of "dirty" industries to countries with lax environmental standards. Thus, there are already moves to incorporate restrictive trade practices in negotiations at various multilateral trade and environmental initiatives. However, many analysts acknowledge that this will further damage global environmental welfare, apart from polarizing trade and investment patterns. Analytical work on the trade-environment competitiveness issue, or more specifically, the "pollution-haven" hypothesis, has at best, left the issue ambiguous.

Global integration of the goods markets has increased in the last 20 years due to reduction of barriers to trade worldwide. The increased globalization of the goods markets has led to concerns over the impact of globalization on the environment, because the current regulatory framework for environmental protection fails in the presence of globalization. This is because the vast majority of environmental policies and regulations are designed and implemented at the level of the nation-states, which leads to differences in the level of environmental regulations across countries.

Differences in the levels of environmental regulations across countries are due to several reasons: First, differences in the domestic valuation of environmental quality across countries will result in countries' choosing different levels of environmental regulations. Differences in the valuation of environmental quality are due to differences in assimilative capacity between countries i.e. differences in the capacity of countries to tolerate, dilute, absorb or ignore pollution. It will be welfare maximizing for a country if the government sets environmental regulations at a level that reflects the domestic valuation of environmental quality. However, in the presence of cross-border or even global effects of environmental pollution, this policy is not welfare maximizing for the world as a whole, because it imposes negative externalities on foreign countries.

A second reason for differences in *de-facto* environmental regulations are differences in the institutional capacity of countries to design, implement and monitor environmental regulations. Developing countries have much less formal regulation of environmental issues than developed countries. This is due to lack of clear and legally binding regulations, lack of appropriate measurement equipment, and lack of trained enforcement personnel. As a result, environmental enforcement agencies have inadequate information on emissions and other environmental enforcement criteria of regulated companies. Therefore, the government-imposed "price of pollution" is nearly zero for many manufacturing facilities in these economies. Thus, the *de facto* level of environmental regulation does not frequently reflect the domestic valuation of environmental quality and is thus not welfare maximizing for the country.

The central concern in the trade, environment and competitiveness issue is how the environment affects international trade competitiveness. This trade-environment competitiveness debate involves two intrinsically different, but closely linked types of issues namely: (i) the analytical issues and (ii) the negotiation-related issues.

Among the main analytical issues are (i) the impact of trade on environment, namely the impact of trade liberalization on the environment and the impact of environment-related trade measures on environment and (ii) the impact of environmental regulations on trade patterns (or competitiveness). The negotiation-related issues on the other hand, involve (i) trade measures for international environmental governance and its relationship with trade rules and (ii) the trade effects of domestic environmental measures.

The trade-environment competitiveness issue is basically an analytical issue. However, when combined with politically-oriented concepts such as "level playing field", it becomes a negotiation-related issue, or in other words, the "fair trade issue".

From the analytical perspective, it is widely claimed that a country with abundant environmental resources will exploit that comparative advantage in the sense that it specializes in "pollution-intensive" goods in the international market. Thus, free trade is criticized for its tendency to facilitate migration of pollution-intensive industries from countries with higher environmental standards to those with lower environmental standards, thus damaging overall global environmental welfare.

While many analysts provide strong theoretical arguments for the existence of "pollution-havens", empirical evidence seems to be ambiguous. It is important to note, however, that, while analysts fail to provide clear evidence of competitiveness effects from stringent environmental regulations, policy makers, politicians, and business people are absolutely convinced of such impacts. In fact, much of the negotiations at the international fora are based on the fact that environment impacts directly on international competitiveness and thus needs to be regulated closely in order to discourage any "free-riders". Examples of such a stance are quite discernible in international fora, some of which have been cited in the following discussion.

The fair trade issue is most vocally advocated by the United States. According to Geza Feketekuty (1992), "the United States has the most stringent and well organized legal system for anti-trust, environmental protection and labour standards in the world. Since the American firms have a disadvantage due to higher regulatory standards than those of competing firms in developing countries, there arises the need to flatten the uneven playing field, thus making the game fair".

The WTO has recognized that the trade-environmental competitiveness issue will have grave implications for free trade and while acknowledging that "trade measures have been and will continue to be an important tool for achieving important environmental objectives,"[1] expressed concern that "environmental measures and requirements may adversely affect the competitiveness and market access opportunities of small and medium-sized enterprises especially in developing countries".[2]

One of the most recent international initiatives which is expected to have a great impact on international trade and multilateral environmental governance, is the negotiations on a "Multilateral Agreement on Investments" (MAI).[3] Already, there have been provisions to "discipline" countries with lax environmental standards to conform to international standards. A group of American environmentalists have called for exceptions to MAI provisions, in order to allow for measures to protect the environment, and for the promulgation of mandatory "environmental readiness criteria", which would have to be met before countries could sign the MAI. Another group has called for a broad "Sustainable Development Investment Agreement" (Earth Council, 1996). OECD negotiators have offered to incorporate environmental concerns in the MAI by including a "pollution-haven" clause, whereby countries would pledge not to encourage foreign investment by lowering standards (OECD, 1997).

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1 Report (1996) of the Committee on Trade and Environment, WTO.

2 CTE conclusions and Recommendations to the First WTO Ministerial Meeting held at Singapore, December 1996.

3 The MAI is designed primarily to promote foreign investors' interests by reducing political risk and enhancing the principle of national treatment. The rules and principles which shape investment decisions, both domestic and foreign are crucial to good environmental management. An international investment agreement represents an opportunity to build a global policy framework that encourages the investment necessary for good environmental management. The framework could include policy guidelines such as requirements for environmental and social impact assessment prior to undertaking investment projects; country standards; adherence to international labour and human rights norms; and capacity-building commitments to transfer technology and train local personnel.

The present work considers the trade-environment competitiveness issue, with its primary focus being on the "pollution-haven" hypothesis. The idea is to test the "pollution-haven" hypothesis using cross-country data on foreign direct investment (FDI) flows. The intention is to test whether FDI flows into developing countries have been significantly induced by lax environmental regulation standards, and thus to reflect on the validity (or non-validity) of the "pollution-haven" hypothesis.

Chapter II reviews the available literature on the issue of migration of "dirty" industries due to environmental factors. While it is impossible, nor feasible to review all work done in this area, an attempt will be made to bring out the diversity of theoretical and analytical work so as to cover as comprehensively as possible different view points and empirical work conducted by analysts so far. The primary purpose of this literature review is to see whether each of these studies adequately and comprehensively addresses the essence of the "pollution-haven" debate. Thus, it is an attempt to analyze whether academic and empirical work done so far supports or rather complements the general perception held by political analysts, policy makers, and the business community on the issue of trade, environment and competitiveness.

As mentioned earlier, this study tests the validity or otherwise of the "pollution-haven" hypothesis using a cross-country data set on FDI flows. We examine the "pollution-haven" hypothesis from MNCs' capital investment behaviour, while recognizing that a great volume of capital flows actually occur through media other than the MNCs, e.g. multilateral lending agencies, official aid, portfolio investment, etc. However, this need not be a major limitation to our study. Given that MNCs continue to increase their dominance of world trade and investment activity, an appraisal of the validity of the "pollution-haven" hypothesis based on the behaviour of these firms will become increasingly valuable. Chapter III presents the data and methodology of the study. We present the model for the determinants of FDI and put forward the justification for our choice of variables. Further, we provide a rationale for the methodology used and also lay down the data sources.

The data set used is a cross-country data set for 51 developing countries. To substantiate the validity or otherwise of the "pollution-haven" hypothesis, we run various cross-country regressions for the year 1996. The regression model used is linear and the methodology underlying the empirical analysis is the method of least-squares, the rationale for the use of which is dealt with in Chapter III. The testing of the model and the analysis of the regression results have been put forth in Chapter IV. Finally, Chapter V provides a summary of the findings and some concluding remarks.

CHAPTER II

THE "POLLUTION-HAVEN" HYPOTHESIS: A REVIEW OF THE LITERATURE

Environmental regulations have proceeded at different paces in different countries of the world. These differences are particularly pronounced between industrialized countries and developing countries, and have given rise to much controversy and debate on the influence of environmental regulations on economic growth in an open economy. One important aspect of the debate is the impact of environmental regulations on international competitiveness and location of polluting industries. Overly strong regulations are hypothesized to lead to "industrial flight", whereas lax regulations are feared to turn the country into a "pollution-haven". The underlying hypothesis is that, environmental regulations have a strong effect on industrial location and that differential regulations between two countries will at the minimum induce specialization and probably significant capital movements to the country with the weaker regulations.

Both the "pollution-haven" and "industrial flight" hypotheses suggest that increasing globalization allows firms to take advantage of differences in national environmental regulations, by relocating production to countries with lower levels of environmental regulations. The "pollution-haven" hypothesis (Walter, 1982) suggests that falling trade barriers will lead to the location of pollution-intensive industries in countries with lower levels of environmental regulations. Thus, low regulation countries will become production platforms for pollution-intensive goods, and export them to the rest of the world. This will lead to a deterioration of worldwide environmental quality compared to a situation in which these goods would be produced in high regulation countries, because lower levels of pollution abatement will be used. Empirical studies of the "pollution-haven" hypothesis have analyzed changes in the international location of pollution-intensive industries after environmental regulations started to become more stringent in developed countries in the early 1970s (Jaffe, Peterson and Portney, 1995). These studies found that developing countries attracted more pollution-intensive industrial sectors when environmental regulation in industrialized countries increased in the 1970s and 1980s (Low and Yeats, 1992; Lucas, Wheeler and Hettige, 1992). However, it is not clear whether this is due to a normal pattern of evolution of industrial development, in which pollution-intensive industries such as steel are associated with early stages of industrialization. Thus, these studies cannot distinguish the effects of trade and increased globalization from the effects of the industrialization process of the country.

There is, however, some theoretical justification for the "pollution-haven" hypothesis. Several authors use a general equilibrium framework[4] to conclude that a country with lenient environmental regulations will tend to specialize in pollution-intensive industries or at least enjoy a comparative advantage in such industries. This implies that it is optimal for polluting industries to transfer their production facilities to "pollution-havens". Multinational corporations (MNCs), which have already distributed overseas production, would appear to be particularly likely to organize their overseas operations, locating production facilities in countries with lax environmental regulations.

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4 Siebert (1974), Pethig (1976), McGuire (1982), Baumol and Oates (1988) and Carraro and Siniscalco (1992).

An alternative view without as much theoretical justification is that, environmental regulations have no effect on plant location. The basic argument is either that cost effects are so small as to be negligible or that increased environmental quality is reflected in reduced employee compensation. Without regulation, employees would have to be paid more to live and work in polluted conditions. Thus, in equilibrium, the total costs will be the same. The empirical literature to date tends to support the view that environmental regulations do not matter.

Even though existing studies suggest little or no evidence of industrial relocation, arguments over "pollution-havens" exist. The question arises: why? One answer lies in the fact that the existing literature is primarily based on anecdotes and scattered case studies. Even the best studies, such as Leonard (1988), make no effort to assess statistically, the relationship between the distribution of US foreign investment and pollution intensity. Most of these studies make no attempt to control for other factors which may play a role in determining foreign investment, such as large protected markets. Many of the earlier studies (Pearson, 1985 and 1987; Walter, 1982) use evidence from the 1970s and early 1980s, when the flow of foreign investment to developing countries was not as high as it is today. One exception is the work by Grossman and Krueger (1993), which focuses on maquiladora activity in Mexico. Yet, their research also serves to highlight the difficulty in explaining the pattern of US investment abroad. They show that neither pollution abatement costs nor other likely determinants can adequately explain the maquiladora activity in Mexico.

2.1 The Conceptual Framework

Although, there is a growing literature on the determinants of global environmental quality, little research has been done to test the "pollution-haven" hypothesis. The literature on the "pollution-haven" hypothesis is sparse, particularly in theoretical treatment. Attempts thus far seem predisposed to extending existing trade models. The Heckscher-Ohlin theorem has provided a starting point for most of the early theoretical evaluation on how environmental regulations affect the pattern of international trade and investment. According to the neo-classical trade theory, an increase in regulatory stringency (relative to that experienced by competitors) would lead to a fall in net exports of heavily regulated sectors within an economy, relative to the net exports of less stringency regulated sectors. This is an application of the Heckscher-Ohlin theorem, which states that a country will export that commodity which requires relatively intensive use of the factors of production which are found locally in relative abundance. The environment is brought into this framework by treating the capacity of the environment to absorb pollution as a factor of production, access to which is reduced as pollution control is applied (or made more stringent). Reduced access to environmental resources or assimilative capacity can be expected to reduce exports of the goods and services, which use that factor (i.e. environment) extensively. In other words, stringent pollution control policies would reduce a country's comparative advantage in assimilative capacity, which would then result in reduced exports (and increased imports) of pollution-intensive products.

Nearly all studies on the issue of trade, environment competitiveness have employed this theoretical underpinning in their analyses. Thus, the environment is considered as a factor of comparative advantage (or disadvantage), usually measured in terms of pollution abatement costs, and is fed into the classical factor models to analyze its significance in translocation of industries. Most of these studies implicitly make the assumption that there is a dichotomy in terms of "pollution-havens" (where environmental regulations and enforcement are lax and therefore production activities incur significant or much less pollution abatement costs) and "non-pollution-havens". This dichotomy is reflected in the broad classification of "developing" and "developed" countries respectively.

2.2 A Review of the Empirical Literature

Kalt (1988) was one of the first to test the "pollution-haven" hypothesis based on the above conceptual framework. He examined US net exports in 1977 (compared to 1967): (i) across all industries (ii) for manufacturing industry only and (iii) for manufacturing, excluding chemicals. Three linkages were tested: the relationship between the level of compliance costs and the level of net exports; the relationship between the change in compliance costs and the change in net exports; and the links when costs to downstream industries are included. Kalt found that, in

1977, US exports were significantly less pollution-intensive than imports, which was not the case in 1967. However, the regression results are statistically insignificant at the all industry level, but significant at the manufacturing industry level in the expected negative direction. Overall, it was concluded that there is some evidence of a negative effect of environmental regulation on net US exports (a validation of the "pollution-haven" hypothesis), but the relationship is statistically weak and not robust to model specification.

Han and Braden (1996) expanded and updated the Kalt study, examining 19 manufacturing industries in the US between 1973 and 1990. They looked for the relationship between pollution abatement costs and net exports over time. Their regression results show pollution abatement expenditure having a statistically significant negative effect on exports of most of the sample period. It also shows the effect diminishing over time, consistent with the gradual convergence of environmental standards between the US and other countries. The authors conjecture that from the late 1980s, marginal changes in environmental compliance expenditures did not diminish the international competitiveness of domestic industries, presumably because other countries were changing their standards more rapidly than the US.

Han and Braden also analyzed the elasticities of net exports with respect to the pollution abatement expenditures for the 19 industries. Large elasticities would imply that added abatement expenditure would lead to a substantial marginal decrease in net exports. The industries shown to have large elasticities and large pollution abatement costs were paper and allied products; chemicals and primary metal. Textiles and electronics had large elasticities, but small abatement expenditures. Many industries – including furniture, printing, leather and allied products, fabricated metals, petroleum and coal products, had elasticities close to zero. Over the 18 year period, the elasticities declined in almost all industries. The authors conclude overall, that there has been a negative effect on net manufacturing exports due to environmental regulations.

James Tobey (1993) tested a similar hypothesis, this time across countries, using a Heckscher-Ohlin model of international trade. He chose 24 pollution-intensive industries (defined as those that in the US have high abatement costs). Industries meeting these standards were mainly pulp and paper, mining, iron and steel, primary non-ferrous metals and chemicals. Using an ordinal approach to measure regulatory stringency, countries' environmental stringency was ranked on a scale of 1 to 7. He then regressed net exports of each country's dirty industries on their factor inputs (land, labour, capital and natural resources).

Tobey concludes that "the important and consistent finding of the empirical tests was to show that the hypothesis that environmental regulations alter the pattern of world trade is not supported empirically. The effect of the measure of stringency of environmental policy on changes in net exports is insignificant statistically. Interestingly, the most significant result concerns the chemical industry, and the relationship is positive. Other analysts, however, have cast some doubt on these findings, questioning whether the arbitrary ranking of environmental stringency across countries, in the absence of actual cost data, is precise enough to yield discernible results.

Grossman and Krueger (1993) analyzed the determinants of US imports from Mexico to examine whether the size of pollution abatement costs in US industry influences the pattern of bilateral trade and investment. Manufacturing trade data from 1987 and 1988 on US pollution abatement costs were subjected to various regression analyses, along with variables to account for factor shares, effective tariff rates, and worker injury rates as a proxy for labour protection laws. The authors hypothesized that if the composition of US-Mexico trade revealed Mexico to be a "pollution-haven", further specialization resulting from trade liberalization under "North American Free Trade Agreement" (NAFTA) would have adverse environmental implications. They found, however, that Mexican exports to the US are determined largely by the factor uses of the industries.

A more recent study by Eskeland and Harrison (1997) looked at the patterns of US foreign investment in Mexico, Venezuela, Morocco and Cote d'Ivoire between 1982 and 1994, to see whether it is influenced by US pollution abatement costs. They begin by presenting a simple theoretical model which shows that the effect of environmental regulations imposed at home on outward investment is ambiguous. Depending on possible complementarities between capital and pollution abatement, environmental regulation could lead to an increase or decrease in investment in both the host (developing) country and the originating (developed) country.

To resolve the theoretical ambiguity, the authors then turn to an empirical analysis of the pattern of foreign investment in the above-mentioned developing countries – looking for evidence, which reflects increasing costs of pollution-intensive activities at home. Eskeland and Harrison find no evidence that foreign investment in these developing countries is related to abatement costs in industrialized countries. Furthermore, they find almost no evidence that foreign investors are concentrated in "dirty" sectors. The only exception seems to be Morocco, where the tendency is caused by one observation: the heavy concentration of foreign investment in the cement industry. The authors then proceed to test whether, within industries, there is any tendency for foreign firms to pollute more or less than their peers. They construct a proxy for pollution intensity in the form of use of energy and "dirty fuels". The tests reveal that the foreign firms are significantly more energy efficient and use cleaner types of energy. Thus, in conclusion, the paper rejects the hypothesis that the pattern of US foreign investment in any of the recipient countries is skewed towards industries with high costs of pollution abatement.

Sorsa (1994) analyzed trade flow data in "environmentally-sensitive" goods (based on pollution abatement costs in the US, 1988) and environmental expenditures in seven OECD "high standard" countries; Australia, Finland, Germany, Japan, Norway, Sweden and the United States. The study compared world trade shares in the sensitive goods from 1970 with those from 1990. It also calculated "Revealed Comparative Advantage" (RCA) indices for those industries in the various countries. The share of environmentally sensitive goods in total national exports fell for all the sampled countries; and for industrial countries overall. Sorsa notes that this is likely to be due to the expansion of non-environmentally-sensitive goods in world trade and increased specialization. The most substantial declines were in Norway, attributable mostly to the relative growth of oil in total exports; and in Japan, where considerable structural adjustment and overseas investments have taken place.

In terms of shares of world market for environmentally-sensitive sector, Sorsa comments that the world market shares in environmentally-sensitive goods have not changed dramatically over the past two decades, despite the introduction of higher environmental standards in most industrial countries. The trends in trade shares indicate that there has been no across-the-board decline in the market shares of environmentally-sensitive goods in the higher standard industrial countries. Measured as shares in world exports, the share of industrial countries was about the same in 1970 as in 1990. Measured by world import, the share of industrial countries declined between 1970 and 1990. The bulk of world imports of environmentally-sensitive goods continue to originate in the industrial countries – over 70%.

World Bank researchers Patrick Low and Alexander Yeats tested whether developing countries gained a comparative advantage in pollution-intensive products (Low and Yeats, 1992). The question they asked was whether a locational pull of dirty industries towards developing countries exist and if so what is its magnitude? Using trade data for the period between 1965 and 1988, they analyzed trade flows in environmentally-sensitive industries along the same lines as Sorsa. The paper utilizes a model developed by Yeats (1985), for analyzing different countries' "Revealed Comparative Advantage" (RCA) within a specific industry. RCA is defined as the share of an industry in a country's total exports relative to the industry's share of total world exports of manufactures. The authors defined environmentally dirty industries as those incurring the highest level of pollution abatement and control expenditures in the United States.

The authors asked two key questions: (i) what was the share of these goods in international trade and what was the trend in that share over time? (ii) what are the geographic and economic characteristics of countries in which trade in environmentally dirty goods originates? Low and Yeats looked at RCAs of 109 countries for pollution-intensive industries. Their list of pollution-intensive industries selected on the basis of pollution abatement costs in the US consists of iron and steel, non-ferrous metals, petroleum refining, metal manufacturing and pulp and paper. The study is cast not in terms of competitiveness, but whether it can be shown that dirty industries have migrated, i.e. testing the "industrial flight" hypothesis. Low and Yeats conclude:

(a) the share of pollution-intensive industries in total world trade has fallen during 1965-1988.

(b) While the industrial countries still supply around three-quarters of the exports of pollution-intensive industries, these industries represent smaller shares of industrial countries' total exports than previously.

(c) The share of global exports of these industries originating in North America fell from 21% to 14%, while the share originating in South-East Asia grew from 3% to 8% over the period.

(d) Polluting industries' activities are being dispersed internationally and the dispersion is greatest in the direction of developing countries. The authors found that Eastern Europe followed by Latin America and the Caribbean are the regions with the highest concentration of dirty industries.

A recent study at the World Bank has extended the research of Low and Yeats using the data on industrial production, trade and environmental regulation for the period between 1960 and 1995. This research by Mani and Wheeler (1998) examines shifts in trade and production patterns in the main trading regions of the world economy in relation to changes in other factors, such as, income growth, land prices, energy prices, and environmental regulation over the 35 year period. The authors conclude that their cross-country analysis has found a pattern of evidence which does seem consistent with the "pollution-haven" story. Pollution-intensive output as a percentage of total manufacturing has fallen steadily in the OECD countries and risen steadily in the developing world. Moreover, the periods of rapid increase in net exports of pollution-intensive products from developing countries coincided with periods of rapid increase in the cost of pollution abatement in the OECD countries. However, the authors caution that in practice, "pollution-havens" may be a transient phenomenon as in the case of "low-wage havens", as economic growth in developing countries bring about countervailing pressures to bear on polluters through increased regulation.

Another article (Abimanyu, 1996), focussing on trade between the United States, Japan, Australia and the "Association for South-East Asian Nations" (ASEAN), also used an RCA model to find that dirty industry expansion was faster in developing countries. However, it concluded that differences in environmental standards between developing countries were not a significant cause of the movement of dirty industries.

Xing and Kolstad (1996) examined foreign direct investment in 22 countries (7 developing and 15 developed) by the US chemical industry, the US electrical machinery industry and the US non-electrical machinery industry during 1985 and 1990. Measuring capital outflows captures the case where a multinational increases production capacity in existing offshore subsidiaries, either in addition to or instead of existing home capacity, as well as cases of completely new greenfield investments, which may or may not be plant relocations. The authors use measured sulphur emissions as the proxy for stringency of environmental policy, reasoning that there is an observed direct relationship between policy measures and this measure of pollution. Their statistical analysis shows that laxity of environmental regulations in a host country is a significant determinant of FDI from the US chemical industry, though not from less polluting industries. Furthermore, the more lax the regulations in the host country, the more likely it is to attract the investment capital of the US industry.

While this study stands out as yielding the predicted negative results more clearly than most other studies, there is room to question the use of sulphur dioxide emissions as a proxy for stringency of environmental regulation. The level of air pollution depends heavily on the industrial structure of the economy and the nature of the receiving environment, as well as the stringency of environmental regulation. Furthermore, there may be the problem of reverse causality involved.

More ambitious results have been obtained by Bouman (1996). This research uses measured pollution abatement costs (current and capital costs) in Germany and data for German FDI to the rest of the world (i.e. not specific countries), to test the theory of industrial migration. The regression analysis mostly finds a significant, but small, negative effect of German compliance costs on capital outflow, although some of the regressions find the reverse (i.e. increased compliance costs and reduced foreign direct investment). Also, the results vary, depending on whether the compliance cost measure concerns capital expenditures or current expenditures, raising further questions about the robustness of the results.

A different type of question was put forward by Nancy Birdsall and David Wheeler (1992). They asked if greater openness in trade and foreign investment was associated with pollution-intensive development. Their hypothesis was that if trade was encouraging the existence of "pollution-havens", the more open developing economies should have relatively higher pollution-intensive development. Birdsall and Wheeler first consider the case of Chile. Chile is a country with limited or no controls on industrial emissions and openness to trade and foreign investment. The authors ask the question: Is Chile a "pollution-haven"? Their findings suggest that openness to foreign investment and the absence of barriers to technology imports encourage MNCs to invest in Chile and ensure that domestic firms will have to compete with them. The MNCs often attempt to reduce local competition by encouraging the government to introduce or raise environmental standards. The overall effect is that, openness in Chile is associated with, if not contributing to, the opposite of a "pollution-haven" effect – perhaps even implying, higher standards than are actually efficient, given social preferences in Chile. Next the authors turn towards cross-country evidence and investigate the trend in the mix of "dirty" vs "clean" industries. The data base is a pooled cross-section of time-series for 25 Latin American countries for the period 1960-1988.

The paper constructs indices of the toxic intensity of industries per dollar of output in the US. The measures of toxic intensity are applied to the industrial outputs for the 25 Latin American countries. This yields an annual index of pollution intensity for each country. The evidence suggests that over the 1970s and 1980s, the more open economies ended up with a cleaner industrial sector. This is consistent with the growing literature suggesting that it is capital-intensive industries that have both enjoyed protection and have been heavy polluters. While pollution intensity did grow more rapidly in Latin America as a whole after environmental regulation in OECD countries became stricter, anecdotal evidence suggests that openness to foreign technology and capital gives rise to pressures for more stringent environmental standards. Fast growing open economies experienced faster growth in "clean" industries, even in the environmental era. The authors conclude that "pollution-havens" can be found, but not where they have generally been sought. They are in the protectionist economies.

Similar conclusions were reached by Lucas, Wheeler and Hettige (1992). The authors focussed on production and not investment flows. They examined the changes in the relative output of various industrial sectors over the period 1960-1988, using time series estimates of the pollution-intensity of manufacturing for a large sample of developed and developing countries.[5] The results show that the pollution-intensity of developing countries has grown steadily. In addition, pollution-intensity has grown most rapidly in countries that are relatively closed, to world market forces. Relatively closed, fast growing economies experienced very rapid structural transitions towards greater toxic intensity. The opposite seems to have been true, however, for more open economies. Restrictive trade practices imposed by the developing countries themselves may even have been the main stimulus to toxic industrial migration, rather than regulatory cost differences between the North and the South.

[5] In the absence of data on pollution-intensity of actual production in different countries, the study calculates toxic intensity based on US toxic release data; hence inter-country differences in technologies and performance are not taken into account.

Repetto (1995) analyzed the 1992 data for US direct investment abroad (USDIA), by sector and by regional destination. He notes that while developing and transitional economies received 45% of total USDIA in 1992, a much smaller proportion of that direct investment went into the environmentally sensitive industries (petroleum and gas, chemicals, and primary or fabricated metals), than was the case for US direct investment abroad in the already developed countries with relatively tight environmental standards. 24% of USDIA into the advanced countries went into the pollution-intensive sectors, but only 5% of USDIA into the less developed economies went into those sectors. Of the total direct foreign investment in pollution-intensive industries, 84% went to other developed countries, compared to 49% of overseas investment in other industries. To the extent that the advanced countries seem to be exporting their "dirty" industries, they seem to be sending them to each other, and not to the less developed countries.

In a recent study, Christmann and Taylor (1999), using evidence from China, suggest that globalization of the goods market should not necessarily be expected to have a negative effect on the environment. The authors argue that in low regulation countries, implementation of environmental management systems and environmental performance are much more determined by firm characteristics and by external pressures than by government regulation. They identify 3 firm characteristics that can be expected to contribute to the implementation of environmental management systems and to environmental performance: firm size, education level of employees and multinational ownership. They also suggest that firms in countries that emphasize the implementation and certification of environmental management systems will put pressure on their suppliers to implement such systems. Consequently, firms from low regulation countries with high exports to Japan and Europe are more likely to implement environmental management systems and have better environmental performance.

Christmann and Taylor test these hypotheses using survey data collected from a sample of 118 Chinese firms. Results provide support for the importance of firm size, employee education and exports to Japan, as determinants of implementation of management systems. Multinational ownership was found to positively affect environmental performance and the implementation of management systems. Because, two of the factors contributing to the implementation of environmental management systems or to environmental performance, namely, exports to industrialised countries and multinational ownership, can be expected to increase with globalization of the goods market, globalization might actually positively affect environmental performance. The authors thus conclude that we can be more optimistic about the relationship between globalization and the environment, than the "pollution-haven" and “industrial-flight” hypotheses actually suggest.

The classical framework ignores the fact that in recent times, dynamic factors exert more influence on competitiveness than static comparative advantage factors. Factors such as technology and innovation, market access, strategic partnership through sharing complementary assets, exert more influence on today’s production and trade flows than the classical factors. Raman Letchumanan analyzes the trade-environment competitiveness issue from a totally different perspective, compared to most existing studies on the subject. First, he analyzes the pattern of cross-border industrial location by performing a simple yet highly illuminating analysis of correlating the migration of industries (through FDI), with the pollution-intensity of each industrial sector, in order to empirically test the "pollution-haven" hypothesis. Based on this result, he asserts that such patterns are best explained in terms of neo-technology trade theory rather than the classical comparative advantage trade theories. For this purpose, the hypothesis is that, "in the high-tech era, technological rationality can override neo-classical economic rationality in deciding on the division of labour (and therefore international industrial location) among developed and developing countries". The author then provides evidence in support of this hypothesis by analyzing technological innovations in selected products in the electronics sector, and performing an empirical analysis of the critical factors that determine MNCs' decision to locate their operations overseas. Finally, to further substantiate his argument, Letchumanan looks at recent FDI flows (a primary means of trans-boundary location of industries) to elucidate the rationale and motivation for cross-border production by MNCs, especially on whether they are driven by dynamic competitive factors, or by locational comparative factors such as lax environmental standards.

On the basis of the cross-country analysis of recent patterns of industrial location, Letchumanan categorically asserts that the "pollution-haven" hypothesis is not valid empirically. He finds absolutely no correlation between FDI flows into the developing countries and the corresponding pollution content of these industries. In fact, all the developing countries that were analyzed, had received investments in relatively cleaner industries. The author concludes that the relative specialisation in cleaner industries in developing countries may be explained by the increased "mobility" of high technology industries, due to technological improvements and product structure.

2.3 A Critical Review of the Existing Research

The review of the existing empirical studies brings out the fact that there have, in general, been 3 approaches to the testing of the "pollution-haven" hypothesis. One approach is to study foreign direct investment (FDI) of multinational firms and assess whether there has been a tendency for FDI in "dirty" industries to be concentrated in countries with low environmental standards. The second approach analyzes the evolution of production and exports in a defined group of "dirty" industries, and asks whether dirty industries have grown faster than cleaner industries in unregulated economies. The third approach asks whether the addition of some measures of countries' endowments of environment as a factor of production to traditional trade models increases the models' quality to predict patterns of trade.

All three approaches have serious limitations. The FDI analysis essentially limits us to an analysis of the behaviour of multinationals. But as Pearson (1987) has suggested, there is no reason why one should expect multinationals, as opposed to domestic firms, to capture the lion's share of increased manufacturing output. The second approach fails to distinguish accurately the impacts of trade from the environmental effects of the industrialisation process. The formal trade modelling approach is largely limited by difficulties with defining and measuring an environmental factor. All studies are hampered by two additional measurement problems. First, it is difficult to define a convenient and sufficient statistic for the complexities inherent in each country's environmental regulations.[6] Second, the data available to define the set of "dirty" industries are extremely limited; all studies are forced to use only US data to define the set,[7] even though, international differences in regulating factor prices and technologies disallow any assumption that an industry's pollution-intensity is independent of location. This second limitation implies that all these studies are in effect only measuring the composition effect of trade. In the final analysis, many of these studies seem to have focussed solely on plant migration. However, it is the amount of production in a country that should be measured, and not the number of plants. Expansion of old plants and opening of new ones, both have the effect of increasing production, and both should be counted equally in tracking the location of industrial activity.

Thus, major empirical works conducted in this field show that while there is some support for the "pollution-haven" hypothesis, most analysts put forward arguments for the non-existence of "pollution-havens". In fact, Repetto (1995)

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6 Often income levels are used as proxy for the standards under the assumption that environmental regulations are more stringent in rich countries than in poor countries.

7 Most commonly, "dirty" industries are defined as those industries which in the US have the highest pollution-abatement costs.

claims that "pollution-havens" exist, but not in the developing countries, as is widely believed. He notes that the developed countries are sending their “dirty” industries, not to the developing countries, but amongst themselves. Again, Birdsall and Wheeler (1992) conclude that "pollution-havens" can be found, but not where they have generally been sought. They are in the protectionist economies. Thus, empirical studies have at best left the issue unresolved.

However, there seems to be an incongruence between academic empirical analysis and the conventional wisdom so far as the question of "pollution-havens" is concerned. While empirical work has not conclusively proved the existence or non-existence of "pollution-havens", it is almost an accepted paradigm among practitioners of multilateral environmental diplomacy that "pollution-havens" are real.

Thus, it seems that empirical work has largely failed to sway public opinion, as many studies have left the question rather vague. The reason for this gap between empirical work and public opinion lies mainly in the conceptual framework and the methodologies employed. However, it is to be noted that such ambiguity further substantiates the conventional wisdom that “dirty” industries migrate. It is not the empirical results that cast doubt on the "pollution-haven" hypothesis, but the general over-emphasis on classical theoretical approach of existing studies. In fact, almost all studies have avoided addressing the question from the technology perspective, even though most acknowledge that technology impacts greatly both on the migration of industries and the polluting content of an industry.

CHAPTER III

DATA SOURCES AND METHODOLOGY

INTRODUCTION

Data sources and methodology comprise an essential part of any empirical study. It provides an insight into the theory underlying the particular model at hand, as well as helps in understanding the mathematical and statistical tools used in the process of estimation. Although the name of the present chapter is "Data Sources and Methodology", its scope, however, is much wider. It lays down the objective of the study and highlights the various nuances involved in building up the model for empirical analysis. This will become clear as we proceed further.

Although discussed earlier in Chapter II, Section 3.1 briefly highlights some of the drawbacks of earlier empirical analysis with the emphasis being on the choice of the endogenous variable. It points out why, compared to other variables, the choice of Foreign Direct Investment (FDI) as an endogenous variable is better suited for the purpose of testing the "pollution-haven" hypothesis. With this backdrop, Section 3.2 reviews the determinants of FDI, providing proper theoretical justification in each case. Section 3.3 then goes on to discuss the choice of variables for our particular model, drawing on the theory enumerated in Section 3.2 to justify such choice. Further, it also deals extensively with the data sources of each and every variable used in the model. Finally, Section 3.4 provides the methodology underlying the estimation procedure. We discuss briefly, why we think the method of "Ordinary Least Squares" is most suited for our purpose and also mention some of the difficulties that might arise in the process of estimation.

3.1 Problems Relating to Previous Empirical Analyses

As discussed earlier, while empirical studies on the "industrial flight"/ "pollution-haven" hypotheses have been illuminating, their shortcomings suggest that the question has not been fully answered. One problem with previous empirical studies is that the endogenous variable, intended to track the effects of environmental regulations, is unsatisfactory. For instance, Low and Yeats (1992) use a country's share of production in total world trade of pollution-intensive products as a proxy for specialization in polluting goods. This is a coarse measure of specialization. Such a variable is determined by a wide variety of factors in addition to the strictness of environmental regulations. Furthermore, it is capital flow and not goods flow, which should be most affected by differential environmental regulations. Only in the long run will a country's production-mix reflect capital movements induced by differential environmental regulations.

Another shortcoming of previous empirical studies lies in measuring the strictness of environmental regulations. Considering the complexity of any country's environmental regulations, this is not an easy task. In most empirical studies, there is no measure of the strictness of regulations and the policy discussion is primarily descriptive. Batik (1988) uses a variety of quantitative measures for the magnitude of stringency of environmental regulations. Fundamentally, all the measures are based on pollution abatement and control costs. It is well known that there is no precise definition of control costs, and further the average control costs per unit of output is an inappropriate measure of stringency. To examine the effect of environmental policy on trade, Tobey (1992), employs a subjective scale ranging from 1 to 7 to indicate the degree of stringency of environmental policy.[8] Although this is an useful paper, yet such a qualitative measure is disquietingly ambiguous and potentially imprecise.

The purpose of this study is to complement previous studies by using a different methodology, examining the effect of environmental policy on the location of polluting industries. To test the "pollution-haven" hypothesis, foreign direct investment (FDI) is used as a proxy. This is the endogenous variable of our model. The rationale is that, for an industry, locating its production capacity overseas is basically FDI. In addition, if environmental regulations generate distortions in the operation of polluting industries, the multinational enterprises may initially respond by intra-firm transfer of production facility, or increase the investments in subsidiaries located in countries with more lenient regulations. Such adjustment may not involve the relocation of an entire plant, but it would change FDI flows. Hence FDI may be more sensitive to environmental regulations than other proxies. Of course, a country's specialization in polluting industries need not be via FDI, but if FDI is attracted to areas with weak environmental regulations, then the "pollution-haven" hypothesis will nonetheless be supported.

As has been pointed out in Chapter I, we focus on several countries, all of them being developing countries and use FDI to reflect location decisions.

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8 In fact, Tobey's subjective index applies to only 23 countries, mostly OECD countries.

But before proceeding further, it seems imperative on our part to review the determinants of FDI, which would then help us in choosing or determining the parameters or exogenous variables of our model.

3.2 Determinants of Foreign Direct Investment

Foreign Direct Investment (FDI) is a special form of capital flow that not only includes capital but also intangible assets, such as management skills. A variety of theoretical studies on FDI have identified many determinants of FDI. Agarwal (1980) and Caves (1983) provide comprehensive reviews of the theories of FDI determination.

The classic explanation of FDI is based on capital return differentials across countries. The argument is that FDI is driven by international differences in the marginal return to capital. FDI flows out of countries with low returns to those countries where the marginal returns are expected to be higher. In other words, then, FDI is a capital-arbitrage phenomenon. The "industrial-flight" hypothesis mentioned earlier emphasizes production cost differentials caused by environmental regulation, implying that such cost discrepancies would result in the relocation of polluting industries. The conventional economic analysis of the effect of environmental policy on capital movements of polluting industries is basically an application of the capital-arbitrage argument. For instance, in McGuire (1982), the expected capital outflow for a polluting industry from a country with stringent environmental policy to one which has no or lax environmental policy, is triggered by different factor rewards, which are caused by differential environmental policies between the two countries. In a recent study on the location of plant in reaction of environmental policy under imperfect competition, Markusen and Morey (1993) conclude that plant location can be a function of environmental policy. This conclusion is based on the cost effect caused by an emission tax representing environmental protection.

In studies confined to US direct investment from 1958-1968, Scaperlanda and Mauer (1969) emphasize the role of the host country market in FDI decision, particularly market size and market growth. FDI flows can be influenced by the market size of the recipient country for two reasons. The first recognizes that servicing the host market will only become profitable, when the average costs of operating in the host country are lower than the cost of serving the market through exports from the home country. This requires a critical volume of sales to be achieved in the host country. If consumer adoption rates are identical in different markets, then it is argued that this critical level will be quicker met in larger markets. Thus, the market size hypothesis basically states that FDI will not flow into a country until its market approaches a certain size, a size necessary to implement efficiently the production technology. Once a foreign investor creates a production facility in a country, the capital inflow increases and the demand rises. Secondly, market size may act as a strategic motivation to FDI. Oligopolists react to competitive effects of competitors establishing in foreign markets, so as to prevent a fall in sales and/or market share, and to prevent the possibility of first mover advantage accruing to their competitors. In empirical analysis, the market size is generally approximated by the host country's Gross Domestic Product (GDP) or per capita GDP. The role of demand growth is based on the relationship between aggregate demand and the capital stock needed to satisfy that demand. Specifically, the growth hypothesis postulates a positive relationship between capital inflows and the rate of growth of the host country's GDP. Again, following Agarwal (1980), another proxy for the market size can be the measure of a country's manufacturing exports as percentage of its GDP. Theory postulates a positive relationship between FDI and the above mentioned variable, as it can be used as an indicator for the desirability of a particular country as an export platform.

The "liquidity hypothesis" is another explanatory basis of FDI theory. This hypothesis conjectures a positive relationship between internal cash flows and the investment outlays of a firm. They hypothesis is based on the premise that the internal funds are viewed by investors as cheaper than external financial resources. In recent theoretical studies on FDI, Froot and Stein (1991) argue that the incompleteness of financial markets results in incomplete information to investors which results in internal financial resources being cheaper than external funds for multinationals. Many economists have examined the "liquidity hypothesis" and found some evidence in favour of the argument. In the studies of US MNC overseas operation, Barlow and Wender (1955) observe that the initial investment of US companies in foreign markets is modest. The expansion of their foreign affiliates is largely conducted through reinvestment of their local profits. Similar evidences have been found in other empirical studies. These studies suggest that FDI should depend positively on the availability of internal funds in the host country. In order to capture the relationship expounded in the "liquidity hypothesis", it is necessary to use a proxy. In fact, a country's gross domestic investment as percentage of its GDP can exactly serve as such a proxy.

Further, the labour endowments of a country can affect the FDI flows for industries which rely on the intensive use of such factors. Thus, labour force participation rates may well be used in determining a country's inward FDI. The indicator used in this case is generally the total labour force of a country expressed as percentage of its total population.

Before rounding off this discussion on the determinants of FDI, it seems imperative for us to mention that there can be a host of other factors which might perceptibly affect FDI flows, e.g. political stability of a country may be a factor affecting foreign private investment, in the sense that a country with a favourable and stable political climate would obviously tend to attract more investment than a country affected by inherent political conflicts and disturbances. One can of course think of many such factors which may be political, financial or economic in nature. Now, while these factors are very important, yet it becomes quite difficult to quantify most of them at times. So, there arises the need for using proxies to capture the essence of these factors. These proxies are generally in the form of indices on a certain scale. international risk ratings can conveniently be used as such proxies. In our model, we use one such proxy, the "International Country Risk Guide" (ICRG), the justification for the use of which we provide in the next section.

3.3 Choice of Variables and Data Sources

Our discussion in the previous section provides a fair idea as to what the determinants of FDI should be. This is in fact the basis for our choice of variables. Another important consideration in choosing the variables has been the availability of data. The data set is basically a cross-country data set for 51 countries.[9] This sample has been chosen with two specific criteria in mind. Firstly, we have chosen countries exhibiting a wide range in the per capita GDP. Our sample includes countries with per capita GDP as low as $93.7 (Ethiopia) to per capita GDP of $5577.2 (Uruguay), in order to capture the huge diversity prevalent among the developing countries. The second criterion as previously mentioned is the availability of data. We have made sure that data on all variables are available for each and every country that we have chosen in our sample.

Coming back to the question of the choice of variables, it has already been mentioned in the previous section why we feel that inward FDI flows should be the proper endogenous variable, rather than other variables that have been used in a host of other empirical studies. We have considered FDI data for our sample of 51 countries for the year 1996, and the proxy we use is FDI as percentage of GDP. The code used for this variable is simply FDI. As is

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9 See appendix 3A at the end of the chapter.

evident, this variable is unit free. The data on FDI are based on balance of payments data reported by the International Monetary Fund (IMF), supplemented by the data on net foreign direct investment reported by the Organization for Economic Co-operation and Development (OECD) and official national sources. The internationally accepted definition of FDI is that provided in the fifth edition of the IMF's Balance of Payments Manual (1993). FDI has three components: equity investment, reinvested earnings and short and long-term intercompany loans between parent firms and foreign affiliates. FDI, as distinguished from other kinds of international investment, is made to establish a lasting interest in or effective management control over an enterprise in another country. The data on FDI, the variable we use, have been collected from the "World Development Indicators, 1998", published by the World Bank.

Turning to the choice of exogenous variables for our model, the first such variable that we have chosen is adjusted real GDP per capita, lagged by one period. The code for this variable in our model is GDPPC and data for all countries have been expressed in terms of the US $. As mentioned previously, GDP per capita is a potential indicator of the market size of a country. Moreover, it was also noted that FDI would not flow into a country before its market attains a critical size, such that serving that country through exports would not be more profitable than setting up operations in that country. This is the justification for the inclusion of the variable GDPPC in our model. Now, it is to be noted that the data on GDPPC for the sample 51 countries is for the year 1995 and not for 1996, i.e. the variable has been lagged by one period. This has in fact been typically the case with all the other variables we have used. The explanation for this is quite simple. Today's GDP per capita or for that matter any of the other variables affects tomorrow's FDI flows and not today's FDI flows. Thus the exogenous variables in our model have all been lagged by one period. It needs to be mentioned at this juncture, however, that we have chosen adjusted real GDP per capita (PPP$) and not GDP at market prices as our exogenous variable. The logic behind this choice is easy to understand. GDP per capita at market prices reflects only the income side of an economy. However, this is in some sense an incomplete measure. It is important to consider both the income and consumption patterns of an economy, when indulging in cross-country comparisons. This is because consumption patterns reflect upon the price structure of an economy and prices invariably play a decisive role in economic decision making. Therefore, what is needed is a measure which takes into account not only income, but also the prices prevailing in an economy. This is where the concept of "Purchasing Power Parity" comes in. PPP considers how much a basket of goods which costs $1 in the US would cost in terms of the local currency of a country. This is used as a conversion factor and GDP per capita is adjusted using this factor to obtain the adjusted real GDP per capita (PPP) for that country in terms of the US $. Obviously the conversion factor for the US is 1. This is the standard pattern used in constructing the Human Development Index (HDI) by the World Bank and making comparisons across countries. This is why we have also preferred the adjusted real GDP per capita (PPP$) over GDP per capita at market prices. Data on this variable for our sample of 51 countries was collected from the "Human Development Report, 1998", published by the World Bank.

The previous section also mentioned manufacturing exports as another variable which could potentially serve as a proxy for the market size of a country. There we expounded a positive relationship between FDI and merchandise exports, as this could be an indicator for the desirability of a particular country as an export platform. Keeping this in view, therefore, we have included merchandise exports in our analysis. The variable we particularly use is merchandise exports as percentage of GDP and the code used is EXG. As can be evidently seen, this variable is unit free. Moreover, data for the 51 countries pertain to the year 1995, and the justification for this is the same as that mentioned previously when discussing GDP per capita. However, data on merchandise exports expressed in million $ was collected from the "World Development Report, 1997" and this was converted into percentage terms for each country by dividing the absolute value of merchandise exports by the value of GDP, expressed in million $, which was collected previously. Merchandise exports show the "free on board" (f.o.b.) value of goods provided to the rest of the world valued in US$. The most detailed source of data on international trade in goods is the COMTRADE database maintained by the "United Nations Statistical Division" (UNSD). The data on exports are estimated by the World Bank from the COMTRADE database. Where necessary, data on exports are also supplemented from the IMF's "Direction of Trade Statistics".

The third exogenous variable that we choose in our model is gross domestic investment as percentage of GDP and the code for this variable is GDIG. This is again a unit free measure. The justification for the inclusion of this variable comes from the "liquidity hypothesis", which we discussed in the previous section. Thus, investment is used as a proxy to indicate the extent of development of financial markets in a country and as theory leads us to believe, greater this development, greater would be the flow of FDI into a country. Thus, *a priori*, we would expect to find a positive relation between FDI and GDIG. The variable GDIG has also been lagged by one period in the sense that all data on GDIG pertain to the year 1995. Once again the source of our data on GDIG for the sample 51 countries was the "World Development Report, 1997".

Next, we added labour force participation rates as an exogenous variable to our model. The labour force of a country indicates its factor endowments and greater the labour force participation rates, greater would be the flow of FDI into industries using the factor labour intensively, thus establishing a positive relationship between the two variables. Now, the countries included in our sample are all developing countries and hence they tend to be labour-intensive in most cases. In such a situation, the importance of labour endowments in determining the flow of FDI cannot be overemphasized. The variable we use i.e. labour force participation rates, is basically the total labour force of a country expressed as percentage of the total population. The variable is expressed as LFP and it is unit free. Here too, data on total labour force expressed in millions for the year 1995 was collected from the "World Development Report, 1997" and converted into percentage terms for the 51 countries using the data on population collected previously.

In the discussion on the determinants of FDI, we mentioned that FDI may also depend on a host of other factors, which may be either political, financial or economic in nature. These factors do affect FDI, but the problem with them is that they are not easily quantifiable and as such data on them are not easily and readily available. In such a situation, it becomes important to use some kind of proxy measure to reflect on these factors. In the present analysis, we have used one such measure, which to our knowledge has not been used in any of the previous studies on the "pollution-haven" hypothesis. This variable is a measure of investor confidence, in the sense that it is a risk rating, which would obviously reflect on the unobservable factors that we have mentioned before. In fact, our proxy is Political Risk Services' "International Country Risk Guide", which we have denoted by the code ICRG. Most risk ratings are numerical or alphabetical. For numerical ratings, a higher number means lower risk. Risk ratings may be highly subjective, but these subjective perceptions are the reality that policy makers face in the climate they create for foreign private flows. ICRG collects information on 22 components of risk, groups it into three major categories (political, financial and economic) and converts it into a single numerical risk assessment ranging from 0 to 100.

Ratings below 50 are considered very high risk, and those above 80 very low risk. It is obvious that lower the risk, higher would be the flow of FDI into a country. The data on ICRG for the 51 countries for the year 1995 was obtained from the "World Development Indicators, 1996", published by the World Bank.

Now, we turn to the choice of our environmental variable, which we feel is one of the most crucial aspects of the entire study. The "pollution-haven" hypothesis indicates that lax environmental standards would lead to relocation of polluting industries, thus creating "pollution-havens". This brings us to a very important issue: "how to deal with the fact that stringency (or laxity) of environmental regulation is not directly observable?" We solve this problem by using observations on pollutant emissions to infer stringency. Dealing with unobserved variables has some history in economics; there are a number of approaches, all relying on the relationship between the unobserved variable and the related observed variable. The pollutant we consider is carbon dioxide (CO_2) emissions, one of the most significant air pollutants worldwide and one of the variables most commonly used as a proxy for environmental quality. However, we use CO_2 emissions per $ output for each country. This measure helps in comparing the pollution emissions of the different countries. It tells us how much CO_2 a country emits in order to produce $1 of output. Data on CO_2 emissions expressed in million kilograms for the year 1995 was collected from the "World Development Report, 1998-99" and this was divided by the GDP of each country expressed in million US $. As a result, we obtained the variable CO_2 emissions per $ of output, expressed in kg/$. This variable has been denoted by ENVS. In passing, we note that CO_2 emissions may only reflect environmental policy in a narrow category rather than overall stringency of environmental regulation. However, as noted before, CO_2 emissions constitute one of the most significant components of air pollution, and moreover, CO_2 emissions are in general highly correlated with emissions of many other pollutants. Further, data on CO_2 emissions are readily available, which may not be the case with the other pollutant emissions. Thus, it seems that we are quite justified in selecting this particular variable in order to reflect the environmental quality of a country. But how do we relate CO_2 emissions with stringent (or lax) environmental regulations and further how do we use it to test the "pollution-haven" hypothesis? It can be readily understood that laxer the environmental standards and regulations in a country, greater would be the CO_2 emissions per $ of output. Now, this can in turn be related to the "pollution-haven" hypothesis, in the sense that if we accept the "pollution-haven" hypothesis to be true, then with laxer environmental standards, we would have greater CO_2 emissions per $ of output. This would increase the flow of FDI into the country, thereby signifying a positive relationship between lax environmental standards and relocation of polluting industries. This is the basic objective of our study. We would like to test whether, what we have just said is true or whether the environmental effect on FDI is insignificant, thus invalidating the "pollution-haven" hypothesis. If the latter is true, then we would be in a position to vindicate the results obtained in most empirical studies, and conclude that environmental regulations have no effect on plant location.

The preceding section thus lays down the justification for our choice of variables as well as their relevant data sources. For expository purposes, we have presented the variables, their data sources and the name of the sample 51 countries separately in the appendix 3A at the end of the current chapter.

3.4 Methodology

The previous section dealt exclusively with the choice of variables and the justification for their use. The basic objective underlying the entire exercise is to test the validity (or non-validity) of the "pollution-haven" hypothesis i.e. in terms of our model, we would like to see whether CO_2 emissions of a country significantly affect FDI flows into that particular country. For this, we need certain mathematical and statistical tools. "Econometric analysis" provides us exactly with such tools. Literally interpreted, "Econometrics" means "economic measurement". Although measurement is an important part of econometrics, the scope of econometrics is much broader, as can be understood from the following definition:

> "Econometrics may be defined as the quantitative analysis of actual economic phenomena based on the current development of theory and observation, related by appropriate methods of inference".[10]

[10] P.A. Samuelson, T.C. Koopmans, and J.R. Stone, "Report of the Evaluation Committee for Econometrica", Econometrica, vol. 22, no. 2, April 1954, pp. 142-146.

3.4.1 Regression Analysis and the Method of Ordinary Lease Squares

The main tool of econometric analysis is "regression". Regression analysis is concerned with the study of the dependence of one variable, the "dependent variable" on one or more other variables, the "explanatory variables", with a view to estimating and/or predicting the mean or average value of the former in terms of the known or fixed values of the latter. Thus, the first task is to estimate the population regression function (PRF) on the basis of the sample regression function (SRF) as accurately as possible. There are several methods of constructing the SRF, but insofar as regression analysis is concerned, the method that is used most extensively is the method of "Ordinary Least Squares (OLS). This method forms the basis of our procedure of estimation.

In a general K-variable Classical Linear Regression Model (CLRM), the PRF is written as:

$$Y_i = \beta_1 + \beta_2 X_{2i} + \beta_3 X_{3i} + \ldots\ldots + \beta_k X_{ki} + U_i \quad (3.4.1)$$

where Y_i is the dependent variable and X_s indicate the values of the independent variables, the values of which are fixed in repeated sampling i.e. they are non-stochastic in nature.

Moreover, i=1,2, ..., n i.e. the i^{th} observation, n being the size of the population.

β_1 = the intercept term

β_2 to β_k = the partial slope coefficients and

U_i = a stochastic disturbance term, which takes into account all other factors that might affect Y_i but cannot be easily quantified or incorporated in the general model.

The method of OLS permits us to construct the SRF in order to estimate the parameters β of the PRF. Under certain assumptions, the method of least-square has some very attractive statistical properties, that have made it one of the most powerful and popular methods of regression analysis.

Let us, for the moment, turn to the specific model we are concerned with. On the basis of the variables that we have chosen, our model can be specified as:

$$FDI_i = C + \beta^{GDPPC}GDPPC_i + \beta^{GDIG}GDIG_i + \beta^{EXG}EXG_i + \beta^{LFP}LFP_i + \beta^{ICRG}ICRG_i + \beta^{ENVS}ENVS_i + U_i \quad (3.4.2)$$

This is the PRF in our model. It can easily be compared to the generalized multiple regression model where FDI_i is our dependent variable and C the intercept term. Our objective is to estimate the βs in this model on the basis of the SRF. The sample we have chosen for our purpose is a cross-country sample which includes 51 developing countries. In the section that follows, we will provide an explanation as to why we choose the method of OLS for estimating our model.

The Classical Linear Regression Model (CLRM) makes a set of assumptions. Without going into the details of these assumptions, it can be noted here that the method of least-squares can only be applied when all of these assumptions hold true. The generalized k-variable model can be expressed more compactly in the matrix form as:

$$Y = X\beta + U \tag{3.4.3}$$

where Y = n x 1 column vector of observations on the dependent variable Y

X = n x k matrix of observations on the independent variables

β = k x 1 column vector of the unknown parameters $\beta_1, \beta_2, \ldots, \beta_k$

U = n x 1 column vector of n disturbances U_i.

Using the method of least-squares, we obtain

$$\hat{\beta} = (X'X)^{-1} X'Y \tag{3.4.4}$$

where $\hat{\beta}$ is the estimate of β in (3.4.3). It can be readily shown that this estimate is unbiased i.e. $E(\hat{\beta}) = \beta$. Thus we see that under the classical assumptions, OLS provides unbiased estimates.

It is evident from (3.4.4) that the least-square estimators are a function of the sample data. But since the data are likely to change from sample to sample, the estimates will change *ipso facto.* Therefore, what is needed is some measure of "reliability" or "precision" of the estimator $\hat{\beta}$. In statistics, the precision of an estimate is measured by the standard error (SE). The SE is nothing but the standard deviation of the sampling distribution of the estimator, and the sampling distribution of an estimator is simply a probability or frequency distribution of the estimator, that is, a distribution of the set of values of the estimator obtained from all possible samples of the same size from a given population. Sampling distributions are used to draw inferences about the values of the population parameters on the basis of the values of the estimators calculated from one or more samples. The SE is a measure of reliability in the sense that smaller the standard errors of $\widehat{\beta}$, the more precise are the estimates.

As noted previously, the least-square estimates possess some ideal or optimum properties. These properties are contained in the well-known "Gauss-Markov theorem". The Gauss-Markov theorem states that given the assumptions of the classical linear regression model, the least-square estimators in the class of all linear unbiased estimators have the minimum variance, that is, they are the "Best Linear Unbiased Estimators" or BLUE. This implies that the least-square estimators are the most "efficient" estimators. So under the method of OLS, the estimators possess two very important statistical properties: they are "unbiased" and "efficient".

Thus far, we had been concerned with the problem of estimating regression coefficients, their standard errors and the statistical properties of the estimators. These properties provide a very good theoretical justification for the use of OLS in the estimation of models such as the ones mentioned in (3.4.1) and (3.4.2). However, we now consider the "goodness of fit" of the fitted regression line to a set of data i.e. how well the sample regression line fits the data. Generally, there will be some positive $\widehat{U_i}$ s and some negative $\widehat{U_i}$ s. What we hope for is that these residuals around the regression line are as small as possible. The "Coefficient of determination" R^2 is a summary measure that tells us how well the sample regression line fits the data. Alternatively, it measures the proportion or percentage of the total variation in Y explained by the regression model, or simply the "explained sum of squares" (ESS).

$$\text{Thus, } R^2 = \frac{ESS}{TSS} \qquad (3.4.5)$$

where TSS denotes the "total sum of squares".

$\Sigma \hat{U}_i^2$ or $\hat{u}'\hat{u}$ in the matrix form denotes the "residual sum of squares" (RSS) i.e. the proportion or percentage of the total variation in Y not explained by the regression model.

3.4.2 The Normality Assumption and the t Test

Till now, what we have been discussing relates essentially to point estimation, one aspect of statistical inference. However, the other aspect, viz. hypothesis testing is equally important. Since our objective is estimation as well as hypothesis testing, we need to specify the probability distribution of the disturbances U_i. This is because, the OLS estimators $\hat{\beta}_i$ are linear functions of U_i,[11] which is random by assumption. Therefore, the sampling or probability distributions of the OLS estimators will depend upon the assumptions made about the probability distribution of U_i. And since the probability distributions of these estimators are necessary to draw inferences about their population values, the nature of the distribution of U_i assumes an extremely important role in hypothesis testing.

The classical normal linear regression assumes that each U_i is distributed normally, with

[11] The estimators are actually linear functions of the dependent variable Y. But Y is itself a linear function of U. Hence, the estimators are linear functions of U, which is random by assumption.

$$\text{Mean} \quad : \quad E(U_i) = 0 \qquad (3.4.6)$$

$$\text{Variance} : \quad E(U_i^2) = \sigma^2 \qquad (3.4.7)$$

$$\text{Cov}(U_i, U_j) : E(U_i, U_j) = 0; \; i \neq j \qquad (3.4.8)$$

These assumptions can be more compactly stated as

$$U_i \sim NID(0, \sigma^2) \qquad (3.4.9)$$

where NID stands for normally and independently distributed.

Now, by the celebrated "central limit theorem" of statistics, it can be shown that if there are a large number of independent and identically distributed random variables, then with a few exceptions, the distribution of their sum tends to a normal distribution as the number of such variables increases indefinitely. It is this central limit theorem that provides a justification for the assumptions of normality of U_i.

Turning once again to the matrix form, (3.4.9) can be written as

$$U \sim NID(0, \sigma^2 I) \qquad (3.4.10)$$

where U and 0 are n x 1 column vectors and I is an n x n identity matrix, 0 being the null vector. Moreover, given the normality assumptions, it can be shown that

$$\hat{\beta} \sim N[\beta, \sigma^2 (X'X)^{-1}] \qquad (3.4.11)$$

that is, each element of $\hat{\beta}$ is normally distributed with mean equal to the corresponding element of the β and the variance given by σ^2 times the appropriate diagonal element of the diagonal matrix $(X'X)^{-1}$.

Since in practice, σ^2 is unknown, it is estimated by $\hat{\sigma}^2$. Then by the usual shift to the t distribution, it follows that each element of $\hat{\beta}$ follows the t distribution with n-k degrees of freedom (df).[12] Symbolically,

$$t = \frac{\hat{\beta}_i - \beta_i}{SE(\hat{\beta}_i)} \qquad (3.4.12)$$

with n-k df, where $\hat{\beta}_i$ is any element of $\hat{\beta}$.

The t distribution can therefore be used to test hypotheses about the true β_i as well as to establish confidence intervals about it. To illustrate the mechanics, let the null hypothesis and the alternative hypothesis respectively be as specified below:

H_0: $\beta_i = 0$ and H_1: $\beta_i \neq 0$.

The null hypothesis states that holding other Xs constant, X_i has no influence on Y_i. To test the null hypothesis, we use the t test given in (3.4.12). If the computed t value exceeds the critical t value at the chosen level of significance, we may reject the hypothesis; otherwise we may not reject it. Thus, the t test provides a very good method of testing the significance of individual variables.

3.4.3 Testing the Overall Significance of the Sample Regression

We have already seen how the t test helps us in testing the significance of the estimated partial regression coefficient individually, that is, under the

[12] The term number of degrees of freedom means the total number of observations in the sample (=n) less the number of independent constraints or restrictions put on them. In other words, it is the number of independent observations out of a total of n observations.

separate hypothesis that each true population partial regression coefficient is zero. But, now we consider the following hypothesis:

$$H_0 : \beta_2 = \beta_3 = \ldots\ldots = \beta_k = 0.$$

The null hypothesis is a joint hypothesis that β_2, β_3, ..., β_k are jointly or simultaneously equal to zero. A test of such a hypothesis is called a test of the overall significance of the observed or estimated regression line, that is, whether Y is linearly related to all Xs. Now, it can be shown that under the assumption of normal distribution for U_i and the null hypothesis

$$H_0 : \beta_2 = \beta_3 = \ldots\ldots = \beta_k = 0,$$

the variable

$$F = \frac{ESS/df}{RSS/df} \tag{3.4.13}$$

is distributed as the F distribution with k-1 and n-k df, i.e. the F-statistic is used to test the overall significance of the regression analysis.

The discussion so far in Section 3.4 has dealt explicitly with the method of least-squares and how this method can be used to estimate the parameters of the population as well as to test the significance of the regression coefficients. Moreover, as mentioned earlier, the OLS estimators are unbiased and efficient. This provides a very strong rationale for using this method in cross-sectional analyses, as in the model specified by us. Our cross-country model satisfies all the criteria for using the least-squares method. Therefore, we have selected this method for estimation and derivation of our results, as will be highlighted in Chapter IV. For the purpose of hypothesis testing, we have made use of the t and F statistics to test the individual significance and the overall significance of the sample regression as specified in the preceding discussion. However, before proceeding any further, it is important to discuss briefly, what problems, if any, might arise in the process of estimation using the least-squares method.

3.4.4 Violation of the Classical Assumptions and the Associated Problems

As mentioned in Section 3.3.3, the method of least-squares can be applied only if the assumptions underlying the Classical Linear Regression Model (CLRM) hold true. But these assumptions may not always hold true. The typical problems that might arise in the process of estimation are multicollinearity, heteroscedasticity, autocorrelation and micronumerosity. In the following analysis, we discuss these problems briefly and spell out the consequences they can have in the process of estimation using the least-squares method.

The CLRM assumes that there is no correlation between the explanatory variables. The problem of multicollinearity arises when this assumption is violated, that is, when one or more of the explanatory variables are either perfectly or highly correlated amongst themselves. In such a situation, the estimates of the parameters either become undefined, or even if it is possible to estimate the parameters, the variances and covariances of the estimates tend to become infinitely large, thus reducing their degree of precision substantially. Moreover, the t statistic tends to become very small, thus accepting the null hypothesis invariably, even if it is false.

Homoscedasticity or equal variance of U_i is another assumption of CLRM. It means that given the values of Xs, the variance of U_i is the same for all observations. Symbolically, therefore, we have

$$Var\ (U_i/X_i) : E\ (U_i^2/X_i) = \sigma^2 \qquad (3.4.14)$$

where Var stands for variance.

Heteroscedasticity is the situation where this assumption is violated, so that the error terms no longer have constant variance, such that

$$E\ (U_i^2/X_i) = \sigma i^2 \qquad (3.4.15)$$

In the presence of heteroscedasticity, the OLS estimators still remain unbiased, but they are no longer efficient, that is, they violate the Gauss-Markov theorem in the sense that they no longer remain the minimum variance estimators. In such a situation, the least-squares method no longer remains the best method of estimation. It is rather the method of "Weighted Least Squares", that is the most efficient procedure of estimation in the presence of heteroscedasticity.

CLRM also makes the assumption that the error terms are not serially correlated, that is,

$$Cov\ (U_i, U_j) : E\ (U_i, U_j) = 0;\ i \neq j \qquad (3.4.15)$$

The problem of autocorrelation arises when this assumption is violated and

$$Cov\ (U_i, U_j) : E\ (U_i, U_j) \neq 0;\ i \neq j \qquad (3.4.16)$$

Here again, the OLS estimators are no more BLUE. However, it needs to be mentioned that autocorrelation is typically a time-series problem and its importance in cross-sectional data is thus not significant. Nonetheless, it can be mentioned that in the presence of autocorrelation, it is the "Generalized Least

Squares" (GLS) method and not OLS which is the most suitable method of estimation.

In the following chapter, where we deal with our method of estimation and describe our results, we take a look into our data set and see whether it exhibits any of the problems mentioned in the preceding discussion. We also discuss what steps we have taken to mitigate these problems.

Before rounding off this section, we would very briefly like to mention the problem of micronumerosity. This problem arises when the number of observations is less than the number of parameters to be estimated i.e. when $n < k$, thus contradicting an important assumption of the CLRM. This is a situation where estimation becomes impossible. However, in order to pre-empt this problem, we have chosen our sample size in such a manner that the sample size is sufficiently greater than the number of variables. This can be readily seen from the fact that whereas the number of observations i.e. $n = 51$ in our model, the number of parameters to be estimated i.e. $k = 7$. Therefore, we can safely conclude that we do not need to worry about the problem of micronumerosity in our case unnecessarily.

Conclusion

This chapter dealt explicitly with the data sources and the methodology underlying the empirical analysis at hand. In order to test the "pollution-haven" hypothesis, a model with foreign direct investment (FDI) was set up. The choice of variables for the model and the rationale for such choice were then put forward. The methodology underlying the estimation and testing procedures was then dealt with exclusively, so as to provide a justification for the use of the least-squares method in our analysis. In the chapter that follows, we will use our cross-country data set to test the validity (or non-validity) of the "pollution-haven" hypothesis, using the methodology enumerated in Section 3.4. This will be supplemented by the results of the empirical exercise and an analysis of the results.

APPENDIX 3A

Table 3.1 below provides a summary measure of the variables and their corresponding data sources. Data on the dependent variable, that is, FDI corresponds to the year 1996, whereas that in case of the independent variables, correspond to the year 1995.

Table 3.1: Measurements and Data Sources

VARIABLE	CODE	UNIT	SOURCE
Dependent Variable: A ratio of inward FDI/ GDP at market prices	FDI	(percent)	World Development Indicators, 1998-'99
Independent Variable:			
Adjusted Real GDP per Capita (PPP$), lagged by one period	GDPPC	(US $)	Human Development Report, 1998
Merchandise exports as a ratio of GDP, lagged by one period	EXG	(percent)	World Development Report, 1997
Gross domestic investment as percentage of GDP, lagged by one period	GDIG	(percent)	World Development Report, 1997
Labour force participation as percentage of total population, lagged by one period	LFP	(percent)	World Development Report, 1997
International Country Risk Guide, lagged by one period	ICRG	(unit free)	World Development Indicators, 1996
CO_2 emissions per $ of output, that is, a ratio of CO_2 emissions to GDP, lagged by one period	ENVS	(kg/$)	World Development Report, 1998-99

Table 3.2 provides a list of the 51 developing countries, that is, the sample that we have chosen for the purpose of empirical analysis. As can be readily seen, this sample is a most diversified one, with countries chosen from all across Africa, Asia and Latin America.

Table 3.2: Sample of developing Countries

Ethiopia	Pakistan	Jamaica
Tanzania	Zimbabwe	Jordan
Malawi	Senegal	Algeria
Sierra Leone	China	El Salvador
Burkina Faso	Cameroon	Paraguay
Madagascar	Côte d'Ivorie	Tunisia
Bangladesh	Albania	Colombia
Uganda	Congo	Peru
Vietnam	Sri Lanka	Costa Rica
Haiti	Egypt	Lebanon
Mali	Malaysia	Panama
Kenya	Indonesia	Turkey
India	Morocco	Venezuela
Nicaragua	Papua New Guinea	Mexico
Ghana	Bolivia	Brazil
Zambia	Guatemala	Chile
Angola	Ecuador	Uruguay

CHAPTER IV

ESTIMATION AND RESULTS

Introduction

The previous chapter was used to set up the platform for our empirical analysis. There we discussed the rationale for the choice of variables, laid down their data sources and also put forth the methodology underlying the entire exercise. In the present chapter, we pen down the results of our empirical analysis. However, before doing so, we discuss briefly the basic framework used in the analysis. In \section 4.1, we acknowledge Ravi Ratnayake and Michael Wydeveld for making use of the framework which they have used in an earlier study, albeit with modifications. We discuss Ratnayake and Wyderveld's framework briefly and outline the modifications that we have made in the present analysis, providing appropriate justification for such modifications. Next in Section 4.2, we have engaged ourselves in a discussion of the descriptive statistics for our sample data set, which we think would provide a fair idea as to the degree of variability or heterogeneity present in the data set. Finally, Section 4.3 engages in a detailed analysis of the estimation results. There we lay down the regression results and analyze these results to reach a conclusion regarding the validity or otherwise of the "pollution-haven" hypothesis. These results have also been presented in tabular form at the end of the chapter in Appendix 4A for expository purposes.

4.1 In Retrospect: The Basic Framework

In Chapter III, Section 3.4, while discussing the methodology underlying the present work, the theoretical model used for testing the "pollution-haven" hypothesis was briefly spelt out. Earlier, we discussed the factors determining FDI flows into a country and the rationale for the choice of variables in our model. For expository purposes, the equation portraying the model is spelt out once again in the following discussion. As described in Section 3.4, the basic equation used for our purpose is

$$FDI_i = C + \beta^{GDPPC} GDPPC_i + \beta^{GDIG} GDIG_i + \beta^{EXG} EXG_i + \beta^{LFP} LFP_i + \beta^{ICRG} ICRG_i + \beta^{ENVS} ENVS_i + U_i \quad (4.1.1)$$

where C is the intercept term

U_i is a stochastic disturbance term

And the explanation for the other variables in the model is as specified in Section 3.3 and summarized in Table 3.1 of Appendix 3A.

This is the complete model that we have chosen for the purpose of our estimation. However, before proceeding any further, it needs to be mentioned that the basic framework has been borrowed from the paper titled "The Multinational Corporation and the Environment: Testing the pollution-haven hypothesis" by Ravi Ratnayake and Michael Wydeveld. Ratnayake and Wydeveld have used a similar kind of framework using FDI flows to test the "pollution-haven" hypothesis. The authors have considered a wide variety of variables to highlight the factors determining FDI flows into a country. In certain cases, they have constructed indices of their own to capture the impact of factors that are not directly observable, such as political stability, protectionism, etc. The sample used is a large sample of 89 countries, both developed and developing and FDI flows for the year 1994 have been considered for the purpose of empirical testing. They have also taken into account a number of environmental factors such as CO_2 emissions, SO_2 [13] emissions and greenhouse gas emissions. The methodology used is the same as the one that we have specified in our study and the data used is essentially cross-sectional in nature. This is indeed an interesting paper in the sense that the framework used for testing the "pollution-haven" hypothesis is different from those used in most of the earlier empirical works. However, a point needs to be mentioned at this juncture. The paper nowhere mentions how the indices reflecting political stability, availability of skilled labour, environmental regulations affecting competitiveness, etc. have been designed. As an example, political stability has been measured in terms of an index of a stable and well adapted political system, the scale used being 0 to 10, where 0 implies that the political system is not adapted to today's economic challenges. But this kind of an index lends itself to subjective value judgments and lacks clarity in terms of objective criteria. This is because words like "economic challenges" are highly subjective in nature and therefore one might question the validity of creating such indices.

However, we do not question the merit of the paper, as we think that the framework used is basically correct and intuitively appealing. Keeping in view the merit of the framework, therefore, we have adopted it for the purpose of our analysis. However, we have made certain modifications. Instead of using a whole lot of variables, whose effects on FDI flows can well be questioned, we have tried to keep the model as simple as possible, by including those variables that we think are truly relevant in the present

[13] where SO_2 stands for sulphur dioxide.

context. Moreover, Ratnayake and Wydeveld have used GDP per capita at market prices as a proxy for the potential market size of a country. But as discussed in Section 3.3, GDP per capita at market prices only reflects the income side of an economy. It does not take into account the consumption patterns of a country. However, in cross-country comparisons, the consumption patterns assume as important a role as the income patterns. To capture income as well as consumption patterns in our model, we have, therefore, used adjusted real GDP per capita (PPP$) instead of GDP per capita at market prices as our proxy for the potential market size of a country. Since the rationale for this has already been provided in Section 3.3, we, therefore, refrain from going into the details of such choice once again. A very vital difference of our model with that of Ratnayake and Wydeveld has been the inclusion of the variable "International Country Risk Guide" or ICRG. While the above mentioned authors have designed various indices to capture the effect of the factors not directly observable, we feel that such an exercise is fraught with all kinds of subjective shortcomings, as has been mentioned earlier. However, ICRG is a much more widely accepted index, since it is based on a wide spectrum of risk measures as has already been elucidated in Section 3.3. Therefore, we feel that the inclusion of ICRG as a proxy measure for all those variables that are not directly observable is much more appropriate and lends itself to a comparatively lesser degree of subjectivity. Further, we have chosen a different time period for our analysis. While Ratnayake and Wydeveld's study pertains to the year 1994, for our analytical purpose, we have chosen the year 1996 to evaluate the effect (if any) of environmental regulations on FDI flows. Finally, we think that our sample of 51 developing countries is unique. Therefore, what we have done is that although we have borrowed the basic framework from the study of Ratnayake and Wydeveld, we have modified it in a way which we think is more appropriate and tested the "pollution-haven" hypothesis using a different time period and a different sample.

4.2 A Study of the Descriptive Statistics

Before proceeding on to discuss the results of our analysis, we discuss some statistical measures for our data set, which we think would provide an idea as to the degree of variation (or heterogeneity) in the data across the 51 countries that we have considered. The statistical measures that we have dealt with for each variable are the average (mean), standard deviation, coefficient of variation and the range (computed from the difference between the maximum and the minimum values for each variable). A summary of this discussion has been provided in Table 4.1 of Appendix 4A at the end of the present chapter.

The first measure we discuss is the average or the mean of each variable. The average for FDI as percentage of GDP is 1.89. The maximum value in this class is 6.4 (Vietnam and Bolivia) and the minimum is 0.1 (Bangladesh and Algeria). Since the average value is much smaller than the maximum value and closer to the minimum value, it becomes evident that a greater number of countries have an FDI/GDP ratio which is comparatively small. In fact, out of the 51 countries considered, only 20 countries have an

FDI/GDP ratio greater than the average i.e. 1.89. In fact, Ghana is the country with the most representative value for this variable in the entire class with an FDI/GDP ratio of 1.9. Moving on to adjusted real GDP per capita (PPP$) or simply GDPPC, according to our notation, the average value is $ 3113.06. The maximum value in this class is $ 6116 which pertains to Chile and the minimum value which pertains to Ethiopia is $ 455. The range for this variable is $ 5661 and the number of countries distributed on both sides of the mean are quite symmetrical. Again, gross domestic investment as percentage of GDP or GDIG exhibits an average value of 20.89. The maximum value in this category i.e. 40 is exhibited by China and the minimum value 2 by Haiti. Thus the effective range is 38. However, it seems that the values of GDIG for the sample 51 countries are quite evenly distributed about the mean. Coming to manufacturing exports as percentage of GDP (i.e. EXG), the mean value is 20.80. Here the maximum value, however, is very large, to the order of 94.3 (Angola) and the minimum value is 5.1 (Sierra Leone). The range 89.2 is therefore also quite large. Here again, it can be seen that only 21 out of the 51 countries in the sample have a value of EXG which is greater than the average. The next variable we consider is labour force participation rates as percentage of total population. In our notation, this variable is denoted as LFP. The average value for this variable is 42.12, whereas the maximum value is 60.60 (Albania) and the minimum value is 23.2 (Jordan), with the range being 36.8. For this variable too, the observed values for the 51 countries are distributed evenly about the mean. In our model, we have introduced "International Country Risk Guide" or ICRG as a variable determining FDI flows. This is basically an index on a scale of 0 to 100 with higher values of the index denoting lesser degrees of risk. The mean value of ICRG for our sample is 64.55 with the maximum value 80.3 pertaining to Chile and the minimum value 44.8 pertaining to Angola. This implies that within our sample, the extent of investors' risk is least in case of Chile and greatest in case of Angola. An evaluation of the data set highlights that the values for the majority of the countries in the sample are clustered around the mean. Finally, we consider the environmental variable ENVS which denotes the amount of CO_2 emissions per \$ of output. The mean value for this variable in our sample is 1.11 kg/\$. The maximum amount of emissions, 4.6 kg/\$ are for China and the minimum amount of emissions, 0.2 kg/\$ are for Mali. The effective range here is 4.4 kg/\$ and only 16 countries in the sample exhibit greater emission values than the average 1.11 kg/\$.

Next, we turn to a description of the measures of dispersion i.e. standard deviation and coefficient of variation, for the variables in our model. As has been mentioned earlier, the summary of these measures has been laid down in Table 4.1 of Appendix 4A. As we know, standard deviation (SD), which is also the "root-mean-square-deviation" is an absolute measure of dispersion, whereas the coefficient of variation (CV), measured as

$$CV = \frac{\text{Standard Deviation}}{\text{Mean}} \times 100$$

is a relative measure of dispersion. Both of them, therefore, measure the variability of a particular data set. Moreover, SD is measured in the same unit as the observations, and therefore, cannot be used for comparing the variability of two or more series given in different units. However, the CV, which is a relative measure of dispersion and hence a pure number, is employed for this particular purpose. Coming back to our data set, the SD for the FDI/GDP ratio is 1.86, whereas the corresponding CV is 98.54. Again, SD in case of GDPPC is 1863.92, that for EXG is 15.17 and 0.94 for ENVS. The CV for the corresponding variables are 59.87, 72.94 and 85.33 respectively. Thus, the variability in the data set for the variables FDI, GDPPC, EXG and ENVS are quite high, which is apparent from the values of their corresponding CVs. Turning to the other variables of the model, viz. GDIG, LFP and ICRG, the values of SD are 7.03, 7.43 and 7.58 respectively. The corresponding CV values are 34.13, 17.62 and 11.74. These three sample series, therefore, exhibit a smaller degree of variation compared to the previous four series. In passing, it can be noted that the degree of variation is highest for the variable denoted by FDI and lowest for that denoted by ICRG.

The current section highlighting the discussion on a few descriptive statistics thus helps us to understand clearly the degree of variation or heterogeneity present in the data set. This discussion is important, as it brings out a clear picture of the data set, which would invariably have a significant impact on the results obtained in the empirical analysis.

4.3 An Analysis of the Regression Results

Let us now turn to the basic objective of this chapter i.e. to the results of our estimation and testing procedures. As previously mentioned, the model which we have selected for our purpose is

$$FDI_i = C + \beta^{GDPPC}GDPPC_i + \beta^{GDIG}GDIG_i + \beta^{EXG}EXG_i + \beta^{LFP}LFP_i + \beta^{ICRG}ICRG_i + ENVS_i + U_i \qquad (4.3.1)$$

The equation has already been explained before. Our intention was to estimate the β coefficients in the model and also to test the significance of each and every explanatory variable in the model, particularly the environmental variable ENVS. This variable is most crucial to our study, as its significance would pronounce on the validity (or non-validity) of the "pollution-haven" hypothesis. But before proceeding with the estimation exercise, we checked our data set for the presence of multicollinearity between one or more variables. This is important in the light of the discussion in Section 3.4 of Chapter III. However, our data set exhibited no signs of multicollinearity between any of the variables. Moreover, as was mentioned in Section 3.4 itself, we need not worry about the problem of micronumerosity. This is because the number of observations in the sample (i.e. 51) is much larger than the number of parameters to be estimated (i.e. 7). Section 3.4 also highlighted the fact that autocorrelation, a major problem in the Classical Linear Regression Model (CLRM) is basically a time-series phenomenon and does not make much sense in a cross-sectional analysis. Keeping these points in mind, we have then taken care of problems such as multicollinearity, micronumerosity and autocorrelation in our analysis. Moreover, the standard errors of the estimates were made White's Heteroscedasticity consistent.

We can now turn directly to the regression results. These results have been presented in tabular form in Table 4.2 of Appendix 4A, which should be consulted for quick references. Our regression analysis presents certain interesting and useful results. The intercept term which is significant at the 1% level has a negative sign. This suggests that in the absence of all other variables affecting FDI flows, or rather when all the other explanatory variables are zero, there would occur some amount of outflow of FDI from the country. Now, turning to the other variables of the model, the estimates for the coefficients of merchandise exports as percentage of GDP (i.e. EXG) and labour force participation rates (i.e. LFP) are significant at the 1% level, as can be seen from the p-values of their corresponding t-statistics. This implies that the null hypothesis that H_0: $\beta^{EXG} = 0$ and H_0: $\beta^{LFP} = 0$ are rejected even at the 1% level of significance, such that EXG and LFP significantly affect FDI flows into a country. Further, real adjusted GDP per capita (PPP$) or GDPPC and the International Country Risk Guide (ICRG) are also significant at the 5% level of significance. Moreover, the coefficients of the variables GDPPC, EXG, LFP and ICRG are all positive, thus providing an empirical basis to the theoretical justification that these variables bear a positive and significant relationship with FDI flows. However, the results show that gross domestic investment as percentage of GDP (GDIG) is not significant, thus accepting the null hypothesis that H_0: $\beta^{GDIG} = 0$. Further, as can be seen from Table 4.2, the values of the standard errors of the estimates are all very small. This lends a great degree of "reliability" or "precision" to the estimates, as was pointed out in Section 3.4 of Chapter III that the standard error is a measure of "reliability" or "precision", in the sense that smaller the standard errors, the better are the estimates.

Focussing on the most crucial result of our analysis, we find that the environmental variable ENVS does not significantly affect the dependent variable FDI. This can be gauged from the p-value of its corresponding t-statistic. The hypothesis that H_0: $\beta^{ENVS} = 0$ is accepted even at higher levels of significance. In other words, this implies that environmental regulations do not affect FDI flows into a country or phrased differently, environmental regulations do not affect plant locations. But this is a categorical rejection of the "pollution-haven" hypothesis, which seeks to establish a direct relationship between environmental regulations and relocation of pollution-intensive industries from the developed to the developing countries.

Addressing the question of "goodness of fit" of the regression model, it can be seen from Table 4.2 once again that the value of the "coefficient of determination" i.e. $R^2 = 0.3240$. The adjusted R^2 value is 0.2319. This however need not come as a surprise, as R^2 in most cross-sectional analyses is usually low. Moreover, the F-statistic and its corresponding probability value reflects the overall significance of the model. As was pointed out in Section 3.4, the F-statistic measures the overall significance in the sense that it considers the joint hypothesis that all the βs are simultaneously equal to zero. A rejection of this hypothesis implies an overall significance of the sample regression. It is evident from the F-statistic and its p-value in Table 4.2 that our sample regression is overall significant.

The previous regression result categorically emphasized that the environmental variable does not affect the dependent variable FDI. However, in that model, gross domestic investment or GDIG turned out to be insignificant. Therefore, in the subsequent analysis, we dropped this variable from our model and constructed the following equation:

$$FDI_i = \alpha + \beta^{GDPPC}GDPPC_i + \beta^{EXG}EXG_i + \beta^{LFP}LFP_i + \beta^{ICRG}ICRG_i + \beta^{ENVS}ENVS_i + v_i \qquad (4.3.2)$$

where α is the intercept term and v_i the stochastic disturbance term in this modified model. Our intention was to check whether this change could lead to any major changes, whatsoever, in the earlier results. As before, the data set was free from the problems of multicollinearity and micronumerosity and moreover, the standard errors for the estimates were made White's Heteroscedasticity consistent. However, here too, the results were in the expected direction without any major changes.

The intercept term is again significant with a negative sign, the explanation to which is exactly the same as before. Also, EXG and LFP are again significant at the 1% level, which can be deduced from the p-values of the corresponding t-statistics. GDPPC and ICRG are also significant, but at the 5% level. Moreover, the coefficients of all the above mentioned variables are positive, as in the previous case, thus pertaining to the theoretical justifications laid down in Section 3.3. Finally, the standard errors for all the estimates are very small, thus ensuring the "reliability" or "precision" of the estimates.

Once again, let us consider the environmental variable or CO_2 emissions per \$ of output, denoted by ENVS. Here too, the results show the same trend as before. The estimate for ENVS is insignificant and the null hypothesis H_0: $\beta^{ENVS} = 0$ is once again accepted. So, the "pollution-haven" hypothesis is again rejected, enabling us to firmly conclude that environmental factors do not affect plant locations. The R^2 value for this regression is 0.3235 and the adjusted R^2 value is 0.2484, almost the same as before. Further, the F-statistic and its probability value depict overall significance of the sample regression by rejecting the joint hypothesis that all the βs are simultaneously equal to zero.

The second regression analysis thus projects similar kinds of results as the first one. The results vary only slightly without there being any major changes. For easy reference, the results of this sample regression have been presented in Table 4.3 of Appendix 4A. Thus, the core of the entire analysis stands out in the form of a refutation of the "pollution-haven" hypothesis. We emphatically assert that environmental regulations do not affect plant locations. It is the other factors like GDP, exports, labour force participation rates, etc. which play a much more decisive role. In passing, it needs to be mentioned that our study is based on a cross-sectional analysis for a particular time period i.e. the year 1996. However, a panel-data analysis would definitely have served the purpose better. Although we do not feel that the results would have been substantially different, yet a combination of cross-sectional and time-series data would definitely have provided a better insight into the entire problem. Thus, we feel that there is definitely further scope of research in this area.

Conclusion

The "pollution-haven" hypothesis has been a widely debated issue. Theoretical literature drawing mainly on the theory of comparative advantage and the Heckscher-Ohlin model, argue in favour of the hypothesis. However, empirical analysis in this area, in general, fail to supplement the theoretical justification. Empirical work till date overtly tend to reject the so-called "pollution-haven" hypothesis. In this chapter, we presented the results of our analysis. These results have also been laid down in the tables provided in Appendix 4A at the end of this chapter. Our empirical exercise too, fails to find any kind of significant relation between industrial locational decisions and environmental factors, thus invalidating the "pollution-haven" hypothesis. The present study tends to support the conclusions of previous empirical literature. Indeed, other factors such as GDP, labour force participation rates, exports, etc. appear to be much more significant than environmental factors in locational decisions.

Aappendix 4A

Appendix 4A presents the results of the regression analyses and a summary of the descriptive statistics relating to the data set. Table 4.1 presents the summary statistics, whereas Table 4.2 presents the regression results corresponding to (4.3.1) and Table 4.3, those corresponding to (4.3.2).

Table 4.1: Summary Statistics

Variable	Average	Standard Deviation	Coefficient of Variation	Maximum	Minimum	Range
FDI	1.89	1.86	98.54	6.40	0.10	6.30
GDPPC	3113.06	1863.92	59.87	6116.00	455.00	5661.00
GDIG	20.59	7.03	34.13	40.00	2.00	38.00
EXG	20.80	15.17	72.94	94.30	5.10	89.20
LFP	42.18	7.43	17.62	60.60	23.80	36.80
ICRG	64.55	7.58	11.74	80.30	44.80	35.50
ENVS	1.11	0.94	85.33	4.60	0.20	4.40

Note: The average, standard deviation, maximum, minimum and range have all been expressed in the same unit as the variable in question and the coefficient of variation as a pure number (in percentage terms).

Table 4.2: Results of OLS Estimation (A)

Dependent Variable: FDI

Number of Observations: 51

VARIABLE	COEFFICIENT	STANDARD ERROR
C	-9.32706* (0.0002)	2.252048
GDPPC	0.000355** (0.0171)	0.000143
GDIG	0.006672 (0.8732)	0.032286
EXG	0.037947* (0.0038)	0.012427
LFP	0.110846* (0.0003)	0.028257
ICRG	0.070154** (0.0303)	0.031340
ENVS	-0.019550 (0.9416)	0.265312

R^2 : 0.3240
Adjusted R^2 = 0.2319
F-statistic: 3.5154
Prob (F-statistic): 0.0063

Notes: (a) (A): corresponds to (4.3.1) in the analysis.
(b) the standard errors for the estimates are White's Heteroscedasticity consistent.
(c) p-values for the t-statistics have been provided in the parentheses.
(d) * implies 1% level of significance and ** implies 5% level of significance.

Table 4.3: Results of OLS Estimation (B)

Dependent Variable: FDI

Number of observations: 51

VARIABLE	COEFFICIENT	STANDARD ERROR
α	-9.380170* (0.0001)	2.222298
GDPPC	0.000361** (0.0142)	0.000141
EXG	0.038698* (0.0028)	0.012233
LFP	0.112280* (0.0002)	0.028129
ICRG	0.071416** (0.0211)	0.029873
ENVS	-0.007458 (0.9756)	0.242047

R^2 : 0.3235
Adjusted R^2 = 0.2484
F-statistic: 4.3053
Prob (F-statistic): 0.0027

Notes: (a) (B): corresponds to (4.3.2) in the analysis.
(b) the standard errors for the estimates are White's Heteroscedasticity consistent.
(c) p-values for the t-statistics have been provided in the parentheses.
(d) * implies 1% level of significance and ** implies 5% level of significance.

CHAPTER V

CONCLUSION

Towards the end of the 1980s, international interest in the links between trade and the environment grew significantly. A major factor contributing to this interest was a dispute between the United States and Mexico over American trade restrictions on imports of Mexican tuna. The United States believed that Mexico was taking insufficient precautions to prevent the accidental catching of dolphins while fishing tuna, and therefore, placed an embargo on Mexican tuna in 1990. Mexico protested against these measures claiming that the sanctions imposed by the United States were not compatible with either international law or GATT regulations. This incident brought to the forefront a major issue – "Is increasing international trade detrimental to the environment?" Today protection of the environment is a major concern for many. It is felt that if the environmental concerns are not taken into account, development of the world economy as a whole will not be sustainable. To be precise, if the institutional structure in a country ignores the fact that production of goods deteriorates life support systems, trade with these goods will strengthen this trend. Trade will increase the environmental consequences that occur when goods are produced and consumed.

5.1 The "Pollution-Haven" Hypothesis Revisited

The debate over the role international trade plays in determining environmental outcomes has at times generated more heat than light. Theoretical work has been successful in identifying a series of hypotheses linking openness to trade and environmental quality, but the empirical verification of these hypotheses has seriously lagged. Foremost among these is the "pollution-haven" hypothesis suggesting that relatively low-income developing countries will be made "dirtier" with trade. The dominant trend in the world economy in the 1990s was towards liberalized trade. At the global level, the decade witnessed a new round of negotiations under the GATT that resulted in the creation of the "World Trade Organization" (WTO). At the regional level, free trade agreements were initiated or strengthened in Europe, Asia, Africa, Latin America and North America.

What happens to the environment when international trade is liberalized? Economic theory suggests that trade between countries with differing levels of environmental protection could lead pollution-intensive industries to concentrate in nations where regulations are lax. Developing countries frequently have less stringent environmental regulations than the developed countries. Since countries with low environmental standards can gain a comparative cost advantage in the international commodity market, the "pollution-haven" hypothesis suggests that foreign investors will flock to poorer countries to take advantage of their lax environmental standards. It has long been debated whether this fear is a legitimate concern in terms of preserving the global environment. The "pollution-haven" hypothesis is based on a simple intuition that people in a poorer country would have a lower marginal valuation of the environment (or a lower marginal disutility of pollution) and hence a lower marginal social cost of production.[14] To maximize social welfare, the government in a poorer country would set lower environmental taxes or standards, which would result in a lower production cost. This would attract multinationals to relocate their production from a richer country to a poorer country to minimize their marginal costs of production. In view of a long-term tendency for industrial countries to adopt increasingly stringent environmental control measures that impose costs of compliance on polluting industries,, the question is to what degree more stringent standards will induce investors to shift the location of their production to countries with lower standards. For environmentalists, dirty industry migration puts global environmental quality at greater risk than it would be if factors of production were unable to relocate in response to variations in environmental standards. For labour interests, dirty industry migration might be considered the product of an unfair situation in which conscientious governments would make workers in their jurisdiction pay for the neglects of other governments.

5.2 <u>Highlights of the Present Study</u>

Not much work so far has been done to determine how far international shifts in industrial location have been prompted by differential environmental standards. A review of major analytical works conducted in this area show that

[14] Empirical studies on the relationship between pollution and income growth, which affects one's marginal disutility of pollution include Grossman and Krueger (1995) and the World Bank (1992).

while there is some empirical support for the "pollution-haven" hypothesis, most analysts have put forward arguments for the non-existence of "pollution-havens". There seems to be an incongruence between academic empirical analysis and the conventional wisdom as far as the question of "pollution-havens" hypothesis is concerned. This was highlighted in Chapter II while reviewing the literature in this field. There we saw that while a sporadic few papers found evidence in favour of the "pollution-haven" hypothesis, the bulk of the empirical literature tends to strongly reject the hypothesis. To do justice to both sides, one might conclude that empirical work has at best left the issue ambiguous and hence the debate over the "pollution-haven" hypothesis is still an unresolved issue of economics. The main purpose of the present study was to deepen the understanding and to verify empirically the trade-environment competitiveness issue. For this purpose, FDI flows into a country were used as a proxy for the relocation of polluting industries. The determinants of FDI were specified and a model relating FDI flows to a host of other factors was built up to test the "pollution-haven" hypothesis. In particular, CO_2 emissions per $ of output was introduced as a variable in the model as a proxy measure for environmental stringency in a country. The underlying purpose was to test whether overt environmental regulations significantly affect FDI flows into a country. Various cross-country regressions were run using a data set comprising of a sample of 51 developing countries. The sample was chosen carefully, keeping various characteristics in mind. However, the regression results strongly refuted the "pollution-haven" hypothesis, in the sense that the effect of the environmental variable on FDI flows and hence on international relocation of dirty industries from the developed to the developing countries, was highly insignificant. Our empirical results, therefore, compelled us to reject the "pollution-haven" hypothesis and conclude that environmental regulations do not matter as far as plant location (or rather, relocation) is concerned. Thus the present study, in its own way, complements major empirical works in this area, by failing to find any empirical evidence in favour of the "pollution-haven" hypothesis.

5.3 Major Implications of the Research

The explanation for the lack of evidence for the existence of "pollution-havens" is not very difficult to comprehend. Low income, countries typically have both low-incomes per capita and low capital-labour ratios. The "pollution-haven" hypothesis suggests that a low income economy would be made dirtier by trade. But if pollution-intensive industries are also capital-intensive, then whatever benefits that accrue from lax pollution regulations could be largely undone by the relatively higher price of capital in the capital scarce country. As a result, further openness to trade will have a very small effect on the pollution-intensity of output for low-income countries. Indeed, it is worth reiterating at this stage that even if differences in national approaches to environmental issues do account for some investment decisions, this does not provide a justification for policy actions that aim to stem the movement of dirty industries. Assuming the absence of some overriding environmental objective, of the kind that would attract widespread support beyond national frontiers, such actions would threaten the growth and development prospects of developing countries. Moreover, it does not follow that dirty industry migration engenders environmental degradation. The contrary may be true. Whether or not, dirty industry migration *per se* is bad for the environment is a matter that can only be settled empirically. One factor that will influence the relationship between dirty industry migration and the environment is the type of technology that is used in different locations. A broad range of clean and dirty technology choices exists in many industries. On the other hand, there can be significant variations in ambient pollution absorptive capacities according to location. In addition, differences in income levels and social preferences will influence the manner in which environmental quality is perceived and defined in different locations.

The major implication of this research is that it has established categorically that "pollution-havens" do not exist in the real world. Unfortunately as previously mentioned, most negotiations at the international fora are based on this widely held concept, thus further exacerbating the North-South divide. Therefore, instead of freeing up world trade and investment flows, restrictive trade practices are being imposed under the guise of promoting sustainable development. This has detrimental effect not only on the developed countries, but also on the developing countries, where in effect unhindered flow of investments would encourage migration of cleaner industries and therefore catalyze the "greening" of national efforts along an environmentally sustainable development trajectory. This will certainly lead to a general upgrading of environmental welfare for the whole world. Indeed, the implications of substantiating the "pollution-haven" hypothesis, or failing to thoroughly disprove it are profound. The "pollution-haven" hypothesis taken on faith, as it currently is in some quarters, provides a rationale for harmonization of world environmental standards, unilateral actions against trade and/or the restriction of capital movements. Such actions have grave implications for the world's ecological environment, multilateral trading system and any particular country's prosperity.

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