Environmental Technology Diffusion in a FDI Regime

A developing Country Perspective

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Abstract

The environmental impact of Foreign Direct Investment is still to be explored totally. It is often argued that investment may come to a region or country where environment protection norms are less strict. Investors may be induced to outsource their pollution-intensive production where the expected cost of pollution abatement is significantly less. This gave birth to the much debated idea of 'pollution havens', parallel to low-wage havens. Developing countries are more vulnerable to such cases since the environmental legislation and monitoring is not rigorous over there. Again, many have debated that such 'pollution havens' does not typically exist or at the best, transient in nature.

Over the last decade, as a result of its policy towards opening up of the economy to the global markets, the extent of multinational activities and their share in trade and industrial production have risen steadily in India. Viewing this development, this paper primarily attempt to show the very existence of such a pollution haven in Indian scenario, analysing time series data for industrial production and international trade of identified pollution intensive industries in the country. Then it argues that, even if of transient nature, the phasing out of such a pollution haven regime is typically dependent upon the active institutional intervention. One important factor, this paper identifies, is of making of state-of-the-art knowledge base of impact analysis and alternative production possibilities that help design prudent environmental policy regime. Also it searches for the right kind of institutional interface at the international, national and industry level; and endeavours to find the implications thereof.

Introduction

In a December midnight in 1984, forty tons of highly toxic Methyl IsoCyanate (MIC) gas; which had been manufactured and stored in Union Carbide's chemical plant in Bhopal, a state capital in India; escaped into atmosphere and was wind borne directly to the City habitat. The estimate of death toll numbered around 8000 with an over 200,000 people injured due to the inhaling of the toxic. Along with the enormity of human tragedy, what is more agonising is that after 18 years or so passed, the government have neither been able to pay compensations to all of the victims, nor it could punish the responsible Union Carbide authority thus providing justice to the suffered humanity. This case, being the most vivid example of industrial toxic accident, points us to the gross incapacity of the industrial environmental law and policing in the country. It reflects that even after such a sheer tragedy, the responsible can escape only after paying a statutory compensation to the victims.

I – The Case

Though the above is only an extreme example, what we understand from that is that environmental or pollution preventing norms are grossly inadequate in the country; especially when compared with the same of the developed nations. So there are reasons to believe that, the manufacturers, who search for a 'safer' location for their pollution intensive production activities, would take interest in countries like India. In fact, a country with lax environmental norms and weak monitoring would emerge out as the natural choice for such manufacturers, where the expected abatement costs are sufficiently less.

Environmental Legislation in India

India, in terms of its environmental legislation, lags behind all the advanced nations in almost each of the aspects. To mention, in the developed world, the cry for environment started in the decade of sixties last century, if not before; and most of the developed nations come out with their environmental/ pollution abatement legislations by then. That is why the 1960s are sometimes correctly referred as the 'decade of environmentalism'. India has, however missed the bus of the said environmental era and people have to wait until Seventies to have an environmental act. The first of its kind in India was the Wildlife Act, came into existence in 1972. Easy to understand, it has hardly any applicability to industrial pollution. The Water (Pollution and Prevention) act came in 1974, which can be marked as the true beginning point of environmental legislation in the country. The Air (Pollution and Prevention) act and the Environment (Protection) act, both came in 1981.[1] But for a comprehensive industrial pollution preventing legislative mechanism in India, people have to wait until 1994; when the Ministry of Environment and Forest (MoEF), Government of India (GoI) issued a circular for mandatory environment clearance certificate for industrial projects. [2] By that

time, India has already set its path for a new economic era and rapid industrialisation under state encouragement.

The New Economic Policy in India

The 1990s was a phenomenal decade for India in terms of its economic orientation and impacts thereof and change in the stance towards international economics. In 1991 July, a New Economic Policy (NEP'91) was launched by GoI which had path breaking strategies. It encouraged a private enterprenurship-lead development path with a more open approach to the international economics. The economy changed its stance to an export oriented approach from a hitherto protectionist strategy. It opened many sectors for the private foreign enterprenurship which earlier were captivated to state activities only. The coverage is still increasing with various pro-foreign investment policies being adopted time to time. Foreign Direct Investment (FDI) was assumed to be an important vehicle for economic development and many major pro FDI policies have also been taken. Over the last decade, the FDI came to play an important role with respect to providing India with sources of long-term capital, creation of job, technology transfer- which all could together put India on a higher path of growth.

Flow of FDI to India

For this favourable strategic stance of the govt.; and with the natural competitive advantages India poses, like the big market, cheap labour and so; an increasingly bigger flow of FDI started to come in India, amounting a close to US$ 4 Billion in 2001-2002 from a mere US$ 155 Millions in 1991 (Table 2, Data Appendix) Not only that, the export performance of the manufacturing sector has been improved significantly, pointing to a very high affiliate production level. For all this, it has been acclaimed to be a great success story for the economy. However, there are also a number of questions raised from different quarters about the quality of the foreign investment and impact of this kind of industrialisation of the economy and its said integration with the global market. Among this, we would address here the question of the impact on environment of such a pattern of industrialisation, leaving aside the others for independent discussions.

II – The Evidence

The environmental impact assessment of an industrial production pattern mainly asks for the study of sustainability of the case. That is to say, whether the current pattern is sustainable by the

economy and the environment even after the initial stimulant or the cause of inception is ceased to exist. In our case, we would examine that, the change in industrial production pattern in the economy due to strategic changes, if there is any, whether capable to continue; if the country, in terms of its environmental legislation becomes at par with the other economies. To be explicit, we would look into whether the lax environmental norms played as a determining factor to the locational decision of the investors. A positive answer would suggest that there has *been* some 'Pollution Haven' effect in reality. We define the term as a manufacturing location where the perceived cost of pollution abatement is less than the other locations. The perceived cost of abatement is a resultant perception of the investors about the coverage of the law and penalty thereof and institutional monitoring mechanism, discounted for the spread of getting caught. Thus the term 'pollution haven' becomes somewhat similar to the concept of 'low-wage haven', where the manufacturers can hire labour at a cheaper average wage even after discounting for the skill levels.

In our analysis we will follow the methodology of determining the 'dirty-industry' pattern. We will see whether the pollution intensive sectors are growing more rapidly than the others. For that we will study the growth of industrial production in the selected sectors, vis-à-vis the overall industrial growth path. One may argue that the pollution intensive production may increase more than proportionately due the domestic demand factors also, for that matter the idea of pollution haven ceased to exist to a significant extent. To capture this, we will also study the export behaviour of such products over the time. A continuous increase in exports would suggest an outsourcing of pollution intensive activities in the country.

Defining Dirty Industries

To start with, we need a basis to define the 'dirty' industries, i.e., the industries with high polluting effects. One conventional approach in the literature has been to identify pollution intensive sectors as those having high levels of abatement expenditure per unit of output (Robison (1988), Mani (1996)). Another approach would be to identify sectors with high energy consumption coefficient per unit, since there is a direct positive link between energy production and pollution. But the lacunas in environmental knowledge-base in India prevent us to adopt any of the approaches aforesaid. In fact such a database is available only in a handful of developed countries like the US and some other OECD countries. This deficiency itself shows us the inadequacy of the monitoring mechanism in the country! Here we take a rather straightforward approach to select the pollution intensive industries- we take the set of seventeen industries identified by the MoEF, GoI as the most pollution intensive ones[3]. The MoEF took a rather direct approach to identify this set by taking their actual emission (per unit). We take this set as the basis of our analysis.

Before that we would take a look on the nature of the stock of the FDI flow generated in India over the past decade (Table 1, Data Appendix), we recall that in 1994, in the comprehensive circular issued by the MoEF, GoI as a basis for environmental management of industrial activities, the authority has identified 29 industrial activities where a new project would require environmental clearance mandatory, prior to the establishment and commissioning the project. These activities said to have highest threat of environmental damage during their course of operation. A study (Veena Jha 1997) shows that around 80% of the approved FDI projects since 1991 falls in any of the above categories.

Limitation of the Methodology and Overcoming

Before proceeding any further, we must confess about the limitation of such a methodology for identifying a pollution haven effect. As it is generally understood, a locational decision about an investment project not only depends on a single point notion of (lax) environmental norms, rather it asks for many other locational variables like labour abundance, infrastructure, market size, natural resource abundance etc, as normally found in OLI models of investment decision (Dunning). So considering only environmental norms as the parameter would, at best, give a partial view of the whole picture; until and unless we account for the other factors in the comparative advantage story by taking their relative prices scenario across the locations. This effect, however, could be minimised somewhat when we consider only the pollution intensive sectors; in a sense that the other effects are equal across all the industries and all the other industries have been equally benefited from those effects, and they are not particular to the set of pollution intensive industries.

Data Analysis

We first analyse the production growth of the selected industries. Figure 1 shows the growth trend of the combined production of the selected 13 industries (in physical terms) for the period 1981-82 to 1999-2000. It covers the initial years after the policy, and a decade before that, for the sake of comparison. It clearly shows an upward trend for all the industries, with a major shift in the rate of growth around the early 1990s in some of the industries, when India has opened up to world investment scenario.

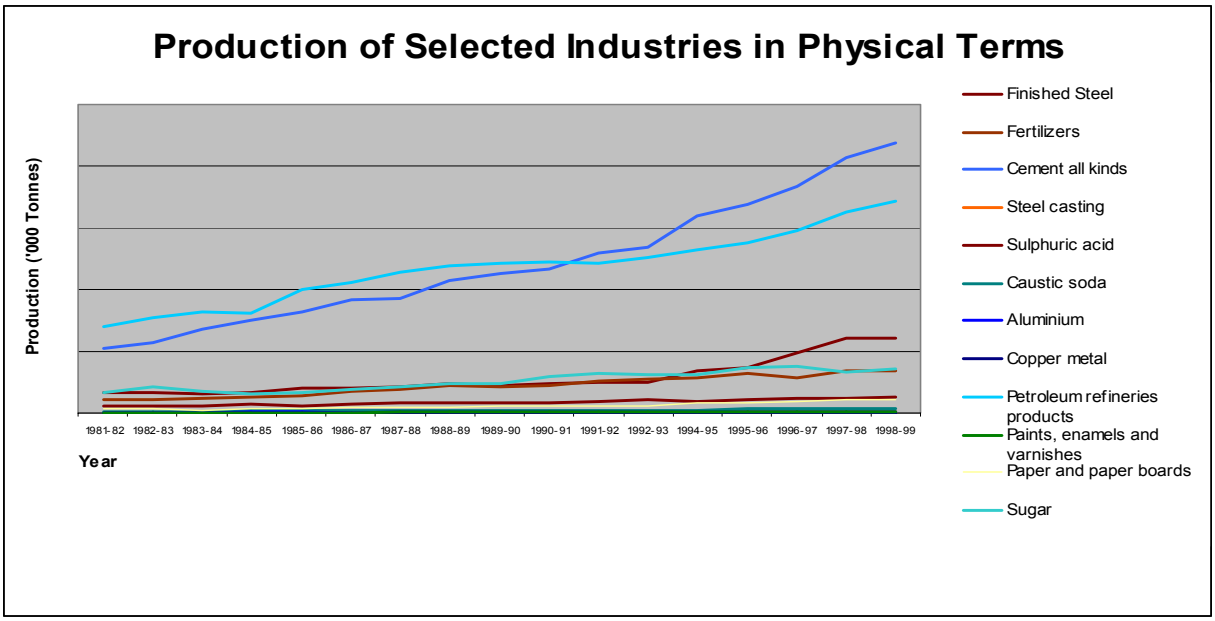

Figure 1

One may argue that the shift in production of the said industries may be influenced by the domestic consumption demand itself. This is nevertheless may be true to some extent, but evidence also shows that domestic consumption of these goods have not been increased at that pace what the above figure may suggest; rather, export of such productions shows a spurt.

Our next analysis deals with the export-import trend of such selected sectors. Here we take the ratio of value of export to that of import for the period 1981-82 to 1999-2000 (Figure 2) for them. Here also it covers the initial years after the policy, and a decade before that, for the ease of comparison. This trend also shows an upward rising path all through, gradually approaching unity.

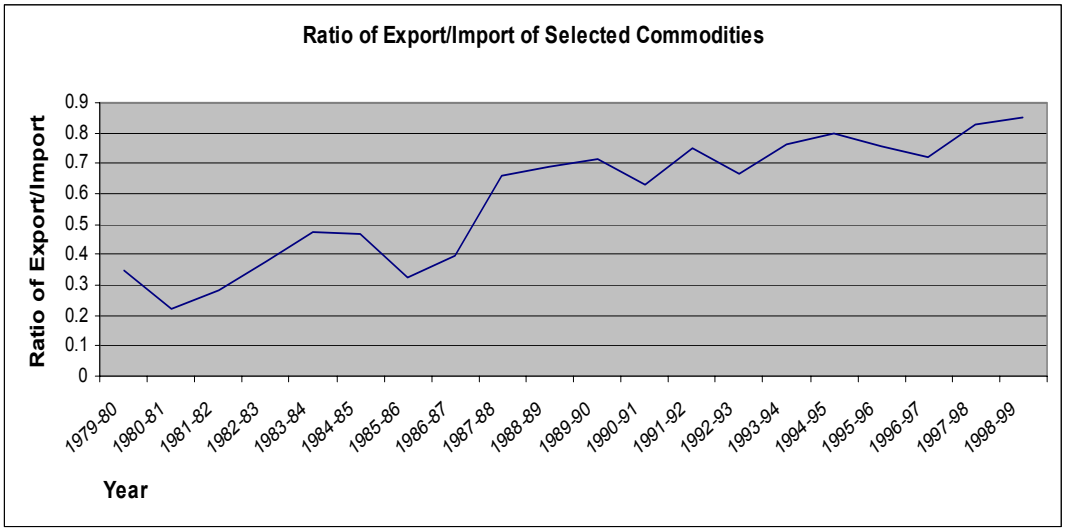

Figure 2

Implication of the Results

Our analysis have suggested two main results- one is the faster growth rate of the pollution intensive industries in the post policy period; and two, India has been exporting such pollution intensive products in a increasingly higher proportion of its import. With this we club two empirical facts, first is the concentration of FDI in those identified industrial activities (Table 1), and second is the rapid increase in the pollution abetment expenditure in the developing countries during this period. These altogether have the implication that there has been a shift in the favour of dirty sector production. This is either fueled by the increase in the affiliate production or through outsourcing, or both. Any of these suggests a possibility of existence of what we call a 'pollution haven'. In fact, we can find support of this result in the literature, to mention- Mani and Wheeler (1997).

Empirical research also shows that there will be some countries that lag behind in their efforts to control pollution by now and may even take years to catch up with the rest of the world. They all possess a serious threat to have a pollution haven effect in reality. But at the same time, many have also argued that such a phenomenon is merely transient in nature and will be phased out in time, like the low wage havens. To them, environmental regulation increases continuously with income and seems to have played a role in the shift from dirty to cleaner sectors. Thus any tendency towards formation of a pollution have seems to have been self limiting. Dasgupta et al (1995) finds a very strong, monotonously increasing relationship between national income per capita and the strictness of environmental regulation. Economic growth brings countervailing pressure to bear on polluters through increased regulation, technical expertise and knowledge-base, and citizen demand for clean environment. This way it makes the phase transient.

Motivation of the Paper

But, this paper argues, that such a transition necessarily requires active intervention of the institution. In fact the motivation of the paper is to find out the mechanism of such a transition, and to identify the areas where it needs active institutional interventions to make the transition smooth and effective and thus to enable the society to reach the optimum. The problem has its typicality in the nature in a way that it attracts an externality effect; since the pollution affected society is not directly involved in the decision making. Thus it requires for a mediation of legislative institution and govt. execution. The next part of the paper deals with this mechanism of institutional intervention; taking the theoretical aspects at first, then endeavouring towards identification of thrust areas where the intermediating agency has got role to play. The last part of that paper deals with the practical problems of such a mechanism in a country like India, especially in a situation like current one.

III The Analysis

Over the globe the industry is growing its awareness to the need of environmental protection, since the issue of environment is being brought to the forefront of political and economic agenda. Environmental policies in virtually all the countries, with differential extents, are forcing industry to become more accountable for their actions through the adoption of 'eco-friendly' production processes. For the industry, once only an ethical issue, now this is a necessary business practice. We aim, in this paper, how best such practices can be operational on the soil of a developing country like India, with necessary positive input from the state.

Conceptual Issues

From a theoretical perspective, the issue encompasses two different conceptual aspects- the technology diffusion by the firms and the environmental policy of the state. Therefore, we must at first understand the interaction of these two and, where and how they intersect. From an industrial organisation point of view, for the firm the state policy works out to be an external influence over the technology diffusion. Particular to the environmental policies are that they don't necessarily yield any direct gain to the firm for the adoption of any abatement technology, at best that reduces the perceived threat of non-compliance. So in theory, firms value the cost of such adoption against the expected penalty. Thinking mainly in this line, past studies have focused on the efficiency of particular policy instruments to make firms adopt abatement technology. The other breed of

research in the environmental policy was to measure the institutional feasibility of such an instrument. In both the cases, they look the firm's adoptability to such norms as given. Thus they more or less neglected the other dimension of the story, namely, the technology diffusion by the firms. More, the time frame over which the industry would stablise has rarely been addressed to. Here comes the dynamics of the technology diffusion that addresses the question of equilibrium in the industry.

Technology Diffusion

Literature on technology diffusion suggests that; one, policies are an important consideration because they advance the diffusion of technological innovations, which under normal circumstances may not occur even; and two, institutional control do influence the rate of technology adoption by firms (Brown, 1981). This paper, thus analyses various factors that contribute to the innovation and diffusion of technology. The particular case we attempt to is the diffusion of environmental technology, in a developing open economy, in response to pollution control legislation. The analysis would be suggestive in pointing out the factors which an economy should look into when considering policy formulation. At the same time we also confess that the literature is in deed thin with reference to empirical tests of significance of such factors (Ashford, 1994) and few case studies are available.

Environmental Policy

For the case o pollution control, the primary objective universally worked out to reach some optimal, or, if not feasible, some desired standard of environmental quality. This standard can be achieved by motivating the polluting agents (the firms) to internalise 'unaccounted for' costs of their actions. There are three widely recognised inducements for the firms: economic incentives, environmental regulation, and moral suasion (Hanley, Shogren and White, 1997; among others). In the first two methods we find a direct scope for institutional intervention. The basic idea of economic incentive tells that- producers profit comes from a market price which does not necessarily reflect society's preferences for the environmental quality. The producer has no economic motivation to supply the level of pollution control the society desires to. According to the economic incentive concept, the state is to raise the cost of environmental shirking while allowing the producer the flexibility to find the least cost pollution control technology itself. The increased cost of pollution would drive the firm towards the socially desired production/pollution level.

The environmental regulation, or the standards approach, is a command mechanism used by the policy to achieve compliance with stated policy objectives. To make this work, the regulatory authority chooses any of the two approaches- a performance standard or a technology standard.

Under the former, the firm is free to choose whatever means it deems necessary to reach the designated level of environmental quality. This allows the firm the flexibility to choose the process that best suits its particular operation and cost structure. The costs of controlling are irrespective to the firms and under a performance standard each will use the most effective technology. Under a perfect competition in the input market and with perfect mutual knowledge, in the absence of product differentiation variables; all the firms are expected to use a uniform abatement technology. The technical standard approach involves the embodiment of a detailed technological specification of the controlling/production process. With a free and full flow of information in intra and inter-industry level, this approach would lead to the most cost effective method adopted by everybody and the market would reach a stabilising equilibrium.

To add, at the very beginning, due to the lack of knowledge about the abatement technology and initial set up cost, the regulating authority would go for a performance standard where the firms also comply rather easily with little or medium modifications to their existing production processes. This can be referred to as 'incremental technology'. But latter in the time with the innovation of sophisticated and integrated control technologies, the authority would opt for a technology standard resulting in homogeneity across industry.

This view is also supported in the literature of technology diffusion. Incremental innovations will be adopted earliest due to their cost effectiveness and less disruptive influences to the existing production process. But the effectiveness of the adopted technology may differ between firms or even plants within the same firms but in different location or different management. Different plants may have differential abilities to deal with them; also the local conditions matter. At this juncture, the interaction between the firms and the institution becomes clearly visible, with the institution got role to play to influence the local condition.

A Formal Analysis

We may now move into a formal analysis of how technology diffusion takes place in response to a government policy. Particularly, the analysis would shed light on a case of large MNCs present in a newly opened developing country with its obvious limitations regarding environmental norms. The above discussion suggest that mandatory environmental legislation catalyses the technology diffusion towards pollution control norms. More, the rate of diffusion is not only a function of innovation, but also of the firms and industry; particularly the flows of information between them. We can conceive a functional relationship between innovation and diffusion of environmental technology (TD) and government policy (Pol_g), with other factors like the information flow among the firms ($Info_{ij}$), that of individual firms and linkage industries ($Info_{iL}$) and that of

government/institution and Industry as a whole; the localisation of the policy (Loc), the degree of coverage of policy and surveillance. The last factor has been adequately summed up into a perceived non-compliance cost (E (NC)), as described earlier, which takes the form of an expectation. Here we assume, taking cue from reality, that more often than not, the pollution abatement technology is supplied by some third party firms having expertise on that, rather innovating it by the firm of its own. The contribution of such outsourcing of abatement technology depends upon the free flow of information between the industry and technology supplying linkage firms. Though in a later stage, with research efforts of the firm, the option of internal development of abatement technology can be assumed. This typically depends upon the cost effectiveness of the alternatives. More, we describe here the equilibrium, or the stabilization in the industry after such policy enforcement comes when the abatement technology becomes uniform across the firms; and any new entrant finds it optimum to comply with the policy norm rather shirking, and also adopts the same technology. Assuming a free and full flow of information across firms and related industries and institution, formally we can write:

$TD_i = Pol_g.\ F\ (Info_{ij,}\ Info_{iL,}\ Info_{GI},\ E\ (NC),\ Loc)$

$\forall$ i, j (individual firms)

Where the govt. policy is a necessary condition to kick start the process. At the equilibrium, individual firm's abatement technology (for all) coincides with the technology standard fixed by the authority:

$TD_i = TD_j = TD_G$

Note on the contributing factors of technology diffusion:

Studies suggested that there is a causal relationship between the particular policy instrument employed and the technological responses by the industry (Millman and Prince, 1989). However, we here trace out some basic ingredients in formulation of any policy to such effect. The primary two inputs we find out are the information base and communication, and the 'local content' of the policy.

Information and communication: information or knowledge base plays a key role in formulation and effectiveness of any policy. In the cases of industrial pollution control policies, the scope of information base is much wider. It first requires a rigorous technical knowledge about the pollution, pollutant, polluters and the effected environment. Also it needs to know the state-of-the-art technology about control mechanism of such polluters. With the knowledge of economic benefit of

the activity, and the acceptable quality of environment to the ecology base, it can chalk out a policy framework. It must also check that the policy option should be technically and economically viable to the industry, to prevent it from a suboptimal level of functioning. One may correctly argue that this kind of information base and decision mechanism are rarely available in developing countries and so their environmental policies are roughly vague to a significant extent—which can be, and being exploited by the large firms. Examples are many where some obsolete or abandoned technology has been tried shift to India (Veena Jha, 1997, Divan and Rosencranz 2001). With this we may add up the necessity of monitoring, which also requires systematic information and control mechanism; which are lacked by resources in developing countries. Though, parallelly, many political and public interest groups have emerged over the world in the field of environmental protection, many of them also have developed a good information base also. The authority may take into confidence their data source after correcting for obvious biases.

Beyond the regulating authority, there are factors that influence the rate of diffusion. As identified earlier, these are the flow of information across the industry and across the linkage industry, along with the information exchange with the government. Since the linkage industries are the supplier of the control technology, the rate of technology diffusion will be governed by the multiplex interaction among the firms and the information network existing in the industry. Close communication networks and stronger producer-compliance-technology-supplier interaction would foster the rate of diffusion. Innovation is a cumulative process and achieved faster when inputs/information flows from both the sides. The process of learning is governed by the complexity of technology and existing/accumulating knowledge base of the technology users (Rosenberg 1976, 1982; Lundvall 1988). The coupling of producers of compliance technology into the information net is thus becomes especially important in the technology diffusion dynamics.

ii) Local Content of the Policy: if we see more deeply to the global pattern of industrial pollution protection these days, we find a process of decentralisation emerging out of the picture. The local authority in given increasingly more autonomy to combat the problem through effective fiscal measures. There are two distinct reasons behind this development. The first is that though having wider implications, most of the industrial pollutions are local and confined in nature that is, contained in one small geographic region; so the information about the pollution is much more available locally. The second is, due to the proximity, the surveillance becomes easier and accountability increases since both the industry and authority is placed in the vicinity of the affected citizen. So it has been much easier to prevent such problems with local level instruments- one interesting example of the case is the Ontario Environmental Protection Act (1971, 1980) and

Ontario Municipal Industrial Strategy or Abatement (1986) . More examples can be found at Forth Estuary, Scotland (Hanley and Moffat 1993). One interesting theoretical discourse can be found at (Saskin et al, 1983) One must note a point over here- different kind of control instrument have been used in different cases, according to the circumstances. The authority tried to use the best suitable instrument according to their perception. This increases the efficiency of the policy action. Being under a general environmental protection scheme at the central level, the local bodies empowered so and equipped with, can more effectively address the problem. Many of the developing countries like India, though having the all encompassing umbrella legislation about environmental protection, are more reluctant to work with the decentralised pattern of control- which is one of the possible sources of exploitation. These loopholes have been addressed by different public interest groups and NGOs (Veena Jha, 1997; Divan and Rosencranz, 2001).

Another source of possible decentralisation is to identify one particular pollutant or polluting process and cultivate necessary legislation to control. Examples are found in Carbon Tax Act in the Netherlands (Bovenberg, 1993). It facilitates the formulation of the policy being point focused and also eases the monitoring. But this also requires specific and pointed information on all the aspects of the problem.

However the story alters slightly with the entrance of multinational firms (MNCs) who often have other production facilities in different locations. It can be rightly argued that in some other location they have been made to use the compliance technology which must be along the line of newly introduced environmental norms in the region of question. In this case, the diffusion of technology and abatement know how becomes an intracorporate information exchange issue. Here the earlier compliance technology supplying linkage industry becomes passive. Though the possibility of linkage cannot be ruled out if the affiliate finds it cost- or otherwise- effective than to sourcing from the parent firm. However, when parent affiliate relation comes into action, the authority is to ensure that no obsolete/ abandoned technology is transferred, which is also forbidden by WTO. To one's wonder, the examples of such transfer are not unlikely, as in the case of Du Pont plant in Goa, India (Veena Jha, 1997)

The rate of technology diffusion also depends upon the noncompliance cost. The liability rule should be set in a way that there is an incentive for the offender to follow the mandate rather than shirking or reducing the scale, or at its worst, closing the operation altogether. The incentive design must also ensure a speedy adoption of the compliance technology. In each of the aspects of the liability rule, that is, the coverage of the legislation in relation to the scope of activities of the

producers, the level of penalty and the policing mechanism, we understand easily that there is a scope for active institutional interface.

Scope for Institutional Intervention

Having Identified the factors affecting the diffusion of environmental technology across the industry, we may now go on to the exploration of the scope and possible role of institutions to foster he process. We are mainly interested in a case where the technology is owned by the MNEs and the concerned industry is located in a less developed economy. The case readily involves three parties; namely, the concerned economy, the MNE and the comprehensive sphere of the international institutions that effectively controls the affairs of environment, technology transfers and investments. These institutions are expected to have a positive approach towards the facilitation of dissemination of environmental technology.

A survey of the International Agencies and their Agreements on Environmental Technology Transfer:

To understand the existing international institutional mechanism in the context of environmental technology transfer, we better proceed in a dichotomised way, providing sufficient room for the interaction between two respective paradigms. They are, firstly, the issue of technology transfer in general, which forms the first part; and there are some special negotiations which address the issue of transfer of environmental technology in particular, which forms the second part. As clearly understood, the issue of technology transfer among economies is mainly governed by the WTO with its different chapters in operation. Under WTO, the Doha Ministerial Conference (November 2001) was instrumental in defining the scope and role of WTO in terms of technology transfer. The agreements reached by the WTO members in Doha Ministerial Declaration has clearly ushered to examine the relationship between trade and transfer of technology and to work out possible recommendations that could be taken on the general mandate of the WTO to increase the flow of technology to developing countries (Paragraph 37). The Doha declaration mandates the Working Group on Trade and Investment (WGIT), formed at the Doha Ministerial itself, to clarify certain aspects related to a possible framework for the WTO in this context. It firstly stressed upon the common understanding of the definition of technology transfer, and also identified various channels through which advanced technology might disseminate among countries. In the context of technology, the overall objective of WTO towards the developing countries should be to help them in their efforts to integrate with the global economy with technology standardization. So an all-

encompassing definition of 'technology' and its 'transfer', which does not exclude relevant factors and hinders processes, is required. A broader definition would include the flow of technical know-how, experience sharing and managerial skills as well, to understand effectively the dimensions of technology transfer. Next, the proper identification of channels for technology transfer will provide a common basis to asses the effectiveness of certain measures and provisions. Proper measures and provisions can only be made after realizing the nature of the problem of the channels themselves, problems of capacity constraints and absence of factors that help constitute favourable circumstances of technology transfer. FDI involves the dissemination of technology through the transfer of production factors, by the provision of services, through licensing agreements etc. Though there is no mechanical relationship between flow of FDI and transfer of technology, especially in the case of environmental technology, still one can find some factors that can influence such technology flow. A key element is the capacity of the developing countries to attract and absorb the appropriate environmental technology. In this context, considerations should be given to measures and provisions that encourage the creation of growth opportunities in the host country in terms of backward linkage development, capacity building etc. This issues and considerations were deemed necessary in the workings of the WGIT and needed to be properly addressed.

Two other agreements under WTO is important in this context; those are, the Trade Related Aspects of Intellectual Property Rights (TRIPs) and the Trade Related Investment Measures (TRIMs). The MNEs invest much of their proceeds into the R&D and so a newly developed technology/process is of significant value to them. That also gives them the coveted edge in the market competition. So naturally they would be rather shaky in terms of dissemination of such knowledge, especially in the regions where intellectual property rights are not precisely defined. This would hinder the process of technology diffusion towards the developing countries that often lack strict IPR norms. WTO has framed different datelines for the countries to formulate their IPR policies in order to smoothen out the conflicts on IPR and flow of technology to them. However, the developing countries rightly argued that there is a possibility of expropriating the biological and otherwise conventional wisdoms (*genius loci*) in the forms patenting (bio-piracy); and therefore the developing countries have asked the WTO to harmonize this with provisions of UN Convention of Biological Diversity.

The TRIMs deal with policies that are considered inconsistent with GATT in the context of technology investment, and a time frame have been fixed here also to gradually eliminate such measures from the developing countries. Though the developing countries wanted to retain such measures which they deemed important to meet their development goals and ultimately the WTO

resolute to form a Working Group on Transfer of Technology to study the implications of agreements of WTO for technology transfers and ways for enhancing such transfers to developing countries. However, the issue of 'domestic content measures', which the developing countries have been using as a measure of foreign investment control has a influencing role in ensuring linkages of FDI into the domestic economy and encouraging indigenization of FDI, has been a issue of many debates and needed to be sorted out effectively.

WTO contributes towards the issue of environment in the context of technology transfer mainly through the chapter on Trade and Environment, raised during the ministerial at Marakesh (April 1994). It comes out with some rather indirect approach towards the environmental technology transfer and encompasses the Multilateral Environmental Agreements (MEAs) outside the WTO to address the question of trade and environment. WTO addressed the issue through the Committee on Trade and Environment (CTE) with a two fold mandate; first, "to identify the relationship between trade measures and environmental measures in order to promote sustainable development", and second, "to make appropriate recommendations on whether any modification of the provisions of multilateral trading system are required, compatible to open, equitable and non-discriminatory nature of the system". This broad base mandate covers goods, services and Intellectual Property Rights (IPRs) and builds on the progress already achieved in the previous GATT Group on Environmental Measures and International Trade. Discussions of the items under the CTE work programme have been grouped into two main areas: market access issues and the issues related to linkages between the multilateral environmental agenda and the multilateral trade agenda. The WTO Secretariat Report (October 1999) mentioned some direct references to the environmental technology transfer across borders and the involvement of multinational firms. It has suggested the possibility of such technological diffusion through MNEs.

With this indirect involvement of WTO, different MEAs contribute towards the institutional capacity to control and mould the environmental technology transfer. The 2001 United Nations Environment Programme (UNEP) conference on "Compliance, Environmental and Dispute Settlement in MEAs and WTO" elaborated on the jurisdiction and functinings of the MEAs to work under the WTO regime. It particularly addressed the potential conflict between international trade and environmental laws, also identified concrete synergies and overlaps relating to technology transfer. It thus has paved the way of building an institutional implementation-oriented cooperation among different MEAs, the WTO and the UNEP.

Most of the existing Multilateral Agreements on Environment (MEAs) contain technology transfers as part of affirmative measures aimed at assisting the developing countries to meet their MEA

obligations. Examples of such MEAs that provide for technology transfer are the Basel Convention on the Control of Transboundary Movement of Hazardous Waste and their Disposal, The Montreal Protocol on Substances That Deplete The Ozone Layer, The UN Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol. The Chapter 34 of Agenda 21 (Transfer of Environmentally-Sound Technology, Co-operation and Capacity Building), of the UN Program of Action from Rio (1992), (hereafter only Agenda 21), has been the main guiding body of the MEAs on diffusion of environmental technology. It clearly defines what is meant by Environmentally Sound Technology (EST) transfers; the definition encompasses the know-how, procedures, goods and services and equipments, and the organisational and managerial procedures of the total system as well. This implies that an issue of such technology transfer should also address the human resource development and local capacity building aspects of technology choice to make the process sustainable. This indicates the desire to improve upon the terms and conditions under which developing countries can obtain ESTs from the private enterprises or the MNEs and access the publicly held technological knowledge related to better management of the environment.

One important consideration for the developing countries in better management of environment is the issue of technological knowledge base. Due to resource constraints and poor history of systematic data collection, most of the developing countries suffer from a proper and effective information base on the industry and pollution, which hinders them from designing effective policy and to provide alternatives by the local government. Also it limits the scope for bargaining in multilateral negotiations. This kind of effective information about pollution at global or local levels and knowledge about pollutants is mainly residing with developed country institutions. The multinational enterprises also have the technological knowledge of pollution preventing mechanisms and regularly enhancing them through research and development. The developing country institutions also lag behind in such R&D due to their heavily resource oriented nature. But the efficient designing of environmental policies are dependent upon the amount and quality of such available information and knowledge. So the issue of access of such knowledge by the developing countries has become crucial. The Agenda 21 attempts to provide the developing countries EST transfer terms which differ from those dictated by international technology markets. The measures it postulated in doing so includes:

- Removal of barriers to transfer privately owned ESTs and scientific knowledge
- Creation of favourable circumstances of such transfers with fiscal and other incentives
- Supplying of Patents and licenses to the developing countries on non commercial terms, as part of development cooperation for sustainable development
- Preventing abuse of IPRs

- Provisions of financial resources to acquire ESTs by the developing countries
- Strengthening of institutional capacity for R&D and programme implementation; among others.

It also addresses the issue of capacity building in the context of environmental management in the developing countries and provided guideline for assisting them through financial and other forms of capital. However, the source of such financing has always been a dispute. Agenda 21 also addresses the issue of use and abuse of IPRs in terms on environment and biodiversity. The issue has been raised in the WTO also by the developing countries and asks for specific provision for ensuring proper and logical use of IPRs. To summaries, Agenda 21 seeks for active participation of governments of the advanced countries and other national/international bodies to engage the private sector (the MNEs) who actually own ESTs and control their diffusion, and asks for sharing of/ giving access to public domain knowledge as well.

Other MEAs

An initial survey of the other MEAs[4] shows that most of them have an explicit orientation of easing the process of technological disseminations to the developing countries. As UNFCCC (Article 4, 1.c) says "Promote and co-operate in the development, application and diffusion, including transfer, of technologies, practices and processes that control, reduce or prevent anthropogenic emissions of greenhouse gases" and in 5 "The developed country Parties and other developed Parties included in Annex II shall take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing country Parties". The Kyoto Protocol to the UN Framework Convention on Climate Change, 1997 also asks the parties to "Cooperate in the promotion of effective modalities for the development, application and diffusion of, and take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies, know-how, practices and processes pertinent to climate change, in particular to developing countries.

The MEA and bilateral environmental negotiations, by this time grown beyond 200 in number, depict a wide range of provisions; from very specific and elaborated provisions to rather general and ambiguous ones. We find a conflict of interests on some provisions of MEAs between developing and developed country parties. In certain agreements, like UNFCCC, developed countries are seeking collaboration and considerations from developing countries to address global environmental problems which have significantly been caused by environmentally unsustainable

practices in the developed countries. This is expected to strengthen the bargaining powers of the developing countries and given an opportunity to push through their specific demands related to transfer of ESTs.

Another issue of MEAs is that of reciprocity; which makes the implementation of agreed obligations by the developing countries conditional upon effective implementation of obligations by the developed country parties (e.g.: UNFCCC Article 4.7)

An important dimension of the MEAs in provision of diffusion of ESTs is their endeavour towards overcoming the financial constraints to acquire such technologies and access technological know-how by the developing countries. Financial constraints have been a major problem for the developing countries to adopt the state-of-the-art technology in environmental management. The Montreal Protocol (Article 10, 10A)' along with Kyoto Protocol (Article 10) and UNFCCC (Article 11) has been most explicit in this issue of providing financial support in capacity building in developing countries. The Source of the funds, however, has been a much debated issue within the framework.

Institutional Mechanisms at the National Level

Since one accept FDI as a major channel for the transfer of ESTs, proper stimulations should be in place which favors the transfer of ESTs. The institutional framework and functioning of that at the national level is a crucial issue in the process of dissemination of ESTs. Good and stable governance and transparent and predictable regulatory frameworks are primary necessities. Ensuring a proper competitive framework for the industry is another component of national level efficiency. Next are the issues of absorbing the delivered technology into the industrial framework of the host country. Effective use of transferred ESTs requires conducive macroeconomic, in particular, fiscal and other incentives based policies. The policy framework should a) encourage the full use of the acquired technology, and b) should drive the private sector in developing countries to seek partnerships with industry and institutions in the developed countries; to keep up with the new research and developments. Certain further issues at the national level of policy formulation deserve deeper understanding. The import liberalisations by the government is said to have an adverse effect on transfer of technology; because this opens up the economy to the possibility of export of the MNEs without establishing production facilities over there. Financial mechanisms of the MEAs and effective forms of technical assistance to the developing countries must be used in a proper form to compensate that tendency. Secondly, opportunities created by various channels of transfer of technology will tend to concentrate in a country according to its

ability to develop its own technical capabilities. Therefore, creating an enabling a favourable environment for the further development of indigenous technological capabilities is of utmost importance in designing policy.

The Global Technology Market and the MNEs

The third entity in the story of EST transfer is the industry framework within which the MNEs are working and the extent of their integration. Environmentally friendly technologies and practices are obviously part of the MNCs assets which may benefit developing host countries. MNCs may be a vehicle for the diffusion of environmentally friendly management practices and technologies in developing countries. Furthermore, FDI may lead to some standardization of technologies used across countries and may also promote the diffusion of environmentally friendly technologies through the expansion of the market for environmental goods and services. Many of the MNCs are at the frontier in research on, and the application of, the pollution preventing technologies; their affiliates are expected to play a positive role in diffusing those technologies in developing countries.

While there is no doubt that MNCs have the potential for introducing environmentally sound technologies in host developing countries, their actual environmental impact depends on many factors. Most important of them are the sectors in which they invest, the age of their facilities, their strategies -i.e., market, resource, efficiency or asset-seeking (see Dunning, 1994a) etc. The degree of export orientation of the investment (especially when the destination market is "environmentally-sensitive") also contributes towards the diffusion of environmental technology to the developing country production facilities. Much important also is their corporate environmental policies, and approach towards environmental management. These strategies ultimately develop the extent of integration in the host country industrial sector and type of their linkages with domestic suppliers, clients and competitors. The host country environmental regulations and their degree of enforcement and the role played by stakeholder groups such as non-governmental organizations, consumers, workers and local communities can have significant say on the development of such linkages and technology diffusion.

The market as an institution and the practiced technology norms influence the technology transfer and environmental management significantly. A matured environmental management paradigm generally asks for integrated pollution management rather than end-of-the-pipe treatments. This induces the advanced pollution preventive technology to come through the affiliates of MNCs. They may also influence the environmental management of their affiliates' suppliers, competitors and customers both by setting an example and by introducing their own environmental standards.

Furthermore, the parent companies may also provide local engineers and technical staff with training in pollution prevention technologies and practices and waste minimization.

However, they are also facing increasing difficulties in this front due to direct and indirect cost escalations. The direct cost increases are related to the increases factor payments and increasingly technical and capital oriented nature of researches. The indirect costs increase mainly due to shorter product life cycles and intensifying competition in the global markets. This is giving birth to an international pattern of different kind of (technical or financial) collaboration with respect to R&D. this sometimes even incorporates government agencies or academic or other research institutions also. But this has been significantly less in cases of developing countries, at least when compared to purely commercial collaborations or mergers or acquisitions. However, this process has a potentiality to build the indigenous capacity in a developing country, and more attention to this point is needed. The MNEs also have been increasingly using IPRs to extend their market powers and to compensate the loss due to shorter product life cycles. This has an adverse effect on the process of dissemination of technological know-how to the developing countries. Institutional mechanisms are required to observe and control this phenomenon to strike a balance of technical diffusion between developed and developing countries.

Conclusion

Trying to show the possibility of a 'pollution haven' effect to be real in the case of India, the paper endeavored to find out the mechanism of phasing out such a phenomenon. In the process it attempted to bring together the issue of environmental policy with that of technology diffusion in order to understand better how industry might react to policy. In fact, to effect a better management of the industrial pollution problems, the understanding of the dynamics of the relation between the said two becomes much more important. In our analysis, the interaction between them became crucial and deterministic. A free flow of information encompassing the industry, the linkage firms, and the government as well is needed to have a better management. This clearly points out the area of interaction between govt. and industry and the international institutional interface. In the one hand, the local factor suggests its contribution towards a better management of the case, especially where the impact is geographically limited. It ushers for the direct and active involvement of the local authority, and also asks for the possible involvement of the public interest groups like citizen forums to measure up the challenge more effectively. On the other hand, the efficient designed of the liability norms may induce the industry to adopt the abatement technology rather than any other alternative action. With this theoretical understanding, the paper endeavors to understand the institutional mechanism at the international and national level and tries to find the

scope of their intervention to effectively guide the process of environmental technology diffusion through the MNEs in a developing country. The dynamics of such diffusion is multiplex and requires a comprehensive understanding to control and encourage the process.

At the bottom, we would say that the analysis presented over here is only exploratory in nature and thus should be considered as being suggestive rather than conclusive. But such a framework might help carry out empirical research to provide with quantitative insights about the case and thus could help effective policy formulation.

Notes

1. The Body of Environmental legislations in India

- Wildlife Protection Act, 1972
- Forest Conservation Act, 1980
- Water (Prevention and Control of Pollution) Act, 1974
- Water (Prevention and Control of Pollution) Cess Act, 1977
- Air (Prevention and Control of Pollution) Act, 1981
- The Environment (Protection) Act, 1981
- The Public Liability Insurance Act, 1991
- The Environmental Impact Assessment Notification, 1994

2. MoEF, GoI – the Environmental Impact Assessment Notification, Schedule A, 1994

3. The selected industries are: Aluminum, Caustic, Cement, Copper, Distillery, DYES & D.I., Fertilizer, Iron & Steel, Leather, Pesticide, Petro-Chemical, Pharmaceuticals, Pulp & Paper, Refinery, Sugar, TPP, Zinc.

4. The main MEAs in the context are:

- The Basel Convention On Transboundary Movements Of Hazardous Wastes And Their Disposal
- Montreal Protocol on Substances That Deplete The Ozone Layer
- The Un Convention On Biological Diversity
- The Un Framework Convention On Climate Change
- Rotterdam (Pic) Convention
- Stockholm (Pops) Convention
- Un Fish Stock Agreement

Data Appendix

- Table 1: Sector-wise Breakup of FDI and technical Collaboration Approved (01.08.1991 to 31.03.2002); SIA Newsletter April 2002; Secretariat for Industrial Assistance, Department of Industrial Policy, GoI
- Table 2: Flow of FDI to India, Ministry Of Commerce, GoI
- Figure 1 is inferred from Table 27: Production of Selected Industries; Handbook of Statistics on Indian Economy, Reserve Bank of India, 2000 (pp 44-45).
- Figure 2 is inferred from Table 116: Exports of Principal (pp 163-166) and from Table 118: Imports of Principal Commodities (pp 171- 173); Commodities Handbook of Statistics on Indian Economy, Reserve Bank of India, 2000

References

1) Ashford N (1993), Understanding Technological Responses of Industrial Firms to Environmental Problems: Implications for Govt. Policy- in *Environmental Strategies for Industry: International Perspectives of Research Needs and Policy*, edited by K Fischer and J Schot; Island Press, Washington DC.

2) Barton, J. (1997), "The North-South Dimension of the Environment and Cleaner Technology Industries", *Discussion Paper Series N° 9803, United Nations University, Institute for New Technologies, Maastricht.*

3) Blomstrom, M. and A. Kokko (1997), "How foreign investment affects host countries", *Policy Research Working Paper 1745, World Bank, International Trade Division, Washington D.C.*

4) Bovenberg, A (1993), 'Policy Instruments for Curbing Carbon Dioxide Emissions: The Case of Netherlands' Environmental and Resource Economics, Vol 3, Issue 3

5) Brown, L (1981): Innovation Diffusion- a New Perspective; *Macmillan NY.*

6) Dasgupta, S, A Mody, S Roy and D R Wheeler (1995): Environmental Regulation and Development- A Cross Country Empirical Analysis; *World Bank Policy Research Department, Working Paper No. 1448, Washington D C.*

7) Divan, Shyam and Amin Rosencranz (2001): Environmental Law and Policy in India- Cases, Materials and Statistics (2nd Ed.) OUP, New Delhi.

8) Dunning, John (1994): Multinational Enterprises and the Globalisation of Innovation Capacity; *Research Policy, 23, 67-88.*

9) -- (1994): Multinational Enterprises and the Global Economy; Reading, Addison-Wesley.

10) -- (1994a), "Re-evaluating the benefits of foreign direct investment", *Transnational Corporations,* Vol. 3, No. 1.

11) Eskeland, G. and A. Harrison (1997), "Moving to greener pastures? Multinationals and the pollution haven hypothesis", *mimeo, World Bank*, Washington D.C.

12) Goyal, Arun and Noor Mohd. (2001), WTO in the New Millennium: Commentary, Case Law, Legal Texts- Academy for Business Studies, New Delhi, India

13) Hanley, N; J F Shogren, B White (1997): Environmental Economics - in Theory and Practice; *Macmillan India Ltd.*

14) Hanley and Moffat (1993)- Controlling Water Pollution Using Market Mechanisms: a Simulation Approach; in R K Turner (ed) Sustainable Environmental Economics and Management, Belhaven Press, London

15) Hettige, H., M. Huq, S. Pargal and D. Wheeler (1996), "Determinants of pollution abatement in developing countries: evidence from South and Southeast Asia", *World Development*, Vol. 24, No. 12.

16) Jha, Veena (1997): Investment Liberalisation and environmental Protection- Conflicts and Capabilities in the Case of India; *Report as part of UNCTAD/DICM Project Cross Border Environmental Management in Transnational Corporations*

17) Kumar, Nagesh (2002): Globalization and the Quality of Foreign direct Investment; Oxford University Press, New Delhi.

18) Lundvall (1988), Innovation as an Interactive Process: from User-Producer to the National System of Innovation in G Dosi (ed) Technical Change and Economic Theory.

19) Mani, Muthukumara and David Wheeler (1999): In Search of Pollution Havens? Dirty Industry in the World Economy, 1960- 1995; *OECD Conference on FDI and the Environment 1999*.

20) Millman, S and R Prince (1989), Firm Incentives to Promote Pollution Control, *Journal of Environmental Economics and Management Vol 17*

21) Mukherjee, D (1995) Industrial Organisation – Readings in Economics Series; Oxford India

22) OECD (1998), "Foreign direct investment and the environment: an overview of the literature", *mimeo, prepared for the Negotiating Group on the Multilateral Agreement on Investment.*

23) Robison D H (1988): Industrial Pollution Abatement- the Impact on the Balance of Trade: *Canadian Journal Of Economics, 21, 702-706*

24) Rosenberg, N (1976), Perspectives on Technology, Cambridge University Press, NY

25) --1982; Inside the Black Box: Technology and Economics; Cambridge University Press, NY

26) Seskin E P, R J Anderson, R O Reid (1983)- An Empirical Analysis of Economic Strategies for Controlling Air Pollution *Journal of Environmental Economics and Management Vol 10*

27) Tirole, J: Industrial Organisation *Prentice Hall*