OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

18075

Distr.
LIMITED

IPCT.118(SPEC.)
27 August 1990

ORIGINAL: ENGLISH

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

ECONOMIC INCENTIVES AND DISINCENTIVES FOR THE INTRODUCTION AND APPLICATION OF CLEAN TECHNOLOGIES IN DEVELOPING COUNTRIES *

Prepared by

Demetrios Cacnis
UNIDO Consultant

5 1/1

* This document has not been edited.

Abstract

ECONOMIC INCENTIVES AND DISINCENTIVES FOR THE INTRODUCTION AND APPLICATION OF CLEAN TECHNOLOGIES IN DEVELOPING COUNTRIES

This paper is an economic examination of why clean technology is or is not for use in developing countries. The economic and environmental problems of developing countries are discussed first. An overview of technology transfer problems and issues is the next topic area. How technology is chosen for use by industry is the following topic. The "Polluter Pays" is examined as a way of making the price of a good reflect its true environmental cost. Finally, fiscal incentives for the use of clean technologies is discussed.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

ECONOMIC INCENTIVES AND DISINCENTIVES FOR THE INTRODUCTION AND APPLICATION OF CLEAN TECHNOLOGIES IN DEVELOPING COUNTRIES

INTRODUCTION

Industrial development is essential to the economies of both developed and developing nations and is the basis of their expansion and growth. Economic growth and industrial activity benefit our standards of living in terms of material goods but progressively have also contributed to the deterioration of environmental resources. The need and urge for rapid industrial development is ever greater in developing countries than that experienced by developed nations.

The adjustment pressures on the economies of developing countries to pursue their industrialization have increased drastically and so has the damage caused to the environment and natural resource base on which economic growth depends. It is evident that damage is being caused to the natural environment by the technologies and practices employed in industrial development and less harmful alternatives must be discovered and applied. For both developed and developing countries, the challenge to face is to continue their economic and social development in a sustainable way. That is, to ensure that they meet the needs of the present without compromising the ability of future genera- tions to meet their own needs.

Technological innovations have the potential of achieving this objective. How to use technology is not always a simple decision, but above all is an important one, upon which our survival depends. Technology constitutes one of the most important factors of the industrialization process, which is a necessary condition for economic development.

A significant outcome of technological progress is the development of clean methods of production which not only have major economic and technical, but ecological implications as well. Clean technologies reduce production cost through savings in raw material and energy and increase productivity, which in turn leads to increased profitability and competitiveness. On the other hand, clean technologies limit discharge, avoid the production of by-products and reduce the risks of accidental pollution and transfer of pollution between physical environments.

Nevertheless, new and clean technologies are mostly developed by industrial countries, and developing nations are highly affected by technological developments abroad in one way or another, since for the majority of these countries new technologies have to be acquired from abroad rather than developed domestically. Moreover, the technological feasibility, the complexity of economic and environmental problems and the financial implications of solutions are different in industrial nations and developing countries. Namely, it is economically more difficult for developing countries to promote economic development and protect the environment at the same time.

However, measures to assist developing countries to promote both economic development and environmental quality, are now needed more urgently than ever. In addition, developing countries should be assisted in establishing the conditions for developing clean technologies themselves or to build their capabilities for technology acquisition.

The main objective of the present study is to use various economic mechanisms in order to induce developing countries to introduce and apply clean and low-waste technologies for promoting economic development and environmental quality as well. In pursuing this objective, we consider and analyze the implications of two types of policies. Policies focussing on the identification of pollution generating sources and penalizing the polluter and policies focussing on providing economic incentives for users of technologies to choose and adopt less or non-polluting technologies.

A policy may be desirable and/or applicable as far as the economic and social gains outweigh the costs to society derived from its implementation. One such policy is the polluter pays principle (PPP) based on the assumption that the cost of pollution control should be borne by the polluter whenever it is feasible and practical. The relevance of this policy when applied strictly through direct controls and taxes, is that it provides an incentive to the polluter for introducing cleaner technologies.

Application of the PPP however, as a policy instrument may or may not be desirable, depending on a wide variety of factors differing from one case to the next. However, if strict application of the PPP is economically and/or politically undesirable then various types of subsidies should be considered as the appropriate instruments providing economic incentives for introducing

and applying clean technologies. Subsidies as a policy instrument, especially in the case of developing countries, are more appropriate and efficient than direct control or taxes.

The present study is divided into six chapters. Chapter I, reviews recent developments related to economic and environmental problems faced by developing countries in general. Chapter II, discusses a number of alternative ways through which technology is transferred. In Chapter III, a graphical model is developed which is used to illustrate the effectiveness of the various policy instruments. Chapter IV, analyses the implications of implementing the PPP-policy through direct controls and taxes. The effectiveness of subsidies as an alternative policy measure is examined in Chapter V. Finally Chapter VI, summarises the main conclusions of the paper and discusses their implications for future policy making decisions.

Chapter I

ECONOMIC AND ENVIRONMENTAL PROBLEMS IN DEVELOPING COUNTRIES

1. Economic Activities and Policies in Developing Countries

Following the serious international recession of the early 1980s, growth in world output and trade has improved markedly but in developing countries was only moderate. As detailed in Table 1, for the developing countries as a group, the growth of Gross Domestic Product (GDP) in 1988 was the highest since 1980 and amounted to 4.3 percent, reflecting mainly the strong expansion in exports by 11.0 percent.

Among the regions of developing countries, the highest growth was demonstrated in Asian countries where the newly industrializing economies - Hong Kong, Republic of Korea, Singapore and Thailand - are located. In this region, output expanded by 9.0 percent in 1988 while per capita GDP and exports rose by 8.2 and 18.4 percent respectively. Middle East developing countries have also shown a strong performance during 1988 in spite of the slowdown in economic activity in the previous year where GDP declined by 1.6 percent and per capita income by 4.6 percent. As it is shown in Table 1, output in that region grew by 3.9 percent owing to the strong expansion of exports by 12.2 percent and reduction of imports by 1.6 percent.

For the European developing countries output expanded by only 2.5 percent in 1988 and it was projected to grow by the same rate during 1989 and 1990.

Table 1

Economic Indicators in Developing Countries, by Region for selected years

ECONOMIC INDICATORS	DEVELOPING COUNTRIES AS A GROUP			REGIONS															
				AFRICA			ASIA			EUROPE			MIDDLE EAST			W. HEMISPHERE			
	1981	1985	1988	1981	1985	1988	1981	1985	1988	1981	1985	1988	1981	1985	1988	1981	1985	1988	
Real GDP (% change)	1.9	3.6	4.3	1.9	3.5	1.7	5.9	6.7	9.0	-.1	2.3	2.5	-1.3	-1.4	3.9	.3	3.6	.9	
Real Per Capita GDP (% change)	-.6	1.5	2.6	-.8	.6	-1.1	3.9	5.0	8.2	-.9	1.6	1.4	-5.2	-4.4	.5	-2.6	1.4	-1.3	
Gross Capital Formation (% of GDP)	26.2	23.6	22.6	26.1	18.4	18.2	28.5	29.1	28.3	27.1	25.9	26.5	27.0	25.7	19.9	22.6	17.4	17.6	
Inflation (Consumer Price Index, % Change)	25.8	39.7	67.1	20.8	13.3	18.8	10.4	7.1	14.6	13.8	25.5	49.3	15.1	17.0	18.8	60.8	144.9	277.6	
Government Fiscal Balance (billion of $)	-3.8	-4.2	-5.8	-5.7	-4.8	-8.0	-3.1	-3.0	-3.7	-4.7	-2.7	-2.2	-2.6	-8.2	-13.0	-4.1	-3.3	-4.8	
Current Account Balance (billion of $)	-49	-26	-19	-22	-.6	-9.5	-19	-14	-10	-14	-3	-3.5	48.5	-3.6	-11.7	-43.0	-4.7	-11.5	
Exports of Goods and Services (% change)	-5.3	-.9	11.0	-13.8	6.4	2.4	7.6	3.7	13.4	2.6	2.7	6.4	-16.5	-7.1	12.2	7.8	.8	11.7	
Imports of Goods and Services (% change)	8.2	-.6	10.2	10.8	-7.0	1.3	8.2	5.7	17.8	-.4	4.1	5.6	18.4	13.2	-1.6	1.8	2.5	7.3	
External Debt (billion of $)	752	1,023	1,240	110	148	195	157	248	319	103	128	161	93	131	153	289	369	412	
Ratio of External Debt to Exports of Goods and Services (%)	95.8	150.8	141.9	119.3	191.3	248.9	73.8	101.8	76.1	136.9	160.5	146.2	34.6	84.9	116.8	209.8	296.9	305.0	
Debt Service Ratios in percent of Goods and Services	16.2	21.3	19.6	17.0	29.1	28.8	9.5	14.4	11.4	21.8	23.7	25.3	5.0	10.3	12.8	43.9	42.1	41.6	

Source: International Monetary Fund, World Economic Outlook, Washington D.C., 1989.

This is due to the fact that their exports did not expand as rapidly as those of the industrializing economies in Asia, and that rising inflation has led to a tightening of financial policies.

In most of the highly indebted countries in the Western Hemisphere, economic activity was weak in 1988, in spite of an increase in exports. In countries like Mexico, Argentina and Brazil, growth declined while exports were increased substantially. On the other hand, in Chile and Colombia growth was relatively good while in Bolivia the recovery that started in 1987 continued further in 1988. In 1989, growth in the Western Hemisphere remained also weak owing to high inflation in some of these countries and to the rise in international interest rates.[1/]

Overall economic growth in sub-Saharan Africa declined during most of 1980's. After a strong performance in 1985, the pace of economic activity slowed in 1988, and real per capita GDP continued to decline. According to the World Bank, the decline in per capita income since 1980 was more than 25 percent for some countries. Africa's crisis is characterized by a decline in industrial output, poor export performance, weak agricultural growth, increasing debt, and deteriorating social institutions and environment.[2/]

Inflation in developing countries increased sharply during 1988 due to a small number of high-inflation countries (Argentina, Brazil), to a moderate increase in inflation in other countries (Poland, Portuagal and Turkey), and

---

1/ International Monetary Fund, World Economic Outlook, Washington D.C. April, 1989.

2/ The World Bank, Sub-Saharan Africa from Crisis to Substantial Growth, Washington D.C., November, 1989.

to a marked decline in Mexico's inflation rate. The International Monetary Fund, has projected that inflation in developing countries will fall in 1990's reflecting mainly the continuing impact of Mexico's stabilization programme and the new policies introduced recently by Brazil and Argentina.[3/]

In relation to the balance of payments, the deficit of the current account of the developing countries amounted to $ 19.1 billion in 1988. The deficit of the current account, was the lowest since 1980 (except in 1987 which had a surplus of $ 1.4 billion) reflecting moderate export growth on the one hand, and strong expanding domestic demand on the other. Due to nigh inflation in many developing countries and to financial difficulties in others, the combined current account balance of the developing countries declined in 1989 and is expected to do so in early 1990's.

In spite of adjustment efforts in many countries, budgetary deficits continue to be a major problem for economic policy in developing countries during 1988. These deficits were mainly the result of external debt-service obligations which resulted in growth in money supply and inflation. Fiscal balances in Middle East countries have deteriorated in the 1980's because of the decline in oil revenue. To reduce the deficits, these countries have implemented various policies directed to reduce government expenditures.

In the Western Hemisphere developing countries, fiscal imbalances improved in 1988, but they still remain too high. Most developing countries in Asia have recently implemented cautious fiscal policies and achieved impressive improvements in fiscal balances during 1988. In European

---

3/ International Monetary Fund 1989, Op. cit.

developing countries, expansionary fiscal policies stimulated domestic demand, increased money supply and inflation and deteriorated fiscal balances during 1987-1988. As a counter measure fiscal policies have recently been tightened in order to reduce public expenditures and curtail private domestic demand.

Among the many economic problems facing developing countries today, perhaps the most serious of all is that of external debt. As Table 1 illustrates, total external debt of al' developing countries combined amounted to $ 1,240 billion at the end of 1988 reflecting a $ 9 billion increase (or 1.0 percent) from the previous year. The most indebted region is the Western Hemisphere with 33.4 percent and second in line is Asian with 25.7 percent followed by Africa, Europe and Middle East.

However, strong export growth combined with slower rise in debt, resulting in a decline of the debt-to-export ratio to 142 percent at the end of 1988 reflecting a drop of 30 points compared with the level at the end of 1986. The debt ratio of the 15 heavily indebted countries remained still around 300 percent in 1988, and it is expected to fall in 1990.[4/] On the other hand, the debt ratio of African countries remained almost the same in 1988, and the sub-Saharan countries' debt ratio is projected to increase through 1990.[5/]

4/ International Monetory Fund, 1989, Opt. cit.

5/ The World Bank, 1989, Opt.cit.

2. The State of the Environment in Developing Countries

The recognition of environmental problems in international society has been promoted in various aspects and is treated as a problem common to all human beings. The relationship between environment and economic development has been accepted on a global level, with the result that the concept of sustainable development has been emerged. In promoting this idea, developed countries bear a special responsibility, but developing countries must also take action in order to prevent further deterioration of their resource base and natural environment.

Factors causing environmental problems are the continued growth of the population and economic activities neglecting the necessary consideration to the environment and lacking sufficient environmental management expertise, as well as the increasing interrelationship between population growth, expansion of the economy, resources use and the environment. Expansion of population is particularly sigificant in the developing countries, where about 90 percent of the growth in world population is expected to occur by the year 2000, mainly in urban areas. Industrialization is also making progress in the developing countries, as we have already discussed.

Due to the increase of population and economic activities, the pressure on the demand for land resources to be used for farmland, industrial sites and urban locations has risen substantially in developing countries during the last two decades. The consumption of water resources also increased owing both to population growth and industrial and agricultural production. In addition, in spite of the progress made in conserving energy since the oil crisis, energy consumption on a worldwide basis increased by 3.7 times between

1950 and 1985 due mainly to expansion in production consumption and transportation activities.

Furthermore, the production of primary products for export contributes to environmental problems of the developing countries. The prices of primary products are very low in comparison to manufactured goods and other commodities which constitute the main imports of developing countries. As a result, their terms of trade have been worsening since the beginning of 1980, causing deterioration of trade balances in most of the regions of the developing countries. The deterioration of the trade balance coupled with the increase in external debts aggravates poverty by reducing economic growth thus causing excessive use and deterioration of environmental resources.

Domestic as well as external factors therefore force many developing countries to overuse and exploit the environment, causing not only difficulties in producing food for domestic consumption (in some regions) but also causing damage to the potential resource base and natural environment on which future growth and development depend.

Having discussed the various factors which in one way or another influence the environment, what follows is a brief descripton of the state of the environment in developing countries. Although compating deforestation and disertification in the tropical areas in developing countries have become apparent, additional air and water pollution problems have emerged in those areas where industrialization is making progress and population growth and urbanization are taking place. Acccording to a study conducted by the Environment Agency of the Government of Japan, the concentrations of sulfur

dioxide in many urban cities of developing countries are of the same level or higher than those in developed countries and are tending to become worse.[6/]

Emissions of sulfur dioxide as well as of carbon dioxide and nitrogen dioxide result from the consumption of fossil fuels in the sectors of industry, energy and transportation. Because of the growth in industrial activity during the last decade, the consumption of fossil fuels have increased substantially in those sectors and so has air pollution.

Water pollution is also high in developing countries due to the disposal of industrial and untreated household wastes into rivers, lakes and waterways. A study conducted by UNEP, found that 47 percent of the urban population and 86 percent of the population outside the urban areas in developing coutries discharge their household wastes untreated.[7/]

The quantities of solid wastes have also increased during the last 10 to 15 years either because of population growth or because of increased industrial activity. Although the rate of generating wastes is higher in developed countries, it is expected that municipal wastes will increase in developing countries along with the rise in population, income and urbanization. In addition, installation of systems to treat municipal wastes in the developing countries is lagging and this presents serious problems. With respect to industrial wastes, on the other hand, the rate of increase in

---

[6/] Environment Agency, Government of Japan, Quality of the Environment in Japan, Japan, 1988.

[7/] UNEP, "The State of the World Environment", 1987.

volume has slowed down due to the progress of recycling, but the problem has become more complicated due to toxic and other hazardous wastes which are difficult to treat.

In conclusion, it is essential that all developing countries actively participate in confronting environmental issues and achieving sustainable development at the same time. Assisting developing countries, on the other hand, in identifying and managing environmental problems at the level of policies and specific programmes and projects must be a priority task of industrial countries and international institutions. Finally, contributing to environmentally sound and sustainable development is a central task for development co-operation in the 1990s, requiring the mobilization of additional financial resources and technological transfers to developing countries.[8/]

8/ Organization for Economic Co-operation and Development (OECD), Development Co-operation in the 1990s, Report of the Development Assistance Committee, Paris, 1989.

Chapter II

TECHNOLOGY TRANSFER

1. General Considerations

Perhaps the most important contribution to economic development is made by technology. Technology commonly means the stock of knowledge which permits the introduction of new or improved machinery and equipment, products, processes and services. During the last two decades, technological change has accelerated and technological considerations are assuming an increasing importance in international trade and competitiveness.

In relation to environmental considerations, technological change should concentrate on developing clean and energy saving technologies. Clean technology simply implies low-waste and low-emission technologies covering all possible stages of the production process starting with the planning and designing of products, through the construction and operation of industrial processes and ending with the rational utilization of products and the reclamation of by-products. Energy-saving technology, on the other hand, means the development of new or improved production methods, which reduce energy requirements for each production stage by raising energy efficiency or reducing energy loss.

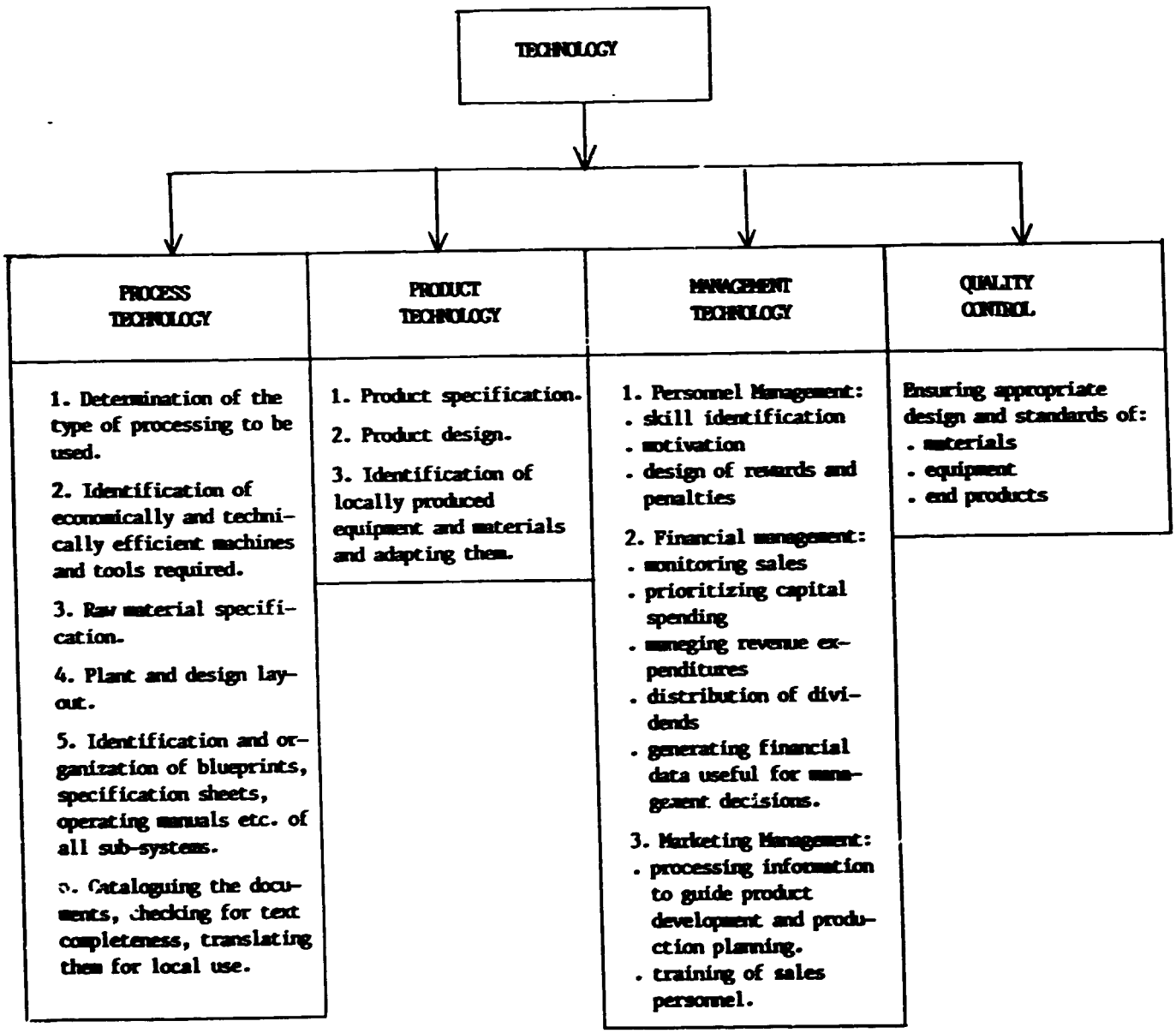
Development of technologies take place usually in industrial countries since these coutries devote a lot of resources to research and development (R&D) either from the public or private sector. Namely, developed countries are mostly the owners of know-how and it is up to them to decide where to

transfer tnis know-how, i.e., to other developed or developing countries. For this reason, developing countries assign particular importance to the transfer of technology from industrial countries because their technological transformation generally implies the adoption, adaptation and diffusion of already existing technologies.

A typical technology transfer is a package consisting of various elements whose importance depends on the product and the technology. These elements are summarized in Table 2. This Table reveals that technology is really a package and not simply the know-how for producing a commodity or service. In the transfer of technology process, transnational (TNCs) or multinational corporations (MNCs) play a major role, since they are the most important actors in the generation, application and international transfer of technology[2/]. Perhaps, the most important function of TNCs is the promotion of international economic interdependence by transferring goods, productive factors and technical knowledge on a global basis.

2/ The terms TNCs and MNCs are synonymous and refers to those corporations that have Foreign Direct Investment (FDI) in more than one foreign country. The United Nations use the term TNCs to describe these corporations.

Table 2
Elements of a Typical Technology Transfer Package



Source: United Nations Centre on Transnational Corporations, Transnational Corporations World Development, New York, 1988.

2. Technology Transfer Mechanisms

Transnational corporations employ a variety of mechanisms in the transfer of technology process. These include:

- Foreign Direct Investment (subsidiaries, affiliates, and joint ventures with local firms).

- Licensing agreements for processes, patents and other industrial property rights.

- Management contracts; a contract beteween a TNC and a foreign enterprise to provide managerial services to the firms for a fee for a certain period of time. It is popular in the hotel industry.

- Turnkey Contracts; a contract between a TNC and a government or an enterprise to construct a project. It is more popular in the manufacturing and construction industries.

- International Sub-contracting; it is widely used in certain labour intensive, export-oriented industries, such as textiles, clothing and electronics.

Of these mechanisms, Foreign Direct Investment (FDI) involves equity participation by TNCs in foreign enterprises while the rest constitute the non-equity forms of technology transfer. FDI is the most important mode of technology followed by licensing. When countries impose restrictions on wholly or partially owned FDI then licensing is used as the way of technology

transfer. Experience has shown that TNCs are unwilling to transfer sophisticated technologies through licensing or joint ventures with domestic firms because they fear that they may lose control of intangible assets that are the basis for their competitiveness. An example is the computer industry where TNCs are not willing to make technology available through licensing or joint ventures but only by wholly or majority owned affiliates.

On the other hand, there is evidence that some of the advanced developing countries make substantial use of licensing agreements. For example India and the Republic of Korea used licence agreements in the electrical power equipment industry and Egypt made much use of licensing agreements between TNCs and its state enterprises in the pharmaceuticals industries[19/].

On the other hand, there are several industries in which TNCs prefer wholly or majority owned FDI in order to participate in the transfer of technology process. Such cases are the food sector, pharmaceuticals, fashion-wear, electrical consumer products, computers, electrical power equipment, agricultural machinery and automobile production.

However, an important question that developing countries usually face is whether to transfer a particular technology through FDI or a non-equity form. This choice heavily depends on the kind of technology a country wishes to acquire, since some technologies may not be available for purchase in a non-equity form, and the capacity of the country to absorb imported technology. Evidence shows that many of the advanced developing countries have relied on a mixture of the two methods. A case in point is Brazil whose

19/ United Nations Centre on Transnational Corporations, Transnational Corporation in World Development, New York, 1988.

firms have made extensive use of FDI as a means of obtaining technology and at the same time have engaged in licensing agreements from TNCS. The Republic of Korea has also made use of FDI in combination with non-equity forms for improving its level of technological development[11/].

Furthermore, the process of technology transfer consists of three stages including the acquisition of existing technologies relevant to the production of specific goods or services, the assimilation and diffusion of these technologies in the host countries, and the development of capacities for innovation. This implies that a country should develop an active policy for technology transfer which will control and manage the transfer process. Such a policy should encompass the search and selection of technologies as well as measures aiming to facil :ate technology absorption, assimilation, diffusion and innovation.

11/ Transnational Corporation in World Development, 1989, Op. cit.

3. World Foreign Direct Investment

Most importantly, technology may be transferred through foreign direct investment which is the mechanism most favoured by TNCs.[12/] Such investment consists of a package including not only the physical plant itself but access to foreign markets and sources of imported supplies, new know-how, managerial knowledge and continuing access to new developments abroad. FDI involves equity participation by TNCs and it can be 100 percent ownership or partial. In the latter case, when there are two owners of the investment it is called a joint venture and when there are more than two owners it is called a consortium. Perhaps the most important reason why developing countries wish to attract FDI is the possibility of obtaining modern technology. The issue of how developing countries can maximize the contribution of TNCs in upgrading the technological level of their economies has become crucial for many of the developing countries.

Table 3 illustrates some trends of FDI inflows for the period 1980-1985. According to this table, the share of developing countries declined to 23.3 percent in 1985 from 29.3 percent in 1975, owing mostly to poor economic conditions and to heavy external indebtedness of many developing countries. Among the regions of developing countries, the importance of Latin America as a recipient of FDI declined sharply to 9.1 percent in 1985 from 15.3 percent in 1975, while Africa's share increased to 3.4.

12/ FDI do not represent the total activity of TNCs in technology transfer since it does not include the non-equity forms of technology transfer.

Table 3

Inflows of Foreign Direct Investment by Major Region, 1975-1985

(Percentage)

Country Group	1975	1980	1981	1982	1983	1984	1985
Developed Countries	70.6	80.5	73.6	69.8	76.3	78.5	76.7
United States	12.1	32.4	44.7	31.1	27.0	51.7	38.9
Western Europe	47.0	41.0	29.7	32.9	37.0	19.8	33.7
Japan	.9	.6	.4	.9	.9	—	1.2
Other	10.2	6.7	1.2	4.5	11.6	6.7	2.8
Developing Countries	29.3	19.3	26.4	30.2	23.2	21.3	23.3
Africa	2.3	.4	3.2	3.8	3.6	3.1	3.4
Latin Amarrica and the Caribbea	15.3	11.9	13.6	14.4	7.7	7.0	9.1
Western Asia	3.3	.6	—	.7	.7	1.2	1.0
Other Asia and Oceania	7.4	6.1	9.3	10.8	10.7	9.6	9.1
Southern Europe	.9	.2	.4	.2	,2	.4	.4
World Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Billion of Dollars	21.5	52.2	56.8	44.5	44.1	49.0	49.3

Source: United Nations Centre on Transnational Corporations, Transnational Corporations in World Development, New York 1988.

In developed countries, the most important development in FDI inflows is that the share of the United States increased from 12.1 percent in 1975 to 38.9 percent in 1985, while the share of Western Europe declined constantly. The main explanation of this trend is that European and Japanese companies were attracted by the brighter prospects of the United States economy in comparison to their own economies, the size and homogeneity of the market and the prospect of access to United States technology.

With respect to outflows of FDI, in 1985 total world FDI amounted to $ 59.9 billion of which 98 percent was supplied by developed economies and only 2 percent by developing countries (Table 4). In 1975, the United States was the source of over half the total capital invested abroad and in 1985 it was supplying only 25 percent. Western Europe, on the other hand, had become the dominant supplier amounting for 50.4 percent in 1985 from only 36.6 percent in 1975. The United Kingdom, the Federal Republic of Germany, Switzerland and the Netherlands continue to be the major suppliers among the European countries, while Japan's share in world FDI outflows increased from 6.5 percent in 1975 to 10.7 percent in 1985.

Table 4

Outflows of Foreign Direct Investment by Major Home Country, 1975-1985
(Percentage)

Country Group	1975	1980	1981	1982	1983	1984	1985
Developed Countries	98.9	98.1	99.4	96.6	97.3	98.6	98.0
Western Europe	36.6	47.2	53.6	59.0	60.5	59.2	50.4
France	4.7	5.4	8.3	8.6	4.7	4.9	3.7
FR Germany	7.2	7.3	7.6	8.6	8.8	10.0	8.2
Italy	1.1	1.2	2.6	3.1	5.8	4.6	3.0
Netherlands	8.3	10.4	8.7	10.1	10.1	11.6	5.3
Switzerland	—	—	—	—	1.4	2.6	6.0
United Kingdom	10.9	19.8	22.6	22.0	22.5	18.8	18.7
Japan	6.5	4.2	9.1	13.3	9.9	13.7	10.7
United States	51.4	38.0	22.9	19.0	9.9	13.2	25.4
Developing Countries	1.1	1.9	.6	3.4	2.7	1.4	2.0
World Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Billion of Dollars	27.6	57.6	54.1	32.7	36.5	43.1	59.9

Source: United Nations Centre on Transnational Corporations, Transnational Corporations in World Development, New York 1988.

4. The United States Foreign Direct Investment

The U.S. foreign direct investment abroad increased by 6 percent in 1988 to $ 326.9 billion the slowest rate since 1984, according to Table 5. At the end of 1988, 75.1 percent of the total accumulated U.S. investment abroad were located in developed countries and 23.5 percent in developing countries. Among the developed countries, 62.0 percent were located in Europe of which 83.1 percent were in the 12 countries of the European Economic Community (EEC). In addition, the largest increase in 1988 was in the United Kingdom ($ 6 billion) followed by Canada ($ 2.9 billion), Japan ($ 2.2 billion), and Australia ($ 1.9 billion). In all these countries, the increase mostly reflected growth in manufacturing affiliates' operating earnings, most of which were reinvested.[13/] This increase in the above countries, were offset by a substantial decline in Germany ($ 3.1 billion) and in Switzerland ($ .8 billion) resulting from negative reinvested earnings.

In developing countries, U.S. direct investment increased by 9 percent ($ 6.2 billion) to $ 76.9 billion in 1988. Most of the increase ($4.4 billion) was in Latin America, particularly in Brazil and in the Netherlands Antilles owing to reinvested earnings of manufacturing affiliates.[14/] The remainder of the increase was in the Asia and Pacific resulting from reinvested earnings and reflecting strong economic growth. By contrast, U.S. foreign investment grew slightly in Africa and declined in the Middle East.

[13/] U.S. Department of Commerce, Survey of Current Business, August, 1989

[14/] Survey of Current Business, 1989, Ibid.

Table 5
U.S. Direct Investment Abroad by Region for Selected Years (billion of U.S. $)

Regions	1980		1985		1987		1988	
	$	%	$	%	$	%	$	%
All Countries	215.6	—	230.3	—	307.9	—	326.9	—
Developed Countries	158.4	73.5	172.1	74.4	232.7	75.6	245.5	75.1
Canada	45.0	28.4	46.9	27.3	58.4	25.1	61.2	24.9
Europe	96.5	60.1	105.2	61.1	146.2	62.8	152.2	62.0
European Community	77.4	80.2	81.4	77.4	120.1	82.1	126.5	83.1
Other Europe	19.1	19.8	23.6	22.6	26.2	17.9	25.7	16.9
Japan	6.2	3.9	9.2	5.3	14.7	6.3	16.9	6.9
Others	10.6	6.7	10.7	6.2	13.4	5.8	15.2	6.2
Developing Countries	53.3	24.7	52.8	22.9	70.7	23.0	76.8	23.5
Latin America	26.5	49.7	27.3	51.7	32.3	45.7	34.0	44.3
W. Hemisphere	12.4	23.3	1.0	1.9	12.6	17.8	15.2	19.8
Africa	3.8	7.2	4.5	8.5	4.5	6.4	4.6	4.0
Middle East	2.1	3.9	4.6	8.7	4.6	6.5	4.1	5.3
Asia and Pasific	8.5	15.9	15.4	29.2	16.7	23.6	18.9	24.6
International	3.9	1.8	5.4	2.3	4.5	1.5	4.6	1.4

Source: U.S. Department of Commerce, Survey of Current Business, various issues.

The latest developments in foreign direct investment in the United States are shown in table 6. At year end 1988, total foreign investment in the United States amounted to $ 328.9 billion reflecting a 21 percent ($ 57.1 billion) increase from 1987. In relation to ownership, from the total FDI in the United States 92.1 percent was owned by developed countries and only 7.9 percent by developing countries. From the total owned by developed countries, 71.4 percent is owned by various European countries, 17.6 percent by Japan and 9.1 percent by Canada.

From the total increase during 1988, the United Kingdom accounted for the largest share (39 percent) followed by Japan (32 percent) and Germany and Canada (6 percent each).[15/] The position of Japanese parent companies increased by $ 18.2 billion, to $ 53.4 billion (51.7 percent). The largest increases were in manufacturing, real estate acquisitions and wholesale trade.

Starting in early 1970s, foreign multinational companies have increased their investment in the United States as a means of pursuing their strategy of global expansion and diversification. By acquiring U.S. companies, foreign multinationals can gain access to the large U.S. market, increased manufacturing capacity, and new technology.

15/ Survey of Current Business, 1989, Op. cit.

Table 6

Foreign Direct Investment in the United States by Region for Selected Years, (billion of U.S. $)

Regions	1980		1985		1987		1988	
	$	%	$	%	$	%	$	%
All Countries	90.4	—	184.6	—	271.8	—	329.9	—
Developed Countries	78.0	86.3	161.1	87.3	251.8	92.6	302.9	92.1
Canada	9.9	12.7	17.1	10.6	24.0	9.5	27.5	9.1
Europe	60.5	77.6	121.4	75.4	186.0	73.9	216.4	71.4
European Community	54.0	89.3	107.1	88.2	165.4	88.9	193.9	89.6
Other Europe	6.5	10.7	14.3	11.8	20.6	11.1	22.5	10.4
Japan	7.0	8.9	19.3	12.0	35.2	14.0	53.4	17.6
Others	.6	.8	3.3	2.0	6.6	2.6	5.6	1.8
Developing Countries	12.4	13.7	23.5	12.7	20.0	7.4	26.0	7.9
Latin America	1.1	8.9	3.5	14.9	4.4	22.0	5.0	19.2
W. Hemisphere	7.4	59.7	13.3	56.6	8.3	41.5	12.0	46.2
Middle East	3.5	28.2	5.0	21.3	5.0	25.0	5.8	22.3
Africa and Asia	.4	3.2	1.7	7.2	2.3	11.5	3.2	12.3

Source: U.S. Department of Commerce, Survey of Current Business, various issues.

Chapter III

TECHNOLOGY AND INPUT CHOICE DECISIONS

1. Production Theory

Industry is constantly in search of new technologies to improve its efficiency in the use of resources because apart from constraints related to the availability of inputs, limitations of a firm's production decisions are imposed by technology. At each level of output the firm must select the technology that best suits the current economic situation. Inputs and technology choices provide the basic link between outputs and pricing decisions, and therefore new technologies must not be only technologically but economically feasible as well.

In relation to pollution problems, if the firm has to pay the cost of pollution control, optimally it would choose a clean and low-waste technology. Deterioration of the environment will continue to increase if the firm can pollute without cost. If this cost is not reflected in the prices of the commodities produced, the market fails to reflect the scarcity of enviromental resources. On the other hand, if the firm pays for the pollution that it generates it will be forced to make a choice for low and non-waste technologies. The solution for making the right choice is provided by conventional production theory of the firm to which we now turn.

Figure 1 illustrates the case of an individual firm whose objective is to produce a given level of output at least cost without polluting the environment. Given the state of technology, the firm uses two inputs,

X and y, to produce its output. Input Y is a high sulfur content fuel, which when burned causes serious pollution problems control of which is costly to society. Input X, on the other hand, is called pollution control technologies (PCT) including any type of pollution control equipment or processes for recovering and treating wastes which must be incorporated into the production method in order to preserve environmental quality.

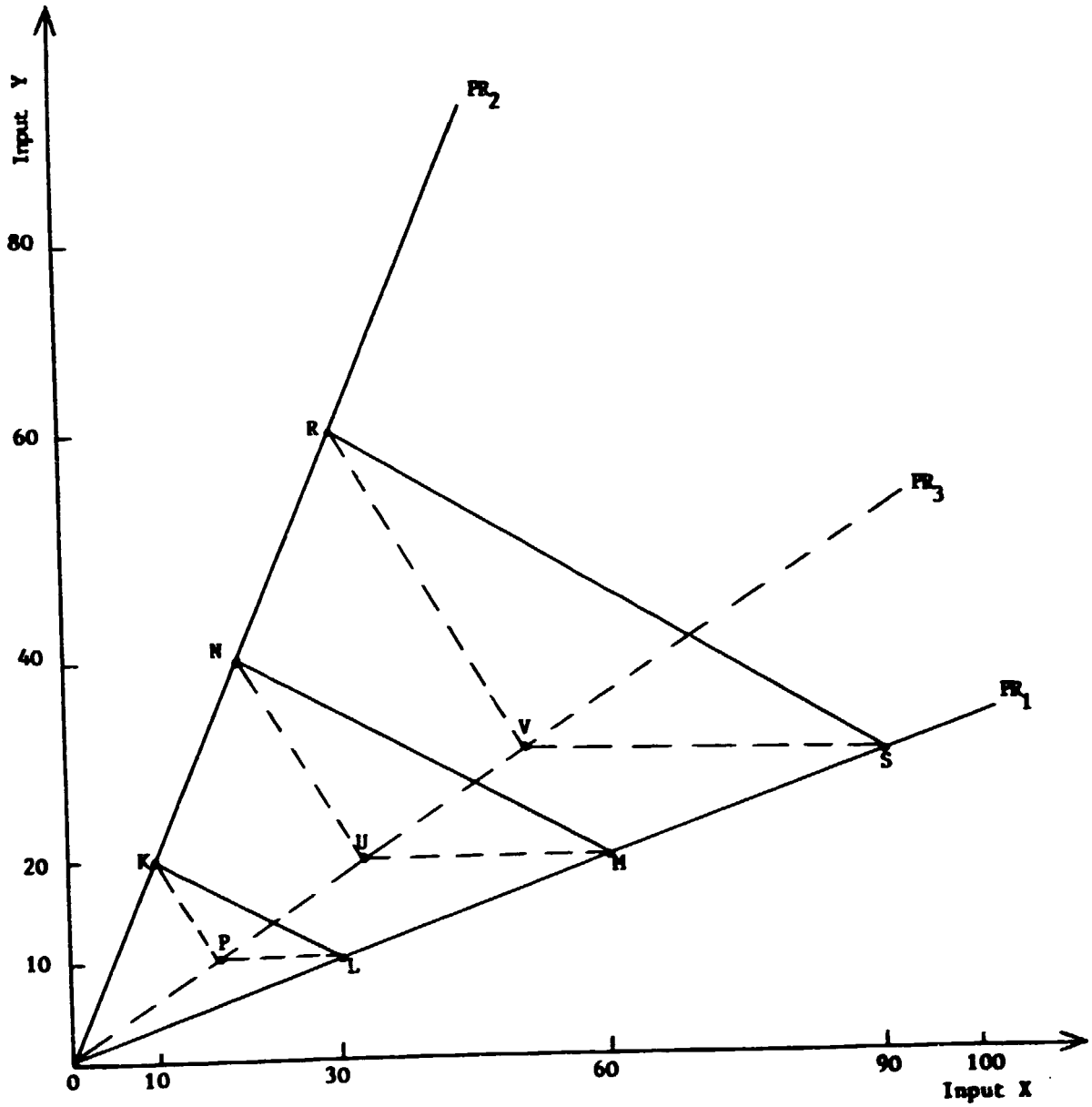
Without environmental regulations, the firm has no incentive to use any of the pollution control technologies and generates high pollution without cost. On the other hand, with environmental regulations the polluting firm, in order to reduce pollution and comply with the regulations, will be forced to install some pollution control equipment or to employ a pollution control technology the cost of which must be borne by the polluting firm.

According to Figure 1, there are two processes of production available to the firm PR_1 and PR_2. A process of production is defined as the ability of the firm to use the two inputs in different proportions. In this example, PR_2 process uses inputs in the ratio of 2 units of Y to 1 unit of X and it is represented by a ray starting from the origin whose slope is equal to 2. This is the polluting process, since it is more intensive in polluting input Y. PR_1 process, on the other hand, uses inputs in the ratio of 3 units of input X to 1 unit of input Y and its slope is 3. This process is more intensive in input X, and it is called the "Clean Process".

Assume that for process PR_2 points K, N, and R are the minimum input requirements for producing Q_1, Q_2 and Q_3 units of output respectively,

Figure 1

Production Isoquants



and that points L, M, and S are the corresponding minimum input requirements for process PR_2. A careful examination of these relations between the level of output produced and inputs used reveals an important principle in production theory. Namely, that the production surface depicted in Figure 1 represents a linear production function. This means that if both inputs are doubled or increased by the same proportion, then the level of output will be doubled or increased exactly by the same proportion. As a result of the linearity assumption of the production function, the isoquants in Figure 1 are linear, i.e., they are composed of flat segments. In reality, a firm's input choice problems are described by isoquants with flat segments implying that they do not permit continuous substitution of inputs. This is very important in appraising the effects of alternative policies aimed at changing production processes in order to reduce pollution.[16/]

An isoquant is defined as the locus of all combinations of the inputs used in the production process which produce the same level of output. However, different combinations of inputs means also different processes of producing the same output. Since in Figure 1 we deal with only two processes the three isoquants coincide with the line segments joining the two processes, i.e., KL, NM, and RS.[17/] Moving along a line segment connecting the two processes PR_1 and PR_2, means that the same level of output can be produced either with process PR_1 or PR_2 or with a combination of both. For example, at point N process PR_2 is being used 100 percent of the time to produce the Q_2 units of output, and at M process PR_1 is being used 100

16/ Robert A. Mayer, Microeconomic Decisions, Houthon Mifflin Company, Boston Mass., 1976.

17/ If we assume that a third process were available to the firm denoted by the doted line PR_3, then the isoquants would be KPL, NUM and RVS in Figure 1.

percent of the time. Along the segment from N to M, PR_2 is used for a successively smaller percentage of the time and PR_1 is used for the rest of the time. Regardless of the percentage mix, output remains constant along a given isoquant, but the level of pollution generated differs.

Suppose now that the firm, in our example, wants to produce Q_2 units of output at least cost. If there are no regulations about pollution, what input mix should be chosen? To answer this question we must also know the total cost of production. Given the prices of the two inputs P_y and P_x for inputs Y and X respectively, then the total cost of production is defined as:

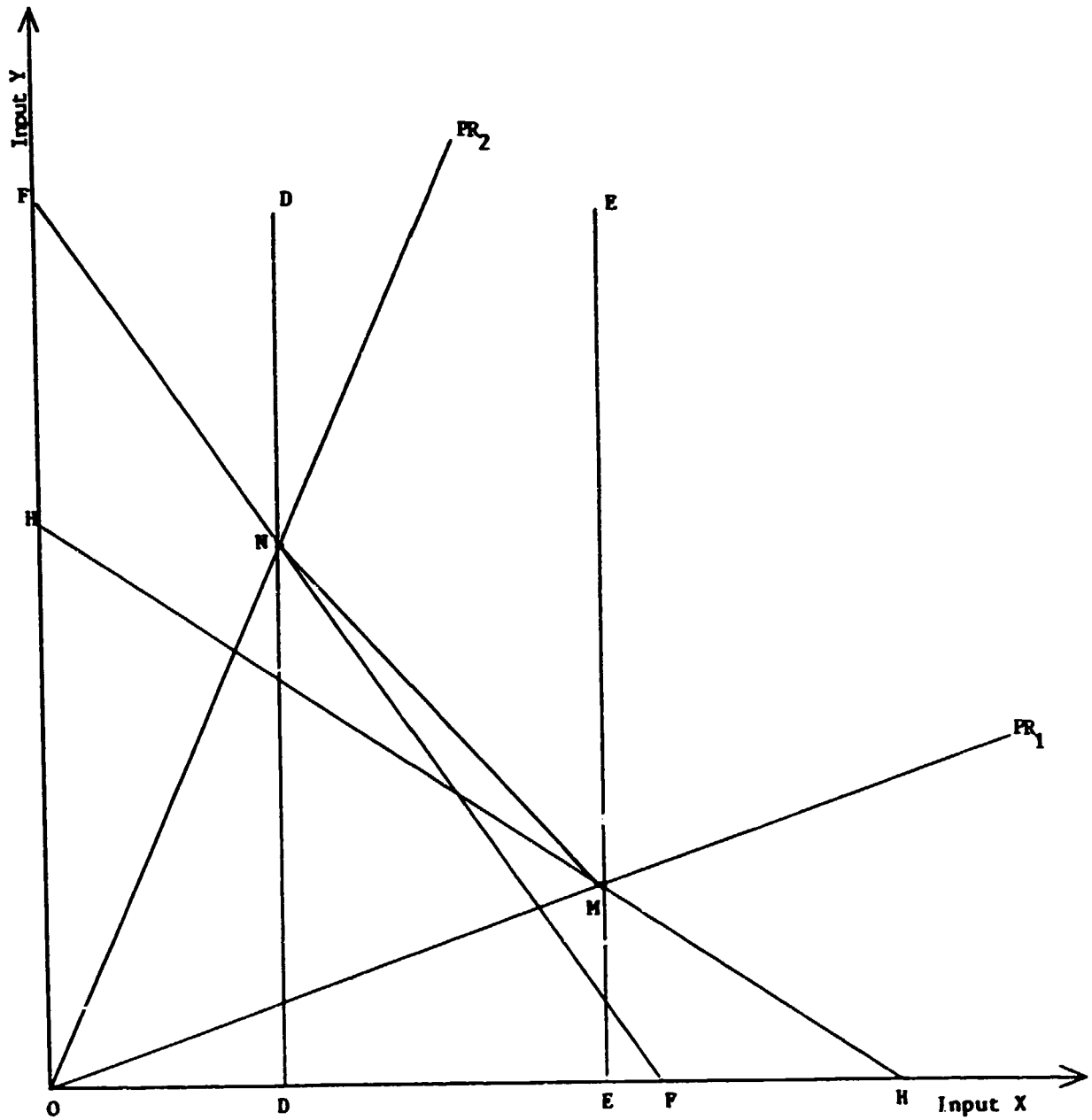
$$TC = P_y.Y + P_x.X \qquad (3)$$

This is the definition of an isocost curve which graphically is represented by a straight line with a slope equal to the negative ratio of the prices of the two inputs. According to production theory, optimal production will take place at a point of tangency between an isoquant and an isocost curve, like points N and M in Figure 2. At these points the relevant isocost curves are FF and HH for N and M respectively which have been constructed under the assumption that the two inputs have a positive price. But do they really deserve a price if we assume no regulations about pollution? Certainly input Y has a positive price and so has input X when it is used. But in the absence of regulations the firm does not employ any of the pollution control technologies (input X) and does not incur any cost for this input.

Assuming then a zero cost to the firm for input X, the isocost curve will be parallel to the vertical axis and any input combination at N or M is an

Figure 2

Production Theory and the Choice of Technology



optimal production choice with DD and EE as the relevant isocost curves for N and M respectively. Without environmental regulations however, the firm will limit the use of X input and make the greatest possible use of the polluting input Y.

Under these circumstances the firm will choose the polluting process PR_2 and the optimal input combination at point N generating large quantities of pollutants. These pollutants will be dispersed into the environment without cost to the producer since he will not use any pollution control technologies. On the other hand, with environmental restrictions, the firm will be forced to adapt the "clean" process PR_1 and select the optimal input combination at M.

Based on the above observations the question arises: what measures should a government undertake or what economic or other incentives should be given to the firm to induce the adoption of cleaner processes ? We deal with this question in the following chapter.

2. Pollution and Market Prices

The most important feature of the price mechanism in a free market economic system is that it indicates to consumers what the cost of a particular commodity is, and to producers what consumers preferences are. In a market system, consumers express their preferences for commodities by their willingness to pay the price attached to them. However, payment of the price is not always a necessary condition for obtaining commodities.[18] Namely, some commodities, although serving economic functions, are not represented in the price mechanism and can be obtained without paying a price, such as public goods and environmental products.

In this report we are concerned with environmental goods and the mechanisms that could upgrade their quality. When an environmental effect is not automatically taken into account by the price mechanism, it is called an external effect. Economists always treat environmental problems caused by economic activities as externalities, i.e., the impact of economic activities by one or more economic unit(s) on the welfare of others.

Environmental externalities result from both production and consumption and are developed rapidly as an economy grows with a substantial impact on the society at large. They are generally considered as the major reason for the difference between private cost and social cost, since environmental products or services are treated as free goods or have zero prices.[19]

---

[18] Robert A. Mayer, Op. cit.

[19] D. Pearce, A. Markadya, and E. Barbeir, Blueprint for a Green Economy, Earthsan Publications Ltd., London 1989.

Moreover, economic goods and services themselves use up some of the environment so that the cost of producing any good or service consists of priced inputs (labor, capital, etc.) and unpriced or free inputs (environmental services). When environmental goods are considered free, externalities are not priced; and this implies that market prices do not reflect the total cost of production. This underpricing of economic products causes a discrepancy between the private cost of the products in question and the corresponding social cost. Misallocation of economic resources results from the existence of such discrepancies.

The only way to correct the misallocation of resources is that environmental externalities have to be integrated with the economic mechanisms so that natural resources can be efficiently managed by allocating costs rationally. That is, externalities can be corrected partially or wholly, through the price mechanism if a price is placed on environmental resources so as to narrow the gap between private and social cost.

In this connection, the task of public policy related to environmental issues should be to use the available instruments - including direct controls, taxation, and subsidies - to find solutions consistent with social welfare regarding environmental quality. Namely, free market prices must be determined in such a way as to reflect the true cost of production including the value of environmental damage caused by any economic activity. The correct prices then should be:

$$P = MC + MEC = MSC \qquad (1)$$

Where, MEC is the marginal environmental or marginal external cost expressed in money terms. For a non-polluting product there is no difference between private and social costs of production and therefore the marginal external cost is zero and the proper price becomes:

$$P = MC = MSC \qquad (2)$$

On the other hand, the proper price for a polluting product or service should reflect the environmental damage as it has been expressed in formula (1) Thus, there is a need to correct the market prices of these products by making the polluter pay the differential amount. This is the process of internalization of externalities which we discuss in the following chapter.

Chapter IV

THE POLLUTER PAYS PRINCIPLE AND ITS IMPLEMENTATION

1. Definition of the Polluter Pays Principle

Economic activity in general tends to cause environmental deterioration, which in a way affects the resultant economic gains and may change their distribution quite drastically. Similarly, improvement of environmental quality may require altering the scope and pattern of economic activity. Society, however, faces serious problems which can only be resolved through collective decision processes.

In short, the question of environmental management is mainly a problem of public policy, because no matter what the economic system, whether market-oriented or centrally-planned, there is no inherent mechanism that automatically corrects the environmental damage caused by production or consumption and internalizes the associated social costs.

Indeed, the necessary decisions have to be taken in a public-policy context, considering the existing environmental conditions and employing the most effective policy instruments to bring about the most relevant costs and benefits to society. It is reasonable to assume then that environmental policies differ among nations. Nations with different political systems and different levels of economic development do not apply uniform environmental policies, or adopt identical ways of implementing these policies.

In spite of the above differences, a common environmental policy on pollution prevention has been accepted and implemented by many nations and in particular among the members of the Organization for Economic Co-operation and Development (OECD). This policy aims at allocating the pollution control cost to polluters and it is called the Polluter Pays Principle (PPP). The Polluter Pays Principle implies that it is the responsibility of the polluter to meet the costs of pollution control and prevention measures, irrespective of whether these costs are incurred as the result of the imposition of some charge on pollution or in response to some direct regulation. It is also irrelevant whether the polluter passes on some or all of the costs to consumers in the form of higher prices or absorbs them.

To achieve an efficient allocation of resources, on the other hand, the prices of goods and services (as we discussed before) should reflect social rather than private costs by making the polluter pays the difference, i.e., the marginal external cost for using up environmenal resources (MEC in Formula 1). The Polluter Pays Principle is a means of moving towards this end. In other words, the Polluter Pays Principle is an efficiency principle for allocating pollution control costs and it does not contribute to distortions in international trade and investment, if strictly applied.[20/]

[20/] OECD, The Polluter Pays Principle: Definition, Analysis, Implementation, Paris, 1975.

2. Direct Controls

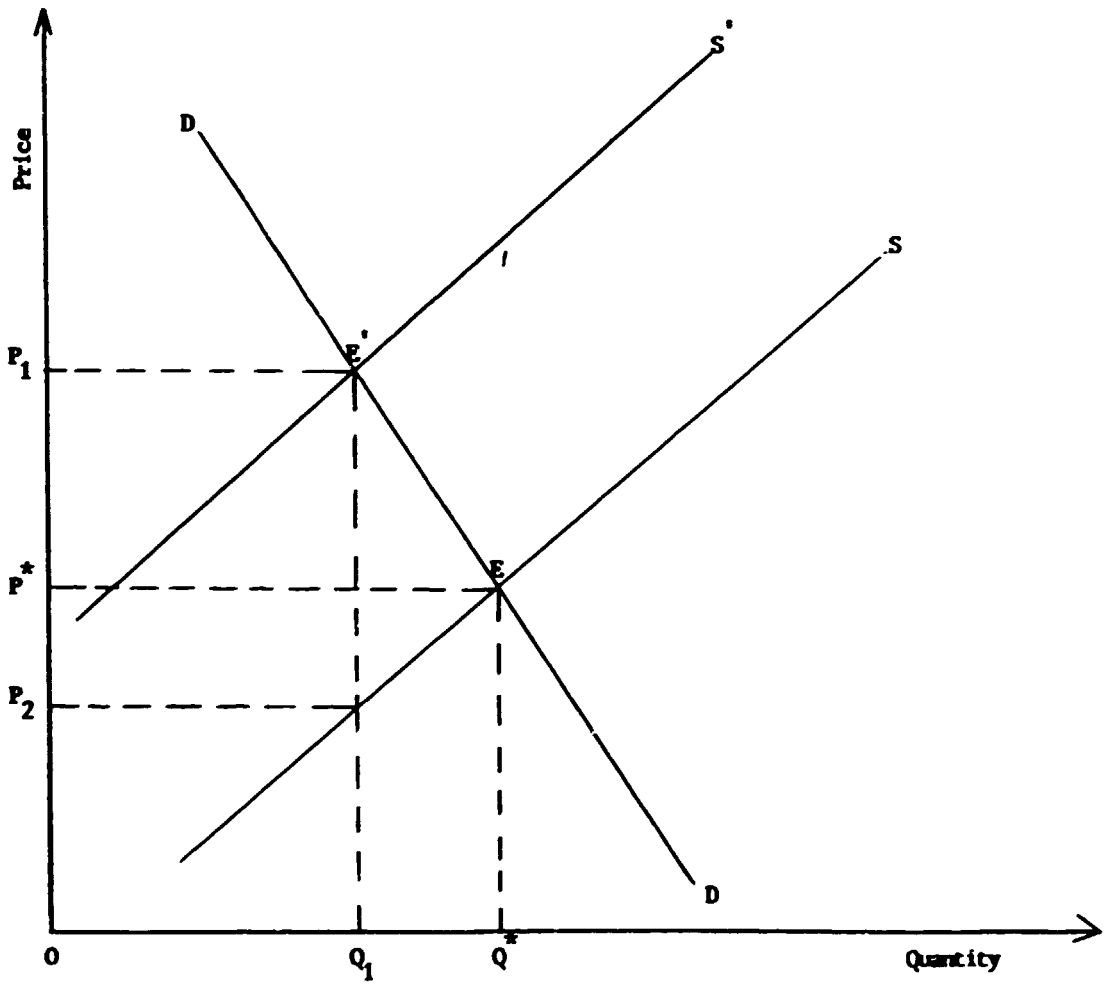
There are various mechanisms making the polluter pay for pollution control costs. One such mechanism is to force him to pay the cost of cleaning-up the environment or to order him to utilize the clean process PR_1 in order to produce his Q_2 units of output, as illustrated in Figure 2, where the polluter with the absence of environmental regulations has chosen the polluting process PR_2. Optimal production takes place at point N with minimum cost C_n represented by the isocost curve DD parallel to the vertical axis Y indicating that input Y costs nothing to the firm without environmental regulations. At this point the firm has generated an undesirable level of pollution which must be reduced to pre-setting standards. The solution, however, is to force the polluter to employ the clean process PR_1 and produce at point M by making him pay a lump-sum equal to the clean-up cost C_n-C_m. This simply implies that the firm must use pollution control technologies (input X) so that its cost rises to C_m denoted by the new isocost curve EE through point M.

The impact of the above policy in improving environmental quality is an increase in the total cost of production borne by the polluting firm. But as with any increased cost, the producer may be able to pass some or all of the pollution control cost on to consumers (through higher prices) depending on the elasticity of the demand and supply curves. Namely, the more elastic is the demand curve (the higher the competition), the more of the increased costs will be borne by the producer and not by consumers. In reality, the environmental control cost is shared between the firm through reduced profits and the consumers through higher commodity prices. This point is clea ly demonstrated in Figure 3 showing a conventional demand-supply model.

reduced profits and the consumers through higher commodity prices. This point is clearly demonstrated in Figure 3 showing a conventional demand-supply model.

Figure 3

Demand-Supply Model and the Distribution of Pollution Control Cost



According to Figure 3, before any pollution clean-up cost is imposed on the producer, the price paid by the consumer or received by the producer is P*. Assuming now that the producer pays a pollution charge, the production cost will increase causing a parallel shift of the supply curve to S'S'. The new market price is P_1 which reflects also the cost of pollution control. This is the real price paid by consumers, but producers receive only price P_2 since they have borne part of the charge. The loss to producers and consumers is measured by the area P^*EAP_2 and $P^*EE'P_1$ respectively, in Figure 3. Thus, the environmental control cost is paid partially by consumers and producers, and the exact amount depends on the degree of competition faced by the firm (as we mentioned before).

3. Pollution Charges or Taxes

Another mechanism through which the polluter pays principle can be implementd is by imposing a per unit tax or charge on the product itself, resulting in raising the cost of producing the product. The effect of a tax is that it adjusts market prices to reflect the use of environmental goods, which otherwise would be treated as being free. The amount of the tax must be equal to the marginal external cost so that private and social costs become equal (Formula 2). More specifically, the tax must be equal to the amount at which the marginal social costs of pollution abatement equal the marginal social damage from pollution. If this tax is imposed, the polluter will reduce the polluting input Y up to the point where a further reduction in this input (further reduction in pollution) will cost him more per unit than paying the tax, because he would prefer to pay the tax beyond this point.[21/]

The amount of the tax should also have some relationship to the value of environmental services used in the production of a given product. For example, the value of a carbon tax should be according to the carbon content of fuels, so that a higher tax must be charged for coal than oil which in turn would be charged a higher tax than natural gas. Soft coal with high sulfur content should be charged a higher tax than hard coal with low sulfur content. This differential in imposed taxes may create an incentive, for instance, for the electricity industry to alter its input mix to a less polluting form.

[21/] OECD, Pollution Charges: An Assessment, Paris, 1976.

Furthermore, a higher tax on leaded than unleaded gasoline may induce consumers to use unleaded gasoline so as to improve air quality standards.

The impact of this policy in abating pollution is also shown in Figure 2. Assuming again that without environmental regulations the firm has chosen the optimal combination of production at point N employing the polluting technology PR_2 and confronted with a low cost indicated by the isocost curve DD. To make the producer adopt the clean technology PR_1, a tax per unit of input Y or output produced equal to the marginal external cost should be levied so as to make prices reflect social rather than private cost. This will increase the production cost and make the producer select the optimal combination at point M with HH as the relevant isocost curve implying that both inputs have now positive prices.

The two policies we have discussed so far have different effects on product prices. With direct controls, the firm was forced to pay a lump-sum environmental control cost, and nothing was done to alter the initial prices created by the market. Input Y had a positive price while input X had zero price. This implies that the polluter will pay the same cost regardless of the amount of the polluting input Y employed in the production process, unless environmental quality standards change.

On the other hand, imposing taxes on polluting inputs or products raises the prices of these products and make them less attractive to consumers. Market prices determined that way reflect both the use of economic resources as well as of environmental services and achieve a more efficient allocation of scarce resources. The effectiveness of such a policy to consumers is

illustrated by the oil crisis of 1973 and 1979. The abnormal increase in oil prices - although not intended to abate pollution - relative to other types of energy, forced many American households, for example, to substitute the more expensive and more polluting oil-heating system for the less expensive and less polluting gas-heating system. The oil crisis also forced many Americans to switch to smaller and more energy-efficient cars and put pressure on auto-makers to produce these cars. Both of these examples indicate that the oil crisis resulted in energy conservation and reduced air pollution, in spite of the fact that energy conservation by oil-intensive industries around the world caused a worldwide recession.

According to Baumol and Oates, the difference between direct controls and taxes or fees is that direct controls are enforced through fines or other penalties and involve a directive to individual producers requiring them to satisfy some predetermined environmental quality standards. If their activity satisfies these requirements, they are legal and no penalty is imposed, but if the standards are violated they must be subject to punishment. With taxes or fees on the other hand, even if they are based on stadards, the producer is not told what level of economic acitivity to select. The amount of payment will vary with his activity level, with no imputation of illegality to the activity level he chooses. [22/]

Moreover, pollution charges or taxes are generally considered more effective and should be used to internalize pollution abating costs. According to D. Pearce, the basic reason why pollution charges are likely to be better

---

[22/] W.J. Baumol, W.E. Oates, The Theory of Environmental Policy, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1975

than direct controls is that, "charges enable a polluter to choose how to adjust to the environmental quality standards. Polluters with high costs of abating pollution will prefer to pay the charge. Polluters with low cost of abatement will prefer to install abatement equipment. By making abatement something that low cost polluters do rather than high cost ones, charges tend to cut down the total cost of compliance" [23].

In conclusion, in implementing the PPP (regardless of the mechanism chosen), the cost of internalising environmental externalities is borne by consumers and producers depending largerly on the degree of competition faced by the producer. In turn, the international competitive implications of the PPP depend on whether the environmental control costs are variable or fixed. If they are variable, they will influence the pricing and output decisions of the firm passing part of the cost to consumers in the form of higher prices. But, if we assume that industries which are involved in international trade are characterised by more competitive market structures, the effect of PPP-induced cost increases may be in the form of reducing production rather than price increases. In the case of fixed costs, the burden of pollution-control costs will be most probably borne by the producer in the form of reduced profitability, rather than in price changes.

---

[23] D. Pearce, A Markadya, and E. Barbier, Op. cit.

Chapter V

FISCAL INCENTIVES

1. Subsidies

As national environmental policies are applied, it seems that strict enforcement of the Polluter Pays Principle may create economic difficulties for certain enterprises, industrial sectors, regions or countries. In such cases, making the polluter pay is wholly unjustified and a transitional policy can be adopted to facilitate adjustment. This being so, exceptions can be made to the PPP when there are special circumstances which the authorities regard as justifying them. Such situations could arise when application of the PPP would hinder the achievement of one or more regional or national economic objectives.

This would be the case, for example, when the additional environmental control cost incurred by polluting industries in developing countries would result in holding back regional development or adversely affecting the labour market. In addition, to abate pollution, changes in production technology are required in many cases, which may cause distortions in the operations of an enterprise or industry. Production lines may have to shut down, economies of scale may have to be sacrificed temporarily, and workers may have to be laid off. Another situation may arise when an enterpsise or industry in a developing country, in order to abate pollution must apply a new cleaner technology which has not yet been introduced in the country in question. Then this techology must be transferred from abroad which in many cases is very costly.

Under these circumstances, a case can be made for public assistance to help a firm or an industry to meet transitional adaptation costs, so that the public as a whole will benefit from the process of maintaining a viable balance between environmental and other economic or social goals. Although the sharing of transitional adjustment cost, through public or international assistance, constitutes a departure from the spirit of the PPP, it seems that the general problems of adjustment and policy implementation require exceptions to be made in the aforementioned special cases. Furthermore, exceptions from the PPP have been widely accepted in the form of "adjustment assistance" under a wide variety of circumstances, ranging from import competition to the effects of rapid technological change.[24/]

The major goal of implementing efficient environmental policy then should be to minimize adjustment costs and nationally or internationally financed programmes should be provided aiming at reducing the overall adaptation cost to society. This is possible through the use of "subsidies" which eventually allow adjustment to occur with reduced cost to the firm or the industry. A subsidy is an aid to a polluter of all or part of the cost of the anti-pollution measures with which he is obliged to comply. In fact, subsidies may be of advantage in facilitating and speeding up the implementation of an environmental policy during a transitional period of adaptation.[25/].

Graphically, the case of subsidies is illustrated in Figure 2. If the firm, without environmental regulations, produces at point N using the

---

[24/] Ingo Walter, 1978, International Economics of Pollution, John Wiley and Sons, New York, 1978.

[25/] OECD, 1975, Op.cit.

polluting process PR_2, at the prevailing set of prices its total cost would be C_n, while producing at M its total cost would be C_m. Having a public body willing to pay a subsidy, its size must be equal to the difference C_n-C_m (full subsidization) or less rtial subsidization) in order to induce the firm to voluntarily choose the clean process PR_1 and produce at M instead of N. Any subsidy greater than $C_n - C_m$ will generate a total cost of producing at point M which is less than that at point N.[26/]

A comparison between subsidies and the enforcement of the PPP policies reveal that the two policies have different distributional effects. In the case of the PPP, the cost is borne by the producer and the consumer of the commodity in question; while in the case of subsidies, the cost is paid either by public authorities, or it is shared by the polluter and the authorities. In the latter case however, the cost of abating pollution is subsidized by a public body from revenue drawn not only from the consumers of the commodity in question, but from all taxpayers. In this respect, the subsidies policy may be preferred to the PPP because its indirect influence makes it difficult to determine who is paying and how much.[27/]

[26/] If for example, C_m = $ 60 and C_n = $ 20, in the case of full subsidization the size of the subsidy must be $ 40 (C_m-C_n). If it is greater than $ 40 (i.e. $ 50), then the actual cost at M will be only $ 10 which is less than that at point N ($20).

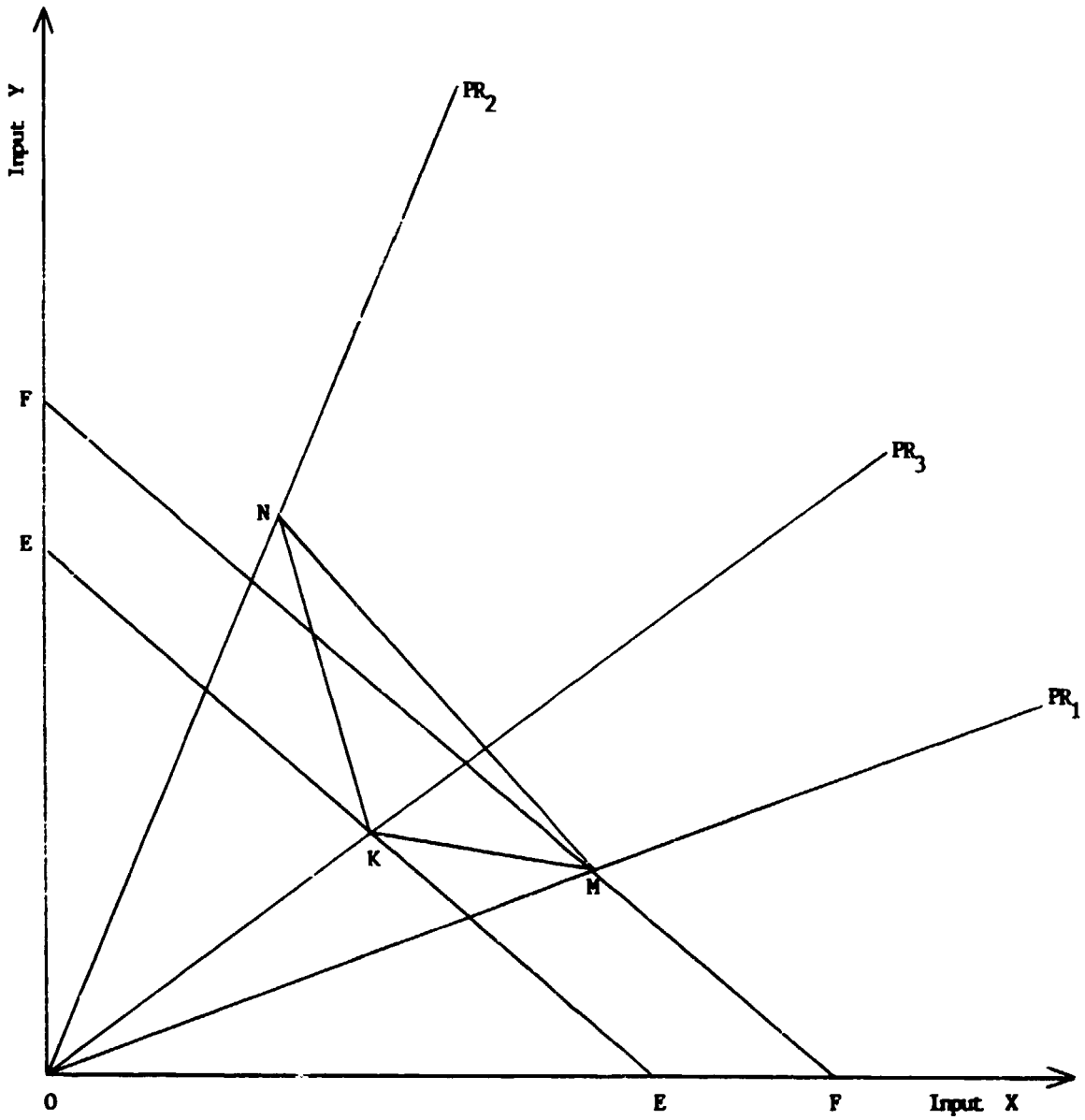
[27/] Robert A. Mayer, 1976, Op. cit.

2. The Technological and Ecenomic Impact of a New Process of Production

It has been recognized that a significant outcome of technical progress is the development of clean processes of production which have not only ecological, but also major economic and technical implications. Namely, clean technologies limit discharge, avoid the production of undesirable by-products and reduce the risks of accidental pollution and transfer of pollution between physical environments. With respect to economic impact, clean technologies lead to a reduction in production cost through savings in raw material and energy, and increase productivity, which in turn increases profitablity and competi- tiveness.

The case is illustrated in Figure 4 where, as before, there are two processes of production available to th firm PR_1 and PR_2. Assuming that the firm produces 200 units of output with the cleaner process PR_1 and given the prices of the two inputs, optimal production will take place at point M with total cost represented by the isocost curve FF through point M. Now assume that a new, cleaner, process PR_3 becomes available to the firm which is using less of both inputs X and Y. This process is technologically more advanced than either PR_1 ro PR_2. It is also more economical, because in order to produce 200 units of output with the same set of prices, optimal production will occur at point K with total cost indicated by the isocost curve EE which is parallel and to the left of the isocost curve FF. This means that with the same set of prices, it costs less to the firm to produce 200 units of output by the new cleaner process than either PR_1 or PR_2. However, clean processes are not only ecologically feasible but economically efficient as well.

Figure 4
The Technological and Economic Impact of a New Process of Production



For example, in order to manufacture a ton of panel board it was necessary to use 30,000 liters of water which was disposed of in water ways at the end of the production chain. Now, with a cleaner process, the required quantity of water has been reduced to 100 liters per ton. In order to produce a ton of hydrazine hydrate, the quantity of thermal and electrical power was 4.7 and 9.0 TOE respectively. Implementing a cleaner process, it was possible to reduce these needs by 83 percent for electricity and 50 percent for gas. These energy savings significantly reduced production costs. In addition, it has been estimated that the cost of environmental damage in France amounted to 100 billion FF per year, whereas investments in clean technologies were only 55 billion FF for the same period.

In conclusion, since developing countries today are confronted with various economic difficulties, in order to promote economic development and protect the environment at the same time, they need to introduce and apply clean technologies. Since usually these technologies are developed by industrial countries, the policy makers in developing countries should provide effective instruments for assessing the impact of these technologies and stimulate their development domestically or transfer them from abroad. But as many developing countries have pointed out, the high acquisition cost is the crucial bottleneck for acquiring and adapting these new technologies. What is needed however is a close co-operation between developed and developing countries and international organizations to intensify their efforts in promoting the early diffusion of clean technologies among developing countries. At the national level, on the other hand, governments should provide any financial or regulatory assistance to enterprises or industries in

order to facilitate the acquisition and adaptation of clean technologies. That is exactly where subsidies can be an effective mechanism for pursuing this objective.

2. Types of Subsidies

In this paper, we define subsidies as the various instruments or techniques actually employed in order to make a public body or international organization (or in general somebody else) to bear wholly or partially the environmental-control costs rather than the polluter himself. That is, the polluter pays nothing or a part of the total pollution abatement costs. All these instruments are considered departures from the polluter pays principle, but some have less distortive impact on international competitiveness than others. The following section describes the economic instruments available for pollution control and reduction.

1. Government Capital Grants. They represent the most important and most effective form of subsidization by governments of productive enterprises and consist of direct financial assistance to the firm in order to reduce the capital cost required for pollution control facilities. As a result, the firm's average cost per unit of output is lower than would otherwise be the case, and its national and international competitiveness is raised.

   In terms of international competitive implications, government grants are the most objectionable since they reduce the firm's per unit cost and lead to unfair competition. They are also prohibited by the General Agreement of Trade and Tarrifs (GATT) in international trade relations.

Regardless of the objections, capital grants should be provided to individual firms or industries of developing countries to induce them to introduce clean and low-waste technologies in the process of implementing their environmental policy without sacrificing economic growth or other social or commercial priorities.

2. Tax Abatement. Tax relief of any kind constitutes an implicit subsidization by governments of capital or operating expenditures related to pollution control, reduces the firm's overall tax liability, and affects positively its profitability. Tax concessions may be granted either in the form of lower corporate tax-rate or as credits against tax liability of a certain percentage or of the entire capital investment associated with pollution control [28/].

Taxes employed under these two schemes may be direct (lower profit tax-rate) or indirect (i.e., tax credit against property taxes). In either case, tax abatement affects either fixed costs, variable costs or the profits of the enterprise and strengthens its competitiveness in domestic as well as in international markets.

In addition, tax concessions are granted as economic incentives by all developing and many developed countries in order to attract foreign direct investment. If this is the case, then taxes should be also used for pollution control investment as well.

28/ Lower profit tax-rates should be granted for a limited time period. Usually it should not exceed the number of years required to recover the original cost of the capital investment.

3. Accelerated Depreciation. By writing off capital investment for environmental purposes more rapidly than otherwise, the firm effectively reduces its current tax liability and can employ the resultant savings for other productive purposes. This method is different from tax abatement because it influences the firm's fixed costs with long-term competitive implications.

On the other hand, accelerated depreciation raises the firm's profitability - at least for the depreciation period - by allowing the firm to recover the capital investment costs faster. For this reason, accelerated depreciation is one of the many economic incentives offered by developing nations to multinational corporations to increase the inflow of foreign investment in their economies. It is also used as a fiscal instrument to stimulate investments and economic growth in periods of recession.

Accelarated depreciation works as follows: Assuming that anti-pollution control equipment costs $ 10,000, and its normal life is five years. If we employ the straight-line method for estimating depreciation allowances, the firm is allowed to reduce its tax burden by $2,000 for the next five years. In other words, the firm's profits increase by $ 2,000 for this period, and it recaptures the original cost of the investment within five years[29/].

29/ The annual depreciation charges are estimated by dividing the original cost of the investment by the number of years of its life.

To use accelerated depreciation as an incentive to introduce clean technologies for pollution purposes, the government should allow the entrepreneur to depreciate the equipment in a shorter period, i.e., in two year period. This means that the producer recovers the cost of the investment in two years and at the same time his profits increase by $ 5,000 for the next two years. Accelerated depreciation is very effective and should be provided as an economic incentive to abate pollution either alone or in combination with other instruments.

4. Concessionary Loans. This is another way of reducing capital costs associated with pollution control. Loans may be provided to a firm either directly by public authorities or indirectly by international institutions, at rates of interest and amortisation terms more favourable than those available from financial institutions. Alternatively, government credit guarantees may be extended to the firm, allowing it to borrow from other financial institutions at more favourable rates.

Both such methods lower the cost of capital to the firm and increase its profitablity. Concessionary loans have long-term rather than short-term competitive implications since they influence the firm's average fixed cost. Because, many developing and developed countries provide concessionary loans as incentives to attract foreign investment, they should also be provided for pollution control purposes.

5. Tariff and Non-tariff Restrictions. These instruments may be employed in cases where an industry is highly trade-oriented and its competitiveness is threatened by capital investment costs for environmental purposes.

Then a case can be made for the government to protect the industry in question through raising tariffs or other trade barriers for a certain time period.

Although such restrictions are inconsistent with existing GATT rules, exemptions should be made to facilitate the implementation of efficient environmental policies by the industry and secure at the same time its competitive position. In this case the full cost of capital investment is paid by the industry, but the restrictions imposed may offset the negative impact on its profitability and do not affect its pricing and output decisions. It is therefore necessary that a comparative study should be conducted to assess the benefits and costs - to the industry and to society at large - associated with trade restrictions imposed for pollution control purposes.

6. Export Premiums. Levying trade restrictions for environmental purposes, as we just discussed, concerned a whole industry. On the other hand, export premiums should be granted to an export-oriented individual firm whose competitivenss may be jeopardised by the incremental cost of capital investment for implementing specific environmental policies.

In this specific case, the governments may provide export premiums or increase the ones already in existence to the affected firm in order to subsidise - partially or wholly - its resultant cost increase from its capital investment. The size of the premium must be equal to or a certain percentage of the incremental cost so as to minimize the negative impact of the firm's international competitive position.

7. Research and Development Expenditures. Government sponsored research and development activity associated with environmental control may generate the necessary technical advances more rapidly and more effectively than resarch undertaken by individual enterprises. Once innovations have been generated, they are diffused very quickly nationally and internationally. That is, research and development benefit both domestic and foreign enterprises, in meeting environmental objectives with relatively low cost especially when they are tax-financed.

As a departure from the PPP, tax-financed research and development has been recognised as an exception and appears to be non-controversial in nature, since governments have implicitly concluded that its benefits outweigh its costs[10/]. Therefore, international competitive distortions may be minimal, because government sponsored research and development generates innovations which become available abroad and lead to the development of industries producing pollution control products for export.

8. Concessionary Leasing. This is another method of reducing capital costs related to pollution control investment. The required equipment may be purchased by public authorities and then leased in individual firms on more favourable terms than they would obtain if the firm had to acquire them itself. This is an implicit subsidisation which reduces the enterprise's capital investment costs due to cheaper credit available to government agencies. Leasing of capital equipment is growing rapidly in importance and may grow in significance in the future as well.

[10/] Ingo Walter, 1978, Op. cit.

Chapter VI

CONCLUSIONS

Concern about the future quality of the environment is not limited to a particular country or region but it is a global concern. This concern was the central theme of the report "Our Common Future" or "Brundtland Report" issued by a special United Nations Commission consisting of representatives from industrial and developing countries. The report concludes that the most significant threat facing humanity and development is characterized by increasing poverty and simultaneous deterioration in environmental quality. In order to promote both global justice and environmental protection, the developing countries must be granted the opportunity to grow economically in an environmentally responsible manner.

At present, developing countries are confronting with two important issues. Deterioration of their environment and natural resource base and achieving sustainable economic growth. The two are totally interdependent and policies to promote both are urgently needed. These policies should be designed in such a way as to provide better linkage between economy and environment and between government and industry in reaching the goals of sustainable development.

The problems faced by developing countries must be solved now through maximum utilization of the existing clean technologies which increase both economic efficiency and environmental quality. Nevertheless, these technologies are mostly developed in industrialized countries and affordable

instruments and measures should be provided to enterprises or industries in developing countries in order to enable them to transfer and apply these technologies.

In this study, we considered two sets of such instruments, the polluter plays principle and subsidies. In implementing the PPP, we discussed and analysed the implications of two mechanisms: direct controls and charges or taxes. Direct controls are the safest means of preventing irreversible effects or unacceptable pollution levels, and their effectiveness depends mainly on good administrative organization, on which efficient environmental management also depend (OECD 1975). It should also be noted that direct controls are mainly preferred by industrialists, because controls are open to bargaining and compromising over the fixing of standards; and once the polluter has complied with the regulations, he has no further charges to pay. In addition, direct controls are flexible since they can induce changes in polluting activities, and this is another reason for their popularity among regulators (Baumol and Oates, 1975). Moreover, direct controls are consistent with the PPP if each polluter affected by the controls has to bear the cost necessary for complying with the standards (OECD, 1976).

Pollution charges or taxes, on the other hand, play an important role in the process of internalizing environmental externalities. First, unit taxes represent a very attractive method for achieving specified standards of environmental quality, and they automatically lead to the least-cost pattern of modification of externality-generating activities (Baumol and Oates, 1975). Second, pollution charges or taxes oblige the polluter to include in his production cost the pollution control cost; and by doing so, he re-establishes correct pricing, so that the gap is bridged between private and

social cost (OECD, 1975). Third, a charging policy may achieve the objective of abating pollution at least cost to society and it can provide a continuing incentive for improved pollution abatement (OECD, 1976). Finally, the application of charges in promoting clean technologies make the cost of pollution visible to manufacturers and the revenues from the charges can be used for environmental investments (Economic Commission for Europe, 1989).[31/]

In summary, in spite of the difficulties encountered in estimating appropriate fee levels and administering the system, controls and taxes can be effective in promoting the use of clean technologies, if technology options are available and they are implemented in conjunction with other policy instruments, including legal requirements. It seems, however, that in most developing countries not only there are no technology options, but the existing clean technologies have not yet been introduced. What is needed therefore is a system of such instruments which will assist individual firms or industries in developing countries in transfering these technologies from abroad.

It is suggested that the various subsidies we have discussed in this paper are relevant and appropriate instruments to fulfil this objective. Besides, most of these subsidies - including tax consessions, accelerated depreciation, consessionary loans, and trade restrictions - are part of the package offered to TNCs by the governments of developing countries in order to attract foreign direct investment, which as we have seen is the most important

---

31/ Economic Commission for Europe, Seminar on Economic Implications of Low-Waste Technology, Report of the Seminar, The Hague, Netherlands, October 1989.

form of technology transfer. The same instruments must become available to individual enterprises or industries in order to assist them in the process of transferring and adopting these technologies. Despite their drawbacks, subsidies must be employed in environment policy for reasons of social policy or regional developement, and they can prove useful as complements in cases of recognised exceptions to the PPP, as during transitional periods of policy implementation in developing countries.

Among the various types of subsidies, capital grants for pollution control investment must be provided in cases where enterprises cannot otherwise make the necessary investment themselves without financial support. Investment grants do not simply lower investment costs, but also reduce production costs. For that reason, they should be granted to overcome temporary uncertainties and disadvantages of integrating clean technologies within enterprices. In general, grants may have a stimulating effect on the development and application of clean technologies, if the conditions in which they are to be applied are known and taken into account.

Research and development funds have stimulating effects on innovation and diffusion of clean technologies and should be directed towards long-term, internationally co-ordinated programmes. In this respect, many developing countries have expressed the need for improving the utilization of existing R&D centres by allocating more funds into their research and development activities. For example, Thailand has provided tax incentives for small and medium sized enterprises for the acquisition of new technologies and the establishment of science-based Parks (Expert Group Meeting, 1989).[32/]

[32/] UNIDO, Regional and Country Studies Branch, Expert Group Meeting for Industrialization Policies in Developing Countries, Vienna, April 1989.

Furthermore, many industrialized countries have set up two types of financial aid mechanisms for pollution control: direct aid for investment expenditure and anti-pollution operation and aid for research and development expenditure.[33/] Direct aid is granted subject to conditions which encourage the introduction of new and clean technologies. This policy, for instance, has been applied in Norway in the paper and pulp industry and in Germany in the metal-plating industry. In relation to the second category, the government finances programmes for research and development on new processes either by funding research institutes or by assisting given industrial projects. In France, for example, the Ministry of the Environment provides financial aid to industries for R and D in non-polluting, more efficient, and energy and raw-material-saving technologies. The Netherlands set up a special aid programme for clean technologies in 1975. In France and Germany, the government provides 50 percent or more of the financing for research programmes on pollution control and energy conservation.

In conclusion, the developing countries should reassess, upgrade and make more efficient the existing research and development facilities in order to strengthen their capabilities to develop and/or acquire and absorb new and clean technologies and analyze the impact on their industrialization process. To obtain access to information and know-how in new technologies, international collaboration is required more than ever before. To this end, UNIDO's role and potential contribution becomes even more crucial and significant. It should intensify its efforts in establishing information

---

33/ OECD, Environment Policy and Technical Change, Paris, 1985

centres for the production, availability and exports of clean technologies. In addition, it should initiate the development of programmes which would assist developing countries in their efforts to develop new and clean technologies.[34/] Such programmes would include assistance in promoting research and development activities, training of human resources, creation of appropriate institutional infrastructure etc. The implementation of these programmes would strengthen the positions of developing countries in the international system.

34/ A. Biswas, "Environmental Aspects of Hazardous Waste Management for Developing Countries", in Hazardous Waste Management, edited by S.P. Maltezou, A. Biswas and H. Sutter, Tycooly Publishing, London, 1989.

BIBLIOGRAPHY

1. Baumol W, and Oates W, The Theory of Environmental Policy: Externalities, Public Outlays and the Quality of Life, Printice - Hall, Inc., Englewood Cliff, New Jersey 1975.

2. Biswas A, "Environmental Aspects of Hazardous Waste Management for Developing Countries:Problems and Prospects", in Hazardous Waste Management, Edited by S.P. Maltezou, A. Biswas and H. Sutter, Tycooly Publishing, London, 1989.

3. Environment Agency, Government of Japan, Quality of Environment in Japan, Japan, 1988

4. International Monetory Fund, World Economic Outlook, Washington, D.C., April 1989

5. Mayer R., Microeconomic Decisions, Houghton Mifflin Company, Boston, Mass., 1976

6. Economic Commission for Europe, Seminar on Economic Implications of Low-waste Technology, Report of the Seminar, the Hague, Netherlands, October, 1989.

7. Organization for Economic Co-operation and Development, Development Co-operation in the 1990s, Paris, 1989

8. Organization for Economic Co-operation and Development, Environmental Policy and Technological Change, Paris, 1985.

9. Organization for Economic Co-operation and Development Polluting Charges: An assessment, Paris, 1976.

10. Organization for Economic Co-operation and Development, The Polluter Pays Principle: Definition, Analysis, Implementation, Paris, 1975.

11. Pearce, D., Markardya, A. and E. Barbier, Blueprint for a Greeen Economy, Earthscan Publications Ltd. London 1989.

12. UNEP, "The State of the World Environment," 1987

13. UNIDO, Regional and Country Studies Branch, Expert Group Meeting for Industrialization Policies in Developing Countries, Vienna, April 1989.

14. U.S. Departme ⌊ of Commerce, Survey of Current Business, August, 1989 and other issues

15. Walter I., International Economics of Pollution, John Wiley and Sons, New York, 1978.

16. World Bank, Sub-Sahara Africa from Crisis to Substantial Growth, Washington, D.C., November 1989