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Oil Industry, Environmental Externalities & Social Costs

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Abstract: ***The paper traces the theoretical background of studying pollution emitted by the Extractive Industries like the petroleum industries as negative externalities. The study also explores loss of welfare to the third party due to transaction between two parties. Externalities are transformed in terms of cost incurred by the producers and cost to the society. These costs are transformed in terms of private costs, external costs and social costs. The paper concludes that pollution in terms of externality can be studied with the purpose to finding costs to the society and can be rationalized to pin corporate social responsibility on the erring Firms. In the literature of Environmental Economics, pollution is treated as a negative environmental externality and also is called external diseconomy. A negative externality is an external cost and is said to exist when an economic transaction and activity between two parties lead to loss of welfare to third or external party that goes uncompensated. The requisite conditions for creation of a negative externality or external cost are- 1) An economic transaction or activity takes place between two parties/agencies 2) The said transaction or activity leads to loss of welfare to an external party 3) Loss of welfare caused to the external party is compensated. Compensation of loss of welfare in any form leads to internalization of the external cost and mathematically is said to cease to exist. However, cessation of external cost in this sense implies abolishment of economic pollution that may not lead to end of physical pollution.***

Keywords: Environment, Externalities, Pollution, Cost, Private and Social Cost

1. Theories of Externalities

In traditional theories and practice of economic and industrial development, environment was taken to be an exogenous constant that was supposed to withstand rapid industrialization and subsequent consumption of goods and services to an unlimited extent. In other words, Mother Nature was assumed to possess infinite assimilative capacity to intake all the wastes created out of human economic activities. Therefore, the traditional economic and development model of production and consumption encompassed a two-way relationship between the households (the suppliers of the factors of production like land, labour, capital, organization and most importantly-natural resources) and the producers of goods and services. Environment was considered to be a free gift that was only to supply natural resources for human use and sustain modern life. However, in the early 20th century, environmental concerns begin to surface and turned vehement in its second half. Movements like the Green Peace, evolution of the environmental sciences and pollution control technology, etc., gained momentum. Biologists and scientists from other disciplines of the natural sciences began exploration on the impact of human activities on environment and also the impact of environmental damages on health, flora, and fauna, and on the entire mankind. In the late 20th century concepts like Green House Effect (GHE), global warming, ozone layer depletion and so on became quite popular, and serious endeavors to achieve the goal of sustainable development became more or less a global effort. Gradually, over a period of time, it was realized that somewhere the traditional public policies and economic theories failed to capture the essence of three-way relationship among households and their consumption, producers and their production and the environment. This led to emergence of a new field called the environmental economics that encompassed an interdisciplinary approach to the solution of the problem of externalities like pollution, and built an economic model of development that aimed for sustainable development. Broadly speaking, sustainable development is a pattern of economic development that ensures the needs of not only the present generation, but also the future generations to come. Technically speaking, the model of sustainable development is based on the 'materials balance model' that incorporates environment within the relationship of household and producers. Thus, households/owners of the natural resources drawing such resources for their own uses and supplying the same to the producers of goods and services, producers producing goods and services, and the household producing wastes out of consumption and producers creating wastes out of production that is continuously discharged into the environment, are now being accepted as part and parcel of environmental management. Moreover, there is a marked change in the attitude towards the environmental problems. In earlier times the focus of pollution control or management of externalities was 'end of the pipe treatment' where pollution was allowed to be produced and only in the post-production stage the issue of safe disposal or pollution control was considered. There is a distinct method of incorporating the environment in the production-consumption relations. In order to ensure sustainable development, discharging of wastes in the form of pollution, poisonous chemicals, acids, etc. into the environment is now regarded poor management practice in many developed nations and to some extent in the developing nations too. The emphasis is on recovery of wastes, followed by its recycling and ultimately reuse so that externalities are neutralized, and otherwise safe disposal of wastes so that externalities are minimized. Externality in layman's language refers to a positive or negative effect on a third party due to economic activities taking place between two other parties, and that goes unpaid for (in case of benefit) or uncompensated (in case of loss). According to Heath Gibson, "externality is a cost (loss) or benefit arising from an economic transaction that falls on a third party and that is not taken into account by those who undertake the transaction". Thus, in production of paper by a paper mill and in its subsequent purchase transaction, burden of costs arising due to water pollution created locally that result in losses for the local society, is not accounted in the accounts

as a part of cost added to the total costs of the paper mill. Generally, negative externalities are more in debate as they are the root cause behind the 'local to global' environmental problems. These are what are referred to as the external costs of production of a private producer. The main objective of solution to these externalities is to incorporate these external costs in the cost of production of the private producer, say the cost of production of paper by the paper mill, and make someone (preferably the paper mill owner and also the purchaser) responsible so that some kind of compensation is made to the local people by way of cash transfers for corrective measures, or lowering of production to an environmentally safe (optimum) levels, or for that matter of fact adopting some form of cleaner technology akin to the MPFI EURO II/III engines nowadays used in cars. In fact, incorporation of pollution costs in the cost of production of goods and services is a new trend that has defied the traditional thinking that environmental goals are incompatible with the goals of economic growth and development. The man, who is credited to bring in the issue of environmental quality into the mainstream of public policies and economics in a specific way, is the first Nobel Prize winner for Economics on Environmental Economics (1991) is Ronald Coase.[31] His widely referred and adopted solution for achieving sustainable development is grant of property rights to either the polluted or the polluters that leads to efficient outcome in terms of reduced pollution. Well, certain intricacies of the Coase's solution may be outside the ambit of layman's requirements of understanding, but the moot issue is that property rights on environment, be it in the form of rights on our local rivers or ponds that is source of livelihood of many poor people, or the air we breathe and land we use, can provide solution to the environmental problems. In case of right of ownership on any property, law ensures that infringement on that right can invite punitive action against the violator. But the problem of environment is that it is a public property that is susceptible to the "*tragedy of commons*", which implies that common property resources like free public parks, toilets, free grazing land or our environment, are all vulnerable to overuse and misuse. Since common property resources do not belong to any particular party, it is overused, misused and vandalized by the masses, especially in nations where the level of civic sense and duty sense are awesomely lacking. It is of common experience in many parts of our country where we come across public walls mired in betel nut spit stains, open disposal of garbage in public ponds and fills and what not. Hence grant of property rights can prevent such occurrences and ensure optimum and sustainable use of these common property resources. For example, grant of property rights to the villagers on the section of the river that flows by the village, can facilitate them to ask the locally established paper company to either lower production to the extent of the damage to fishes in the river, or compensate to the extent of their economic losses due to extinction of certain species of fishes due to discharge of wastes into the river.

However, the phenomenon of *tragedy of commons* has not been restricted to the developing nations. Rather, the damage inflicted on environment by the western developed and industrial nations for the last 100 years or so has been of unsustainable magnitude. So, phenomenon like the Enhanced Green House Effect, a form of *tragedy of commons* are fall out of the constant release of, human activities (like exploration of oil and natural gas, production of medicines, other industrial products, etc.) induced green house gases into the environment that has caused serious problems like global warming. Water vapor, Carbon dioxide, Nitrous oxides and Methane are naturally occurring green house gases that help to retain a portion of the energy (heat) received from the sun in the form of short wave radiations, most of which is radiated back, thus helping the earth to keep itself sufficiently warm for sustenance of life on earth. But, human economic activities have resulted in production of additional green house gases and compounds like the CFC those enhance temperatures leading to the phenomenon of global warming. The developed nations are responsible for such an alarming situation where global temperatures over a period of last 100 years have risen by over 1 degree Fahrenheit.

In these contexts, studying the economic perspective of externality is made in this Study.

Oil and Negative Externalities

Incorporation of externalities in the cost structure of a producer whose production or service provision activities generates pollution in the form of an externality leads to derivation of the social cost of production. **Addition of externality to the private cost of production of producers cost structure is an Environmental Economics approach**. **Figure 1.1** is a graphical explanation[1] of the aforesaid relationship for OIL[2] that pollutes the environment.

[2] Coase, R. H. (1960), "The Problem of Social Cost", Journal of Law and Economics

[1] Jain, Deepak and Mukta Kumra (2001), "Market and Environment" as a part of the Joint Education Programme of Center for Preventive Environmental Management (CPEM), Nagpur

[2] Refer to the section on Theoretical Ideas in Chapter 1 for finding the relationship between operations of OIL and pollution

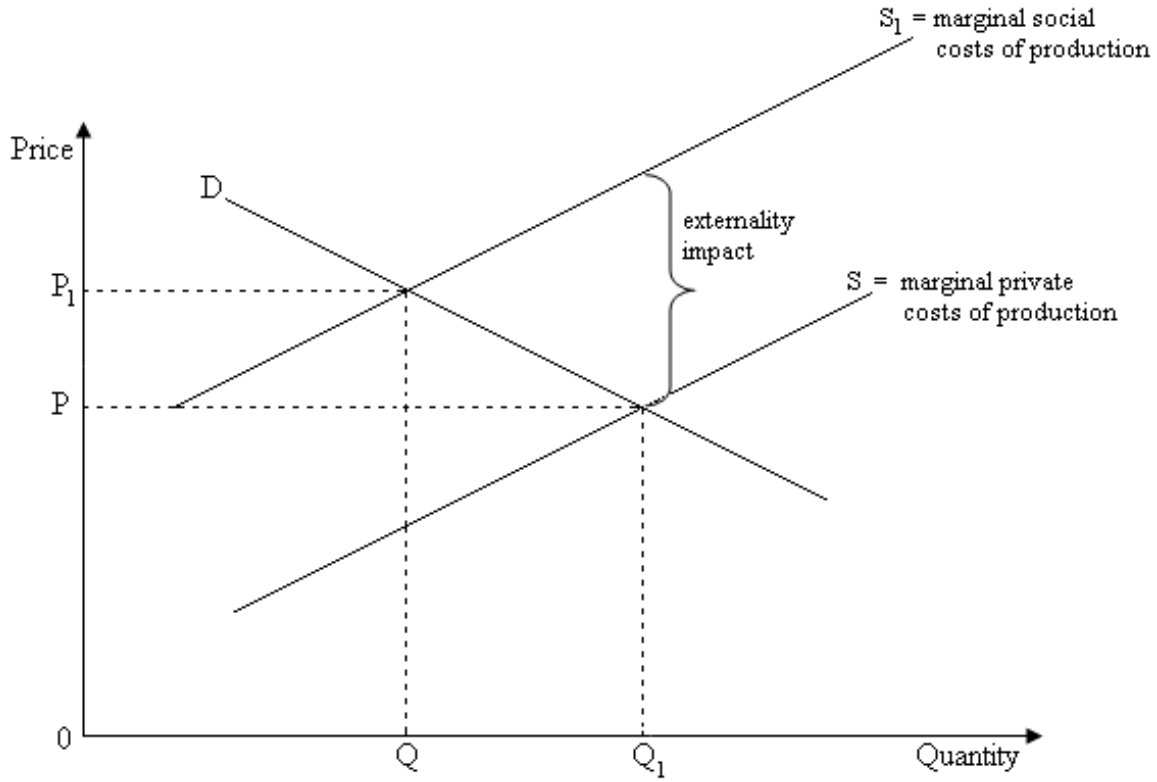

Figure 1.1: Pollution as an Externality
Derived from (Source): R. Kerry Turner [Pearce, D. W. and R. K. Turner (1990), "Economics of Naturament", Harvester Wheatsheaf and Hemel Hemstead]

In technical terms of Environmental Economics, pollution is treated as a negative externality. The technical definitions and relationships in the context of the operations of OIL are given below-

Marginal Private Cost (MPC) of production is the additional cost incurred by the OIL in producing an additional unit of output and includes only costs those accrue to only OIL and no other party bear partial or full burden of the same. MPC is derived from data on Total Private Cost (TPC) of production. TPC includes expenditure incurred on output of crude oil and natural gas that entails management, pollution control, staff, outsourcing of works from contractors, payment of taxes and duties, royalty, compensation to individuals or groups and others when adversely affected by the operations of OIL and all other financial liabilities. There are negative and adverse effects to other parties like people, land, water bodies, air, flora and fauna and others loving in and near the central complex of OIL at Duliajan, and the EPS and OCS. It is difficult to calculate the real cost of these adverse effects by collecting field data. Moreover, it is also not feasible to take up bio-chemical and physical study of the pollutants and then generating data on real costs in financial terms at the individual level and/or by researchers in Environmental Economics. Such studies are beyond the scope of Environmental Economics. Therefore, data on real costs of the negative externalities are generated by using exogenous scientific data[3]. Extraction of crude oil and natural gas, and flaring of natural gas produces Sulphur Oxides (SO_x), Nitrous Oxides (NO_x), Methane (CH_4) in abundant quantities. The adverse effects of these compounds have been elaborately dealt in Chapter 1 of this thesis[4]. In 1991 in the Minnesota state legislature of the United States of America (USA) enacted a law requiring the Public Utilities Commission (PUC) to establish Externality Values[5] for various pollutants and it was finally established in 1994. Accordingly, the Minnesota State Clean Air Act provides for imposition of *Contamination Fee*[6]and the details of the same are given in **Table 1.3** and **Table 1.4**.

Table 1.3: Contaminant Fees for Air Emission Permits or Approvals

Sl. No.	Contaminants	Fee Per Ton of
1	Ammonia	$ 11.30
2	Carbon Monoxide	$0.30
3	Chlorine & Chlorine Oxides	$7.60
4	Hydrocarbons	$11.30
5	Hydrogen Chloride	$7.60
6	Nitrogen Oxides	$7.60
7	Sulfur and Sulfur Oxides	$8.80
8	Total Particulate	$11.30
9	Other Contaminants	$11.30

Source: Jain, Deepak and Mukta Kumra (2001), "Market and Environment" as
a. Part of the Joint Education Programme of Center for Preventive Environmental Management (CPEM), Nagpur

[3] Bernerd, J. Nebel and Richard T. Wright, "Environmental Science", Prentice Hall Publications

[4] Section on "Theoretical Ideas" in Chapter 1
[5] EV refer to the calculated value in terms of potential damage to the environment (including the third party)
[6] Fee collected for potential contamination of the environment

Table 1.3: Contaminant Fees for Effluent Permits or Approvals

Sl. No.	Contaminant	Fee Per Ton Discharge
1	Ammonia	$69.30
2	Metals	$184.00
3	Oil & Grease	$46.20
4	Petroleum Products	$46.20
5	Suspended Solids	$9.20
6	Other Contaminants	$9.20

Source: Jain, Deepak and Mukta Kumra (2001), "Market and Environment" as a Part of the Joint Education Programme of Center for Preventive Environmental Management (CPEM), Nagpur

Besides the aforesaid Contaminant Fees based on EVs, this study has incorporated the two instances of taxes on externality and pollution causing compounds those are associated with extraction/production of crude oil and natural gas. They are-

- CARBON DI OXIDE (CO_2) TAX (DENMARK)
- NITROUS OXIDE (NO_X) TAX (SWEDEN)

Denmark introduced Carbon dioxide (CO_2) tax in 1992 for the emission of the same and is charged at different rates for different categories of tax-payers. Business houses are required to pay $ 14.30 per ton of CO_2 and households are required to pay $ 7.15 per ton of CO_2 discharged along with their production or activity. Nitrous Oxide (NO_X) tax was introduced in Sweden in 1991 at a rate of $2.18 per pound of discharge and was imposed on the NO_2 variety.

Table 1.4: Environmental Taxes

Country	CO_2 tax Rate per pound	NOx tax rate per pound
Denmark	$14.30	-
Sweden	-	$ 2.18

Source: Jain, Deepak and Mukta Kumra (2001), "Market and Environment" as a Part of the Joint Education Programme of Center for Preventive Environmental Management (CPEM), Nagpur

These taxes are part of what is known as green taxes[7] or Pigouvian taxes[8] and theoretically are considered to be superior to other forms of pollution control like setting of abatement standards or imposing fines and fees. A case for environmental or green (Pigouvian) taxes can be made *Vis a Vis* fixed standards set for control of pollution or negative externalities. Fixed standards of limiting pollution with provision of penalizing the violators of standards are widely implemented in the west. However, penalty levels below the optimal point of pollution (equilibrium point) tend to encourage firms/polluters to produce output beyond sustainable levels, till their Marginal Net Private Benefit (MNPB) is greater than the penalty (i.e., MNPB>Penalty). Imposition of an environmental tax, equivalent to the optimal point of pollution, acts as an incentive to cut output and hence the level of pollution associated with that output. Therefore, environmental externality arises when cost of transaction (to human beings in the form of environmental damage and subsequent adverse effects) is not incorporated as a part of the cost structure of the agency in question. Incorporation of the externality or external cost in the cost structure of the firm that pollutes the environment, the social cost of production is derived. The optimal level of externality or pollution is hence the point at which the external cost is added to the Marginal Private Cost (MPC) that gives the Marginal Social Cost (MSC) of Production. The optimal point of externality hence is the point at which the MSC cuts the Marginal Net Private Benefit (MNPB) curve. MNPB curve is the Marginal Revenue or Demand curve of the firm.

In Figure 3.3, Part 'A' shows derivation of the Marginal Cost (MC) curve in a perfectly competitive market. As shown in Part 'B' of this figure, subtraction of the MC curve from the Price leads to derivation of the Marginal Profit or Marginal Benefit curve for the producer at his/her individual level. The Marginal Benefit curve is alternatively referred to as Marginal Net Private Benefit (MNPB) curve in the literature of Environmental Economics.

In case of externalities pertaining to operations of OIL, the values for external cost was derived by using the data on the Minnesota State Clean Air Act provides for imposition of Contamination Fee[9]on Hydrocarbons. The given value is $11.30 per ton. As per the official records of the OIL, the annual discharge of hydrocarbons in the form of crude oil, including spillage and overflow, is approximately restricted and/or amounts to 0.5 percent of the total production. The calculations are as follows-

Rate of Contamination Fee Hydrocarbons/ton = $ 11.30
$ 1 = Rs.45.00 (Foreign Exchange Rate as per the average of the 2003-05 period)

These discharges, however, do not include the spillage or discharge caused by accidents, negligence and pilferage by anti-social elements, and acts of sabotage whose incidence has been very high during the recent years. The OIL's liability is restricted to discharges caused by their own negligence and resultant accidents caused by its own employees. But such incidents have been by and large negligible during the period of study. The liability of other discharges lies with the government and its security agencies responsible for maintaining law and order.

At point Q*, MNPB = MEC
P = MC + MEC as MNPB = P-MC (MC is Marginal Cost of producing the polluting product) and P MC = MEC

The externalities produced by the producers can be further analyzed as-

1) Optimal Level of Externality
2) Optimal level of Economic Activity
3) Level of Economic Activity generating Maximum Private Benefits (for the Producer)

[7] Pearce, D. W. and R. K. Turner (1990), "Economics of Naturament", Harvester
Wheatsheaf and Hemel Hemstead
[8] Pigou, A. C., "The Economics of Welfare", Macmillan, London
[9] Fee collected for potential contamination of the environment

The Marginal Social Cost (MSC) of production is the sum of marginal costs of the economic activity, like extraction of oil and natural gas and is given in the form of sum of Marginal Private Cost (MPC) and Marginal External Cost (MEC).
Therefore, P = MSC and optimal level of pollution is achieved when, MNPB = MEC and P = MSC

This condition is also called Pareto-Optimal Condition[10] that is defined as a situation when no one can be made better off without making someone worse off. In the context of operations of OIL while producing/extracting crude oil and natural gas, the aforesaid condition is Pareto-Optimal in the sense that pollution cannot be further increased without forcing the OIL to incur losses or decreasing pollution to levels that is considered to be lower than the socially (optimally) desirable.

The figures and tables have been referred to in context of the operations of OIL in the process of extracting/ raising/ producing crude oil and natural gas.

In this chapter, the following secondary data and information on the following variables were collected in order to find and assign an approximate value to the negative externalities produced by OIL during its operations-

1) Production levels of crude oil and natural gas
2) Raising cost of crude oil and natural gas
3) Approximate discharge of crude oil as sludge
4) Approximate magnitude of flaring of natural gas
5) Green tax rates at international level
6) Contaminant fees at international level

2. Conclusion

Extractive industries, those are basically fossil fuel industries like oil and coal are the major contributors to the greenhouse gases, especially Carbon di oxide that enhances the global warming and creates hosts of environmental problems. If the theories of environmental externalities are applied in research of such industries, the private production costs and social costs can be calculated and the pollution created can be quantified for reflecting the burden to the society in quantifiable terms.

[10] Koutsoyiannis A, (1987), "Modern Microeconomics" ELBS, London.