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Environmental Subsidies in India: Role and Reforms

D.K. Srivastava, Rita Pandey and C. Bhujanga Rao

With inputs from
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MSE
Mentoring Excellence

MADRAS SCHOOL OF ECONOMICS
Gandhi Mandapam Road
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Technical Paper 4 of the project
"Integrating Pollution-abating Economic Instruments in Goods and Services Tax (GST) Regime"

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India

Phone: 2230 0304/ 2230 0307/2235 2157
Fax : 2235 4847 /2235 2155
Email : info@mse.ac.in
Website: www.mse.ac.in

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D. K. Srivastava
Rita Pandey
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Executive Summary

Fiscal intervention for promoting environment will be most effective if environmental taxation is complemented by environmental subsidies. In India, the design of fiscal instruments for environmental management has additional considerations arising because of the federal arrangements. Combinations of taxation and national subsidies can suit handling different types of environmental quality considerations in a federal context.

Subsidies in India require considerable restructuring to play an effective positive role in promoting environment. Quite a number of subsidies in the present regime can be considered as environmentally perverse. These will have to be modified and replaced by environment promoting subsidies. Restructuring of subsidies can provide source for financing environment-promoting subsidies. In particular, resources can be released from environmentally perverse subsidies and these resources can then be allocated towards correcting the environmental damage. It has been estimated that the share of environmentally perverse subsidies in India is quite large and that considerable resources can be released by discontinuing these subsidies and using these resources for environment promoting subsidies.

Given competing claims on budgetary resources, it is often that adequate priority to environment promotion is not accorded. Given that in the current discussions on Goods and Services Tax (GST) all cesses and surcharges are likely to be abolished, it may have adverse effects on the environment. In this context, some have argued in favour of a non-rebatable excise or cess over and above the core GST rate particularly in the taxation of petroleum and other major polluting goods and services. The revenue from this additional non-rebatable rate can be earmarked for use for environmental purposes only. Here also, an excise may be preferable over a cess since the cess will be sector specific but the overall revenue from the non-rebatable excise can be earmarked for reducing pollution and promoting environment considering all sectors together. These revenues can be used for environment promoting subsidies.

Although a large volume of resources can be released by converting the environmentally harmful subsidies into environment promoting subsidies and further supplemented by revenues from earmarked eco-taxes, their impact can be maximized by suitably targeting the most polluting industries. In the Indian context, the main industries that can be supported for encouraging innovations and substitution of cleaner inputs can be listed as energy, particularly thermal energy, iron and steel, motor vehicles, paper, textiles, and plastics.

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Chapter 1

SUBSIDIES: MEANING AND MEASUREMENT

Subsidies and indirect taxes are both indirect fiscal instruments aimed at modifying market-determined outcomes. In both cases, relative prices of the subsidized / taxed goods are affected relative to others. In the case of subsidized goods the relative price is lowered, while for the taxed good, it is raised. Taxes reduce disposable income while subsidies inject money into circulation. Subsidies cater to positive externalities while taxes take care of negative externalities. Subsidies can promote environment-promoting technologies and use of environment friendly inputs.

1.1 Defining a Subsidy

Defining subsidy has not been an easy task and more so defining environmental subsidies, which can both be environment-promoting or environmentally harmful. As OECD (2006) notes, there is no universally accepted definition of a subsidy. There are several definitions and one may use a definition of subsidy that is most relevant for the analytical purpose at hand. The literature on subsidy has recognized that the definition of a subsidy is a useful part of the framework for a policy discussion and that the term subsidy should be differently defined for different contexts[1]. Barg (1996) proposed three different definitions of subsidies for economic, fiscal, and environmental issues as follows:

Economic Definition

A government-directed, market-distorting intervention which decreases the cost of producing a specific good or service, or increases the price which may be charged for it.

Fiscal Definition

Government expenditure, provision for exemption from general taxation, or assumption of liability which decreases the cost of producing a specific good or service, or which increases the price which may be charged for it.

[1]For instance the total volume of the budgetary subsidy will be of particular interest to those wanting to assess the drain on the public money; the resource use perspective will consider subsidies looking at whether the price reflects the true resource price (shadow price) of the good; implicit subsidies relating to not paying for environmental impacts may concern not only the local people and the local governments, but also the neighboring jurisdictions/countries and the society at large depending upon the nature of environmental impact.

Environmental Definition
An environmental subsidy consists of the value of uncompensated environmental damage arising from any flow of goods or services.

Environmental subsidies have been defined in the broadest way, incorporating any flow of benefits that arise from reduction of environmental degradation, even if they are not government-directed, and do not pass through a market mechanism, and reflect indirect costs. For example, harvesting a forest without reforesting, or without recognizing non-timber values, involves an unpaid cost. This amounts to subsidization of these harvesters, to the extent of the unpaid cost, by the user of the environment, i.e., the society. However, even this definition does not fully address the potential irreversible harm to an ecological system for which there may be no substitute.

In studies dealing with budgetary subsidies, subsidies have often been defined as unrecovered costs of public provision of private goods (Mundle and Rao, 1991; Srivastava *et. al.*, 1997). In the environmental definition of subsidies given by Barg (1996) also subsidies are taken as unrecovered costs. The concept of cost however is broader than the one usually applied in the budgetary studies. In environmental context, the cost to the society arises from uncompensated damage to the environment commonly shared by all members of the society by activities producing private goods (even if sometimes provided by the public authorities). These uncompensated losses may arise both when the concerned private goods are subsidized and when they are not subsidized. When a budgetary subsidy is used to encourage the production/use of such a good (for example, fertilizer) there are two types of unrecovered costs: those that constitute the difference between the cost of provision of the good and the receipts from the users, and those that amount to the value of the damage to the environment because of the use of the good, which needs to be paid by its users to the society for the damage to the environment. The two unrecovered costs are both subsidies, and can be added up. However, the latter involves crucial issues of identification and quantification of such costs.

In practice, the issue of un-internalized externalities is treated differently across different sectors. For example, in the transport sector the generally accepted definition of subsidy includes the failure to internalize the marginal social cost of transport (OECD, 2005). In the water sector, the failure to include the full cost of water is considered to be a subsidy (OECD, 2005). In contrast, in the energy sector the most commonly used definition considers a subsidy to be any government action that lowers the cost of energy production, raises the price received by energy producers, or lowers the price paid by energy consumers (IEA, 1999; OECD, 2005; UNEP, 2008). Environmental externalities are not considered to be a subsidy in these definitions.

While a broad definition including both full cost pricing of resources and externalities is operationally difficult, it is important to recognize that such implicit subsidies exist and can be quite significant in all sectors with serious implications for the livelihood and health of citizens.

1.2 Measuring Subsidies: Alternative Approaches

a. Explicit Budgetary Subsidies

It is commonly recognised that entries in the budget under the head 'subsidies' would give a very incomplete picture of subsidies. An alternative approach is used in the national income accounting framework. Another possibility is to define subsidies as unrecovered budgetary costs. Explicit subsidies provide only a limited idea of the overall volume of budgetary subsidies in the system. Since observed or explicit subsidies cover only a fraction of total subsidies, methodologies have been developed to estimate the implicit subsidies in the system as unrecovered costs of public provision of goods/services that are not classified as public goods. In these cases, it should be possible to recover, at least in principle, the cost of providing services according to the extent of their consumption.

b. National Income Accounting Approach

In national income accounts (NIA), indirect taxes net of subsidies constitute the difference between gross domestic product (GDP) at factor cost and GDP at market prices. Indirect taxes that are part of the sale price of commodities do not create incomes for factors of production. These are, therefore, deducted from GDP at market prices to get at GDP at factor cost. On the other hand, subsidies have the reverse effect. A subsidy received by a firm will be paid out as wages, rents or profits, and would therefore, become incomes of the factors of production. However, this component of their income is not generated by the sale of output. Hence, subsidies must be added to expenditure, i.e., GDP at market prices.

In India, the Central Statistical Organization's NIA methodology, subsidies include grants on current account which private industries, public corporations and government enterprises receive from the government. These may be in the form of direct payments or those estimated on the basis of differentials between buying and selling prices of government trading organizations. The NIA approach focuses only on firms/producers or government departments. It does not fully cover all the budgetary costs in the public provision of non-public goods.

c. Budgetary Subsidies: Subsidies as Unrecovered Costs

Under this approach subsidies are measured as "unrecovered" costs of governmental provision of goods/services that are not classified as public goods. The unrecovered costs are measured as the excess of aggregate costs over receipts from the concerned budgetary head. The aggregate costs comprise two elements: (i) current costs and (ii) annualised capital costs. Current costs consist of revenue (current) expenditures directly related to the provision of services classified under different heads. Transfers to funds are not included, as these do not contribute to the provision of service in the current cost. Transfers from funds are included. Transfers to individuals are also separated out, as these add to incomes of individuals and do not constitute provision of goods/services. For capital costs, a distinction is made between three forms of government investment resulting in accumulated capital stock. If services are departmentally provided, there is investment in physical capital. In addition, there is investment in the form of equity and loans including those given to public enterprises. The annualised cost of capital is obtained by applying the interest rate at which funds have been borrowed by the government to capital stock. This represents the opportunity cost of capital. In the case of physical capital, a depreciation cost is calculated, in addition. The receipts come in three forms: revenue receipts from the user charges, interest receipts on loans, and dividends on equity investment.

In terms of symbols, these costs may be written as:

$$C = RX + (i + d^*) K_o + iZ_o$$

where

RX = revenue expenditure on the service head net of adjustments

i = effective interest rate

d^* = depreciation rate

K_o = aggregate capital expenditure at the beginning of the period

Z_o = sum of loans and equity investment at the beginning of the period

Adjustments in deriving RX relate to transfer to funds which are deducted and transfer from funds which are added. Transfers to individuals are also not counted, although these are separately compiled. Expenditure on running secretariat social and economic services are also not counted as these relate to general administration, and are also not decomposable among different heads of services.

Receipts are:

$R \ = RR + (I + D)$

Where:

RR = revenue receipts

I = interest receipts

D = dividends

Subsidy is defined as: $S = C – R$.

Other parameters are effective interest rate and depreciation rate. In Chapter 5 while estimating the budgetary costs of environmentally perverse subsidies at the centre and select state level, the effective interest rate is obtained by dividing the interest payment by outstanding debt at the beginning of the concerned year.

The depreciation rate is to be calculated with reference to the stock of capital at the beginning of the year. This stock of capital is the sum of nominal investments in previous years. Since these are additions of nominal figures, all at different prices, the calculation of depreciation rate has to take this into account. The methodology used for this purpose in the context of results reported is explained in Appendix A.

1.3 Environmentally Harmful and Environment Promoting Subsidies

In the context of environment, subsidies are often interpreted as opportunity costs which arise due to negative environmental externalities. For example, car drivers pollute the atmosphere for all citizens and gain a benefit at everyone's expense implying that common citizens subsidize the car owners. Similarly, when farmers spray pesticides, they introduce toxic effluents into the commonly shared ecosystems. Industrialists often introduce pollutants into commonly shared water bodies. Although, this kind of subsidization is widespread, it almost goes unnoticed. The conventional GNP accounting generally presents such activities as economic pluses, whereas there is a case to consider these as making a negative contribution to output. When soil erosion causes farmers to apply extra fertilizer to compensate for loss of plant nutrients, this is viewed as an economic activity to be recorded as an additional item for GNP—while the costs to society are not taken into account. Barg (1996) gives these examples to illustrate the point. The Exxon oil spill caused clean-up efforts costing $3 billion; the GNP arithmetic counted them as an advance for GNP. When Kobe city was hit by an earthquake, only the rebuilding activities entered into the GNP which showed the country's economy had actually come out ahead. Thus, the environmental costs of these episodes went completely unaccounted.

Environmental degradation may result from both market failures and policy failures. Policy instruments for containing environmental degradation within acceptable thresholds have mainly focused on market failures. However, when economic policy leads to the use of such fiscal instruments as subsidies which themselves become a cause of environmental degradation, these may be cited as instances of policy failures. Several examples of the environmentally harmful subsidies which are introduced as part of a conscious economic policy may be cited. For example, subsidization of agriculture through subsidization of water or fertilizer or support prices can foster over-loading of croplands, leading to erosion and compaction of top soil, pollution from synthetic fertilizers and pesticides, and de-nitrification of soils. Subsidies for road transportation can engender atmospheric pollution. Subsidies for water encourage misuse and overuse of this scarce resource.

Some examples of environmentally beneficial subsidies are afforestation programs, subsidies to promote renewable energy, cleaner fuels, energy efficiency, wasteland development, and soil and water conservation.

Thus, in the context of environment, subsidies can be divided into two groups: environment-promoting subsidies and environmentally harmful subsidies. It is quite likely that the volume of environment promoting subsidies is small, and its impact is limited. On the other hand, the volume of the environmentally detrimental subsidies is large, although its environment degrading impact remains unrecognized, unmeasured, and unmonitored.

Subsidies that encourage human action causing damage to the environment are harmful because they create incentives to behave in ways which decrease social welfare. In order to analyze such situations, one must first examine the environmental problems that arise from the human activity that is encouraged by these subsidies. Thus, one must come at the problem from both directions: define the subsidy and how it affects the human behavior, and define the environmental situation and how it is affected by the subsidy induced behavior. Panayotou's list of Economic manifestations of Environmental Degradation is a useful starting point for analyzing such situations. This is presented in Box 1.

Currently there is no commonly agreed definition of environmentally harmful subsidy. Even the OECD studies offer a generic definition due to several issues such as the relevant reference level that would constitute an acceptable level of environmental damage along with associated property rights and the fact that environmentally harmful subsidy varies over time and place. Thus, determining the environmental impact of a subsidy can only be done on a case by case basis.

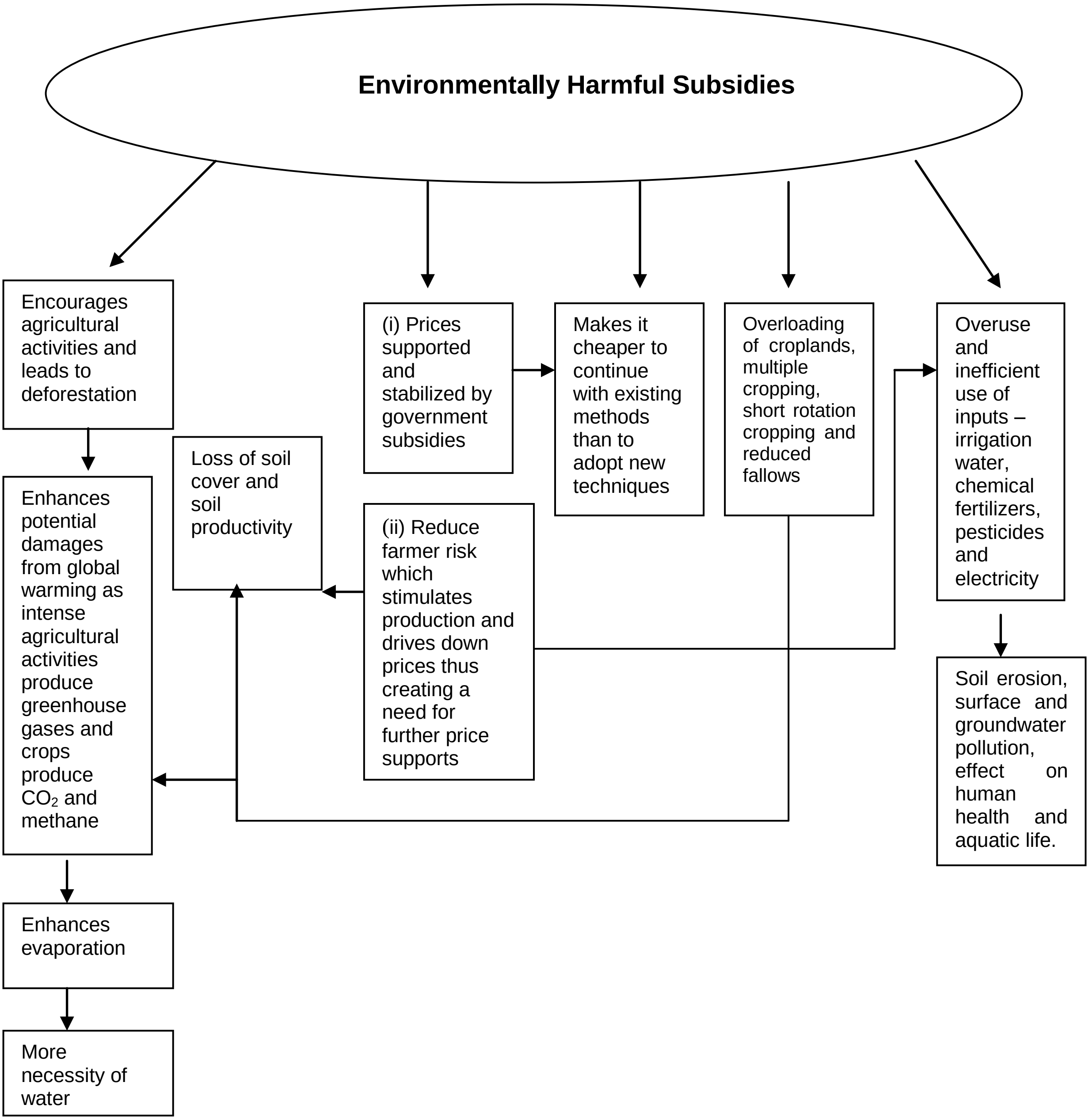
As long as subsidies nurture hidden costs in the form of environmental damage, they may be considered as harmful/perverse subsidies. Box 2 illustrates broadly the ways in which ill-targeted subsidies in agriculture could be harmful.

BOX 1: REPRESENTATIVE LIST OF ECONOMIC MANIFESTATIONS OF ENVIRONMENTAL DEGRADATION

- Overuse, waste and inefficiency co-exist with growing resource scarcity (shortages).
- An increasingly scarce resource is put to inferior, low-return, and unsustainable uses, even though superior, high-return and sustainable uses exist.
- A renewable resource, capable of sustainable management is exploited as an extractive resource (i.e. it is mined).
- A resource is put to a single use, when multiple uses would generate larger net benefits.
- Investments in the protection and enhancement of the resource base are not undertaken, even though they would generate a positive net present value by increasing productivity and enhancing sustainability.
- A larger amount of effort and cost is incurred, when a smaller amount of effort and cost would have generated a higher level of output, more profit and less damage to the resource.
- Local communities and tribal and other groups, such as women, are displaced and deprived of their customary rights of access to resources, regardless of the fact that, because of their specialized knowledge, tradition and self-interest, they may be the most cost-effective managers of those resources.
- Public projects are undertaken that do not make adequate provision for, or generate sufficient benefits to, compensate all those affected (including the environment) to a level where they are decidedly better off "with" than "without" the project.
- Failure to recycle resources and by-products, when recycling would generate both economic and environmental benefits.
- Unique sites and habitats are lost and animal and plant species go extinct without compelling economic reasons which counter the value of uniqueness and diversity and the cost of irreversible loss.

Source: Panayotou (1992).

Box 2:
EFFECTS OF ILL-TARGETED SUBSIDIES IN AGRICULTURE



Environmentally Harmful Subsidies: Growing International Concern

In recent years, the phenomenon of environmentally harmful subsidies has been recognized in the literature, and there is also a widespread international concern about environmentally harmful subsidies. This is both because of their huge monetary costs and the cross-country effects. For instance, subsidies for fossil fuels contribute to pollution effects such as acid rain, urban smog and global warming. These also have cross-border effects.

It has been estimated (Myers and Kent, 2001) that perverse subsidies in the world may amount to as much as $1.5 trillion, which is larger than the economies of all but five countries in the world (using purchasing power parity for the GNPs of China and India). Ironically the total of almost $1.5 trillion is two and a half times larger than the Rio Earth Summit's budget for sustainable development—a sum that governments dismissed as unthinkable. The main findings of Myers and Kent indicates that: (i) total subsidies in the world may be around $1,900 billion per year, and perverse subsidies may be as large as $1,450 billion; (ii) perverse subsidies have the capacity to (a) exert a highly distortive impact on the global economy of $28 trillion, and (b) inflict grand scale injuries on our environment. It is also noted that the OECD countries account for two thirds of all subsidies and an even larger share of perverse subsidies; that the United States accounts for 21 percent of perverse subsidies; and that the single sector of road transportation accounts for 48 percent of all subsidies and 44 percent of perverse subsidies.

While the two totals - overall subsidies of almost $1.9 trillion per year, and perverse subsidies, approaching $1.5 trillion per year may appear to be large, these might still be underestimates. Myers and Kent (2001) observe that many environmental externalities (including what could prove to be as big as the rest put together, *viz*., global warming) are either underestimated or omitted from the final results through sheer lack of documentation of economic costs entailed. Thus, the total for perverse subsidies, approaching $1.5 trillion per year, should be considered as an underestimate.

Beers and Moor (2001) estimate world subsidies for a few identified sectors. Estimates presented in Table 1.1 reveal the alarming levels of subsidy in OECD countries.

Table 1.1: Estimates of World Subsidies 1994-98

(USD billion)

Sector	OECD	Non-OECD	World	OECD as % of world
Agriculture	335	65	400	84
Water	15	45	60	25
Forestry	5	30	35	4
Fisheries	10	10	20	50
Mining	25	5	30	83
Energy	80	160	240	33
Road transport	20	25	225	89
Manufacturing	55	Negligible	55	100
Total	**725**	**340**	**1065**	**68**
Total as % of GDP	**3.4**	**6.3**	**4.0**	

Source: van Beers and S. de Moor (2001).

It can be seen from the above table that as a percentage of world GDP, global subsidies account for a staggering 4 percent. However, in terms of the magnitude in US dollars, OECD countries account of over two thirds of the total subsidies. The environmental implications of the subsidies in these sectors are potentially substantial.

Table 1.2: Some Environmental Effects of Subsidies or Subsidy Removal

Study/Country	Nature of Scenario	Environmental Impacts
Cristofaro *et. al*. 1995, USA	Removal of USD 8.5 billion Energy subsidies Removal of USD 15.4 billion Energy subsidies	- 10 mtC by 2010 - 37 mtC by 2035 - 64 mtC by 2010
Gurich *et. al*. 1995, Russia	Removal of energy Subsidy effects in 2010	76% reduction in TSP 39% reduction in CO_2 43% reduction in NO_x 66% reduction in SO_x
IEA, 1999	Removal of consumer subsidies in Russia, China and 6 other countries	16% reduction in CO_2
Larsen and Shah, 1992	Removal of world energy subsidies of USD 230 billion	21% reduction in CO_2
DRI in Michaelis, 1996	Removal of coal subsidies in Europe and Japan	- 10 to 50 mt. CO_2

Source: Compiled by the authors.

Results of studies presented in Table 1.2 cannot be strictly compared as different definitions and methodologies have been used in these studies. Yet, estimates of environmental impacts of subsidies are significant enough to say that the debate should move away from trying to build consensus on definition and analytical issues to another level to help governments develop a strategy for reduction in environmentally harmful subsidies.

Subsidies and Natural Capital

As we have already mentioned, many subsidies directly or indirectly contribute to the depletion of natural capital. Examples abound: water logging and salinization from subsidized irrigation water; excessive air pollution and greenhouse gas emission transport fuel and stationary energy subsidization; deforestation from subsidies to forest clearance and logging; overfishing due to subsidization of the fishing fleet. However, actual quantification of the loss is difficult. In Table 1.2 some estimates that focus on greenhouse gas emissions and air pollution are presented. These estimates, however, needs to be treated with caution. The loss of human capital cannot be blamed solely on subsidies.

Social Capital and Subsidies

The social capital dimension of sustainable development is one of the unexplored areas of research. Social capital relates to sets of interpersonal and inter-institutional relationships in society. The better are these relationships, the lower is the transaction costs of economic exchange and better the chances of sustained development.

There may be many links between social capital, the implicit trust in human relationship and subsidies. For example, subsidies generate rents and encourage rent-seeking activities. Rent seeking involves lobbying and, ultimately leads to corruption and bribes. Thus the trust in government institutions are reduced, thereby lowering the stock of social capital. The cost is multidimensional: overall economic efficiency gets lowered (under directly unproductive profit seeking activities) and the poor, who cannot pay bribes to secure the subsidy, are excluded from the benefit of it.

Losing social capital also means losing the concern for fellow human beings. Societies that tend to be more selfish also tend to be less caring of the natural environment.

Subsidies and Technology

A final component of the subsidy-sustainability link is via technology. Subsidies can induce environmentally friendly technology (e.g. subsidies in renewable energy sector). But many subsidies provide 'lock in' effects to prevailing technologies, inhibiting the advance of new, cleaner technologies. For example, subsidies are often specified by fuel source or technology, e.g. subsidies to coal sector in UK and Germany. These subsidies block the transition to renewable and low-pollution sources of energy. Nor is there any incentive to develop technologies that lower the pollution content of the fuels.

The ways in which subsidies produce environmental damage are far more complex than the first appearance. To wit, to account for the direct impacts on natural capital are not sufficient. It is also important to understand the links between subsidies, technological change and human and social capital formation. Second, it is necessary to emphasize the role of subsidy in fostering the poverty and inequality, especially in the developing countries that are disadvantaged by the protectionist policies in rich countries.

Chapter 2

CASE FOR ENVIRONMENT PROMOTING SUBSIDIES

2.1 Introduction

For promoting environment, among the market-based instruments both taxation and subsidies for goods and services have significance and serve as complementary instruments. In fact, tax revenues from environmental taxes can be used finance environment promoting subsidies. However using environmental subsidies requires suitable design of subsidies, which can differ from context to context. The idea is to induce the households or firms to find the cheapest possible way to reduce pollution. Such reduction can come through the three R's (reduce, reuse recycle) as well as through greener technologies (newer machines, labor intensive production etc.) or inputs (bio fuels). In all cases, the idea is to develop a set of Pigouvian intervention for social welfare maximization through correction of externalities.

2.2 Combining Environmental Taxation and Subsidy

In administering environmental taxation as well as subsidies, it is important to recognize that it applies to the polluting activity rather than any market transaction. But polluting activities (say, SO_x generation) are hard to monitor (the firm or the consumer have incentive to under-report). This makes both determination and enforcement of taxation as well as subsidies difficult. In order to overcome the problem, Fullerton and Wolverton (1995) have suggested a two part- subsidy. They suggest an instrument that mimics the Pigouvian intervention (generating efficiency) consisting of a tax on the output/consumption of the good, and combining it with a subsidy to other inputs except waste.

To see the logic of the argument, one needs to think the pollution or waste generation as an input to production process. Mathematically, one may express the output as $Q = F(K, L)$ and waste generation as $W = \phi(K, L)$. It is possible then to express Q as a function of W, such as $Q = \Phi(K, L, W)$. Here, K and L are capital/labor and other material inputs.

Pigouvian taxes correct for externality in two different ways: the 'output effect' discourages production and hence consumption of polluting goods. On the other hand, the substitution effect makes pollution (as an input to production) more expensive relative to other inputs. The implied 'substitution effect' reduces waste generation per unit of the remaining amount of the output that still gets produced. A two part instrument, consisting of a tax as well as a subsidy accomplishes the same effects separately. The tax on polluting output reduces production and consumption of the good. The second part that subsidizes all non-waste inputs makes waste relatively more expensive and reduces waste per unit of output.

An example of a two part instrument is a deposit refund system: the consumer pays a deposit (when she buys a bottle of milk or a can of soft drinks) under the presumption that the waste will be discarded improperly and gets a refund only with proper performance. The deposit equals the refund.

Let there be n identical households in the economy. Each of them possesses 1 unit of resource. In exchange to the resource, they buy (from market) a brown consumption good b, a green consumption good g and produce a household consumption good h. Individual resource constraint is b + g + h =1. Utility function of the consumer is given by $u = \sqrt{b} + \sqrt{g} + \sqrt{h} - \sqrt{B},$ where B=nb is the total amount of brown goods available to the society. The first order conditions for a social planner are:

$$\frac{1}{2\sqrt{g}} = \lambda$$

$$\frac{1}{2\sqrt{b}} - \frac{n}{2\sqrt{B}} = \lambda$$

$$\frac{1}{2\sqrt{h}} = \lambda$$

Here, λ is the social marginal value of the resource. These conditions simply state that, the marginal utility from an additional unit of b, g and h equals the social marginal cost, λ. In a decentralized framework, now let there be taxes on consumption of green goods t_g, on brown goods t_b and let I be the tax on per unit of resources sold in the market. The budget constraint then reduces to (1-h) (1-I) = b (1+ t_b) + g(1+ t_g). The first order conditions are

$$\frac{1}{2\sqrt{g}} = \gamma(1 + t_g)$$

$$\frac{1}{2\sqrt{b}} = \gamma(1 + t_b)$$

$$\frac{1}{2\sqrt{h}} = \gamma(1 - t_r)$$

Here, a consumer takes D as given and γ is the private marginal value of the income. Comparing the two systems of equations, if I= t_g =0, such that γ = λ, the optimal tax on brown good is $t_b = \frac{n}{2\gamma\sqrt{B}}$. Thus the tax on brown goods is total social disutility converted into $ values through division by marginal utility of income.

However, if a tax on the brown good cannot be levied as such (t_b = 0), one can still mimic the first best outcome by judicious use of I and t_g. To see this result, notice that, at the social optimum, $\lambda = \gamma(1-t_r) = \gamma(1+t_g)$. Thus, one can write I = -t_g. Using $\frac{1}{2\sqrt{b}} = \gamma$, one can write I= $\frac{n}{2\gamma\sqrt{B}} > 0$, which is a positive tax on purchasing power, and t_g =-I is the rebate on all green consumption goods. A point to note is that the tax-subsidy scheme need not mimic the deposit refund system, since the tax applies to resource (capital/labor) income and the subsidy is on entirely different commodity. Thus the tax can be part of income tax collected by the government, while a separate subsidy applies to g. The subsidy may also appear as a sales tax that is lower on g than on all other goods.

It is possible to extend the model to production, where direct taxes on emission are not possible to levy. By proper choice of (sales) tax on the *consumption of* brown good and a subsidy on usage of clean inputs in *production*, one can achieve the social optimum.

Given this equivalence between Pigouvian taxation and a two part instrument, one needs to take into account other considerations like feasibility, administrative costs, political perception and enforcement for deciding the appropriate instrument..

A Pigouvian tax on brown inputs or emissions may not be feasible, either because emissions cannot be measured or the tax is not enforceable. If Pigouvian tax is not viable, the equivalent two part instrument has an obvious advantage.

Even if the Pigouvian tax is viable, the two part instrument may have lower cost of administration. The Pigouvian tax requires the government to collect data on emissions of the polluter. In contrast, the two part instrument places the data requirements on the polluters. The individual consumer or firm is required to provide the proof proper disposal has taken place in order to obtain the subsidy. The cost of the "proof" must be lower for the firm and the consumer than for a government official who has less knowledge of the production and disposal process. The government only needs to set the deposit and the refund, and to check for the authenticity of a returned item or clean input.

In order to enforce Pigouvian tax, the government must try to prevent illegal dumping by properly setting the rate of taxation, the rate of audit or inspection and the rate of penalty. Usually government auditing is infrequent and poorly performed, and thus does not act as sufficient inducement for accurate paperwork. In itself, the Pigouvian tax provides an incentive to hide taxable emissions. In contrast, the two part instrument provides incentives to reveal data in order to qualify for the subsidy, and so it can discourage dumping the socially desirable level without any additional legal sanctions.

The two part instrument is based on two market transactions, duly recorded in the invoice of two parties, which is difficult to fabricate. In contrast, the single Pigouvian tax on emissions or any less desired type of disposal does not apply to a market transaction. The firm can make up its own records involving emissions, and it can dump illegally without records at all. No other party verifies the transaction.

Politically, Pigouvian tax may not be a popular action if it raises taxes on consumers or firms. A deposit refund system may be more popular with the voters. If those who properly dispose of an item can receive a refund on the tax originally paid, then these taxes increase for those who refuse to participate.

A second reason for the political appeal, at least in the case of deposit-refund system, that it could be self-financing: the refund can be taken directly from the funds generated by deposits. Even if the two part instrument is not strictly a deposit-refund case (funds from tax not to be used for the subsidy), this would generate flexibility in the use of funds.

The other advantages of a two part instrument (or, more specifically, the deposit refund system) include job creation due to an increased demand for truck drivers, sorters and recyclers; and energy savings from the use of recycled rather than virgin materials.

The evidence for a two part tariff comes mainly from US, where bottle-bills and other forms of deposit refund system are practiced extensively. The actual evidence of the states with bottle bills include (a) higher return rate of bottles, (b) lower solid waste generation, (c) reduction in injuries to children due to less littering, (d) higher quality of inputs to be recycled.

The evidence of other benefits seems to be mixed. For example, it is true that some jobs have been created mainly in retailing, transportation and recycling, but there could be a job loss in non-refillable industries. Taking another case, reduction in virgin material in glass production implies reduction in air pollution, water pollution and mining waste generation. On the other hand, fuel bill for transportation of re-usable materials may go up because reusable bottles (and other consumer goods) are bulkier than regular, 'use-and-throw' bottles.

Typical deposit-refund systems are also present in most of the OECD countries (other than US), and these include aluminum cans, beverage containers and car hulks. In literature, one can find other examples of deposit-refund system. Fischer *et. al.* (1995), for example, has proposed a deposit refund system for carbon removal from atmosphere. Here, citizens of each country would pay the proposed tax when they purchase a product manufactured using a polluting process. The subsidy, in the form of a credit to the country's emission quota, is given when a country demonstrates certified carbon removal. In the same vein, a tax and a subsidy is coupled to remove the CFCs from refrigerators and air conditioners (*ibid*). Bohm (1981) has proposed a deposit refund system for removal of SO_x. A deposit would be required on fuel, based on the sulfur content, and refund would be paid to firms when the sulfur is removed from the air.

The authors then provide an example of a two part instrument that does not link deposits and refund, and virtually *all* governments implicitly provide such a two part tax-subsidy combination. For example, a sales tax is collected on purchase of all items (reducing consumption), while the (free) garbage removal service is a subsidized activity provided by the municipal authorities. An alternate Pigouvian solution would have been a tax on garbage bags, but that would create the problem of midnight dumping in the streets.

In the absence of no transaction cost, perfect information, no pre-existing distortion, perfect competition and a closed economy, the two part instrument has some advantages over Pigouvian taxation. The advantages are in enforcement, enactment and in achieving the social optimum. However, if some of these conditions are relaxed, the advantages also become somewhat vague.

For example, there exist transaction costs incurred by the firm that accepts reusable parts. These transaction costs include the promised refund as well as storage and transportation costs. With a number of small transactions, the refund process can actually be costly and there may exist other ways to reach the same goal with lower cost.

In the presence of imperfect information (regarding the true social costs and benefits), the *deposit refund rates* may not be the ideal ones. If the refund is too low, one may encounter no cleaning up at all, if it is too high, recycling will be sub optimally high. The failure to determine these rates efficiently seems to be the root cause of failure of the system in many countries (e.g. Korea). These problems are also associated with Pigouvian taxation.

In a world of pre-existing taxes, further usage of a tax-subsidy scheme will increase the distortion, already present. Here again, the same problem does arise for a Pigouvian tax.

In case of an open economy, the efficacy of a deposit-refund system can be undermined if the deposits are paid on goods before export, but the subsequent recycling is not imported back to reclaim the deposit. Conversely, if the foreign firm pays the deposit on goods shipped to the domestic country and is then responsible for receiving and recycling its own goods, the extra transportation and transaction cost may act as a non-tariff barrier and the domestic firm will have an advantage over the foreign firm. A possible way out is an arrangement with a domestic firm for the collection, storage and collection of its disposed products.

In case of imperfect information, the jury is still out. In case of monopoly, the two part instrument is still equivalent to a emission tax. However, nothing specific can be said about oligopoly.

Chapter 3

ENVIRONMENTAL SUBSIDIES: SELECTED INTERNATIONAL EXPERIENCE

In this chapter, we review the experience of selected countries that have used environmental subsidies. We look specifically at the experience of Sweden, Germany and China.

3. 1 Environmental Subsidies in Sweden

In Sweden, environmental subsidies have been extensively used. For this purpose, it is useful to widen the definition of subsidies as given by the European System of Accounts 1995, which is as follows "…*current unrequited payments from government to producers with the objective of influencing their levels of production, their prices or the remuneration of the factors of production*" (European Commission, 1996). This definition may be broadened to include to the following:

(a) Capital transfers, such as investment subsidies; and
(b) Current transfers from the government to households in their role as consumers.

Environmental subsidies in Sweden may be considered, as per the OECD rules as covering "environmentally motivated subsidies". Most of these are related to energy and transport.

In Sweden, there are two major sources of subsidies - the government and the EU. The total amount of subsidies from the government has decreased from SEK 59833 million in 1993 to SEK 33898 million in 2000. Subsidies from the EU have, on the other hand, increased from SEK 4859 million to SEK 8887 million between 1995 and 2000.

The SNA-subsidies are given to different recipients in the economy. The largest amount of subsidies, SEK 32 000 million, was given to private companies in 1996. Other major receivers were state corporations, state businesses, private companies, the public sector and non-profit-making household associations. Of the state subsidies to private companies, more than 75 percent were interest subsidies for housing construction and approximately 15 percent were subsidies for creating employment. Subsidies from the EU come from a range of different funds, with a large part going to the agricultural sector.

i. Environmental Subsidies in Swedish National Account

In Sweden, the resource-related subsidies are dominated by subsidies to the agricultural sector. Other resource-related subsidies in Sweden affect the fishing sector as well as research. The majority of the energy-related subsidies aim to increase energy efficiency and improve energy technology. Table 3.1 shows the volume of subsidies, per Swedish National Income Accounts (SNA) calculations.

Table 3.1: Total Environmentally Motivated Subsidies

(SEK Million)

	1993	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Resource Subsidies	248	296	1110	947	1638	2694	2432	2028
Energy Subsidies	121	71	152	141	165	178	191	154
Transport Subsidies	0	0	14	2	3	3	14	0
Total	369	367	1276	1090	1806	2875	2628	2182

Source: SCB (2003)

Environmentally motivated SNA-subsidies have increased as a percentage of the total SNA-subsidies in Sweden between 1993 and 2000. Since 1998, environmentally motivated subsidies as a percentage of the total subsidies in Sweden have been constant at around 6-7 percent. One explanation for this development is the decrease of the *total subsidies* over these years, together with the fact that the environmentally motivated subsidies increased rapidly between 1996 and 1998. In 2000, the total environmentally motivated subsidies came to 0.10 percent of GDP, which is a slight decrease compared to 1999.

a. Resource Subsidies

Resource-related subsidies are dominated by subsidies to the agricultural sector, including the following items: "Landscape conservation measures", "Supplementary measures in the agricultural sector" and "Measures for improving the environment in the agricultural sector", which went directly to the sector. The subsidy "Nature conservation measures in the agricultural sector" (NOLA) also went directly to the sector when it existed (1993-1995). The purpose of this subsidy was to conserve the farmed landscape and its valuable semi-natural pastureland and meadows, including forest grazing land. Supplementary measures in the agricultural sector include three different supports:

(1) Environmental programme.
(2) Different forest measures.
(3) Plantation of energy forest.

Except for the financing of environmental measures in agriculture, similar to the objective of the subsidy NOLA before 1995, the programme finances forestry measures and for the plantation of energy forest. The main purpose with the environmental support given in this budget line is to reduce the pressure on the environment caused by agriculture.

b. Other Subsidies for Agriculture

The **landscape conservation measure** was introduced in 1990 and was managed by the Ministry of the Environment. The grant was used to protect arable land that was of interest for natural and cultural heritage reasons. The subsidies were also paid to farmers for maintaining the open landscape.

Measure for improving the environment in the agricultural sector has existed all years between 1993 and 2000 and its purpose is to steer the development in the agricultural and horticultural industry towards reduced nutrient and ammonia leaching, safer and reduced use of pesticides, conservation of biodiversity and increased ecological production. It is primarily used to conduct experiments and for development in the area.

Subsidy for fish cultivation has existed in different forms during the period 1993 to 2000 but always with the same purpose, to work towards a vital and rich stock of fish in Swedish waters. In later years, the environmental purpose has become more distinct. In the long run, the purpose is to maintain the biodiversity by promoting a rich and varied stock and an optimal use of resources.

c. Research on the Environment and Eco-cycles

There are two budget lines supporting environmental and eco-cycle research in Sweden. The purpose is to discover and prevent new environmental threats by interdisciplinary research on, for example, waste and material flows. The research mainly takes place in universities and university colleges. Only the amount given as subsidies from this budget line is documented here.

d. Subsidy for Environmental Work

This budget line includes means for environmental measures managed by other authorities than the Swedish Environmental Protection Agency and by other organizations in this area. It mainly concerns means to restore damage caused by air pollution and acidification, but also to support other work for the control of the environment.

ii. Energy Subsidies

Governments in both developing and developed countries intervene considerably in the energy sector. Heat and power production, in particular, have been exposed to extensive attempts for control in Sweden and the motives for this control have differed over time. During the 1970s and early 1980s, the key focus was identifying a substitution for oil and, shortly thereafter, the preparations for the future phasing out of nuclear power. Since the late 80s, intervention has gradually come to focus on environmental concerns. The subsidies in Table 3.1 were paid out between 1993 and 2000 with an environmental purpose. Other subsidies related to energy, not included in the definition of a subsidy used in this report, are several different tax subsidies. Here we discuss the main energy subsidies.

The purpose of **Energy efficiency measures** is to support technology purchase, information, training, testing, marking and certifying to stimulate the development and introduction of energy efficient technology. The subsidies paid from the grant are principally managed by the Swedish Energy Agency (STEM) and a company can be subsidized for up to 50 percent of the costs for specific allowed activities.

Energy technology support aims to encourage the development of new energy technology in companies and industries. The payment can be given either as a loan or a subsidy. It can amount to up to 50 percent of the investment cost or research collaboration.

Introduction of new energy technologies was introduced in 1999 and is managed by the Swedish Energy Agency. Subsidies are given in order to promote the development of technology based on renewable energy as well as an efficient use of energy in industrial processes. This support is similar to the energy technology support, but the purpose is more specific for promoting technology based on renewable energy. The subsidy can constitute a maximum of 50 percent of the cost for industrial research and a maximum of 25 percent, if the purpose is developing a goods item before it is introduced on the market (up to 30 percent for small- or medium-sized companies).

Energy research subsidies are connected to energy research and bio-energy research. Energy research is by far the larger subsidy, with disbursed payments as large as SEK 165 million in 1998, which is 93 percent of the total energy-related subsidies in this year. In 2000, the amount paid had decreased to SEK66 million, 43 percent of the total energy related subsidies.

iii. Transport Subsidies

Since the definition of an environmentally motivated subsidy focuses on its motive and not its effects, the large amount of subsidies for the purchase of rail transport in Sweden, the investment in railways or public transportation are not included. The main motives for these subsidies are regional and not environmental *per se*, according to the budget proposals. However, there are environmental reasons that have been made clearer in recent years, so some of these subsidies should be counted as environmental subsidies. Based on the narrow definition, the **research subsidy for electrical and hybrid vehicles** is paid out as part of a research, development and demonstration programme initiated in 1993, concerning the use of electric and hybrid vehicles. The amount paid out as a subsidy has differed from year to year, the maximum was SEK 14 million given in 1995 and in 1999.

iv. Investment Subsidies

In the system of national accounts investment subsidies or support given to households are not included. But such subsidies may be disbursed with environmental motive. Table 3.2 shows environment motivated environmentally investment subsidies. It indicates that these subsidies were substantially increased 1998 onwards.

Table 3.2: Environmentally Motivated Investment Subsidies

Year	1993	1994	1995	1996	1997	1998	1999	2000
Amount (SEK Million)	326	444	550	545	369	2907	2140	1998

Source: SCB (2003).

As before, the main components are resource and energy related.

a. Resource-related Investment Subsidies

The resource investment subsidies consist of three different items. The main purpose for **local investment programmes (LIP)** is to significantly speedup Sweden's transition to an ecologically sustainable society. A secondary purpose is to help raise employment levels. This support is given to municipalities working together with local companies and organizations for investments that increase ecological sustainability.

The purpose of **investment subsidy for an ecological restructuring** (1995-96) was to encourage an eco-cycle adaptation of buildings and technological infrastructure. Another purpose was to bring about improvements in the environment. Measures included in the programme were focused on the development of technology, for example in the waste, water and construction area. The support was to be given for investments that would otherwise not occur and subsidies were given of between 15 and 30 percent of the total investment cost. The **LIFE** (Financial Instrument for the Environment) programme is entirely financed by the EU and was introduced in 1992. This is the only subsidy that is directly related to development and implementation of EU environmental policy.

b. Energy-related Investment Subsidies

There are several other investment subsidies related to energy. For example, **Investment subsidy for renewable energy** was paid from 1993 to 2000. Support was given for investments in wind power and bio-fuel fired combined heat and power production for five years. The payments have been between SEK 89 and 464 million.

The investment subsidy for reducing the use of energy was given until 2000 for several measures, such as the installation of effect guards, complementary sources of energy and equipment for heat accumulation. **The grant for the conversion of heating systems**, which still exists, is given for the conversion of electrically heated residential buildings to district heating or to another form of heating. The purpose for both subsidies was to stimulate measures in areas where it is not economically rational to connect to district heating.

Subsidy for solar heat establishments in houses, apartments and premises was introduced in 2000, and the size of the subsidy is decided on the basis of the calculated yearly production of the solar collector, or as a maximum of 25 percent of the investment cost.

Investment for extension of district heating is given for investments for reconstruction and connection of buildings heated by electricity into district heating.

Some additional subsidies (such as for liming of lakes and watercourses to reduce acidity, for maintaining biodiversity and for sanitation and restoration of polluted areas) are paid by the Swedish Environmental Protection Agency.

It must be mentioned that by including investment and direct transfers to the government, we have made definition of subsidy broader than the Swedish National Income account. Yet, these subsidies are '*environmentally motivated*'. Subsidies that actually improve environment, such as disbursed to railways and public transport systems, are not included. If these are included, then the volume of environmental subsidies will appear even higher.

v. Environmentally Harmful Subsidies in Sweden

Some examples of potentially environmentally harmful subsidies in Sweden are those geared towards transport, agriculture, fishing, housing construction, reindeer husbandry and forest roads. The largest "environmental harmful" subsidies are the acreage support[2] and livestock support.[3] It is also of importance that the volumes of such subsidies are far higher than the environmentally motivating subsidies. However, with implementation of the EU guideline to decouple subsidies from production volume may reduce such environmentally harmful subsidies.

3.2 Environmental Subsidies in Germany

According to the article 6 of EU treaty, "Environmental protection requirements must be integrated into the definition and implementation of the Community policies [...] in particular with a view to promoting sustainable development". Such a paradigm shift emphasizes the fact that existing policies have been highly fragmented and created institutions and incentive structure that generated an adverse bearing towards environment.

In Germany, during the pre EU days, subsidies were granted in favor of intensive farming, construction of single occupancy houses in the countryside or CO_2- intensive coal mining. The public finance system that taxed labor rather than natural resources accentuated the distortions generated by subsidy.

[2]Price support designed to compensate farmers for falls in the prices of crops.

[3]To compensate meat producers for fall in the prices of meat.

a. Regional Economic Policy of Germany

Regional economic policy in Germany attempts to reduce the locational disadvantages of regions (e.g. low per capita income and/or problematic economic structure). Such policies have the potential of improving national welfare and the overall efficiency of resource and factor allocation by removing market failures (e.g. agglomeration externalities) and regional bottlenecks. Traditionally, the focus of the policy has been quite narrow. The "Joint Task Improvement of Regional Economic Structure" (GRW) facilitated cooperation between federal and provincial (*Länder*) governments and allowed the federal government to play a coordinating role. The key instrument used to be a capital grant in the form of a subsidy to local governments for economic development as well as investment in economic infrastructure (such as industrial parks). The projects were subjected to a number of restrictions put forward by land use planning, building and environmental regulations. As such, environmental concerns are seen as a necessary evil, one among the restrictions on regional economic development, which nonetheless has to be obeyed.

The unification of Germany with Europe brought an overall change in policy space. The EU structural fund has somewhat weakened the traditional authority of GRW. In contrast to the GRW, the European Commission has put more emphasis on regional programs that took a holistic approach to development. Apart from infrastructural development, the structural funding program also covers R&D and environmental protection. The emphasis on planning, implementation and evaluation has increased the scope for 'greening' the subsidy structure of Germany. At the other end, increasing influence of EU has created the space for less restricted regional policy formulation. As a consequence, the *Länders* can exploit the greater flexibility of the structural funds and spending for environmental purposes becomes an important component of the regional programmes.

On the other hand, the EU has discouraged the use of subsidies (with some exceptions). For the Member States this trend created pressure to develop further alternatives to traditional forms of subsidization. For example, the traditional capital-intensive investment grants are less likely to pass state aid control than less intrusive subsidies, e.g. for education and training, and broader strategies and instruments aiming at the promotion of endogenous development potentials.

Secondly, the scope of subsidies has been continuously restrained over the years. On the one hand, EU funding in eligible German regions will be further restricted and concentrated in 2007 as a result of the enlargement of the European Union. On the other hand, under Stabilization and Growth Pact (advocating fiscal sustainability), a strong pressure exists to put less strain on public budgets and rely less on spending (like subsidies) as a public policy instrument.

b. Energy Policy in Germany

By and large, the German energy policy relate to the Energy Industry Act of 1935, the substance of which remained unaltered until 1998. The industry structure was centralized way and big private energy supply companies and public authorities were in close cooperation. The law against restraints on competition justified the existence of regional monopolies as a "special case". Such a structure generated high profits for electricity and gas supply companies with little or ineffective control mechanisms. It was thought that primary energy consumption is closely connected with GDP growth, and possible "side-effects" of energy consumption were ignored.

The use of subsidies has for a long time been associated with coal, a non-renewable resource in which Germany is richly endowed with. After World War II, the mining sector expanded rapidly (from 38.9 million tonnes in 1945 to 151 million tonnes in 1956). This substantial rise in coal production led to Germany's quick economic post-war recovery and subsequent growth and prosperity. To meet the rising energy demand and reduce social hardships after the war, coal prices were regulated and fixed below the market price, and several policies were put in place to boost coal production even further (e.g. by putting restriction on oil-fired power plants). In the end, coal had to be apportioned due to excess demand.

From the late 1950s, coal policy aimed at restoring competitiveness to the domestic mining industry and limiting social and regional hardships in the mining areas. Most of these policies were based on the assumption that (market-induced) downward trends for German coal production (which happened after 1958) could be stopped or reversed. To ensure these objectives, coal policy has heavily relied on subsidies, in conjunction with regulations and command and control instruments. From 1958 to 2002, measures totaling €157.7 billion can be distinguished as having influence on energy, most of which qualify as subsidies. Unfortunately, these programs developed a dynamics of their own, and programs adopted for boosting coal production (for example, immediately after the oil crisis) were not always abandoned after a crisis.

Coal policy was so sacrosanct that they were untouched even when the environmental issues became more important in the 1970s. It must be borne in mind that mining, energy conversion and use of coal has serious environmental implications vis-à-vis its substitutes. For example, emissions of particulates, dust, sulphur dioxide, nitrogen oxides and greenhouse gas emissions per unit of usable energy are typically higher. Mining itself remained a resource-intensive sector and causes a large number of local and regional environmental burdens (unusable waste land, waste water, change of groundwater table, water pollution, impairment of landscape and ecosystems, change of relief). To counteract (or rather alleviate) these problems subsidy programs were at least devoted to environmental investment. NRW granted structural aids to limit pollution, noise, and agitation between 1969 and 1990 which amounted to €74.1 million.

A more substantial amount of aid fell under the category R&D. Typically these aids were accompanied by the introduction of command-and-control policies, like (stricter) emission standards in the power sector. However, from the point of view of environmental policy, these measures qualify as add-on or end-of-pipe: They do not change the production and consumption patterns and provide marginal incentives for environmental improvements.

During the 1990's two major changes occurred in Germany. One, the emphasis of the European Union on competitiveness reduced subsidies in many parts. Second, there was greater concern for climate change. While coal subsidies were allowed to go on, for good, there were at least substantial changes in subsidy design. Adaptation pressure to reduce coal subsidies has come from the strain they impose on the public budget. An important stimulus for the reform of coal subsidies occurred in 1994 when the German Federal Constitutional Court declared the largest of all coal support measures, the *coal penny*[4] unconstitutional. This triggered reductions in aid volumes. Instead of subsidizing pre-defined quantities of coal and compensating electricity companies (for usage of coal) target ceilings were introduced and a fixed amount of subsidies (deficiency payments) included under these ceilings were passed on to the mining companies. The amount of subsidies paid was no longer dependent on the difference between import prices and domestic prices but the ceilings agreed upon by the parties and fixed in the budget. Due to budgetary pressure these ceiling have been reduced, tightened and unified over the years.

[4]The program levied a special tax on the price of electricity that was used to subsidize generator's consumption of domestic coal.

However, some blind spots do remain. While coal support has decreased in the last decade, no clear commitment to end coal support policies has been made. The introduction of the Ecological Tax Reform (which includes eco taxes) has, by and large, exempted coal. Finally, the trend towards market liberalization in the electricity market is accompanied by mergers and acquisitions. Thus the scope for competitiveness, research and development gets diminished.

3.3 Environmental Subsidies in China

In the context of industrial pollution control in China, several management measures have been concurrently implemented in order to enforce the environmental protection law. The measures include both the command-and-control approach, such as discharge standards, abatement facility installment deadlines and discharge permits, which provide a maximum discharge ceiling for firms, and market based practices such as emission charges and pollution abatement subsidies. The market based instruments have gained in importance since the 1980's. In 1982, after three years experimentation, China's State Council began nationwide implementation of pollution charges. Since then billions of Yuan have been collected each year from hundreds of thousands of industrial polluters for air pollution, water pollution, solid waste, and noise. In 1996, the system was implemented in almost all counties and cities. 4 billion Yuan ($1 = 8 Yuan) were collected from about half a million industrial firms. Table 3.3 lists information about the total levy collected.

Table 3.3: Total Levy Collected in China: 1986-1993

Year	Total Levy (Million Yuan)	Industrial Output (Billion Yuan)
1986	1190.2	1119.4
1987	1427.8	1381.3
1988	1609.0	1822.4
1989	1674.0	2201.7
1990	1751.6	2392.4
1991	2006.0	2824.8
1992	2471.0	3706.6
1993	2680.1	5269.3

Source: Wang and Chen (1999)

These incentives can be viewed as a charge-subsidy double incentive system with discharge standards embedded.

In Wang and Wheeler (1996) province-level data on water pollution was analyzed. The results suggest that province-level pollution discharge intensities have been highly responsive to provincial levy variations.

a. Institutional Setting

There are some unique features associated with the charge system. For wastewater, fees are calculated for each pollutant in a discharge stream and the polluter only needs to pay whichever amount has the highest value among all the pollutants. The Chinese central government constructs a uniform fee schedule; however the implementation across the regions is not uniform. The levy collected is earmarked for institutional development, administration, environmental projects and subsidy to firms' pollution control projects. If a firm decides to invest in pollution abatement, a maximum of 80 percent of the levy paid by the firm can be used to subsidize the investment project proposed by the firm. For defaulters, there is a penalty; however, penalties cannot be used to subsidize firm-level pollution control projects.

b. Theoretical Model

The case for subsidies was argued based on a theoretical model. A representative firm is expected to minimize pollution levies paid to the government, as well as pollution abatement cost. Let us assume a firm plans to invest I_f in wastewater treatment at year t. With this investment, the firm expects to obtain from government a subsidy S. The amount of subsidy is a function of the amount of self-financing I_f (to capture the reality that firms with higher profitability may afford abatement costs, thus deserving lower subsidies), levy paid L, firm's own characteristics Z_{f1} (the government may pay more attention to pollution abatement in certain sectors), and regional characteristics (such as income, education and level of industrial development) Z_g, i.e.,

$$S = f(I_f, L, Z_g, Z_{f1}) \qquad (1)$$

Investment in water pollution abatement I_t is the sum of self-investment and government subsidy, i.e.,

$$I_t = I_f + S \qquad (2)$$

Discharge P_d is a function of the total pollution generated P_g, investment in abatement facility I_t, operating cost V and the firm's characteristics.

$$P_d = g(P_g, I_t, V, Z_{f2}) \qquad (3)$$

where Z_{f2} reflects firm level characteristics.

The firm pays levy for its discharge according to discharge schedule C set by the government.

$$L = h(P_d, C) \qquad (4)$$

The firm minimizes its total cost L+ I_f +V by choosing the amount of self-investment I_f and the amount of operation cost V subject to equation (1) to (4). As a result of the optimization process, the total investment equation (2) can be solved as,

$$I_t = k(P_g, C, Z_g, Z_{f1}, Z_{f2}) \qquad (5)$$

And the operating expenditure can be written as

$$V = m(P_g, C, Z_g, Z_{f1}, Z_{f2}) \qquad (6)$$

Here, P_g is pollution generated from the production process, which sets up the scale for investment. This is expected to have a positive effect on I_t and V. the pollution charge schedule C, which reflects the enforceability of pollution control program, is also expected to have a positive impact on total investment. The third set of variables is regional or community characteristics that may act as instrumental variables for government pollution control subsidy budget and policy. Income could affect the investment volume positively since a higher subsidy budget might be available. Education (percentage of employees with secondary schooling or higher degrees) could have a negative effect on subsidies because people with higher education may favor to eliminate the subsidy policy when other pollution control instruments are in place. However education may have a positive impact on firms' abatement efforts. An industrial firm located in an area with a high industrial density may have a lesser chance of getting the subsidies, but subsidy fund availability may be higher. Therefore, education could have either a negative or positive sign in equation (5). The fourth set of determinants is the firm's own characteristics. It may be more difficult for firms with higher productivity to get subsidies, but they may be able to spend more money in the operation of the facilities. Firms in sectors that adapt to government pollution control strategies are more prone to get subsidies. The costs associated with abating pollution across sectors are also different. Thus, the sign of the sectoral variables will be ambiguous in nature.

c. Empirical Model

Keeping the above argument in mind, the following econometric model was proposed:

$$\begin{aligned}\ln\left(\frac{\text{Depvar}}{\text{O}}\right) &= a_0 + a_1\ln\left(\frac{\text{waste}}{\text{O}}\right) + a_2\ln\left(\frac{\text{levy}}{\text{discharge above standard}}\right) + a_3\ln(\text{consumtion per capita}) \\ &+ a_4(\text{education}) + a_5\ln(\text{industrial share of gdp}) + a_6\ln(\text{per capita output}) + a_7(\text{age}) \\ &+ a_8(\text{ownership dummy}) + a_9(\text{sectoral dummies})\end{aligned}$$

Here, *Depvar* stands for either (1) current value of total investment in wastewater facilities (as a fixed cost in *short run*), or (2) the total operational cost of abatement. O is the gross value of output. Per capita consumption is used as a proxy for income. The levy paid for divided by the discharge above standard defines the effective levy rate.

The regression result is presented in Table 3.4. For the sake of brevity, only the significant variables are included.

Table 3.4: Main Regression Results

Ind Variables	Model 1 (depvar: fixed cost)	Model 2 (depvar: operating cost)
Effective Levy Rate	0.058	0.062
Industry Share	0.826	1.38
Educational Level	-0.745	-0.974
Pollution/Output	0.38	0.482
Per Capita Output	-0.652	-0.548
Coal	-0.425	-0.76
Beer	1.16	1.15
Dye	0.707	0.919
Coking	0.84	1.22
Pesticide	_	0.767
Refinery	1.75	2.47
Steel Processing		-1.32
Dye Material	1.3	1.53

Source: Wang and Chen (1999).

One can observe that effective levy rate leads to higher efforts to curb pollution, both in terms of higher investment and higher operating costs. The coefficients on the productivity of a firm are negative. Firms who are more productive need to spend less investment effort in pollution control. The reason might be that more productive firms are also cleaner. Beer, dye, coking and refinery industries were found to have invested more on wastewater treatment facilities, while the cement industry invested less. This could be related to the difference in the efficiency of pollution abatement among different sectors.

The role of subsidy was inferred indirectly from the regression analysis. Education has a significant and negative impact on total abatement investment and operation cost, which implies a strong negative correlation between subsidy and education. Without subsidy, education would have been expected to have positive impact on pollution control effort because education has been found to be positively correlated with pollution control pressures.

Several empirical studies have been conducted in analyzing firms' behaviors in complying with pollution regulation. There is little empirical study on efforts firms take to reduce their pollution. This study focuses on the investment and operation cost for the end-of-pipe wastewater treatment, and looked at what determines firms' efforts in investing for the end-of-pipe treatment facilities.

The results show that this combination of charge and subsidy has been effective in providing incentives for firms to invest in wastewater treatment facilities. The pollution levy has been found to have a significant positive impact on abatement investment effort. However, the elasticity is only about 0.06. While the levy rate has been generally regarded as low, the levy could affect investment decisions in two ways. One possibility is that the levy itself does provide incentives for firms to invest in pollution abatement. Another possibility is that higher levies generate higher subsidies which firms can use to invest in pollution abatement.

Regional variables such as education and industrial intensity were also found to significantly affect firms' pollution abatement investment efforts. The industrial intensity of a region has been found to have a positive impact, implying that firms invest more in pollution abatement while industries in this area are more developed. Surprisingly, education was found to have a negative impact on firms' pollution control investment efforts. However this correlation is consistent with the model for subsidies where higher education could imply less subsidies, and therefore less total abatement investment.

Empirical research has found that higher education generates higher pressure on industry for pollution control. Pargal and Wheeler (1996) found that while formal regulation was not in place, informal regulation could put significant pressure on the firms. When education is higher, the informal pressure would be stronger. Wang and Wheeler (1996) found that education was positively correlated with effective levy rate in China. While formal regulation is in place and effective levy is included in the modeling, education was found to have a negative impact on subsidy and therefore on total pollution control investment efforts.

Consistent evidence was also found with firms' own characteristics on pollution abatement investment. Higher pollution is linked with the higher investment. More productive firms need to invest less in pollution abatement. Neither the ownership effect nor the vintage effect is significant.

Chapter 4

ENVIRONMENTAL SUBSIDIES IN INDIA

Measurement of the volume of subsidy is often not enough. What is required is the measurement of excess subsidization, that is, the volume or the degree of subsidy provision in excess of what is desirable or optimal. In evaluating a subsidy program, not only the actual volume of subsidy, but also the optimal subsidy needs to be estimated. This requires a much larger information base regarding the objectives and the actual features of the sector including demand and supply functions. It also requires estimation of externalities in which case social demand function and private demand function may both be required.

Further, the same subsidy program may play different roles at different times. As such, subsidization programs should not be thought of as static exercises. Rather they should respond to their past history and the changes that take place in the sector. Viewing subsidies in terms of a life cycle where they may grow in importance initially or in an expansion phase, reach a maximum and then are rolled back in the contraction phase may be the best method of promoting relevant objectives in a sector. When appropriate changes do not take place in response to the history of the subsidy and the external environment, the expansion phase may be over stated and contraction may prove to be very difficult. Subsidy programs that are not scrutinized with respect to their desired life cycle pattern may prove to be more harmful than beneficial. Recognizing a suitable life cycle is especially important in the context of environment.

There is evidence in the literature to show that many subsidies have been constructive at the time of their introduction, but have later become harmful. They have completed their original purpose but have not been phased out afterwards. For instance, certain agricultural subsidies generated substantial and much needed positive spillovers into other sectors in India. Input supports during the 1980s totaled 17 percent of total value added (25 percent for wheat and 35 percent for rice) (Gulati, 1989). They not only achieved much for the country's Green Revolution, they generated many spin-off benefits as well. From the early 1970s through the early 1990's, agricultural subsidies fed into infrastructure of many sorts, with the result that the length of surfaced roads more than doubled and the villages with electricity quadrupled (Vaidyanathan, 1999 and Repetto, 1994). Yet many of the agricultural subsidies remain in place, even though they are now harmful to both the environment and the economy at large.

4.1 Identifying Environmentally Harmful and Positive Subsidies

The issue of subsidies in general and agricultural subsidies (includes subsidy to fertilizer, pesticides, water, electricity) in particular has been in debate in India, since early nineties. It is both because farm subsidies put enormous strain on government budgets and that the environmental impacts of these subsidies are potentially substantial. Some of the reasons that have been advanced in support of farm subsidies are: food security, income redistribution, stability in food prices and encouragement to use new farming methods. In addition to straining government budgets, subsidies distort prices of agricultural inputs and thereby affect levels of input use. This has an effect on the availability of inputs and resources used in agriculture. When supply of inputs is constrained by natural or other factors, the sustainability of agricultural development may be affected. Excessive and inefficient use of agricultural inputs such as fertilizers, water and pesticides is also reported to have detrimental consequences for the environment and human health and welfare.

Agriculture has a significant impact on environment, particularly on soil, water, biodiversity and air. The specific impact depends, among other factors, on the type and quantity of crops produced, the farming practices employed, the level and mix of inputs such as fertilizers and pesticides applied, irrigation methods, and site specific environmental conditions. Farmers will be concerned about the environmental performance of the agricultural sector if they are faced with adequate incentives to include the environmental costs and benefits of their activities in their production decisions. Markets do not penalize farmers for harming the environment, nor offer rewards for avoiding or reducing harmful effects. Government pricing policies of both agricultural inputs and outputs have encouraged a commodity mix narrower than would be the case if these policies were not in place, and have promoted high levels of water, fertilizer and chemical use. This, in turn, has exacerbated environmental pollution, especially soil erosion, and surface and groundwater pollution. The mechanism is a form of derived demand for inputs (Harold and Runge, 1993).

There are three main challenges involved in identifying/evaluating the environmental impact of both environmentally perverse and environment supporting subsidies:

- The impact is likely to differ from one environmental situation to another, because the sensitivity of an ecosystem will differ according to the specific situation, and most subsidy measures will extend beyond a single ecosystem. Often environmental degradation is visible after a long period of time, so these long-term impacts have to be taken into consideration while analyzing the environmental impacts.

- Human behavior will be affected not only by the particular subsidy in question, but also by all the other government programs that affect a given individual. There may be multiple subsidy programs, perhaps with conflicting objectives, that are relevant.

- Some subsidy programs may make payments that are inconsistent with the program's own goals. For example, the program may have outlived the life span envisaged by its designers, or it may apply to "fringe" areas where circumstances do not match those which its designers foresaw (Barg, 1996).

In order to evaluate the impact of subsidies to agricultural inputs it is important to identify their potential impacts on environmental resources, and human health and welfare. The chemical and/or physical changes in the environment associated with an activity or source – in this case agricultural inputs - are described as stressors, which is a term used to denote the types and levels of pollutant emissions or habitat alterations. Through the media of air, land and water, such environmental changes and pollutants ultimately affect resources, people, wildlife and plants (Table 4.1). The impacts may have far reaching effects or may affect the receptor on a smaller scale. They can be on-site (localized) or off-site (regional or even global) impacts, physical (e.g. loss of species diversity) and chemical effects (such as diseases), socio-economic impacts (e.g. loss of income, resettlement of people or land abandonment) or near-term and long-term impacts.

Table 4.1: Taxonomy for Evaluating Potential Impacts of Environmental Stressors

	Effects Category						
	Environmental Resources						
Potential Burdens to Water							
Stressor	**Ground Water Contami-nation**	**Surface water Contami-nation**	**Ground Water Level**	**Coastal, Marine & Freshwater Ecosystems**	**Terrestrial Ecosystems**	**Biodiversity /Endangered Species**	**Sediment-ation**
Fertiliser	x	x		x		x	
Pesticides	x	x		x	x	x	
Irrigation (surface)	x	x	x				x
Electricity			x				
Potential Burdens to Land							
Stressor	**Contami-nation**	**Waterlogging**	**Salinity**	**Erosion**	**Terrestrial Ecosystems**	**Biodiversity /Endangered Species**	**Nutrient Leaching**
Fertilisers	x				x		
Pesticides	x				x	x	
Irrigation (surface)		x	x	x	x		x
Electricity				x	x		
Potential Burdens to Air							
Stressor					**Terrestrial Eco-systems**		
Pesticides					x		

Table 4.1: Taxonomy for Evaluating Potential Impacts of Environmental Stressors (contd...)

	Effects Category				
	Human Health		**Human Welfare**		
Potential Burdens to Water					
Stressor	**Mortality**	**Morbidity**	**Material loss**	**Aesthetics**	**Resource Use**
Fertiliser		x			x
Pesticides	x	x			x
Irrigation (surface)			x	x	x
Electricity				x	x
Potential Burdens to Land					
Stressor	**Mortality**	**Morbidity**	**Material loss**	**Aesthetics**	**Resource Use**
Fertilisers					x
Pesticides		x			x
Irrigation (surface)			x		x
Electricity					x
Potential Burdens to Air					
Stressor	**Mortality**	**Morbidity**	**Material loss**	**Aesthetics**	**Resource Use**
Pesticides	x	x			x

Notes: Changes in the productivity or value of commercial, subsistence or recreational uses of such natural resources as forests (e.g., for timber), agricultural lands (e.g., for crops), fisheries (e.g., for subsistence diets) or wildlife (e.g., for ecotourism). **Coastal and Other Marine Ecosystems**: Includes reef, fishery, and other biological resources in saline water. **Freshwater Ecosystems**: Includes wetlands, watersheds, and other biological resources in fresh water (sweet water). **Biodiversity/Endangered Species**: Impacts on the diversity of flora and fauna, species that are endemic or unique, and species habitats and corridors (e.g., flyways for birds). **Terrestrial Ecosystems**: Flora and fauna, minerals, soil, forest or grassland habitat.

There is evidence in the empirical literature to show that agricultural yield is sensitive to the quality of environmental resources. There are a number of studies (Mausolff and Farber, 1995; Pattanayak and Mercer, 1998; and Byiringiro and Reardon, 1998) which have incorporated environmental information directly into production function to determine the effects of environmental factor on yield. The limitation of this approach has been that these do not provide the information to quantify the dynamic effects and environmental stressors on yields. Analytical model presented in Pandey and Srivastava (2001) attempts to identify environmentally optimal levels of input use and to derive the price changes needed in order to move the farmers towards the social optimum.

4.2 Environmental Impacts of Subsidies: Evidence from Literature

In practice, many subsidies are not only excessive but ill targeted and also tend to become open ended and continued long after they have served their purpose. Recently it has been increasingly recognized that many subsidies directed towards agriculture impose a high cost on society through their adverse impact on environmental resources. In this context, this section reviews the existing literature on the subject with an objective to examine the environmental impact of the subsidies to fertilizers, surface irrigation, pesticides and power and its implications for the sustainability of natural resources and agriculture.

a. Power Subsidy: Impact on Groundwater Depletion

It is generally perceived that reducing energy consumption implies reducing production. However, Singh (1999) reports that this is a misconception. His study cites Mitra (1992) who found that the linkage between energy consumption and economic growth has been broken decisively by the developed countries after the oil crises, which broke out in the early seventies. Middle income and lower middle income countries too have shown that efficiency of energy use can significantly reduce the consumption of energy without impairing economic growth targets. However the low income countries, among them India most prominently, have remained stuck with high energy intensity in their economic development processes and profiles. The persistent neglect of the energy conservation in agriculture is a glaring example of this. The irrational pricing policy of electricity results in the inefficient use of electricity on the one hand and inefficient use of water on the other.

Myers and Kent (2001), notes that irrigation subsidies encourage wasteful use of scarce water worldwide. Power subsidies too, encourage withdrawal of groundwater for agricultural use, leading to a decline in the water table. These have implications for both the availability of scarce water resource and the environmental problems entailed by its overuse and wastage, namely groundwater depletion, and soil depletion which have serious impact on agriculture.

Sidhu and Dhillon (1997), on the basis of a study conducted in Punjab show that the low rates of electricity and the flat rate system of charging have induced farmers to shift to tube well irrigation, water intensive crops and over irrigation which have resulted in a sharp decline in the groundwater level and consequently, the electricity requirement for drawing groundwater is increasing year after year. The groundwater level has declined in 86 percent of the area of the state. The decline was more than 5 meters in 29 percent of the area implying 7 to 10 percent increase in electricity demand. Further, there was a sharp shift from dry crops to water intensive crops. For instance, the area under rice which is a irrigation intensive crop increased from 292 thousand hectares in 1970-71 to 2276 thousand hectares in 1994-95. The marginal lands too were put under the water intensive crops. The study also reveals that the zero marginal cost of irrigation due to the rate system of charges for electricity has induced the farmers to over irrigate. Only 54.7 percent of the farmers applied the required number of irrigations, while the remaining over irrigated the rice crop to various degree.

Subsidy on electricity has affected the efficiency of irrigation systems too. A study conducted by the Punjab Agricultural University (1997)[5] on the operational efficiency of electricity operated tube wells found that 33 percent tube wells were operating at 50 percent of efficiency, 21 percent were at 40-50 percent level of efficiency and the remaining were operating at less than 45 percent level of efficiency.

Joshi (1997) reports that the water table in the good aquifer regions of Haryana has declined ranging between 1 and 83 cm during the last one decade posing serious threat to the agricultural economy of Haryana.

In coastal regions, fresh groundwater supplies are vulnerable to contamination by salt water intrusion. Overdraft of these fresh water zones causes salt water intrusions. Katar Singh (1999) shows that the ground water table has gone down drastically in many areas of the country such as Mehsana district in north Gujarat, and Coimbatore district in west Tamil Nadu. It is estimated that in Mehsana district, water table has been falling at the rate of 5-8 meters annually and that some 2,000 wells dry up every year. In the coastal areas of Gujarat, excessive extraction has depleted the groundwater aquifers and the vacuum so created has been filled in by intrusion of sea water – a phenomenon called salinity ingress. It is estimated that salinity ingress is increasing at an alarming rate of one-half to one km a year, along 60 percent of the 1,100 km long Saurashtra coast.

[5] Cited in Shergill (2005).

The salinity ingress has rendered groundwater in those areas unfit for both domestic and agricultural uses and has adversely affected crop yields. Singh fears that "sometimes, these effects are slow in coming, but by the time they are recognized it may be too late to correct the damage."

b. Irrigation Subsidy: Impact on Waterlogging, Salinity and Soil Erosion

Increase in soil salinity is recognised worldwide as a major deprecating factor in agricultural growth. Myers and Kent (2001) note that world-wide, 454,000 sq. km of the 2.8 million sq. km. of land is salinized which is enough to reduce crop yields, with crop losses worth almost $11 billion per year. The study also notes that the problem derives primarily from subsidies that encourage careless and prodigal use of seemingly plentiful water supplies. Government subsidies encourage wasteful use of water, and eliminate any incentive to use it sparingly. Mexico loses a million metric tons of grain a year because of soil salinity, enough to feed five million people and Pakistan today spends more on pumping out salt-laden water than on irrigation.

Joshi and Jha (1992) show that in the long run, waterlogging and salinity lead to land abandonment, while in the short-term and medium-term, there are adverse productivity impacts. Presently, salinity affects productivity in about 86 million hectares of the world's irrigated land. At least 2 to 3 lakh hectares of irrigated land are lost every year due to salinization and waterlogging. In developed and developing countries, salinity and waterlogging together are responsible for the decline of about 1.1 million tons of grain output each year.

India, being predominantly agriculture based economy and with much inefficiency in its irrigation subsidy policies, is no exception to this problem. Myers (1998) notes that in India 100,000 sq. km out of 420,000 square km. of irrigated croplands have been lost to cultivation through waterlogging, and 70,000 square km. are affected by salinization. It is estimated that Indian farmers could cut back on irrigation water use by 15 percent without reducing crop yields simply by eliminating over-watering. Marothia (1997) shows that subsidized canal irrigation and subsidized electricity (in some cases free) for tube wells, remunerative output price support, availability of HYV seeds and higher returns encouraged the farmers to opt for water intensive crops. Nearly ¼th of the cultivable command area under all canal projects in India is suffering from waterlogging and soil salinity. This has adversely affected the crop productivity and restricted the choice of crops. As precise statistical data are not yet available as to the amount of irrigated lands that have fallen into disuse because of waterlogging and salinity, these concerns are inadequately addressed in most of the irrigation investment decisions.

The study by Joshi and Jha (1992) focuses primarily on the problem of soil alkalinity and waterlogging in the Sharda Canal Command area and attempts to measure its impact at the farm level in terms of resource use, productivity and profitability of crop production. Four villages in the Gauriganj block were chosen for the study covering the 1985-86 cropping year. The study finds that overuse of canal irrigation and underuse of groundwater has disturbed the water balance of the area causing waterlogging and increase in salinization in the command area. The reason for under-exploitation of rather good quality groundwater is low water rate on canal irrigation. It has been shown that the cost of tube well irrigation is much higher (Rs. 825 per hectare for paddy) as compared to the rate of canal water tariff (Rs. 143.26 per hectare for paddy). Such a wide difference in the cost of irrigation has led the farmers to discontinue the use of groundwater, resulting in an increase in water table and soil alkalinity.

The study further notes that crop choices are severely restricted under degraded soil conditions. Under salt affected and waterlogged soils, crops like pulses, sugarcane, potato and a number of other crops are not grown. In such situations intensity of land use goes down and in the extreme such problems lead to abandonment of cultivation. Thus land degradation aggravates land scarcity. Results of the study on productivity and profitability of crop production were far more revealing. Though in farmers' perceptions, yields of paddy and wheat halved in about eight years' time due to increasing soil degradation, estimates of the study indicated that paddy and wheat yields went down by more than 51 percent and 56 percent respectively on salt-affected soils. For wheat, the net income fell by 92 percent. The unit cost of production rose by 59 to 61 percent for paddy and by 85 percent for wheat when cultivation is extended on salt affected soils. The study concludes that with the same level of resources as used on normal soils, gross output would decline by 63-64 percent on salt affected or waterlogged soils. The study concludes that under-pricing in favour of canal irrigation is, by and large, responsible for such a situation. Joshi (1997) based on primary data reports that the crop productivity in Western Yamuna and Bhakra Canal Command showed a declining trend in comparison to normal soils.

Sharma, Parshad and Gajja (1997), find that in Haryana about 70 percent of the geographical area is facing the problem of rising water table due to the dominance of canal irrigation, lack of adequate drainage and low extraction of ground water. Gangwar and Toorn (1987) put the economic loss due to rising and poor quality of water in Haryana at Rs. 26.8 crore and anticipate it to rise to a level of Rs.71.9 crore in 2000. The state is also salt affected. Singh (1984), estimates that an area of 450 thousand hectares under salinity/alkalinity and waterlogging. More severely affected districts are Karnal, Kurukshetra, Jind, Hisar, Sonipat and Rohtak.

In the Central-Southern districts of Jind, Hisar, Sirsa and Bhiwani, where most of the area is canal irrigated , the water table rose at a fast rate during 1974-91 (0.7 metre in Rohtak to 6.5 metre in Sirsa district) leading to waterlogging and secondary salinity. Moreover, these areas are underlain by brackish water. So waterlogging is assuming gigantic proportions in various canal command areas. The worst affected districts are Rohtak, Jind, Hisar and Sirsa.

To sum up, the widespread and repeated use of irrigation water without provision for adequate drainage, and crop intensification in favour of high water requirement crops without utilising the groundwater has resulted in rapid rise in water table in the areas with poor quality groundwater, leading to the problem of waterlogging and salinity. On the other hand, the regions endowed with good quality groundwater are being overexploited without maintaining the water level at a reasonable depth. According to Karwasra, Singh and Singh (1997) both the situations are undesirable for the sustainability of agriculture. Unplanned intensive irrigation also leads to infestation of weeds and inception of water borne diseases.

c. Fertiliser Subsidy: Impact on Soil Productivity, and Groundwater and Surface Water Contamination

Three main fertilisers used in agriculture are urea (N), di-ammonium phosphate (DAP) and Potash (K). Of these the production of urea is under the retention price scheme. There is a flat rate subsidy on DAP. Potash, which is mainly imported, also has a flat rate subsidy. One of the main purposes of retention price scheme is to develop the urea industry in the country. Every individual plant is assured a fixed rate of return. Hence the retention prices are fixed for each individual plant. The subsidy on urea is the difference between the retention price (adjusted for freight etc.) and the price that the farmer pays. According to Gulati and Narayanan (2000), the fertiliser subsidy bill in 1988-89 amounted to Rs. 112 billion. In the eighties there was an unprecedented growth in the fertiliser subsidy in India. Parikh and Suryanarayana (1992) show that the rate of fertiliser subsidy on domestic production has increased from Rs. 565.72 per tonne to Rs. 1383.33 per tonne in 1987-88.

Application of fertilisers and pesticides is essential in order to increase food production and achieve the targeted agricultural production. However, studies reveal that indiscriminate use of fertilisers has proved detrimental. According to a study Mehta (1971), in Gujarat region, nitrogen leaching for 90 cm. soil depth under 564 mm. rainfall was 14 kg/ha. out of 180 kg/ha. N applied. In a rice field near Delhi, loss of 14.3 kg/ha. was reported from an application of 120 kg/ha (Mahalanobis, 1971). Handa (1987) found that the main cause of groundwater pollution is indiscriminate and higher dose of fertilisers and pesticides. The study also finds that the nitrate content in the soil sample of the states where lower doses of fertilisers are used is considerably low as compared to the states where per hectare use of fertiliser is higher. It must be noted the soil health has direct impact on crop yield.

According to Sidhu and Byerlee (1992), in relatively more developed districts of Punjab, such as Ludhiana, fertilizer use has already exceeded the recommended dose at least for nitrogen. Hence marginal contribution of fertilizer to yield increases is predicted to be substantially lower in future. The study computed the land, labor and fertilizer productivity for the years 1975 and 1985 for various states of India and expressed them as percentages of Punjab figures. The results show a decline in fertilizer productivity in Punjab, Haryana, Uttar Pradesh, Madhya Pradesh and Rajasthan due to application of increasing amounts of fertilizers to maintain current levels of yield.

Sah and Shah (1992) find that in irrigated areas of Gujarat where fertilizer use is widespread and has reached 1.5 times or more than the recommended amounts, the issue of fertilizer use efficiency has become increasingly important. The analysis based on a sample of 330 farmers located in 42 villages of 5 important soil-crop zones in Gujarat, finds that excessive use of fertilizers is widespread; only one out of 5 farmers who had received soil test recommendations, used fertilizers as recommended. Farmers' inability to visualize the effect of nutrient balance on crop output distorts their perceptions about yield response, resulting in overuse.

Singh, Singh and Kundu (1997) analyse the environmental consequences of the rice-wheat cropping system in Haryana. The study finds that increasing fertiliser use has led to diminishing marginal gains to nutrient ratio from 14.65 to 9.36 for rice and from 21.5 to 8.67 for wheat between 1970-75 and 1990-94.

Nagaraj, Khan and Karnool (1998) examine the resource use efficiency in cultivation of various crops under different cropping systems in Tungabhadra Command

Area (Karnataka). The results of the study show that the regression coefficients for manure and fertilizers are negative and non-significant in production of paddy indicating a negative influence on the gross returns from paddy and that the input is used in excess of requirements.

According to Joshi (1997) adoption of nutrient responsive high-yielding varieties and application of inorganic fertilisers without soil test and widespread application with wrong nutrient balance have resulted in nutrient imbalance of the soil in many parts of the country. As a result, the actual productivity from using inorganic fertilisers was much lower than that of the potential. Nearly 70 percent of the fertiliser was applied to rice and wheat in Haryana. Several studies report that the farmers in Haryana were applying overdoses of fertiliser, particularly of nitrogenous fertiliser in most of the crops. The recommended ratio of N, P, K (4:2:1), is not being maintained due to subsidies in favour of nitrogenous fertilisers. Some economists argue that soil nutrient related problems were due to imbalance of subsidies for the major nutrients. Nutrient deficiency and loss of organic matter were among other important reasons for declining productivity of rice and wheat.

Ray (1998) observed that although use of fertilizers, pesticides and water are unavoidable for achieving the targeted agricultural growth, indiscriminate use of these inputs creates environmental problems. The study analyses fertilizer consumption data for Andhra Pradesh, Punjab, Haryana, Tamil Nadu, Bihar, Madhya Pradesh, Orissa, and Rajasthan from 1981 to 1995 and concludes that:

(1) due to use of more and more fertilizers the return from per unit of fertilizer was decreasing in almost all states;

(2) the return from per kg. of fertilizer is highest in less developed states where the rate of use of fertilizers is substantially lower as compared to the states where a high dose of fertilizer has been used; and

(3) due to the use of higher dose of fertilizers and pesticides, the pollution of soil and groundwater is more and as a consequence, the marginal physical productivity of fertilizers declined significantly.

The study notes that increasing trends in bringing land under rice and wheat and other profitable crops and applying higher doses of fertilizers are not likely to change in the near future. Therefore, efforts should be made to ensure judicial use of fertilizers and pesticides so that only a small portion is left unutilized which reaches the soil and groundwater.

Joshi (1997) reports that degradation of natural resources has undermined production capacity in different regions. Therefore future productivity levels and growth in production will have to rely on availability of resource friendly technologies and practices.

Huang and Rozelle (1995) in an analysis of the slower growth of grain yields in China in the late 1980s, observe that the intensification of China's agricultural practices and other rural activities appear to have caused an increase in environmental stress that created a drag yield growth.

d. Environmental Impact of Indiscriminate Use of Pesticides

Deep concern is expressed about the excessive use of pesticides in developing countries, which is reported to have led to environmental degradation. Farah (1994) shows that some pesticides persist longer than others or break down to even more toxic components, extending the time span in which they could contaminate agricultural crops, underground water, and surface water bodies. Pesticides affect not only the location of their application but also the ecosystems far removed due to their mobility in air and water. Further, pesticides usually kill pests and their natural enemies alike. Pests are also very adept at developing resistance against the chemical pesticides intended to control them. Thus pesticide use initiated to suppress pests may lead to greater pest outbreaks. The study notes that towards the late 80s, with the growth of herbicide use, at least 48 weed species had gained resistance to chemicals. Another source estimates that from 1930 to 1960, the number of resistant anthropoid species (insects, mites, ticks) rose from just 6 to 137, an average increase of 4 resistant species per year. In the period of 1960-80, on an average 13 species per year are reported to have gained resistance to chemical pesticides. It was estimated that in 1990 approximately 504 insect and mite species had acquired resistance to pesticides in use.

The wipe out of essential predatory insects due to excessive and uncontrolled pesticide treatments has created new pests. For instance, in cotton production in the Canete Valley in Peru, spraying to control the tobacco budworm led to the rapid build-up of the cotton aphid. As chemical treatment intensified to counteract this resistance build-up, other pests developed because their natural predators were eliminated. In Mexico, the tobacco budworm developed resistance to all known pesticides and caused the cotton planted area to drop from more than 280,000 ha to a mere 400 ha in the 60s. Similarly, in Nicaragua, 15 years of heavy insecticide use on cotton were followed by 4 years in which yields fell by 30 percent.

Pesticide-related poisoning could occur in human beings as a result of excessive exposure to pesticides, through inhalation or on consuming heavily or untimely pesticide treated crops. Karwasra, Singh and Singh (1997) assess the impact of agricultural development on nature and extent of resource degradation in Haryana. They observe that in the central-southern districts, intensive canal irrigation has led to waterlogging and increase in salinity and this has encouraged profuse growth of weeds and insect-pests. To control such infestation and to propel any further harvest, intensive chemical control measures will have to be employed. The study notes that the direct ill-effects of farm chemicals have started showing its presence in the form of nitrate concentration in water and pesticides residue in different food items. Bhatnagar and Thakur (1998) observe that in Haryana from 1966 to 1993 both consumption and coverage of area by pesticides has shown accelerating growth rates. Consumption of pesticides has grown at a higher rate than the growth in areas covered by the use of pesticides.

Farah (1994) notes that the pesticide users are hardly aware of the negative externalities on the environment. In the absence of government intervention through regulations and taxation, they tend to overuse pesticides and this tendency is further exacerbated due to international and national institutional economic policies which directly or indirectly lead to farmers applying more pesticides than they would otherwise.

According to Joshi (1997) pesticide consumption in Indian agriculture has increased manifold during the last three decades. Five states, namely, Andhra Pradesh, Gujarat, Maharashtra, Punjab and Tamil Nadu, accounted for more than 90 percent of the pesticide use in the country, although the average consumption of pesticide in India is low, 33 grams/hectare. Indiscriminate use of pesticide in some pockets is causing several environmental and health problems. Farah (1994) reports that, during the 1989/90 season, $27 million worth of pesticides were used in the district of Guntur in the state of Andhra Pradesh. With an average overuse of 20 percent, $5.4 million of pesticides were wasted, which could have been avoided through better pest management. The yield losses due to pest resistance were estimated at $39.7 million. In pesticide application, the red triangle label (extremely hazardous) chemicals have a share of 26 percent in Andhra Pradesh, 39.7 percent in Punjab and as high as 65 percent in Gujarat of the reported use. The yellow triangle label (highly hazardous) group constitutes 59 percent each in Andhra Pradesh and Punjab and 34 percent in Gujarat of the reported use. An analysis of the pesticide use behavior found that pesticide use levels are determined significantly by the extent of irrigation. The intensity of use is higher on small farms. Joshi (1997) shows that with the increase in pesticide use in Punjab, 525 insects have already developed resistance to pesticides. Marothia (1997) reports that nearly 70 percent of all pesticides consumed by Indian farmers belong to banned or severely restricted categories in the developed countries. The Indian Council of Medical Research conducted an extensive study in 1993 covering all the states of India. Results of this study indicate that the samples far exceeded the tolerance limits of pesticide residuals in the case of milk, canned fruit products, poultry feeds and vegetables. The report emphasizes that the private benefits of pesticides use should be evaluated against their social costs. It has been estimated that only 10 percent of the total food grains production can be saved from increased pesticides use. Once the health hazards and other costs are imputed these benefits appear too meager.

Pesticides also find their way into the river through agricultural runoffs because the upstream catchment areas are intensely cultivated. Around 150 tons of pesticides and herbicides are used in the agricultural and plantation areas. The deadly impact of these chemicals has caused destruction of several types of fish and aquatic organisms in recent years.

e. Electricity Subsidies

Electricity subsidies in India (measured as under recovery of costs) are very large and give rise to economic, environmental and social costs – although hidden in these estimates are substantial costs due to procurer and other systemic inefficiencies.

The primary effect of the electricity subsidies is to distort the overall energy market in favour of electricity which results in higher electricity intensity of GDP. Production of electricity which is largely coal based in India, has implications for both local and global pollutants. Electricity subsidies may also indirectly hold back rural development by undermining the ability of the state electricity boards to invest in extending distribution networks to villages. Lack of electricity contributes to poverty, as it precludes most industrial activities and the jobs they create. Subsidies also create incentives for both suppliers and users for inefficiency – which only harms environment, economy and society (UNEP, 2003). Table 4.2 shows the extent of electricity subsidy across various sectors in India.

Table 4.2: Size and Impact of Electricity Subsidies in India

Sector	Avg. Price (Rs./Kwh)	Reference Price (Rs./Kwh)	Rate of Subsidy (%)	Potential Primary Energy Saving from Subsidy Removal
Households	1.50	3.56	57.9	48
Industry	3.50	3.42	-	-
Agriculture	0.25	3.56	93.0	86
Average	-		38.0	34

Source: IEA (2001).

4.3 Reform of Environmentally Harmful Subsidies in India

The importance of review and potential reform of environmentally harmful subsidies is well recognized. Increasing support for analytical research and policy dialogue in developed countries underline that decisive progress is needed (e.g. OECD, 2006; OECD, 2007; OECD, 2009a; TEEB, 2009) towards the reform of environmentally harmful subsidies.

The barrier to the reform on the one hand has been the resistance by vested interests and associated difficulty of gaining public support, on the other hand it is hindered by the lack of preparedness in terms of an agreed method to define, identify and quantify them, and the lack of application of the available tools in assessing the wider implications of the impact of their removal including the economic, social and environmental dimensions.

There can be various ways to address these. One is to formulate alternative policies that target the same subsidy objectives better, while also compensating losers. A related measure is to develop an economic and environmental-policy context that encourages subsidy removal through reducing government controls generally and freeing up markets. A subsidiary measure is to introduce provisions that require surviving subsidies to be re-justified periodically, thus avoiding the perpetual subsidy problem. All these measures can be strongly reinforced by promoting transparency about perverse subsidies, especially in the context of their impacts both economic and environmental, and their costs to both taxpayers and consumers.

However, Policy makers considering removing subsidies or considering reforming subsidies will need to understand the linkages between the existing subsidies and the underlying economic and environmental reality. This lack of preparedness (in reducing economically and environmentally harmful subsidies) in terms of both the magnitudes of subsidy and their impact on the environment is seen as equally challenging, if not more, as political and institutional concerns.

In the literature quantification efforts have mainly focused on budgetary subsidies given that the quantification of off-budget subsidies is complex. In this context, two recent initiatives for the identification and assessment of environmentally harmful subsidy offer great promise.

One, various studies of the OECD (OECD, 1998; OECD, 2005; and OECD, 2007) have developed tools for the analysis of the linkages between financial support to an activity and its environmental impacts. These tools constitute an attempt to unfold the linkages and the circumstances that cause, mitigate, or have rebound effects on the environmental harmfulness of a subsidy. Three different tools have been developed to provide: (i) a framework for the identification of environmentally harmful subsidies, (ii) to assess whether the subsidy removal will benefit the environment, and (iii) help to understand the wider implications of subsidy removal including the economic and social dimensions. The main features of the tools and insights on the crucial elements behind the tools are illustrated in OECD (2009a). These tools have been used to develop a methodology such that these tools can be tested on the selected case studies. The aim of the tests were to assess the strengths and weaknesses, the effectiveness, the user friendliness and the data requirements of the tools as well as gain an overall impression of their use and develop guidelines for removal of environmentally harmful subsidy.

Two, the System of Integrated Environment and Economic Accounts (SEEA) is a satellite system to the system of national accounts that has been under development since the early 1990s. The system brings together economic and environmental information in a common framework to measure the contribution of the environment to the economy and the impact of the economy on the environment. It aims to provide policy makers with indicators and statistics to monitor these interactions and provide a database for strategic planning. This is an international system based on a UN initiative. In Europe, the information is harmonized and coordinated by Eurostat. The SEEA covers: flows of materials per industry (energy, material, and emissions waste); economic variables (labor taxes, subsidies, costs, products and services); and natural resources (stocks, quality, value).

Under the Swedish system of SEEA, subsidies are classified as environmentally motivated subsidies, potentially damaging subsidies, and other subsidies. Subsidies are classified through a detailed review of budget proposals to determine which budget lines have an environmental motive. The SEEA definition of subsidies covers on-budget subsidies to industry, transfers to international beneficiaries and households, as well as capital transfers. While some off-budget subsidies such as tax exemptions can be calculated from SEEA data where there is a direct link between emissions and taxes, other off-budget subsidies such as preferential market access and exemptions from government standards are not currently included given difficulties in obtaining such data (cited in OECD, 2009a).

Methodology developed in OECD (2009a) not only helps to identify and prioritize those subsidies that have clear environmental implication and are more politically viable for reform but also helps to identify information and analytical gaps with regard to identifying environmental benefits and tradeoffs with social and economic objectives, subsidy reform can potentially bring about. There is merit in using this methodology in future work on environmentally harmful subsidies in a developing country like India with a view to develop a strategy for reform of such subsidies.

Chapter 5

ENVIRONMENTALLY PERVERSE SUBSIDIES IN INDIA: BUDGETARY COSTS

5.1 Introduction

Subsidies range from financial transfers to opportunity cost and can be given directly and indirectly to the beneficiaries. In the case of opportunity costs in environmental context could arise due to environmental externalities which may be negative in nature. For example industrialists often discharge pollutants into water bodies without any cost to them, this leads to health and environmental effects on the common citizens. These basically refer to the uncompensated loss to the society at large. Further, environmental degradation may result from the failure of markets and policies. Environmental subsidies can be broadly categorized into two groups, one that promote environment and the other that lead to environmental degradation.

There has been great concern for environmentally perverse subsidies and environmentally harmful subsidies. Some of these have international consequences. Subsidies on fossil fuels aggravate pollution effects such as acid rain, urban pollution and global warming all which have cross-border effects.

The main challenges in containing environmentally perverse subsidies may be institutional and political. There is vast information about these subsidies and the consequences and their ill effects on the environment. The critical issues that need to be addressed are (i) what are the areas/goods in India where government provides subsidies and what is the uncompensated environmental damages due to this, (ii) what is the volume of the environmental subsidies in India?, (iii) is there a need to enhance environmentally positive subsidies?, and (iv) what are the policy changes required to promote environment friendly subsidies?

In this Chapter, we estimate the budgetary cost of subsidies in India that have a bearing on environment. We identify both environment friendly budgetary subsidies and environmentally harmful subsidies. We focus on three agricultural inputs viz., power, irrigation and fertilizer where perverse subsidies are pervasive. We also look at the environmental friendly subsidies in the budget heads like soil and water conservation, sewerage and sanitation, forest conservation, development and regeneration, afforestation and ecology development, ecology and environment, flood control, anti-sea erosion projects, drainage, non-conventional sources of energy, environmental research, prevention and control of pollution, mining in iron and steel industries, and mineral exploration in non-ferrous mining and metallurgical industries.

5.2 Identifying Environmental Subsidies

In this section, we identify the heads that have a bearing on environment, both in the Central and State budgets. Subsequently, these identified environmental related subsidies are categorised into two groups. The first group where the subsidies are designed to have a positive impact on the environment, and second group where, environment may get adversely affected. It is important to note that it is not the *activity*, but the *subsidy* that may be classified as perverse.

There are some subsidies which *prima facie* may have a positive impact on environment. Subsidies that are likely to have a beneficial effect on environment are sewerage and sanitation, and non-conventional sources of energy. Also, subsidies like forestry and wildlife, soil and water conservation and fisheries can be considered as necessary for environmental protection. However, there are several budgetary heads, where subsidisation may have a mixed or adverse effect as in the case of 'irrigation'. Here, subsidisation may lead to both positive and negative effects.

Irrigation as an activity is extremely beneficial to agriculture, but excess use of water due to excess subsidisation of irrigation may damage the fertility of soil, leading to an adverse impact. When subsidy is given in excess, it leads to problems that may sometimes be unanticipated. Environment may be adversely affected by the overuse and/or inefficient use of resources due to improper pricing engendered by the subsidies. It is therefore important that, while framing a subsidy policy and determining agricultural prices, the shadow price of environmental resources be properly taken into account.

In the case of some other items also, the impact of subsidy may be mixed, such as command area development programmes and agricultural research in forestry. Many subsidy-induced research programmes may contribute to commercial forestry rather than environmental forestry and may ultimately actually induce a negative consequence for the environment. Similarly, large irrigation projects may not be the best way of providing irrigation for agriculture. How these areas should be dealt with is an important question.

Budgetary subsidies may be explicit or implicit. Explicit subsidies are explicitly provided for as a separate budgetary item, like fertiliser subsidy, and constitute a distinct budgetary outflow. The explicit subsidy on fertiliser in the Central government budget has risen from Rs.1295 crore in 2001-02 to Rs.54976 crore in 2009-10 (see Appendix Table B.1). Implicit subsidies have a wider connotation covering unstated opportunity costs. In a budgetary context, implicit subsidies may be defined as unrecovered costs in the provision of publicly provided services, provided these services may be classified as other than public goods. This implies that these services are delivered to users who may be identified, and often, the extent of use/consumption of good may be measured. Public goods, on the other hand, are characterised by the twin characteristics of non-rivalry and non-excludability. These are goods that are collectively consumed and the consumption by one does not reduce the availability of the good for another.

General services comprising such services as administration, police, justice, jails, etc. are treated as public goods and no subsidies are estimated. The reasoning is that they have to be borne by the government for smooth functioning of the economy. It is the social and economic services where most of the subsidisation takes place. The budgetary heads that have an environmental impact both in the social and economic services needs to be first identified. With this in view the service are classified into two groups, Group A and Group B. Those that have a 'direct positive' effect on environment are included in Group A. The remaining services, those that have an adverse or mixed effect on environment are placed in Group B. Most Group B items will be judged by the fact that the primary objective of the service is not related directly to environment and the adverse or mixed effects are likely to be generated indirectly or incidentally. The grouping categorisation is similar to the study by Pandey and Srivastava (2001). The grouping is detailed below.

Group A

(1) Sewerage and Sanitation
(2) Soil and Water Conservation
(3) Fisheries
(4) Forestry and Wildlife
    - Forest Conservation, Development and Regeneration
    - Environmental Forestry and Wildlife
    - Afforestation and Ecology Development
(5) Agricultural Research and Education
    - Soil and Water Conservation
    - Fisheries

- Forestry

(6) Special Areas Development Programme
  - Drought Prone Areas
  - Desert Development Programme
  - Wasteland Development Programme

(7) Flood Control and Drainage
  - Flood Control
  - Anti-Sea Erosion

(8) Non-Conventional Sources of Energy

(9) Ecology and Environment
  - Prevention and Control of Pollution

Group B

(1) Major and Medium Irrigation

(2) Minor Irrigation

(3) Command Area Development Programme

(4) Fertiliser

(5) Pesticide and Chemicals

(6) Mining in Iron and Steel Industries

(7) Cement and Non-metallic Industries

(8) Non-ferrous Mining and Metallurgical Industries
  - Mineral Exploration in Geological Survey of India
  - Mineral Exploration in Regulation and Development of Mines

The volume of subsidies has been estimated for these budgetary heads for the Central Government and for four states viz., Maharashtra, Gujarat, West Bengal and Rajasthan for the year 2008-09. The basic data is drawn from the Finance Accounts of the Central and the State governments.

5.3 Methodology of Measuring Subsidies

In this study, subsidies are measured as unrecovered costs of governmental provision of goods and services that are not classified as public goods. The unrecovered costs are measured as the excess of aggregate costs over receipts from the concerned budgetary head. The methodology, described in detail in Mundle and Rao (1991), and with modification in Srivastava *et. al.* (1997), Srivastava and Amar Nath (2001), Srivastava and Bhujanga Rao (2001) and Srivastava *et. al.* (2003) has been followed. The main elements of the methodology are described below.

As discussed in Chapter 1, measurement of subsidy requires (i) identification of budgetary heads that can be interpreted as other than pure public goods, (ii) estimation of costs, and (iii) estimation of receipts. Costs themselves have two components: current or variable costs and annualised capital costs. The current (revenue) expenditure on a budgetary head is taken as the variable cost. The capital cost is worked out as the expected annual return on the stock of capital in the form of equity, loans or ownership of capital assets.

Aggregate costs (C) may be written as

$$C = RX + (i+d^*)\, K_0 + iZ_0$$

Here, RX = Revenue expenditure

i = Effective interest rate

d^* = Depreciation rate

K_0 = Aggregate capital expenditure at the beginning of the period pertaining to the budgetary head

Z_0 = Sum of loans and equity investment at the beginning of the period pertaining to the budgetary head

Aggregate receipts (R)may be written as

$$R = RR + (I + D)$$

Here, RR = Revenue Receipts

I = Interest receipts

D = Dividends

Subsidy (S) is calculated as $S = C – R$

In calculating the current costs, revenue expenditure on the service head is to be taken after deducting transfer funds and adding transfer from funds. This is because when funds are transferred to funds, they are only earmarked for use at a later time, and do not constitute current spending. On the other hand, transfer from funds adds to the current spending on the service.

Estimation of Capital Cost

In the calculation of capital costs, accumulated capital stock pertaining to a service head is divided into three parts: (i) investment in physical assets in departmental activities including departmental enterprises, (ii) investment in equities, and (iii) loans. In all cases, an accumulated investment as outstanding at the beginning of the financial year is taken. In the case of physical capital a depreciation rate is applied.

Since estimates are made with respect to a financial year, annualised cost of capital needs to be estimated. In this context, two rates are important, namely: the depreciation rate and the effective interest rate.

The methodology enunciated in Srivastava and Amar Nath (2001) and Srivastava *et. al.* (2003) has been followed. The average life of a capital asset is taken to be 50 years. The depreciation rate is worked out as a function of the parameters, viz., the rate of growth of nominal investment (z) and the long term rate of inflation (p). Investment data given in Finance Accounts are accumulated stock in the terms of the nominal values prevalent in the year of acquisition of the asset. The depreciation rate is given by d* as indicated below.

$$D^* = \left(\frac{1}{50}\right)\left[\frac{\{1+w+w^2+\ldots\ldots+w^{49}\}.(1+p)}{\{1+x+x^2+\ldots\ldots+x^{49}\}}\right]$$

with $w = (1+p)/(1+z)$
and $x = 1/(1+z)$

Here, p is the long term rate of inflation and z is the growth rate of investment. 'p' has been taken to be 7.89 percent and 'z' has been calculated to be 13.04 percent. d*, the depreciation rate, was calculated to be 0.05308, that is 5.31 percent, by the above method (see Appendix Table B.2).

Apart from depreciation, the effective interest rate is calculated to indicate the opportunity cost of funds. This is to be used in the case of all categories of capital expenditure, i.e. loans and advances, equity investment and own capital expenditure on the functional head.

The effective interest rates are calculated as interest payments as percentage of total borrowing by the concerned government (Centre/State).The effective interest rates used for the Centre and the four states viz., Maharashtra, Gujarat, Rajasthan and West Bengal for the year 2008-09 are shown in Table 5.1. Rajasthan seems to have a higher effective rate as compared to the other States and Centre.

Table 5.1: Effective Interest Rate: 2008-09

(percent)

States	Interest Rate
Maharashtra	9.200
Gujarat	9.291
West Bengal	9.200
Rajasthan	10.592
Centre	9.293

Source (Basic Data): Centre and respective State Finance Accounts.

The estimation methodology has certain important assumptions and limitations arising from those. In particular, the life of an asset is assumed to be fifty years. Estimated subsidies include inefficiency costs. These are integral to the public provision of private goods. Subsidies due to tax expenditures are not captured. Subsidies are calculated with respect to actual prices, even if these are administered, and not on the basis of market prices which would prevail if there were no regulated prices.

5.4 Estimation of Environmentally Subsidies

Subsidies having a bearing on environment in respect of the budgetary heads that have been identified by Pandey and Srivastava (2001) amounted to Rs.5320 crore in 1994-95 and Rs.6471 crore in 1996-97. These as percentage to GDP[6] in the respective years, translate to 0.53 and 0.47 percent respectively. In this paper the estimates for 2008-09 environmental subsidies amounted to Rs.26322 crore and as percentage of GDP remained at 0.47 percent (Table 5.2). Out of these, subsidies on the following items, namely, irrigation (major, medium and minor), fertilisers, pesticides & chemicals and command area development, mining in iron and steel industries, cement and non-metallic industries, non-ferrous mining and metallurgical industries (mineral exploration) are separated as pertaining to Group B[7]. The subsidies which remain may be identified as unambiguously having a positive impact on environment. These have been referred to as Group A subsidies. It will be seen that Group A subsidies are a very small portion of the total subsidies having an environmental impact.

[6] At current market prices, 1993-94 base series.

[7] In Pandey and Srivastava study mining in iron and steel industries, cement and non-metallic industries, non-ferrous mining and metallurgical industries (mineral exploration) are not included.

Table 5.2: Environment Related Subsidies of Centre

(Rs.crore)

Groups/Heads	1994-95*	1996-97*	2008-09
Group A	333.89	624.18	5231.67
Group B	4986.85	5847.11	21090.60
Irrigation (including CAD)	129.88	166.62	486.91
Fertilisers	4793.2	5586.94	20782.62
Pesticides and Chemicals	63.77	93.54	89.86
Mining in Iron and Steel Industries			10.28
Cement and Non-metallic Industries			-203.69
Non-ferrous Mining and Metallurgical Industries			-75.39
Total	5320.74	6471.29	26322.28
As % of GDP	0.53	0.47	0.47

Source (Basic Data): GoI, Union Finance Accounts; GDP at market prices are taken from National Accounts Statistics, C.S.O.,2001 & 2010.

Note: * Pandey and Srivastava (2001); CAD: Command Area Development; GDP at market prices (at 2004-05 base) for the year 2008-09 is Rs. 5574449 crore;

(-) sign indicates that the sector generated surplus in the given year.

The magnitudes of Group A subsidies, identified as having direct positive effect on environment, are shown in Table 5.3.

Table 5.3: Environment Promoting Subsidies (Group A) of Centre

(Rs. crore)

Group A	1994-95*	1996-97*	2008-09
Sewerage & Sanitation	42.00	17.10	1236.06
Soil and Water Conservation	20.45	23.14	26.04
Fisheries	61.16	57.70	221.52
Forestry and Wildlife	-22.83	36.55	696.36
Agricultural Research & Education	52.20	56.96	365.11
Special Areas Development Programmes	0.62	224.66	1560.29
Flood Control & Drainage	32.90	65.83	175.28
Non-conventional Sources of Energy	147.34	142.24	477.21
Ecology and Environment			473.80
Total	333.84	624.18	5231.67

Source (Basic Data): GoI, Union Finance Accounts.

Note: * Pandey and Srivastava (2001);

(-) sign indicates that the sector generated surplus in the given year.

Detailed estimates for 2008-09 is given in Appendix Table B.3 while the detailed estimates for the years 1994-95 and 1996-97 given in Pandey and Srivastava (2001). These include estimated costs comprising actual and imputed components and receipts.

The annualised cost of capital is obtained by applying the effective interest and depreciation rates to the relevant capital stock.

5.5 Inter-state Variation of Environmental Subsidies: An Analysis of Four States

Environment related subsidies emanate relatively more from the state budgets and they indicate huge disparities among states in the magnitude of environment promoting subsidies. In Table 5.4, aggregate and per capita subsidies for Group A and Group B are given for four states. The per capita subsidies indicate wide variations in the two groups. The per capita subsidies of both groups increase as the per capita GSDP of the state increases.

Table 5.4: Environmental Subsidies - Inter-state Comparison of Selected States: 1996-97 and 2008-09

States	Group A Subsidies		Group B Subsidies		Environmental Subsidies	
	Aggregate (Rs. crore)	Per Capita (Rs.)	Aggregate (Rs. crore)	Per Capita (Rs.)	Total (Rs.crore)	Per Capita (Rs.)
	1996-97*					
High Income						
Maharashtra	551.17	64.58	3312.85	388.14	3864.02	442.41
Gujarat	191.43	42.76	1746.72	390.18	1938.15	422.02
Middle Income						
West Bengal	173.02	23.5	440.14	59.79	613.16	81.45
Low Income						
Rajasthan	117.22	24.3	1128.4	233.96	1245.62	247.62
	2008-09					
High Income						
Maharashtra	994.34	91.30	9007.99	827.12	10002.33	918.42
Gujarat	581.52	101.83	2344.03	410.45	2925.54	512.27
Middle Income						
West Bengal	149.70	17.11	972.29	111.11	1121.99	128.22
Low Income						
Rajasthan	344.80	52.88	1837.70	281.86	2182.50	334.74

Source (Basic Data): Finance Accounts

Note: * Pandey and Srivastava (2001).

Among the states that have a sizeable population, Maharashtra stands out, with a substantial subsidy per capita of over Rs.442 in 1996-97 and Rs.918 in 2008-09. In the case of Gujarat per capita subsidies rose from Rs.422 to Rs.512 in the corresponding period while for West Bengal it raised from Rs.81 to Rs.128 and for Rajasthan from

Rs.248 to Rs. 335 in the respective period.[8] The details relating to subsidies are given in the Appendix Tables B.4 to B.7.

Table 5.5 shows the year-wise subsidies as a proportion of total revenue receipts of the state. This is to identify any correlation between the income of the state and its propensity to spend on environment friendly activities. A comparison of per capita GSDP with per capita environment promoting subsidies shows that richer states like Maharashtra and Gujarat have larger per capita subsidies. This implies that with rise in income, investment in these subsidies increases more than proportionately. The middle and low income states have lower share of subsidies to total revenue receipts. However, all the four states show a decline in the year 2008-09.

Table 5.5: Subsidies as Proportion of Revenue Receipts/Revenue Expenditure

(percent)

States	1994-95*	1996-97*	2008-09
Subsidies as percent to Revenue Receipts			
High Income			
Maharashtra	17.46	20.07	12.31
Gujarat	18.63	20.05	7.56
Middle Income			
West Bengal	6.86	7.45	3.04
Low Income			
Rajasthan	17.21	16.48	6.52
Subsidies as percent to Revenue Expenditure			
High Income			
Maharashtra	17.79	18.54	13.21
Gujarat	19.28	18.89	7.55
Middle Income			
West Bengal	6.17	5.92	5.19
Low Income			
Rajasthan	16.12	14.78	6.36

Source (Basic Data): State Finance Accounts.
Note: * Pandey and Srivastava (2001).

Table 5.5 also shows the environment related subsidies as a proportion of total revenue expenditure. This proportion may partly reflect the priority attached to the

[8] The per capita GSDP for the year 2008-09 for Maharashtra is Rs. 70972, Gujarat Rs. 64394, West Bengal Rs. 38917, and Rajasthan Rs. 34535.

environment schemes, although a full examination is not possible without the entire breakup of expenditure into different sectors. Here we find that states like Gujarat and Maharashtra have high subsidy to expenditure ratios in 1996-97 but have declined in 2008-09. In the case of Gujarat the decline has been substantial (7.6 percent in 2008-09 as compared to 19.3 percent in 1994-95). West Bengal seems to retain its share over the period 1994-95 to 2008-09. In the case of Rajasthan the share of subsidies to total expenditure declined from 16.1 percent in 1994-95 to 6.3 percent in 2008-09.

An alternative is to look at the share of revenue expenditures on environment promoting schemes to total revenue expenditure; this would reflect the priority accorded by the respective state to environmental schemes. From Table 5.6 it is observed that the priority has steadily declined over the years. In 2008-09, it is around 3-4 percent of the total revenue expenditure.

Table 5.6: Revenue Expenditure on Environment Promoting Schemes as a Proportion of Total Revenue Expenditure

(percent)

	1994-95*	**1996-97***	**2008-09**
High Income			
Maharashtra	9.2	9.13	3.28
Gujarat	10.73	10.34	3.28
Middle Income			
West Bengal	3.56	3.41	3.04
Low Income			
Rajasthan	9.0	6.98	4.27

Source (Basic Data): Finance Accounts
Note: * Pandey and Srivastava (2001).

Even in terms of recovery rates the scenario is dismal. State-wise recovery rates on environmental promoting schemes are shown in Table 5.7.

Table 5.7: State-wise Recovery Rates on Environment Promoting Schemes

(percent)

States	Total Recovery Rate								
	1994-95*			1996-97*			2008-09		
	Group A	Group B	Aggre-gate	Group A	Group B	Aggre-gate	Group A	Group B	Aggre-gate
High Income									
Maharashtra	0.96	3.70	3.35	0.88	2.00	1.84	0.91	17.38	15.99
Gujarat	1.25	3.45	3.21	1.32	2.28	2.19	0.87	46.57	41.18
Middle Income									
West Bengal	1.66	2.40	2.19	0.76	1.91	1.59	2.68	2.73	2.72
Low Income									
Rajasthan	5.82	4.15	4.47	11.01	3.91	4.62	9.82	41.60	38.15

Source (Basic Data): State Finance Accounts.
Note: * Pandey and Srivastava (2001).

State-wise recovery rates are higher in Group B services as compared to Group A. However, in 2008-09 the recovery rates are substantially higher as this includes non-ferrous mining and metallurgical industries which have substantial subsidy surpluses. If this is excluded the recovery rates are very low.

The division between Centre and States indicates that most of the Group A subsidies emanate from state budgets. The Centre has a higher share in some of the Group B subsidies

5.6 Summary

Environmental subsidies in India often work at cross purposes. Some states are investing in agricultural input subsidies for betterment of the agricultural sector but in the process are harming agriculture itself through a degeneration of the environment. It is observed that adequate environmental protection is lacking in the four states considered. To fully analyse the existing scenario and to draft appropriate policies there is a need for appropriate and reliable data generation. Some of the main findings are as follows:

(i) The identified environment implicit subsidies account for less than one percent of the GDP over the period 1994-95 to 2008-09.

(ii) Centre has a higher share in some of the Group B subsidies. Off the total environmental subsidies Group B accounts for 80-90 percent during the period 1994-95 to 2008-09. Off which in Group B services fertiliser subsidies account for major share (96 to 98 percent).

(iii) A profile of recovery rates for environmental related subsidies across the four states shows that they are extremely low. Though in 2008-09 the recovery rates have been substantially higher in Group B services due to inclusion of non-ferrous mining and metallurgical industries, a surplus sector. In the centre the rates are high as cement and non-metallic industries and non-ferrous mining and metallurgical industries are surplus sectors.

(iv) Inter-state comparisons of per capita environmental related subsidies broadly indicate that:

- per capita subsidy is higher for states with higher per capita incomes; and
- a substantial share of environmental subsidies pertains to forest conservation, development and regeneration in Group A services and in Group B services non-ferrous mining and metallurgical industries followed by irrigation.

(v) There seems to be a positive relationship between per capita revenue expenditure on environment promoting schemes and per capita income of the state, indicating that the propensity of a state to invest in environmental subsidies depends largely on financial condition of the state.

Chapter 6

FINANCING AND RESTRUCTURING ENVIRONMENTAL SUBSIDIES IN INDIA

In this Chapter, we look at issues in regard to financing environmental subsidies. In particular, we examine possible sources of such finance in the Indian context, the allocation of such financing, the targets or objectives, and delivery of such financing. Alongside, we also look at the scope of restructuring subsidies to increase their positive environmental impact.

6.1 Sources of Finance

The financing of environment-promoting subsidies can come from the following sources: government (central and state governments), private sources, and international sources. Government financing can be drawn from general tax revenues as also earmarked cesses. Some funds can be released by expenditure restructuring, particularly by reforming environmentally perverse subsidies.

Government Budget

a. Taxation

Considering that promotion of environment can be considered as a public good with associated high positive externalities, common property features, non-excludability and non-rivalry in consumption, the ideal method of financing is through taxation. Suitable allocation from the general budgetary resources should be made to finance environment-promoting activities, directly or through subsidies.

b. Cess or Earmarked Revenues

However, given competing claims on budgetary resources, it is often the case that adequate priority to environment promotion is not accorded. Often the committed expenditure in the budget become very large and the discretionary space becomes limited and promotion of environment gets relegated in term of importance. Therefore a more practical strategy may be to earmark amounts through cess or excise duties that must be used only for purposes of promoting environment. Examples are: coal cess, petroleum cess, which are earmarked for expenditure on the concerned sector or industry. The coal cess is meant to be spent for cleaning of coal. In the context of GST, this question has to be rethought. In the current discussions on GST, the idea is to abolish all cess and surcharges. However, in the scheme proposed in Srivastava *et. al.*

(2011), in the case of the taxation of petroleum and other major polluting goods and services, a non-rebatable excise or cess over and above the core GST rate has been proposed. The revenue from this additional non-rebatable rate can be earmarked for use for environmental purposes only. Here also, an excise may be preferable over a cess since the cess will be sector specific but the overall revenue from the non-rebatable excise can be earmarked for reducing pollution and promoting environment considering all sectors together. These revenues can be used for environment promoting subsidies.

c. Restructuring Subsidies

A third source for financing environment-promoting subsidies can be restructuring of subsides. In particular, resources can be released from environmentally perverse subsidies and these resources can then be allocated towards correcting the environmental damage. In Chapter 5, we have estimated that the share of environmentally perverse subsidies in India is quite large and that considerable resources can be released by discontinuing these subsidies and using these resources for environment promoting subsidies.

Private Resources

The idea of a subsidy is to induce the private sector also to commit to expenditure that may promote environment. Government subsidies can then leverage private resources.

International Resources

Individual countries can also access international resources. Many of these resources are asking for matching contributions. The government's resources can be leveraged to get international resources also.

In international funding for environmental objectives, "mitigation specific" and "mitigation relevant" support are being distinguished. "Mitigation specific support" aims to achieve greenhouse gas mitigation in developing countries as its main objective. Mitigation specific financial support may include public and/or private support pertaining to investment flows under the Clean Development Mechanism under the Kyoto Protocol.

On the other hand, "Mitigation relevant support" covers funding for development in key sectors that affect emissions in developing countries and thus mitigation potential. Such support includes bilateral as well as multilateral official development assistance in emission intensive sectors, such as energy, transport and/or water infrastructure, waste management, agricultural or forestry sector development. These also include collaborative research and development initiatives that may not target climate change per se (e.g. in the energy and agricultural sectors). "Mitigation relevant" flows of support may have either a positive or a negative effect on GHG emissions.

Mitigation specific flows are shown to be small relative to mitigation relevant flows. Corfee-Morlot *et al.* (2009) document the large magnitude of mitigation relevant private and public sector flows (i.e. in sectors that will affect GHG emission trends over time) relative to mitigation specific support. CDM offers good scope of private funding. This study estimates that mitigation specific financial support flowing to developing countries is in the range of 8 - 53 billion USD in 2007. This represents no more than one-sixth of the total estimated flows of 314 billion USD going to sectors relevant to mitigation in 2007.

Under the Global Environment Facility (GEF), public funding in the GEF has shown a leveraging ratio of about 7 (i.e. the GEF investment leads to a total investment that is roughly 7 times greater due to co-financing largely from the private sector). Both the estimates of large private financial flows under the CDM and the GEF co-financing from the private sector indicate the potential of public private partnerships.

Information regarding funding available in the public domain include bilateral assistance under the UNFCCC reporting system, in the dedicated financial mechanism of the UNFCCC (the Global Environment Facility) and in the OECD Creditor Reporting System. Two last public sources of financing for developing countries that are relevant to mitigation efforts are also covered here: export credits, and public financing flowing through multilateral development bank channels, including a growing number of specific climate change funds.

The UNFCCC monitoring system requires Annex I (developed country) Parties to periodically report information on bilateral financial support for mitigation in developing countries. These countries reported annual flows of financial support of between USD 2 and 5 billion, for the period between 1999 and 2003 although this may give only a partial picture. Available data indicates that industry, energy and transport sectors have received the largest share of total bilateral mitigation relevant assistance (50 percent, 12 percent and 29 percent respectively) and that mitigation far surpasses adaptation spending (the latter represents only 0.2 percent of total).

The Global Environmental Facility is the operational entity of the financial mechanism of the Convention. It is accountable to the COP, which decides on policy orientation in the climate change focal area and provides guidance to the GEF on priorities and eligibility criteria for project funding. GEF funding depends on voluntary contributions from donor countries (i.e. largely Annex II countries but also Non-Annex II and Non-Annex I countries) which follow pre-defined burden sharing rules.

From 1991-2008, the GEF has allocated a total of just over 2.4 billion USD from its trust fund to the climate change focal area (GEF, 2009). Funding of GEF climate change projects averaged about 163million USD per year between 2003 and 2006, with this amount increasing by about 33 percent over the previous four year period.

The GEF also manages two special funds under the UNFCCC, the Least Developed Countries Fund (LDCF) and the Special Climate Change Fund (SCCF), as well the Adaptation Fund under the Kyoto Protocol (GEF, 2009). As of August 2009, the total amount of disbursements from the SCCF was 59.8million USD and the LDCF was 47.5 million USD (ODI, 2009).

GEF financing is small compared to bilateral ODA for climate change as reported below. However, these values underestimate the role of the GEF given that the main objective of the GEF is to transform markets so that development can take a less carbon intensive path. GEF funding is estimated to leverage on average about seven times more investment capital through co-financing; the leveraging ratio varies from year to year with the ratios ranging from 3 to 11 over the last ten years (GEF, 2009).

6.2 Financing Subsidies: Fiscal Federalism Implications

Oates (2001) distinguishes between three cases in the context of environment issues in a federal context: with environmental quality being (a) a pure public good, (b) a local public good, and (c) local public good with spillover effects. In the first case, there is a reason to argue that for setting environmental standards, the central government may be best placed to set the standards. Oates (2001) observes: "There is consequently a need for the central government to set standards. On efficiency grounds, the central environmental authority should set a standard for environmental quality that satisfies the basic Samuelson condition: one for which the marginal benefits (i.e., benefits from a unit of improvement in environmental quality summed over everyone in the nation) equal marginal abatement cost. Efficiency would further require some kind of program (such as a national uniform effluent charge or a nationwide system of tradable emissions permits) that results in an equating nationwide of marginal abatement costs across sources."

In the second case, with local level variation in the environmental quality and impact of pollution, local level financing or setting of standards can be argued for. However, if the standards are set nationally, local level instruments should be available to meet the cost of extra pollution for reasons beyond its control. In a coal-rich state, there may be extra pollution for meeting national level demands for energy. If the country goes for destination based tax system like the GST, there are issues regarding meeting the cost of mitigation and adaptation for local pollution. If no suitable tax instrument is available for the sub-national governments, the cost may have to be subsidised by the national government.

In the case of environmental quality being a local public good with inter-state spillover, the ideal method would be either differentiated tax structure to internalize the cost of pollution externalities or subsidies emanating from national resources but designed to take account of regional effects. In this context, Oates (2001) observes: "The economist's usual response to such externalities is to prescribe a set of emissions taxes that internalize the social damages. But in an intergovernmental setting, this solution is less practical. The central government must either specify some set of differentiated taxes directly on polluting sources across the nation, or offer an appropriate and differentiated subsidy to local governments to induce them to internalize the inter-jurisdictional benefits from pollution control."

6.3 Design of Environmental Subsidies

Environmental subsidies aimed at pollution mitigation may be designed with four primary objectives: (a) to encourage the use of environmental friendly inputs; (b) to encourage the use of outputs that intensively use environmental friendly inputs; (c) to encourage technological innovation that will reduce the use of polluting inputs, and (d) to facilitate adoption of environment promoting technologies.

a. Allocation and Delivery of Environmental Subsidies

Fortunately, the major sources of pollution including carbon generation are limited in number. In terms of industries, attention has to be focused on coal, iron and steel, and power sectors. A major impact on carbon emissions and other local pollutants can be generated through incentivizing technological innovation that promotes environment.

b. Environment-promoting Innovation and Subsidies

Market forces will generally not lead to development of new green technologies. Subsidies can significantly support environment promoting innovation. These can be financed by suitable environmental subsidies, which in turn can be financed by environmental taxation.

A combination of taxes levied on environmentally harmful activities and subsidies that promote environment promoting technologies and innovations can lead to acceptable environmental outcomes without sacrificing growth. The tax will contain the environmental damage and innovation will ensure that desired growth takes place for a given threshold of damage. Innovation can play a key role in promoting long-term economic growth. New products and more efficient processes can lead to new business opportunities and greater profitability for innovating firms.

In respect of innovation, inventors would not generally have the foresight about the opportunities ahead and have access to the necessary financial support. Innovation is also characterized by risk of failure and need for lumpy initial investments. Individual innovators cannot also take into account the positive benefits of knowledge spillover effects.

Market imperfections that hamper the ability for innovation to be developed and for the inventor to foresee the value of the innovation may be summarized as follows:

● *Incomplete information*

Incomplete information can effect the economic potential of an innovation and related uncertainties hampers innovation to a level below the social optimum. The predictability of the policy environment regarding environmentally related taxation or tradable permit systems, changes in the level of a tax rate or in the quantity of allowances can impact on the expected rate of return of a firm. Investing in research and development activities require a higher rate of return to overcome market-related uncertainties.

● *Economies of scale*

Often economies of scale are involved in the inputs to innovation, mainly in R&D. This is so for physical infrastructure and human resources.

● *Externalities related to use*
Many times, the value of an innovative product or process grows as users use it – that is, there are dynamic increasing returns to its use. They become better at using and/or making the item, and this knowledge can leak, providing positive externalities to others.

There is a large range of innovations along the innovation continuum. There are innovations with significant public benefits (such as basic research into nuclear fusion, for example) on the one hand and there are innovations to those with significantly private benefits like a more efficient production technique that can be patented and employed by a monopolist. Firms will focus more attention on innovations with more private benefits.

Governments have undertaken several major efforts to facilitate the general innovative environment as also address the externality aspects:

- *Legal structures for patent protection*
- *Direct support of basic research*
- *Supply of researchers support to departments and placements*
- *R&D tax incentives for encouraging private R&D initiatives.*

Popp (2004) developed a model where innovation is brought about because of the new environmental policies. The effect of this innovation is an increase in welfare of 10 percent under an optimal carbon tax scenario, driven primarily by cost savings rather than additional environmental improvement. Gerlagh and Lise (2005) find that including technological change into a climate change model with a constant carbon tax brings about three times more emissions reductions than scenario without innovation being present. Kemfert and Troung (2007) find that accounting for induced technological change significantly reduces the negative GDP impacts of climate change policies. Similarly, Gerlagh (2008) finds that, accounting for technological change in his model, the optimal carbon tax is less than half of what it is in a scenario without innovation.

In modeling undertaken by the OECD, potential innovation was found to have a large impact on the costs and the climate change mitigation policies. The OECD has developed an innovation strategy (OECD, 2010) to look broadly at the issues of innovation. The development and drivers for innovation, at a basic level, are well understood. First, there are demand factors that create a "market pull" force for innovation. Consumers, reacting to a range of influences and tastes, create demand for new technological advances (and encourage competition to provide existing goods and services at lower cost). Firms react to these forces by investing in R&D and quickly deploying innovations. Second, "product/technology push" innovations, which emerge from supply side through the curiosities of researchers and engineers or as by-product of other activities.

Innovation generally tends to be capital intensive. The costs associated with new technology coupled with the likely existence of older, but still useful, capital suggests that innovation adoption will occur as older technology is replaced and new technology is needed. A common measure to look at innovation-adoption is to look at the ratio of firms adopting the innovation. More important is as to how quickly they put the innovation in place for all relevant parts of their industrial/creative/service processes. Intra-firm innovation diffusion is typically slower than inter-firm innovation because many firms can undertake some limited innovation adoption with ongoing capital replacement while integrating the innovation throughout the entire firm is more involved (Battisti and Stoneman, 2003; Battisti, 2008), suggesting that for areas of particular interest to governments, changing the direction and speed of adoption may focus on this oft-neglected area.

Finally, the diffusion of innovation is not just limited to firms within the same country. The transfer of innovation across countries (such as in intellectual property) can accelerate spread the reach of the innovation and increase abatement options for foreign polluters. Many of the same issues facing innovation adoption also face innovation transfer.

OECD (2010) observes: "the optimal amount and type of innovation to help solve global environmental challenges will likely not be achieved by environmentally related taxation alone. A strong rationale still exists for other instruments being a part of government's overall toolkit to specifically address the innovation externality. These policies could include broad-based innovation policies, such as R&D and support to universities (traditional areas of government policy intervention), or more targeted interventions where required Inputs are only one factor in the overall innovative process but, they provide a good source of information on the resources allocated to invention activities".

OECD (2010) identifies two indicators for measuring government support to innovation: (i) Government direct expenditure on R& D, and (ii) number of researchers. These measures are independent of the outcomes of the R&D process, which does have some factor of luck associated with it".

The presence of R&D activities does not necessarily translate into an innovative firm. In a survey of a number of countries, the percentage of firms having introduced a product or process innovation was significantly higher than the percentage of firms having performed R&D (OECD, 2009b).

One of the most used – and most widely available – figures is the level of government funds directly allocated to innovation. Direct spending by governments (which does not include that delivered through higher education) typically provides less than half of the total expenditures on R&D in the economy. The role of direct government expenditures on R&D has been decreasing in recent years, as funding by the private sector and higher education facilities has relatively increased.

OECD (2009c) finds that most major innovations have been patented, evaluating patent data necessarily excludes some types of innovation. Rule-of-thumb innovations and organisational innovations are difficult, if not impossible, to patent. In addition, patents necessarily reflect the innovative capacity of a country which can be characterised by the productivity of researchers, education policies and other policy tools (Rassenfosse and Pottelsberghe, 2009). Therefore, patent levels can be influenced by the propensity of a country to patent, reflected in their legal, cultural and administrative traditions. Moreover, the actual patent system itself can impact greatly on the level of patents, with administrative fees and the degree of protection a system provides its patent holders.

The European Patent Office and the OECD have developed a unique database (PATSTAT) that provides detailed information on worldwide patents (OECD, 2004). This database brings together patents from major patenting countries and categorises them according to a number of different standards. The database is updated regularly, containing over 70 million patents with significant information about their history and their intended purpose.

The work to date on the effectiveness of economic instruments to induce innovation has not been extensive. One of the most widely analysed examples is the case of sulphur dioxide (SO_2) control in the United States in the 1990s. Burtraw (2000) finds that the tradable permit system (one of the earliest, large-scale schemes) in several north-eastern states was able to achieve its objectives at significantly less cost than *ex ante* analyses had suggested.

Changes in production processes, organisational behaviour and input markets were central. For example, the flexibility brought about by the tradable permit scheme encouraged the expanded used of low-sulphur coal, facilitated by technical innovation and industrial reorganisation in the railroad sector following deregulation in the 1980s. New techniques in fuel blending were discovered. Impacted plants modified their organisational structures, shifting responsibility for the trading scheme from chemists to financial officers. Some analyses have even suggested that firms were better off after the introduction of the tradable permits system, though the large windfall gains from the grandfathering of permits likely contributed to this.

The potential for such results has led to discussion of the Porter hypothesis (Porter, 1991; Porter and van der Linde, 1995), which suggests that new environmental policies, including taxes, can act as a shock to induce firms to re-evaluate their operations. In doing so, innovations to address the new environmental policy can be found to better address pollution levels but that also increase the profitability of the firm, as firms have not previously explored all profitable opportunities. This win-win situation amounts effectively to a free lunch [or even a "paid lunch" as described by Jaffe and Palmer (1997)] for environmental policy: stronger protections for the environment and more profitable firms. The overall empirical evidence for the Porter hypothesis is not strong.

The innovation challenge related to the environment is vast. The presence of well-designed environmentally related taxation can begin to alter the trajectory of the current economic path to one that is more responsive to and innovative in addressing environmental issues. The innovations within the environmental realm that result will be vast and can generally be categorised into three types, based on how they impact the innovator/adopter: product innovation, process innovation, and organisational innovation.

(1) Product innovation: example: CFC-free aerosol deodorants or home water-saving devices.
(2) Process innovation: example: Making a power generation plant more fuel efficient is a typical example of process innovation.

Cleaner production technologies reduce the amount of pollutants created and emitted. This may be because the input source is changed or the production process is modified. Thus, power plants switching from coal to natural gas reduce the creation of emissions directly, calibrating vehicle engines to be more efficient through the use of on-board diagnostic systems can reduce the creation of emissions from driving, and eliminating chlorine from the pulp-and-paper industry can improve water quality.

End-of-pipe technologies seek to reduce the amount of pollutant emitted, not necessarily also the amount created. They do not alter the production process to reduce the pollutants in the first place, but seek to address the pollutants once they have been generated. For example, "scrubbers" are used to capture and render less harmful emissions to air, typically from power generation station. NO_x and SO_x continue to be generated by the electricity production but an after-the-fact process seeks to reduce their actual emission. Moreover, carbon capture and sequestration seeks to capture the CO_2 emissions and store them underground to prevent their release to the atmosphere but has no effect on the creation of carbon dioxide.

Cleaner production technologies are generally considered more efficient, as they cover activities that can reduce input use and make the production process more efficient in addition to meeting environmental goals, while end-of-pipe technologies are generally only aimed at addressing environmental objectives. Power generation firms are likely only able to innovate so far in their production processes to reduce emissions of mercury, SO_x, and other chemicals without fundamentally changing their production processes. As such, end-of-pipe technologies will continue to play a role in the overall mix of issues needed to address environmental challenges.

Environmental policy instruments, apart from their effects, on the different varieties of innovation, also affect the degree of innovativeness. Firms are generally focused on those technologies and solutions that are closest to being market-ready, as those technologies have a more certain probability of success compared to ideas still at the blackboard stage. This is incremental innovation, which brings about better products and more efficient means of producing them through rather small technological advances. This type of innovation can play an important role in bringing about low-cost options to address environmental issues. Because it is only tweaking existing technologies, it generally cannot bring about transformational change. Environmentally related taxation and other market-based instruments provide incentives to accelerate market-ready innovations and to develop innovations that can be brought forward quickly.

In contrast breakthrough technologies provide a major leap forward in pollution abatement and may be critical to achieving environmental targets at less costs in the long-run. These technologies make an effective break with past technologies and offer a near completely different approach. Large-scale carbon capture and storage or carbon-free energy sources would be examples. Assuming the creation of breakthrough technologies in addition to incremental innovation into climate change models, for example, has shown that these can have significant impacts on the estimated costs to GDP (OECD, 2009d; Bosetti *et al.*, 2009).

Inventors typically respond to domestic incentives for undertaking invention but, where a country is behind others, it typically uses foreign innovations (*e.g.* patents) as a starting basis (Popp, 2006a). Even where the country is not behind, other countries can be important sources of innovation. For example, the United States was the first to introduce strict vehicle emissions standards but the majority of related patents came from outside the country (Lanjouw and Mody, 1996). Many times, however, there are some differences between countries and therefore there is a need for adaptive R&D. This adaptive R&D recognises that foreign innovations are not a perfect fit given the different domestic conditions, suggesting that diffusion across countries will be slower than within countries (Pizer and Popp, 2008).

Solutions to global environmental challenges focus increasingly on the role of emerging economies, given their rapidly increasing populations and per capita wealth, where the capacity for innovation may be significantly less than developed countries. Many of these countries will be late adopters, following on the work previously done in developed countries.

Similar to accelerated depreciation provisions, the tax system can encourage other types of environmentally beneficial actions through reduced rates on consumption taxes. A number of countries have implemented reduced VAT rates to encourage consumption of less environmentally harmful products, usually energy efficient appliances.

The general view relating to VAT (in the Indian case, GST) policy is that a standard rate with few, if any, reductions is the optimal design to promote efficiency and reduce distortions in an economy (OECD, 2009e). Rate reductions reduce the revenues of government (necessitating the leveling of other, and likely more distortionary, taxes) while increasing the administrative complexity of the system, both for business and tax administrators. In many cases, rate reductions are implemented to address perceived distributional issues by providing reduced rates on food, energy, and other staples.

However, these reductions benefit both richer and poorer citizens and other forms of distributional policies are likely to be much more effective.

Rate reductions can be effective at encouraging the adoption of existing innovations among customers. In case studies of the European appliances market, the European Commission (2008) suggests that moving from countries' standard VAT rates to reduced VAT rates would lead to some significant changes in market share. "B" category refrigerators and freezers would see market shares decline by twenty points in favour of the more environmentally friendly A and A+ machines. Consumption pattern changes in washing machines and dishwashers are predicted to be slightly less. With the concurrent existence of the EU ETS – a tradable permit system with a hard cap – any emissions reductions due to this initiative will have no impact on the overall level of emissions over the current trading period.

From the innovation perspective, this instrument is likely of limited value and previous studies (Copenhagen Economics, 2008; European Commission, 2008) have not been able to clearly identify innovation induced impacts. The reduced rate can encourage firms to develop new models to take advantage of the increased demand likely to be induced by the lower after-tax price. Where the tax reduction is not passed through, the increased profit margin can be an additional incentive. However, almost exclusively, the reduced VAT is on categories of products that are already on the market, providing incentives to potentially scale-up existing production or transfer the innovation to new models, but not strong incentives to develop new innovations. Moreover, once products have met the criteria for reduced-rate VAT, there is no policy incentive to make the products more efficient, providing no additional incentive for innovation creation.

The structure of value added taxes means that such features can only effectively be targeted to consumers and not to firms. Value added taxes are levied each time a good or service is transferred. Firms are also able to claim credits for all taxes that they pay to others. The tax incidence of VAT falls squarely on final consumption, when the full value added is taxed (and taxed only once because of the refunding of taxes paid at other stages). Therefore, reduced rates of VAT on inputs to production (such as more energy efficient dishwashers for a restaurant) will provide no additional incentive, since businesses do not pay VAT.

The tax system can also be used to provide stronger incentives for innovation which can hopefully lead to newer, lower-cost solutions to environmental challenges by seeking to reduce the costs of undertaking innovation. This can occur via three channels:

- First, governments can provide accelerated depreciation allowances for innovation capital, such as testing facilities and prototype capital. These measures seek to provide a benefit to firms to purchase depreciable capital by allowing depreciation at a more rapid rate.
- Second, governments can focus on reducing the labour costs of innovation activities. This can occur through reducing employers' tax burden on labour, such as through enhanced allowances for R&D labour costs or reductions in payroll taxes or employers' social security contributions for innovation-related staff. These two general approaches can lower the after-tax costs of undertaking innovative activities (regardless of the outcome of that innovation) but can have differential effects on the factors of production used in the innovative activities (*i.e.* capital *versus* labour).
- Third, R&D tax credits can lower the after-tax costs of innovation from both capital and labour expenses by providing a tax credit for all eligible R&D-related expenses. While tax credits, tax allowances and rate reductions are different,18 they all contribute to reducing the costs of undertaking innovation. Coupled with the fact that R&D tax credits are used significantly in OECD and are more general, the rest of this section will focus exclusively on this instrument.

There are three factors that determine a firm's direct and indirect emissions: how much its outputs pollute when used, how much the firm itself pollutes when making the outputs, and how much the firm does to negate its emissions from production after the pollution has already been created.

(a) Create new products for consumers that generate fewer emissions when used. For example, firms could offer to consumers more energy-efficient appliances that reduce carbon emissions, or paints with a high solid content that release fewer VOCs into the atmosphere.
(b) Use less emission-intensive inputs (of the same type). For example, a power generation firm could switch from high-sulphur to low-sulphur coal.
(c) Use less emission-intensive inputs (of a different type). The same power generation firm could generate power from natural gas instead of coal, which will likely require more structural modifications to the existing capital stock.

(d) Reduce pollution intensity per unit of input (without modifying inputs). For example, the same plant could also optimise their equipment to reduce NO_x emissions per unit of fuel (which remains the same) but not impact the overall fuel usage per kWh. An example related to cars would be on-board diagnostic systems.
(e) Reduce input use per unit of output. For example, a power generation firm could make their overall plant more efficient for fuel use without affecting the amount of NO_x emissions per kWh by insulating to minimise heat loss. This occurs through reduced use of fuel per usable kWh, not reduced emissions per unit of fuel.
(f) Finally, undertake end-of-pipe/remedial measures. For example, an aluminium producer could reduce CO_2 emissions by using carbon capture and storage to prevent emissions from entering the atmosphere even though they have already been created.

Organisational innovation cannot be linked exclusively to one area in the equation estimating the total emissions, as they typically affect the general orientation of the firm. As such, they tend to act as complements to other types of innovations within the firm. Of course, the firm (and the consumer) could simply produce (and consume) less. Each of these alternatives is a way in which emission levels can be reduced in the economy. The choice of environmental policy instrument has a direct bearing on which actions are stimulated.

Such an instrument does not affect mitigation measures that are generally not capital intensive, such as actions one, two and four. Even for capital-intensive measures, an accelerated depreciation allowance as the sole policy instrument provides no incentive for abatement unless it is through the greater rationalisation of other inputs (such as fuel) which have a positive price in the market. For this reason, action six is not stimulated by this instrument. Similarly, generally available or environmentally targeted R&D tax credits alone cannot provide incentives for mitigation, unless these help reduce the cost of existing processes or create new products (without a price on carbon, R&D that significantly reduces the cost of carbon capture and storage, for example, would still have no economic rationale to be adopted). As such, only actions one, three and five are stimulated for invention and adoption. Assuming that the invention can be used off the shelf (that is, no adaptive R&D expenditures are required between firms), the R&D tax credit provides no additional incentive for adopting the innovation once it has been created, unless the R&D addresses the use of something that has a pre-existing market price.

Finally, reductions in value added taxes for "green" purchases provide direct incentives for consumers to adopt new innovations, as they lead to a direct and identifiable price reduction *versus* non-reduced goods and services. The incentives for firms to invest in innovation activities are less strong, as the firm receives no direct benefit from the In practice, many countries' environmental policies consist of a wide number of different tools; the OECD's *Instrument Mixes for Environmental Policy* (2007) highlights some examples. Whether multiple instruments are needed and how these tools interact can play a critical role in evaluating the policy's overall innovative and environmental performance.

Popp (2006b) finds that relying solely on taxes or R&D efforts to address the climate change issue will not be sufficient. Subsidies to R&D were more effective in inducing R&D expenditures than the introduction of a carbon tax set at the socially optimal rate. R&D subsidies alone do not bring about significant environmental benefits from the business-as-usual scenario; emissions (and the resulting atmospheric temperature) continue to rise significantly.

Combining an R&D subsidy with an optimal carbon tax provides for somewhat larger R&D expenditures than R&D subsidies alone and significantly more than an optimal carbon tax alone. In 2007, a review entitled, "Report on the Analysis of Existing and Potential Investment and Financial Flows Relevant to the Development of an Effective and Appropriate International Response to Climate Change", was conducted by the secretariat of the UNFCCC. An update was made in 2008, in which the projections were not fundamentally changed. The review provides an analysis and assessment of investment and financial flows in 2030 that will be needed to meet worldwide mitigation and adaptation requirements. The results should be seen as indicative only. One of the key findings of the review is that the additional investment and financial flows in 2030 to address climate change amounts to 0.3 to 0.5 percent of global domestic product in 2030 and 1.1 to 1.7 percent of global investment in 2030. This is a small amount in overall global figures but large compared to the currently available public and private financial resources for climate change (including the ones available under the UNFCCC and its Kyoto Protocol). Current levels of funding will be insufficient to address the future financial flows estimated to be needed for adaptation and mitigation under a strengthened future climate change deal post 2012.

For Mitigation

Mitigation measures needed to return global greenhouse gas emissions to current levels by 2030, require a small increase in global investments and financial flows: between USD 200-210 billion per annum in 2030. In many sectors, such as the power generation sector or industry, the lifetime of capital stock can be thirty years or even more. Total investment in new physical assets is projected to triple between 2000 and 2030. Due to rapid economic growth, a large share of these investments will occur in developing countries. Investments should focus on new facilities in many of these sectors.

Particularly in the energy sector, huge investment flows are needed. For energy supply, USD 432 billion is projected to be invested annually into the power sector. Of this amount, USD 148 billion needs to be shifted to renewables, Carbon Dioxide Capture and Storage (CCS), nuclear and hydro. Investment into fossil fuel supply is expected to continue to grow, but at a reduced rate. Investment flows to developing countries are estimated at about 46% of the total needed in 2030.

The Kyoto Protocol's Clean Development Mechanism, which permits industrialized countries to invest in sustainable development projects in developing countries and thereby generate tradable emission credits, already shows a significant potential to leverage domestic and international investments.

A high post-2012 demand for emission reduction credits could allow the expansion of the carbon market, which would in turn stimulate additional supply of credits. Emission caps, emission trading and project based mechanisms can thus play an important role in promoting the cost-effectiveness of fighting climate change. Funding for the Adaptation Fund post-2012 depends on the continuation of the CDM and the level of demand in the carbon market. Assuming that the adaptation levy of 2 percent on CDM projects applies post 2012, the level of funding could be:

- USD 100−500 million for a low demand for credits from non-Annex I Parties
- USD 1−5 billion in 2030 for high demand.

The level of funding available to the Adaptation Fund would be small compared with the estimated needs for adaptation (several billions worldwide). The Adaptation Fund could be further expanded with additional sources of funding.

Potential of ODA

Official Development Assistance (ODA) funds are currently less than 1 percent of investment globally. Least developed countries, such as Sub-Saharan Africa, and smaller developing countries, still attract very limited private sector investment and continue to rely on ODA and soft loans from international financial institutions.

Potential of National Policies

Policies are needed both in developed and developing countries. In terms of private funds, governments set the rules for the markets in which investors seek profits. If current market rules are failing to attract or drive private investors into lower-carbon, more climate-proof alternatives, governments can introduce policies or incentives to help address these market failures. This includes:

- Regulations and standards to overcome policy-based barriers to entry
- Taxes and charges to make the polluter pay
- Subsidies and incentives to pay the innovator

Governments also need to shift the focus of their own investments. Governments are responsible for 10−25 percent of the investment in new physical assets. Currently most of those investments are driven by local development priorities. In developing countries in particular, shifting funding to climate change related investments has to take social and development priorities into account.

Potential of International Coordination of Policies

Governments set the rules for the markets in which investors seek profits. Relevant policies are needed both in developed and developing countries. International coordination of policies by Parties in an appropriate forum will be most effective. Areas where international coordination would be beneficial include technology R&D and deployment, and energy efficiency standards for internationally traded appliances and equipment.

The major reductions in emissions between the reference and the mitigation scenarios rely on the increased energy efficiency and shifts in the energy supply from fossil fuels to renewable, nuclear and hydro and large-scale deployment of CCS. Much of the shift will need to occur in developing countries where energy demand is projected to grow most rapidly. Multilateral and bilateral funding is a significant source of investment in developing countries (1 to 7 percent).

6.4 Targeting Specific Industries in India for Subsidy Support

Although a large volume of resources can be released by converting the environmentally harmful subsidies into environment promoting subsidies supplemented by revenues from earmarked eco-taxes, their impact can be maximized by suitably targeting the most polluting industries. In the Indian context, the main industries that can be supported for encouraging innovations and substitution of cleaner inputs can be listed as energy, particularly thermal energy, iron and steel, motor vehicles, paper, textiles, and plastics. Brief observations on the kind of support are given below.

(1) **Energy and Coal**

Given the dependence of growth on supply of energy and the dependence of energy on coal, subsidies need to be stepped for cleaner coal technologies and cleaner energy production through solar and wind energy as well as run of the river mini-hydro power plants. In all these cases, the costs of technological innovation, high unit costs of energy, and high initial set-up costs have so far proved to be prohibitive. This has resulted in slow growth of these cleaner energy supply sources.

It is well known that the combustion power plants manufactured by Bharat Heavy Electricals Limited (BHEL), constitute the core of the coal-power sector in India. Although the unit size and efficiency of these BHEL-manufactured power plants have gradually increased, the basic technology remains highly polluting. As onserved by Chikkatur and Sagar (2007), there is now a range of advanced, more efficient, and cleaner technologies for producing electricity using coal. Combustion based on supercritical steam, offers higher efficiencies than sub-critical PC. These are commercially viable and internationally available. Ultra-supercritical PC, which offers even higher efficiency, is also being deployed. Adoption of these in India would require support. Among other initiatives, Chikkatur and Sagar also suggest investment in a focused plan for geological carbon storage options, with detailed assessment of CO2 storage locations, capacity and storage mechanisms in order to collect valuable information for India's carbon mitigation options and inform future technology selection as well as siting decisions for coal-power plants. Similarly washing of coal at the mine heads will reduce the weight to be transported to the power plants and reduce pollution from transport vehicles apart from that in the power production.

(2) **Iron and Steel**

In the case of iron and steel, cleaner technologies must start from the mining of iron ore itself. Recycling of iron is another area where cleaner technologies can be encouraged.

Iron and steel industry also uses a lot of coal, and clean coal technologies would help reduce pollution through the iron and steel industry also.

Innovative technology of micro addition of more earth (RE) to liquid steel is being advocated for production of cleaner and quality steel. Role of RE in steel is that of a scavenger of undesirable elements and a modifier of inclusion morphology. RE as a group are very surface reactive and combine readily with oxygen, sulphur, nitrogen to remove them from liquid steel bath. The deoxidation with RE gives lowest possible residual O_2 lower than even that attainable by vacuum degassing. They also form high melting point intermetallic compounds with tramp elements (Such as Lead, Antimony, Arsenic, Tin etc.) and neutralise their harmful effects.

Another clean technology being advocated is the use of Energy optimizing furnace (EOF), which is the basic unit proposed in place of basic oxygen furnace used for conventional steel making process. The process is being commercially exploited since 1982 but has been introduced in India, only recently. The EOF process is essentially an oxygen steel making process using combined submerged (bottom) and atmospheric (top) blowing. Oxygen is injected horizontally into the molten bath, and also into the furnace atmosphere through water-cooled injectors. These technologies need support for their fast and wide-spread adoption.

(3) **Textiles**

Throuout the value chain in the production of textiles as also for cleaning of garments, cleaner technologies have become available. In textile production, five main segments are fiber production, spinning, weaving and knitting, dyeing-printing and finishing, and garment production. In the conversion of yarn form fiber, solid waste, fiber waste, yarn waste, dust, etc. are created. In the conversion of grey fabric from yarn, waste water containing cellulose derivatives comes out. From grey fabric to finished textile, at different stages, high BOD, high TS, neutral pH, high alkalinity, wasted dyes and solids become by-products. These processes also use up considerable amount of energy. A large number of washing steps involved in the production process also consume substantial amount of water. Due to the use of a variety of dyestuffs and auxiliary chemicals, lots of color and metals appear in the wastewater and also give rise to VOC emissions. Good housekeeping, reducing excessive use of water, recovery and recycling of waste, reuse of dye solutions from dye-bath, recovery of caustic in mercerising (by effective evaporation, using membrane technology) and recovery of size in cotton, processing (using technologies like Ultra-filtration), recovery of grease in wool processing by acid cracking, centrifuging or by solvent extraction are steps that need to be encouraged not just by regulatory norms but by training, demonstration, etc. New technologies in textile manufacturing takes advantages of size by using bigger scale like Jigger-Jumbo jigger-super jumbo equipment sizes, process control like micro processor controlled pad-batches and single stage design scour-bleach processes. Eco-labeling is being used in many developed countries to distinguish between products produced by dirtier vis-à-vis cleaner technologies. Again, most of these initiatives need support.

(4) **Plastics**

While the production and usage of plastics is slated to grow, its production and disposal are major environmental hazards. New ways to use plastics like in road construction, new technologies for plastic recycling show considerable possibilities for reducing the environmental costs, and thus provide scope for intervention and encouragement.

(5) **Clean Materials Initiative**

More generally, across the spectrum of industries, usage of cleaner materials needs to be encouraged. Based on the 'Best available techniques reference documents' (BREFs) drafted at the European Integrated Pollution Prevention and Control Bureau in Seville (See ECOFYS, 2002 for details), other sources of information and expert opinion, an inventory has been established of technologies with the potential to become important for reducing future environmental impact related to material demand. The potentials of reducing the environmental impacts have been quantified for the following categories of technologies:

- material production technologies;
- material application technologies;
- material recycling and product recycling technologies;
- end-of-pipe technologies.

It has been argued that there is strong potential for cleaner production technologies and recycling technologies to reduce environmental effects for all environmental impact categories. For a number of impact categories, such as 'Carcinogenic', 'Summer smog' and 'Ozone depletion', end-of-pipe technologies have a substantial potential to reduce environmental impacts. One important area where technologies for limiting environmental impacts are missing is the recycling of cement/concrete and ceramics. Another issue is the use of oil as feedstock in the production of plastics, leading to a growth in fossil fuel depletion. Only few technologies are emerging in this area, for example the development of bio-plastics. Support for innovations in such technologies can go long way in enhancing the environmental quality.

6.5 Summary

In this Chapter, we have examined issues of finding additional resources for financing environmentally positive subsidies. While some resources should be claimed from the general budget supplemented by earmarked subsidies considerable resources can also be released by restructuring subsides. In particular environmentally harmful subsidies need to be eliminated and environmentally beneficial subsidies need to be encouraged. Support for innovation as well as for industry-specific cleaner technologies should become integral to designing a new subsidy regime in India.

Chapter 7
CONCLUSIONS

Fiscal instruments for environmental management are of two types: environmental taxes and environmental subsidies. They can be used, respectively, for discouraging environment-damaging activities and encouraging environment-promoting activities. In the first case, government also earns revenue. In the second case, government has to spend revenues. Sometimes, the two activities can be combined. The revenue earned from the same sector or other sectors from out of the levy of environmental taxes can be used for administering environmental subsidies. However, the claim for expenditure is more general since maintaining environment up to acceptable standards is considered a public good and it should be financed from the general tax revenues.

The literature on subsidy has recognized that the definition of a subsidy is a useful part of the framework for a policy discussion and that the term subsidy should be differently defined for different contexts. Barg (1996) proposed three different definitions of subsidies for economic, fiscal, and environmental issues as follows:

Economic Definition
A government-directed, market-distorting intervention which decreases the cost of producing a specific good or service, or increases the price which may be charged for it.

Fiscal Definition
Government expenditure, provision for exemption from general taxation, or assumption of liability which decreases the cost of producing a specific good or service, or which increases the price which may be charged for it.

Environmental Definition
An environmental subsidy consists of the value of uncompensated environmental damage arising from any flow of goods or services.

7.1 Defining and Measuring Environmental Subsidies

Here our focus is on government provided services. Government subsidies are seen in three forms: explicit budgetary subsidies, subsidies measured as per the National Income Accounting approach, and subsidies seen as unrecovered costs in the public provision of private goods.

The unrecovered costs are measured as the excess of aggregate costs over receipts from the concerned budgetary head. The aggregate costs comprise two elements: (i) current costs and (ii) annualised capital costs. Current costs consist of revenue (current) expenditures directly related to the provision of services classified under different heads. For capital costs, a distinction is made between three forms of government investment resulting in accumulated capital stock. These are: investment in physical capital, investment in the form of equity, and investment in the form of loans. The annualised cost of capital is obtained by applying the interest rate at which funds have been borrowed by the government to capital stock. This represents the opportunity cost of capital. In the case of physical capital, a depreciation cost is calculated, in addition. The receipts come in three forms: revenue receipts from the user charges, interest receipts on loans, and dividends on equity investment.

In the context of environment, we recognize that subsidies are often interpreted as opportunity costs which arise due to negative environmental externalities. For example, car drivers pollute the atmosphere for all citizens and gain a benefit at everyone’s expense implying that common citizens subsidize the car owners. Similarly, when farmers spray pesticides, they introduce toxic effluents into the commonly shared ecosystems. Industrialists often introduce pollutants into commonly shared water bodies. Although, this kind of subsidization is widespread, it almost goes unnoticed and unmeasured, remaining outside the conventional GNP accounting.

We have also looked at the design of suitable fiscal instruments for intervention with an environmental objective. In particular, we have looked at two part instruments consisting of environmental taxation as well as subsidies. It is recognized that these should apply to the polluting activity rather than any market transaction. But polluting activities (say, SO_x generation) are hard to monitor (the firm or the consumer have incentive to under-report). This makes both determination and enforcement of taxation as well as subsidies difficult. In order to overcome the problem, Fullerton and Wolverton (1995) have suggested a two part- instrument. They suggest an instrument that mimics the Pigouvian intervention (generating efficiency) consisting of a tax on the output/consumption of the good combining it with a subsidy to other inputs except waste.

In India, the design of fiscal instruments for environmental management has additional considerations arising because of the federal arrangements. Oates (2001) distinguishes between three cases in the context of environment issues in a federal context: with environmental quality being (a) a pure public good, (b) a local public good, and (c) local public good with spillover effects. Combinations of taxation and national subsidies can suit handling different types of environmental issues.

7.2 Perverse Subsidies in India

Several environmentally perverse subsidies have been identified in the India context. Some of these are summarized below.

a. Perverse Subsidies in Agriculture: Irrigation

A number of studies have noted the perverse long term effects of irrigation subsidies.

(1) Myers and Kent (2001) note that in India 100,000 sq. km out of 420,000 square km. of irrigated croplands have been lost to cultivation through waterlogging, and 70,000 square km. are affected by salinization. It is estimated that Indian farmers could cut back on irrigation water use by 15 percent without reducing crop yields simply by eliminating over-watering.

(2) Marothia (1997) shows that subsidized canal irrigation and subsidized electricity (in some cases free) for tube wells, remunerative output price support, availability of HYV seeds and higher returns encouraged the farmers to opt for water intensive crops. Nearly ¼th of the cultivable command area under all canal projects in India is suffering from waterlogging and soil salinity. This has adversely affected the crop productivity and restricted the choice of crops. As precise statistical data are not yet available as to the amount of irrigated lands that have fallen into disuse because of waterlogging and salinity, these concerns are inadequately addressed in most of the irrigation investment decisions.

(3) Joshi and Jha (1992) focus primarily on the problem of soil alkalinity and waterlogging in the Sharda Canal Command area and attempts to measure its impact at the farm level in terms of resource use, productivity and profitability of crop production. Four villages in the Gauriganj block were chosen for the study covering the 1985-86 cropping year. The study finds that overuse of canal irrigation and underuse of groundwater has disturbed the water balance of the area causing waterlogging and increase in salinization in the command area. The reason for under-exploitation of rather good quality groundwater is low water rate on canal irrigation. It has been shown that the cost of tube well irrigation is much higher (Rs. 825 per hectare for paddy) as compared to the rate of canal water tariff (Rs. 143.26 per hectare for paddy). Such a wide difference in the

cost of irrigation has led the farmers to discontinue the use of groundwater, resulting in an increase in water table and soil alkalinity.

(4) Sharma, Parshad and Gajja (1997), find that in Haryana about 70 percent of the geographical area is facing the problem of rising water table due to the dominance of canal irrigation, lack of adequate drainage and low extraction of ground water. Gangwar and Toorn (1987) put the economic loss due to rising and poor quality of water in Haryana at Rs. 26.8 crore and anticipates it to rise to a level of Rs.71.9 crore in 2000. The state is also salt affected. Singh (1984), estimates that an area of 450 thousand hectares under salinity/alkalinity and waterlogging. More severely affected districts are Karnal, Kurukshetra, Jind, Hisar, Sonipat and Rohtak. In the Central-Southern districts of Jind, Hisar, Sirsa and Bhiwani, where most of the area is canal irrigated , the water table rose at a fast rate during 1974-91 (0.7 metre in Rohtak to 6.5 metre in Sirsa district) leading to waterlogging and secondary salinity. Moreover, these areas are underlain by brackish water. So waterlogging is assuming gigantic proportions in various canal command areas. The worst affected districts are Rohtak, Jind, Hisar and Sirsa.

Thus, widespread and repeated use of irrigation water without provision for adequate drainage, and crop intensification in favour of high water requirement crops without utilising the groundwater has resulted in rapid rise in water table in the areas with poor quality groundwater, leading to the problem of waterlogging and salinity. On the other hand, the regions endowed with good quality groundwater are being over exploited without maintaining the water level at a reasonable depth.

b. Fertiliser Subsidy: Soil Productivity and Water Contamination

Three main fertilisers used in agriculture are urea (N), di-ammonium phosphate (DAP) and Potash (K). Of these the production of urea is under the retention price scheme. There is a flat rate subsidy on DAP. Potash, which is mainly imported, also has a flat rate subsidy. One of the main purposes of retention price scheme is to develop the urea industry in the country. Every individual plant is assured a fixed rate of return. Hence the retention prices are fixed for each individual plant. The subsidy on urea is the difference between the retention price (adjusted for freight etc.) and the price that the farmer pays. According to Gulati and Narayanan (2000), the fertiliser subsidy bill in 1988-89 amounted to Rs.112 billion. In the eighties there was an unprecedented growth in the fertiliser subsidy in India. Parikh and Suryanarayana (1992) show that the rate of fertiliser subsidy on domestic production has increased from Rs. 565.72 per tonne to Rs. 1383.33 per tonne in 1987-88.

Application of fertilisers and pesticides is essential in order to increase food production and achieve the targeted agricultural production. However, studies reveal that indiscriminate use of fertilisers has proved detrimental. According to Mehta (1971), in Gujarat region, nitrogen leaching for 90 cm. soil depth under 564 mm. rainfall was 14 kg/ha. out of 180 kg/ha. N applied. In a rice field near Delhi, loss of 14.3 kg/ha. was reported from an application of 120 kg/ha (Mahalanobis, 1971). Handa (1987) found that the main cause of groundwater pollution is indiscriminate and higher dose of fertilisers and pesticides. The study also finds that the nitrate content in the soil sample of the states where lower doses of fertilisers are used is considerably low as compared to the states where per hectare use of fertiliser is higher. It must be noted the soil health has direct impact on crop yield.

According to Sidhu and Byerlee (1992), in relatively more developed districts of Punjab, such as Ludhiana, fertilizer use has already exceeded the recommended dose at least for nitrogen. Hence marginal contribution of fertilizer to yield increases is predicted to be substantially lower in future. The study computed the land, labor and fertilizer productivity for the years 1975 and 1985 for various states of India and expressed them as percentages of Punjab figures. The results show a decline in fertilizer productivity in Punjab, Haryana, Uttar Pradesh, Madhya Pradesh and Rajasthan due to application of increasing amounts of fertilizers to maintain current levels of yield.

Sah and Shah (1992) find that in irrigated areas of Gujarat where fertilizer use is widespread and has reached 1.5 times or more than the recommended amounts, the issue of fertilizer use efficiency has become increasingly important. The analysis based on a sample of 330 farmers located in 42 villages of 5 important soil-crop zones in Gujarat, finds that excessive use of fertilizers is widespread; only one out of 5 farmers who had received soil test recommendations, used fertilizers as recommended. Farmers’ inability to visualize the effect of nutrient balance on crop output distorts their perceptions about yield response, resulting in overuse.

Singh, Singh and Kundu (1997) analyse the environmental consequences of the rice-wheat cropping system in Haryana. The study finds that increasing fertiliser use has led to diminishing marginal gains to nutrient ratio from 14.65 to 9.36 for rice and from 21.5 to 8.67 for wheat between 1970-75 and 1990-94.

Nagaraj, Khan and Karnool (1998) examine the resource use efficiency in cultivation of various crops under different cropping systems in Tungabhadra Command Area (Karnataka). The results of the study show that the regression coefficients for manure and fertilizers are negative and non-significant in production of paddy indicating a negative influence on the gross returns from paddy and that the input is used in excess of requirements.

According to Joshi (1997) adoption of nutrient responsive high-yielding varieties and application of inorganic fertilisers without soil test and widespread application with wrong nutrient balance have resulted in nutrient imbalance of the soil in many parts of the country. As a result, the actual productivity from using inorganic fertilisers was much lower than that of the potential. Nearly 70 percent of the fertiliser was applied to rice and wheat in Haryana. Several studies find that the farmers in Haryana were applying overdoses of fertiliser, particularly of nitrogenous fertiliser in most of the crops. The recommended ratio of N, P, K (4:2:1), is not being maintained due to subsidies in favour of nitrogenous fertilisers. Some economists argue that soil nutrient related problems were due to imbalance of subsidies for the major nutrients. Nutrient deficiency and loss of organic matter were among other important reasons for declining productivity of rice and wheat.

Ray (1998) observed that although use of fertilizers, pesticides and water are unavoidable for achieving the targeted agricultural growth, indiscriminate use of these inputs creates environmental problems. The study analyses fertilizer consumption data for Andhra Pradesh, Punjab, Haryana, Tamil Nadu, Bihar, Madhya Pradesh, Orissa, and Rajasthan from 1981 to 1995 and concludes that:

(a) due to use of more and more fertilizers the return from per unit of fertilizer was decreasing in almost all states;
(b) the return from per kg. of fertilizer is highest in less developed states where the rate of use of fertilizers is substantially lower as compared to the states where a high dose of fertilizer has been used; and
(c) due to the use of higher dose of fertilizers and pesticides, the pollution of soil and groundwater is more and as a consequence, the marginal physical productivity of fertilizers declined significantly.

The study notes that increasing trends in bringing land under rice and wheat and other profitable crops and applying higher doses of fertilizers are not likely to change in the near future. Therefore, efforts be made to ensure judicial use of fertilizers and pesticides so that only a small portion is left unutilized which reaches the soil and groundwater.

c. Environmental Impact of Indiscriminate Use of Pesticides

Deep concern is expressed about the excessive use of pesticides in developing countries, which is reported to have led to environmental degradation. Farah (1994) shows that some pesticides persist longer than others or break down to even more toxic components, extending the time span in which they could contaminate agricultural crops, underground water, and surface water bodies. Pesticides affect not only the location of their application but also the ecosystems far removed due to their mobility in air and water. Further, pesticides usually kill pests and their natural enemies alike. Pests are also very adept at developing resistance against the chemical pesticides intended to control them. Thus pesticide use initiated to suppress pests may lead to greater pest outbreaks. The study notes that towards the late 80s, with the growth of herbicide use, at least 48 weed species had gained resistance to chemicals. Another source estimates that from 1930 to 1960, the number of resistant anthropoid species (insects, mites, ticks) rose from just 6 to 137, an average increase of 4 resistant species per year. In the period of 1960-80, on an average 13 species per year are reported to have gained resistance to chemical pesticides. It was estimated that in 1990 approximately 504 insect and mite species had acquired resistance to pesticides in use.

The wipe out of essential predatory insects due to excessive and uncontrolled pesticide treatments has created new pests. For instance, in cotton production in the Canete Valley in Peru, spraying to control the tobacco budworm led to the rapid build-up of the cotton aphid. As chemical treatment intensified to counteract this resistance build-up, other pests developed because their natural predators were eliminated. In Mexico, the tobacco budworm developed resistance to all known pesticides and caused the cotton planted area to drop from more than 280,000 ha to a mere 400 ha in the 60s. Similarly, in Nicaragua, 15 years of heavy insecticide use on cotton were followed by 4 years in which yields fell by 30 percent.

Pesticide-related poisoning could occur in human beings as a result of excessive exposure to pesticides, through inhalation or on consuming heavily or untimely pesticide treated crops. Karwasra, Singh and Singh (1997) assess the impact of agricultural development on nature and extent of resource degradation in Haryana. They observe that in the central-southern districts, intensive canal irrigation has led to waterlogging and increase in salinity and this has encouraged profuse growth of weeds and insect-pests. To control such infestation and to propel any further harvest, intensive chemical control measures will have to be employed. The study notes that the direct ill-effects of farm chemicals have started showing its presence in the form of nitrate concentration in water and pesticides residue in different food items. Bhatnagar and Thakur (1998) show that in Haryana from 1966 to 1993 both consumption and coverage of area by pesticides has shown accelerating growth rates. Consumption of pesticides has grown at a higher rate than the growth in areas covered by the use of pesticides.

Farah (1994) notes that the pesticide users are hardly aware of the negative externalities on the environment. In the absence of government intervention through regulations and taxation, they tend to overuse pesticides and this tendency is further exacerbated due to international and national institutional economic policies which directly or indirectly lead to farmers applying more pesticides than they would otherwise.

According to Joshi (1997) pesticide consumption in Indian agriculture has increased manifold during the last three decades. Five states, namely, Andhra Pradesh, Gujarat, Maharashtra, Punjab and Tamil Nadu, accounted for more than 90 percent of the pesticide use in the country. Although the average consumption of pesticide in India is low, at 33 grams/hectare, indiscriminate use of pesticide in some pockets is causing several environmental and health problems. Farah (1994) reports that, during the 1989/90 season, $27 million worth of pesticides were used in the district of Guntur in the state of Andhra Pradesh. With an average overuse of 20 percent, $5.4 million of pesticides were wasted, which could have been avoided through better pest management. The yield losses due to pest resistance were estimated at $39.7 million. In pesticide application, the red triangle label (extremely hazardous) chemicals have a share of 26 percent in Andhra Pradesh, 39.7 percent in Punjab and as high as 65 percent in Gujarat of the reported use. The yellow triangle label (highly hazardous) group constitutes 59 percent each in Andhra Pradesh and Punjab and 34 percent in Gujarat of the reported use. An analysis of the pesticide use behavior found that pesticide use levels are determined significantly by the extent of irrigation. The intensity of use is higher on small farms. Joshi (1997) shows that with the increase in pesticide use in Punjab, 525 insects have already developed resistance to pesticides. Marothia (1997) reports that nearly 70 percent of all pesticides consumed by Indian farmers belong to banned or severely restricted categories in the developed countries. The Indian Council of Medical Research conducted an extensive study in 1993 covering all the states of India. Results of this study indicate that the samples far exceeded the tolerance limits of pesticide residuals in the case of milk, canned fruit products, poultry feeds and vegetables. The report emphasizes that the private benefits of pesticides use should be evaluated against their social costs. It has been estimated that only 10 percent of the total food grains production can be saved from increased pesticides use. Once the health hazards and other costs are imputed these benefits appear too meager.

Pesticides also find their way into the river through agricultural runoffs because the upstream catchment areas are intensely cultivated. Around 150 tons of pesticides and herbicides are used in the agricultural and plantation areas. The deadly impact of these chemicals has caused destruction of several types of fish and aquatic organisms in recent years.

d. Electricity Subsidies

Electricity subsidies in India (measured as under recovery of costs) are very large and give rise to economic, environmental and social costs – although hidden in these estimates are substantial costs due to procurer and other systemic inefficiencies.

The primary effect of the electricity subsidies is to distort the overall energy market in favour of electricity which results in higher electricity intensity of GDP. Production of electricity which is largely coal based in India, has implications for both local and global pollutants. Electricity subsidies may also indirectly hold back rural development by undermining the ability of the state electricity boards to invest in extending distribution networks to villages. Lack of electricity contributes to poverty, as it precludes most industrial activities and the jobs they create. Subsidies also create incentives for both suppliers and users for inefficiency – which only harms both environment, economy, and society (UNEP, 2003).

7.3 Budgetary Environmental Subsidies in India

The budgetary heads that have an environmental impact both in the social and economic services needs to be first identified. With this in view the service are classified into two groups, Group A and Group B. Those that have a 'direct positive' effect on environment are included in Group A. The remaining services, those that have an adverse or mixed effect on environment are placed in Group B. Most Group B items will be judged by the fact that the primary objective of the service is not related directly to environment and the adverse or mixed effects are likely to be generated indirectly or incidentally. The grouping categorisation is similar to the study by Pandey and Srivastava (2001). The grouping is detailed below.

Group A

(1) Sewerage and Sanitation
(2) Soil and Water Conservation
(3) Fisheries
(4) Forestry and Wildlife
  - Forest Conservation, Development and Regeneration
  - Environmental Forestry and Wildlife
  - Afforestation and Ecology Development
(5) Agricultural Research and Education
  - Soil and Water Conservation
  - Fisheries
  - Forestry
(6) Special Areas Development Programme
  - Drought Prone Areas
  - Desert Development Programme
  - Wasteland Development Programme
(7) Flood Control and Drainage
  - Flood Control
  - Anti-Sea Erosion
(8) Non-Conventional Sources of Energy
(9) Ecology and Environment
  - Prevention and Control of Pollution

Group B

(1) Major and Medium Irrigation
(2) Minor Irrigation
(3) Command Area Development Programme
(4) Fertiliser
(5) Pesticide and Chemicals
(6) Mining in Iron and Steel Industries
(7) Cement and Non-metallic Industries
(8) Non-ferrous Mining and Metallurgical Industries
  - Mineral Exploration in Geological Survey of India
  - Mineral Exploration in Regulation and Development of Mines

The volume of subsidies has been estimated for these budgetary heads for the Central Government and for four states viz., Maharashtra, Gujarat, West Bengal and Rajasthan for the year 2008-09. The basic data is drawn from the Finance Accounts of the Central and the State governments.

The attention to environmental subsidies seems to be mixed. Some states are investing in agricultural input subsidies for betterment of the agricultural sector but in the process are harming agriculture itself through a degeneration of the environment. It is observed that adequate environmental protection is lacking in the four states considered. To fully analyse the existing scenario and to draft appropriate policies there is a need for appropriate and reliable data generation. Some of the main findings are as follows:

(i) The identified environment implicit subsidies account for less than one percent of the GDP over the period 1994-95 to 2008-09.

(ii) Centre has a higher share in some of the Group B subsidies. Off the total environmental subsidies Group B accounts for 80-90 percent during the period 1994-95 to 2008-09. Off which in Group B services fertiliser subsidies account for major share (96 to 98 percent).

(iii) A profile of recovery rates for environmental related subsidies across the four states shows that they are extremely low. Though in 2008-09 the recovery rates have been substantially higher in Group B services due to inclusion of non-ferrous mining and metallurgical industries, a surplus sector. In the centre the rates are high as cement and non-metallic industries and non-ferrous mining and metallurgical industries are surplus sectors.

(iv) Inter-state comparisons of per capita environmental related subsidies broadly indicate that:

- per capita subsidy is higher for states with higher per capita incomes; and
- a substantial share of environmental subsidies pertains to forest conservation, development and regeneration in Group A services and in Group B services non-ferrous mining and metallurgical industries followed by irrigation.

(v) There seems to be a positive relationship between per capita revenue expenditure on environment promoting schemes and per capita income of the state, indicating that the propensity of a state to invest in environmental subsidies depends largely on financial condition of the state.

7.4 Reform of Environmentally Harmful Subsidies in India

It is time that environmentally harmful subsidies are reformed and converted into environment promoting subsidies. Increasing support for analytical research and policy dialogue in developed countries underline that decisive progress is needed (e.g. OECD, 2006, OECD 2007, OECD 2009, TEEB, 2009) towards the reform of environmentally harmful subsidies.

The barrier to the reform on the one hand has been the resistance by vested interests and associated difficulty of gaining public support, on the other hand it is hindered by the lack of preparedness in terms of an agreed method to define, identify and quantify them, and the lack of application of the available tools in assessing the wider implications of the impact of their removal including the economic, social and environmental dimensions.

There can be various ways to address these. One is to formulate alternative policies that target the same subsidy objectives better, while also compensating losers. A related measure is to develop an economic and environmental-policy context that encourages subsidy removal through reducing government controls generally and freeing up markets. A subsidiary measure is to introduce provisions that require surviving subsidies to be re-justified periodically, thus avoiding the perpetual subsidy problem. All these measures can be strongly reinforced by promoting transparency about perverse subsidies, especially in the context of their impacts both economic and environmental, and their costs to both taxpayers and consumers.

However, Policy makers considering removing subsidies or considering reforming subsidies will need to understand the linkages between the existing subsidies and the underlying economic and environmental reality. This lack of preparedness (in reducing economically and environmentally harmful subsidies) in terms of both the magnitudes of subsidy and their impact on the environment is seen as equally challenging, if not more, as political and institutional concerns.

Various studies of the OECD (OECD, 1998; OECD 2005; and OECD, 2007) have developed tools for the analysis of the linkages between financial support to an activity and its environmental impacts. These tools constitute an attempt to unfold the linkages and the circumstances that cause, mitigate, or have rebound effects on the environmental harmfulness of a subsidy. Three different tools have been developed to provide: (i) a framework for the identification of environmentally harmful subsidies, (ii) to assess whether the subsidy removal will benefit the environment, and (iii) help to understand the wider implications of subsidy removal including the economic and social dimensions. The main features of the tools and insights on the crucial elements behind the tools are illustrated in OECD (2009a). These tools have been used to develop a methodology such that these tools can be tested on the selected case studies. The aim of the tests were to assess the strengths and weaknesses, the effectiveness, the user friendliness and the data requirements of the tools as well as gain an overall impression of their use and develop guidelines for removal of environmentally harmful subsidy.

The System of Integrated Environment and economic Accounts (SEEA) is a satellite system to the system of national accounts that has been under development since the early 1990s. The system brings together economic and environmental information in a common framework to measure the contribution of the environment to the economy and the impact of the economy on the environment. It aims to provide policy makers with indicators and statistics to monitor these interactions and provide a database for strategic planning. This is an international system based on a UN initiative. In Europe, the information is harmonized and coordinated by Eurostat. The SEEA covers: flows of materials per industry (energy, material, and emissions waste); economic variables (labor taxes, subsidies, costs, products and services); and natural resources (stocks, quality, value).

Under the Swedish system of SEEA, subsidies are classified as environmentally motivated subsidies, potentially damaging subsidies, and other subsidies. Subsidies are classified through a detailed review of budget proposals to determine which budget lines have an environmental motive. The SEEA definition of subsidies covers on-budget subsidies to industry, transfers to international beneficiaries and households, as well as capital transfers. While some off-budget subsidies such as tax exemptions can be calculated from SEEA data where there is a direct link between emissions and taxes, other off-budget subsidies such as preferential market access and exemptions from government standards are not currently included given difficulties in obtaining such data (cited in OECD, 2009a).

Methodology developed in OECD (2009a) not only helps to identify and prioritize those subsidies that have clear environmental implication and are more politically viable for reform but also helps to identify information and analytical gaps with regard to identifying environmental benefits and tradeoffs with social and economic objectives, subsidy reform can potentially bring about. There is merit in using this methodology in future work on environmentally harmful subsidies in a developing country like India with a view to develop a strategy for reform of such subsidies.

The financing of environment-promoting subsidies can come from the following sources:

1. Government Budget

a. Taxation

Considering that promotion of environment can be considered as a public good with associated high positive externalities, common property features, non-excludability and non-rivalry in consumption, the ideal method of financing is through taxation. Suitable allocation from the general budgetary resources should be made to finance environment-promoting activities, directly or through subsidies.

b. Cess or Earmarked Revenues

Given competing claims on budgetary resources, it is often the case that adequate priority to environment promotion is not accorded. Often the committed expenditure in the budget become very large and the discretionary space becomes limited and promotion of environment gets relegated in term of importance. Therefore a more practical strategy may be to earmark amounts through cess or excise duties that must be used only for purposes of promoting environment. Examples are: coal cess, petroleum cess, which is earmarked for expenditure on the concerned sector or industry. The coal cess is meant to be spent for cleaning of coal. In the context of GST, this question has to be rethought. In the current discussions on GST, the idea is to abolish all cesses and surcharges. However, in the scheme proposed in Srivastava *et. al.* (2011), in the case of the taxation of petroleum and other major polluting goods and services, a non-rebatable excise or cess over and above the core GST rate has been proposed. The revenue from this additional non-rebatable rate can be earmarked for use for environmental purposes only. Here also, an excise may be preferable over a cess since the cess will be sector specific but the overall revenue from the non-rebatable excise can be earmarked for reducing pollution and promoting environment considering all sectors together. These revenues can be used for environment promoting subsidies.

c. Restructuring Subsidies

A third source for financing environment-promoting subsidies can be restructuring of subsides. In particular, resources can be released from environmentally perverse subsidies and these resources can then be allocated towards correcting the environmental damage. In Chapter 5, we have estimated that the share of environmentally perverse subsidies in India is quite large and that considerable resources can be released by discontinuing these subsidies and using these resources for environment promoting subsidies.

2. Private Resources

The idea of a subsidy is to induce the private sector also to commit to expenditure that may promote environment. Government subsidies can then leverage private resources.

3. International Resources

Individual countries can also access international resources. Many of these resources are asking for matching contributions. The government's resources can be leveraged to get international resources also.

In international discussions "mitigation specific" and "mitigation relevant" support are being distinguished. "Mitigation specific support" aims to achieve greenhouse gas mitigation in developing countries as its main objective; it may also target fulfillment of related reporting requirements. Mitigation specific financial support could also be defined to include public and/or private support pertaining to investment flows under the Clean Development Mechanism under the Kyoto Protocol.

Another important policy message from this analysis is the need for domestic policy frameworks to steer private investments across relevant sectors and, within each sector, towards projects fostering mitigation. Capacity building and financial support for mitigation will need to work with partner countries to establish national enabling environments to attract investment and to incentivize investment in low carbon development. Combining existing sources of information about private investment with those on public investment will inevitably provide a more accurate picture of the evolution of mitigation support and shed some light on trends in key mitigation endpoints (e.g., investment in renewable or other low-carbon energy technologies).

7. 5 Subsidies and Innovation

The innovation challenge related to the environment is vast. The presence of well-designed environmentally related taxation can begin to alter the trajectory of the current economic path to one that is more responsive to and innovative in addressing environmental issues. The innovations within the environmental realm are vast and can be generally categorized into three types, based on how they impact the innovator/adopter: product innovation, process innovation, and organizational innovation.

Examples of product innovation include CFC free aerosol deodorants or home water–saving devices. The process innovation on the other hand can aim at making a power generation plant more fuel efficient. Cleaner production technologies reduce the amount of pollutants created and emitted. This may be because the input source is changed or the production process is modified. Thus, power plants switching from coal to natural gas reduce the creation of emissions directly, calibrating vehicle engines to be more efficient through the use of on-board diagnostic systems can reduce the creation of emissions from driving, and eliminating chlorine from the pulp-and-paper industry can improve water quality.

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Appendix A

ESTIMATING DEPRECIATION RATE

Let the life of a capital asset be T years. The rate of depreciation would be (1/T) per year for the asset to be written off. For example, if T = 50 (years), 1/T = .02. Let the current year be T + 1. The past years under consideration are from 1 to T. Let nominal investments in these years be written as

$I_1, I_2, \ldots, I_T$

Assuming an investment growth rate of z, we have

$I_2 = (1 + z)\, I_1$

$I_T = (1 + z)^{T-1}\, I_1$

Thus,

$I_1 = I_T/(1 + z)^{T-1}$

Correspondingly,

$I_1 = I_T/(1 + z)^{T-1}$

$I_2 = I_T/(1 + z)^{T-2}$

$I_{T-1} = I_T/(1 + z)$

$I_T = I_T$

If the long-term rate of inflation is \`I', a nominal amount of 1 in year 1, is $(1 + i)^{T-1}$ in terms of the prices of the T_{th} year.

Then, the sum of I_1, etc., in terms of the prices of the T_{th} year can be written as

$$I_T\left(\frac{1+i}{1+z}\right)^{T-1} + I_T\left(\frac{1+i}{1+z}\right)^{T-2} + \ldots\ I_T$$

$$= I_T\,[w^{T-1} + w^{T-2} + \ldots + 1]$$

where

$$w = \left(\frac{1+i}{1+z}\right)$$

Let, $K_T = (I_T + I_{T-1} + \ldots + I_1)$ indicate aggregate capital expenditure obtained by summing investments measured in the prices of the respective years in which they were made. We can write:

$$K_T = I_T + \frac{I_T}{(1 + z)} + \ldots + \frac{I_T}{(1 + z)^{T-1}}$$

$$= I_T\left[1 + \left(\frac{1}{1+z}\right) + \ldots + \left(\frac{1}{1+z}\right)^{T-1}\right]$$

$$= I_T \,[1 + x + \ldots + (x)^{T-1}]$$

where

$$x = 1/(1 + z)$$

or

$$I_T = K_T/(1 + x + \ldots + x^{T-1})$$

Depreciation for one year in terms of the prices of year T is given by

$$= \left(\frac{1}{T}\right) I_T \,(1 + w + w^2 + \ldots + w^{T-1})$$

$$= \left(\frac{1}{T}\right) K_T \,\frac{(1 + w + w^2 + \ldots + w^{T-1})}{(1 + x + \ldots + x^{T-1})}$$

Depreciation in terms of prices of year (T + 1), i.e., the current year, can be obtained by multiplying the above expression further by (1 + i). Thus, if K_T (i.e., outstanding accumulated capital stock in nominal terms) is to be used as the base, the depreciation rate on this should be

$$\left(\frac{1}{T}\right)\left(\frac{1 + w + w^2 + \ldots + w^{T-1}}{1 + x + x^2 + \ldots + x^{T-1}}\right)(1 + i)$$

We will refer to this expression as the adjusted depreciation rate (ADR). By simulating with alternative values of parameters (I, z) the following features regarding the impact of changes in the parameters on the depreciation rate can be derived.

(i) The higher inflation rate, the higher is the depreciation rate, for any given rate of growth of investment.

(ii) The higher investment growth rate, the lower is the depreciation rate for any given inflation rate.

There are several features and limitations of the estimation methodology, which arise from various assumptions made, or procedures followed at different steps. In particular, it may be noted that tax expenditures are not included in the estimates. Average life of an asset is assumed to be fifty years. Estimates are based on actual prices even if these are administered and not on the basis of market prices which would prevail in the absence of regulations. Subsidies arising from administered price regimes, or off-budget subsidies, are also not captured here. However, Srivastava and Bhujanga Rao *et. al.* (2003) study separately considers some of the implications of off budget and cross-subsidies. Similarly, some of these have also been captured in the Report on Central Government Subsidies in India (2004).

Appendix B

Table B.1: Explicit Subsidies in the Central Budget

(Rs. Crore)

	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11 (RE)	2011-12 (BE)
A. Major Subsidies	30447	40716	43535	44753	44480	53495	67498	123581	135508	154212	134411
1. Food	17499	24176	25181	25798	23077	24014	31328	43751	58443	60600	60573
2. Indigenous(Urea) Fertiliser	8044	7790	8521	10243	10653	12650	12950	17969	17580	15080	13308
3. Imported (Urea) Fertiliser	47	0	0	494	1211	3274	6606	10079	4603	6396	6983
4. Sale of decontrolled fertilizer with concession to farmers	4504	3225	3326	5142	6596	10298	12934	48555	39081	33500	29707
Total Fertiliser Subsidy	*12595*	*11015*	*11847*	*15879*	*18460*	*26222*	*32490*	*76603*	*61264*	*54976*	*49998*
5. Petroleum Subsidy	0	5225	6351	2956	2683	2699	2820	2852	14951	38386	23640
6. Grants to NAFED for MIS/PPS	353	300	156	120	260	560	860	375	850	250	200
B. Other Subsidies	763	2817	788	1204	3042	3630	3428	6127	5843	9941	9159
7. Import/Export of sugar Edible Oils etc.	8	0	0	0	0	0	0	0	198	918	366
8. Interest Subsidies	210	750	170	564	2177	2809	2311	3493	2687	5223	6869
7. Grants to NAFED for MIS/PSS											
9. Other Subsidies	545	2067	618	640	865	821	1117	2634	2958	3800	1924
Total-Subsidies	31210	43533	44323	45957	47522	57125	70926	129708	141351	164153	143570

Source: GoI (2011), Union Budget, 20011-12, Expenditure Budget Vol. 1, Annexure 3.1 p. 135.

Table B.2: Estimation of Depreciation Rate

(Rs. crore)

Year	GDCF Public Sector	Gross Domestic Capital Formation (GDCF)			GDCF- Public Sector after adjustment
	Current prices Nominal Investment	Current Prices	Constant Prices at 1999-00 prices	Deflator (long term rate of inflation)	
1955-56	563	1,395	39798	0.04	16061.85
1956-57	738	192	48223	0.00	185357.16
1957-58	908	1,829	44927	0.04	22303.84
1958-59	989	1,755	44633	0.04	25152.16
1959-60	1,000	1,951	44355	0.04	22734.50
1960-61	1,259	2,433	52500	0.05	27167.08
1961-62	1,272	2,419	51617	0.05	27142.13
1962-63	1,590	2,880	58725	0.05	32421.09
1963-64	1,852	3,143	63651	0.05	37506.09
1964-65	2,146	3,677	69412	0.05	40510.78
1965-66	2,438	4,432	77792	0.06	42792.62
1966-67	2,366	5,251	84686	0.06	38157.89
1967-68	2,570	5,130	79229	0.06	39691.72
1968-69	2,422	5,073	77235	0.07	36874.27
1969-70	2,530	6,285	87852	0.07	35364.45
1970-71	3,104	6,965	89870	0.08	40051.18
1971-72	3,631	7,759	94318	0.08	44138.25
1972-73	4,152	8,085	93933	0.09	48238.69
1973-74	5,212	11,304	111567	0.10	51440.84
1974-75	6,083	12,951	100075	0.13	47004.57
1975-76	8,236	14,079	103685	0.14	60654.14
1976-77	9,360	16,011	117640	0.14	68772.12
1977-78	8,689	18,530	129808	0.14	60868.95
1978-79	10,805	23,729	156955	0.15	71469.46
1979-80	12,898	24,793	141769	0.17	73752.13
1980-81	12,994	28,975	149728	0.19	67146.35
1981-82	18,092	33,507	144196	0.23	77858.18
1982-83	21,543	36,353	143958	0.25	85310.35
1983-84	22,810	40,608	151247	0.27	84957.25
1984-85	27,366	48,745	163269	0.30	91661.08
1985-86	32,063	59,623	178991	0.33	96254.61
1986-87	37,275	64,391	179971	0.36	104182.56
1987-88	26,361	79,089	205216	0.39	68400.14
1988-89	43,137	99,470	233728	0.43	101360.46
1989-90	49,707	118,371	249711	0.47	104860.01

Table B.2: Estimation of Depreciation Rate (contd.)

(Rs. crore)

Year	GDCF Public Sector	Gross Domestic Capital Formation (GDCF)			GDCF-Public Sector after adjustment
	Current prices Nominal Investment	Current Prices	Constant Prices at 1999-00 prices	Deflator (long term rate of inflation)	
1990-91	56,874	148,206	291611	0.51	111905.62
1991-92	62,052	144,466	246099	0.59	105706.08
1992-93	68,533	173,498	269647	0.64	106512.57
1993-94	75,923	194,724	286305	0.68	111630.48
1994-95	94,775	259,355	349266	0.74	127630.80
1995-96	97,749	311,782	375888	0.83	117847.33
1996-97	103,159	330,806	374006	0.88	116630.55
1997-98	107,830	385,808	419378	0.92	117212.52
1998-99	122,849	408,109	419885	0.97	126393.81
1999-00	144,610	506,244	506244	1.00	144610.00
2000-01	144,638	488,658	511788	0.95	151484.25
2001-02	156,537	474,448	520655	0.91	171782.31
2002-03	149,399	555,287	619485	0.90	166671.36
2003-04	174,579	665,625	775647	0.86	203435.38
2004-05	216,962	795,642	1013761	0.78	276440.43
2005-06	272,002	950,102	1271953	0.75	364143.81
2006-07	321,753	1,053,323	1487786	0.71	454466.11
CGR	0.1304			0.0789	4.77
	(z)			(ρ)	

Source (Basic Data): CSO, National Account Statistics, 2007, 2009 and 2010.

Table B.3: Estimating Environment-Related Budgetary Subsidies for Centre: 2008-09

(Units in Rs. Lakh)

INDIA (Centre)	**Rev Rec.**	**Rev Exp.**	**Div.**	**Int.on Loans**	**Effect. int. rate** 0.09293		**Total Rec.**	**Subsidy**	**Recvy. Rate (%)**
Parameters :					**Annualised Cost of Cap.***	**Total Costs**			
Description									
Sewerage & Sanitation	3.64	123379.39			230.21	123609.60	3.64	123605.96	
Soil and Water Conservation		2312.67		19.24	310.87	2623.54	19.24	2604.30	0.73
Fisheries	610.53	18875.07		1.42	3889.01	22764.08	611.95	22152.13	2.69
Forestry and Wildlife	**2151.52**	**68185.10**	**0.51**		**3603.23**	**71788.33**	**2152.03**	**69636.30**	**3.00**
Forest Cons., Dev., and Regen.	953.53	23352.96			3338.98	26691.94	953.53	25738.41	3.57
Environ. Forestry and Wildlife	1197.99	8816.11	0.51		264.24	9080.35	1198.50	7881.85	13.20
Afforestation and Ecology Development		36016.03				36016.03		36016.03	
Agri. Research and Education	0.11	36511.00				36511.00	0.11	36510.89	
Special Areas DevProg.		156028.71				156028.71		156028.71	
Flood Control and Drainage		17527.81				17527.81		17527.81	
Non-Conv. Sources of Energy	51.62	37699.35		180.63	10254.20	47953.55	232.25	47721.30	0.48
Ecology and Environment		47379.87				47379.87		47379.87	
Total A	**2817.42**	**507898.97**	**0.51**	**201.29**	**18287.51**	**526186.48**	**3019.22**	**523167.26**	**0.57**
Industry									
Mining	27.03			112.55	1167.88	1167.88	139.58	1028.30	11.95
Cement and Non-metallic Industries	40437.66	201.84		1886.04	21753.33	21955.17	42323.70	-20368.53	192.77
Fertiliser	140.82	1945573.10	8285.79	568.70	141684.34	2087257.44	8995.31	2078262.13	0.43
Pesticide and Chemicals	908.02	1738.50			8155.78	9894.28	908.02	8986.26	9.18
Non-Ferrous Mining and Metallurgical Industries		2691.05	54089.17		43859.30	46550.35	54089.17	-7538.82	116.19
Irrigation									
Major and Medium Irrigation	663.89	29809.87			4065.46	33875.33	663.89	33211.44	1.96
Minor Irrigation	39.41	14638.81			759.88	15398.69	39.41	15359.28	0.26
Command Area DevProg.					120.40	120.40	0.00	120.40	
Total B	**42216.83**	**1994653.17**	**62374.96**	**2567.29**	**221566.38**	**2216219.55**	**107159.08**	**2109060.47**	**4.84**
Total (A+B)	**45034.25**	**2502552.14**	**62375.47**	**2768.58**	**239853.89**	**2742406.03**	**110178.30**	**2632227.73**	**4.02**

Basic Source: GoI, Union Finance Accounts 2007-08 and 2008-09.

Notes: * including imputed interest on investment, dividends and return on capital stock

Agricultural Research & Education comprises of Soil & Water Conservation (02), Fisheries and Forestry (05).

Special Areas Development Programme comprises Drought Prone Areas (02), Devlp./Desert Devlp. Progs. (03) and Wasteland Devlp. Progs. (05)

Flood Control & Drainage comprises Flood Control (01) and Anti-Sea Erosion (02).

Non-Ferrous Mining and Metallurgical Industries includes Geological Survey of India's Mineral Exploration [2853 (01/102)] and Regulation and Development of Prevention [2853 2/102)] and Control of Pollution under Ecology and Environment [3435 (04)]

Mining under Iron and Steel Industries [2852 (01/101)]

Pesticide and Chemicals under Chemicals and Pharmaceutical Industries [2852 (05/205)]

Table B.4: Estimating Environment-Related Budgetary Subsidies for Maharashtra: 2008-09

(Units in Rs. Lakh)

Maharashtra	**Rev Rec.**	**Rev Exp.**	**Div.**	**Int.on loans**	**Effect. int. rate** 0.09200		**Total Rec.**	**Subsidy**	**Recvy. Rate (%)**
Parameters :					**Annualised Cost of Cap.***	**Total Costs**			
Description									
Sewerage & Sanitation	229.24	5697.50			96.49	5793.99	229.24	5564.75	3.96
Soil and Water Conservation		3086.87			48415.21	51502.08		51502.08	
Fisheries	675.93	14780.78			4053.44	18834.22	675.93	18158.29	3.59
Forestry and Wildlife									
Forest Cons., Dev., and Regen.	24728.41	54752.21			7207.79	61960.00	24728.41	37231.59	39.91
Environ. Forestry and Wildlife	1247.47	7031.25			-66.81	6964.44	1247.47	5716.97	17.91
Agri. Research and Education		1007.75			188.38	1196.13		1196.13	
Special Areas DevProg.		14328.79				14328.79		14328.79	
Flood Control and Drainage					2442.06	2442.06		2442.06	
Non-Conv. Sources of Energy	12.99	2339.43				2339.43	12.99	2326.44	0.56
Ecology and Environment		3915.02				3915.02		3915.02	
Total A	**918.16**	**45156.14**			**55195.58**	**100351.72**	**918.16**	**99433.56**	**0.91**
Industry									
Mining					19.01	19.01		19.01	
Cement and Non-metallic Industries									
Fertiliser					60.68	60.68		60.68	
Pesticide and Chemicals					2.52	2.52		2.52	
Non-Ferrous Mining and Metallurgical Industries	121566.56	9747.40			40.31	9787.71	121566.56	-111778.85	1242.03
Irrigation									
Major and Medium Irrigation	63176.40	143202.32			719657.55	862859.87	63176.40	799683.47	7.32
Minor Irrigation	4755.03	48543.26			167612.22	216155.48	4755.03	211400.45	2.20
Command Area DevProg.		1371.15			41.04	1412.19		1412.19	
Total B	**189497.99**	**202864.13**			**887433.33**	**1090297.46**	**189497.99**	**900799.47**	**17.38**
Total (A+B)	**190416.15**	**248020.27**			**942628.91**	**1190649.18**	**190416.15**	**1000233.03**	15.99

Basic Source: GoI, State Finance Accounts 2007-08 and 2008-09.

Notes: * including imputed interest on investment, dividends and return on capital stock

Agricultural Research & Education comprises of Soil & Water Conservation (02), Fisheries and Forestry (05).

Special Areas Development Programme comprises Drought Prone Areas (02), Devlp./Desert Devlp. Progs. (03) and Wasteland Devlp. Progs. (05)

Flood Control & Drainage comprises Flood Control (01) and Anti-Sea Erosion (02).

Non-Ferrous Mining and Metallurgical Industries includes Geological Survey of India's Mineral Exploration [2853 (01/102)] and Regulation and Development of Prevention [2853 2/102)] and Control of Pollution under Ecology and Environment [3435 (04)]

Mining under Iron and Steel Industries [2852 (01/101)]

Pesticide and Chemicals under Chemicals and Pharmaceutical Industries [2852 (05/205)]

Table B.5: Estimating Environment-Related Budgetary Subsidies for Gujarat: 2008-09

(Units in Rs. Lakh)

Gujarat	Rev Rec.	Rev Exp.	Div.	Int.on loans	Effect. int.rate 0.09291		Total Rec.	Subsidy	Recvy. Rate (%)
Parameters :					Annualised Cost of Cap.*	Total Costs			
Description									
Sewerage & Sanitation		2634.62			0.81	2635.43		2635.43	
Soil and Water Conservation		31934.57			1543.37	33477.94		33477.94	
Fisheries	510.17	13371.36			465.97	13837.33	510.17	13327.16	3.69
Forestry and Wildlife									
Forest Cons., Dev., and Regen.	4050.69	15370.79			34446.01	49816.80	4050.69	45766.11	8.13
Environ. Forestry and Wildlife		4967.06			1.98	4969.04		4969.04	
Agri. Research and Education		118.95				118.95		118.95	
Special Areas DevProg.		3760.15				3760.15		3760.15	
Flood Control and Drainage		2922.36			1709.80	4632.16		4632.16	
Non-Conv. Sources of Energy		200.00				200.00		200.00	
Ecology and Environment									
Total A	**510.17**	**54942.01**			**3719.95**	**58661.96**	**510.17**	**58151.79**	**0.87**
Industry									
Cement and Non-metallic Industries					0.61	0.61		0.61	
Fertiliser					112.88	112.88		112.88	
Pesticide and Chemicals					0.09	0.09		0.09	
Non-Ferrous Mining and Metallurgical Industries	154956.08	129.61	2353.20		81.97	211.58	157309.28	-157097.70	74348.80
Irrigation									
Major and Medium Irrigation	45577.18	34313.46			317822.65	352136.11	45577.18	306558.93	12.94
Minor Irrigation	1456.60	36627.34			48692.37	85319.71	1456.60	83863.11	1.71
Command Area DevProg.		964.01			0.74	964.75		964.75	
Total B	**201989.86**	**72034.42**	**2353.20**		**366711.32**	**438745.74**	**204343.06**	**234402.68**	**46.57**
Total (A+B)	**202500.03**	**126976.43**	**2353.20**		**370431.26**	**497407.69**	**204853.23**	**292554.46**	41.18

Basic Source: GoI, State Finance Accounts 2007-08 and 2008-09.

Notes: * including imputed interest on investment, dividends and return on capital stock

Agricultural Research & Education comprises of Soil & Water Conservation (02), Fisheries and Forestry (05).

Special Areas Development Programme comprises Drought Prone Areas (02), Devlp./Desert Devlp. Progs. (03) and Wasteland Devlp. Progs. (05)

Flood Control & Drainage comprises Flood Control (01) and Anti-Sea Erosion (02).

Non-Ferrous Mining and Metallurgical Industries includes Geological Survey of India's Mineral Exploration [2853 (01/102)] and Regulation and Development of Prevention [2853 2/102)] and Control of Pollution under Ecology and Environment [3435 (04)]

Mining under Iron and Steel Industries [2852 (01/101)]

Pesticide and Chemicals under Chemicals and Pharmaceutical Industries [2852 (05/205)]

Table B.6: Estimating Environment-Related Budgetary Subsidies for Rajasthan: 2008-09

(Units in Rs. Lakh)

Rajasthan	Rev Rec.	Rev Exp.	Div.	Int.on Loans	Effect. int. rate 0.10592		Total Rec.	Subsidy	Recvy. Rate (%)
Parameters :					Annualised Cost of cap.*	Total Costs			
Description									
Sewerage & Sanitation	3013.50	18082.81			1033.64	19116.45	3013.50	16102.95	15.76
Soil and Water Conservation		4280.42			4136.46	8416.88		8416.88	
Fisheries	740.48	1122.09			106.26	1228.35	740.48	487.87	60.28
Forestry and Wildlife									
Forest Cons., Dev., and Regen.	5131.42	25953.51			9269.05	35222.56	5131.42	30091.14	14.57
Environ. Forestry and Wildlife	642.21	31182.25			288.33	31470.58	642.21	30828.37	2.04
Agri. Research and Education		13.86			2.84	16.70		16.70	
Special Areas DevProg.		6673.70			0.00	6673.70		6673.70	
Flood Control and Drainage					2732.97	2732.97		2732.97	
Non-Conv. Sources of Energy		30.17			18.28	48.45		48.45	
Ecology and Environment									
Total A	**3753.98**	**30203.05**			**8030.46**	**38233.51**	**3753.98**	**34479.53**	**9.82**
Industry									
Mining					0.26	0.26		0.26	
Cement and Non-metallic Industries									
Pesticide and Chemicals					18.38	18.38		18.38	
Non-Ferrous Mining and Metallurgical Industries	122181.24	634.53	1550.83		3312.77	3947.30	123732.07	-119784.77	3134.60
Irrigation									
Major and Medium Irrigation	5415.78	101680.87			147124.81	248805.68	5415.78	243389.90	2.18
Minor Irrigation	1735.91	10477.04			25660.27	36137.31	1735.91	34401.40	4.80
Command Area DevProg.		3511.31			22233.86	25745.17	0.00	25745.17	
Total B	**129332.93**	**116303.75**	**1550.83**		**198350.36**	**314654.11**	**130883.76**	**183770.35**	**41.60**
Total (A+B)	**133086.91**	**146506.80**	**1550.83**		**206380.81**	**352887.61**	**134637.74**	**218249.87**	**38.15**

Basic Source: GoI, State Finance Accounts 2007-08 and 2008-09.

Notes: * including imputed interest on investment, dividends and return on capital stock. Agricultural Research & Education comprises of Soil & Water Conservation (02), Fisheries and Forestry (05). Special Areas Development Programme comprises Drought Prone Areas (02), Devlp./Desert Devlp. Progs. (03) and Wasteland Devlp. Progs. (05). Flood Control & Drainage comprises Flood Control (01) and Anti-Sea Erosion (02). Non-Ferrous Mining and Metallurgical Industries includes Geological Survey of India's Mineral Exploration [2853 (01/102)] and Regulation and Development of Prevention [2853 2/102)] and Control of Pollution under Ecology and Environment [3435 (04)]. Mining under Iron and Steel Industries [2852 (01/101)]. Pesticide and Chemicals under Chemicals and Pharmaceutical Industries [2852 (05/205)]

Table B.7: Estimating Environment-Related Budgetary Subsidies for West Bengal: 2008-09

(Units in Lakh)

West Bengal *Parameters :* **Description**	**Rev Rec.**	**Rev Exp.**	**Div.**	**Int.on Loans**	**Effect. int. rate** 0.09200 **Annualised Cost of Cap.***	**Total Costs**	**Total Rec.**	**Subsidy**	**Recvy. Rate (%)**
Sewerage & Sanitation	1.41	1358.81			25.44	1384.25	1.41	1382.84	0.10
Soil and Water Conservation		2409.52			9.99	2419.51		2419.51	
Fisheries	411.11	7520.47			2958.07	10478.54	411.11	10067.43	3.92
Forestry and Wildlife									
Forest Cons., Dev., and Regen.	4418.76	14698.43			550.28	15248.71	4418.76	10829.95	28.98
Environ. Forestry and Wildlife	114.70	4684.94				4684.94	114.70	4570.24	2.45
Afforestation and Ecology Development									
Agri. Research and Education									
Special Areas DevProg.									
Flood Control and Drainage									
Non-Conv. Sources of Energy		1100.59				1100.59		1100.59	
Ecology and Environment									
Total A	**412.52**	**12389.39**			**2993.49**	**15382.88**	**412.52**	**14970.36**	**2.68**
Industry									
Mining									
Cement and Non-metallic Industries									
Fertiliser					9.39	9.39		9.39	
Pesticide and Chemicals					6000.88	6000.88		6000.88	
Non-Ferrous Mining and Metallurgical Industries									
Irrigation									
Major and Medium Irrigation	693.22	24736.18			29414.65	54150.83	693.22	53457.61	1.28
Minor Irrigation	2033.38	28028.21			10157.49	38185.70	2033.38	36152.32	5.32
Command Area DevProg.		452.81		0.15	1155.94	1608.75	0.15	1608.60	0.01
Total B	**2726.60**	**53217.20**		**0.15**	**46738.35**	**99955.55**	**2726.75**	**97228.80**	**2.73**
Total (A+B)	**3139.12**	**65606.59**		**0.15**	**49731.85**	**115338.44**	**3139.27**	**112199.17**	2.72

Basic Source: GoI, State Finance Accounts 2007-08 and 2008-09.

Notes: * including imputed interest on investment, dividends and return on capital stock

Agricultural Research & Education comprises of Soil & Water Conservation (02), Fisheries and Forestry (05).

Special Areas Development Programme comprises Drought Prone Areas (02), Devlp./Desert Devlp. Progs. (03) and Wasteland Devlp. Progs. (05). Flood Control & Drainage comprises Flood Control (01) and Anti-Sea Erosion (02). Non-Ferrous Mining and Metallurgical Industries includes Geological Survey of India's Mineral Exploration [2853 (01/102)] and Regulation and Development of Prevention [2853 2/102)] and Control of Pollution under Ecology and Environment [3435 (04)]

Mining under Iron and Steel Industries [2852 (01/101)]

Pesticide and Chemicals under Chemicals and Pharmaceutical Industries [2852 (05/205)].

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