05

Environmentally Harmful Subsidies

Linkages between subsidies, the environment and the economy

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Summary

The objective of this report is to inform about the general linkages between subsidies and their potential adverse effects, particularly on the environment but also on the economy. Subsidies that are harmful to the environment and the economy at the same time are also called perverse subsidies. The linkages between subsidies and their potential adverse effects are described mainly qualitatively, since very little data exists on quantitative effects, particularly effects on the environment, from the usage of harmful subsidies. The first part of the report gives general definitions and outlines the theory on subsidies and the linkages to harmful consequences for the environment and the economy. The second part of the report provides empirical examples of the linkages between distorting subsidies, the environment and the economy within six different sectors: agriculture, fishery, energy production, transport, water and forestry. These examples mostly contain qualitative assessments, but to give an impression of the magnitude of the problem, estimates of total subsidies granted worldwide are included. The report is based on existing literature in the area and no new calculations are conducted.

The report begins with a definition of subsidies in general. Non-internalised externalities are not included in the definition of subsidies.

A general link between subsidies and environmentally harmful effects is when subsidies cause increased production (of output or input) and this production entails environmentally harmful effects. Price support and input/output support are types of subsidies that can be expected to have relative large effects on production and thus be harmful to the environment. Another link is the so-called “lock-in effect”, which is when a subsidy results in old, environmentally harmful technologies not being replaced by new, more efficient and less environmental harmful ones because the support favours the existing, old technology.

The harmful effects of subsidies on the economy are mainly efficiency losses, negatively affecting GDP and growth. Furthermore, subsidies that are conditional on the levels of input use or levels of production often leak away to industries other than the intended beneficiaries.

Finally, subsidies may also affect trade and have global environmental and economic consequences through changes in the comparative advantages. The net environmental effects from removing harmful subsidies can be difficult to foresee, though, and depends on factors such as the spatial distribution of polluting industries, the scale of production and transportation and whether changes in production occur in biologically sensitive areas. Furthermore, existing and new regulatory measures affect the environmental consequences from changes in production.

When it comes to the global economic consequences there seems to be a potential for considerable economic gains for OECD countries as well as for non-OECD countries from removing subsidies in general. In the longer run, this can also lead to environmental improvements, since increasing income in poor countries can lead to higher environmental awareness and willingness to pay for environmental improvements.

An important consequence of removing subsidies in general is the effects on equity, i.e. distributional effects. Though society may benefit economically and environmentally, the receivers or beneficiaries of the subsidies are likely to incur losses. These losses should be dealt with politically.

The literature contains some estimates of the total subsidies granted to the specific sectors worldwide, as shown below. Some very rough estimates (guesstimates) of the share which perverse subsidies represents of the total subsidies are also shown.

Billion US$	Total conventional subsidies	Perverse subsidies out of total conventional subsidies
Agriculture	376	207
Energy	85 – 244	64 – 216
Road transportation	225 – 300	110 – 150
Water	69	50
Forestry	35	35
Fisheries	20	19
Total	810 – 1044	485 – 677

Such estimates can give an impression of the magnitude of the problem and the potential financial savings, though optimally the size of the environmental and the economic effects from removing subsidies should be established. The data on these effects are scarce in literature and future research in the area is needed.

When analysing the usage of subsidies, it is important to look at the net effects (positive or negative) from subsidies, both when implementing new subsidies or removing existing subsidies. Such an exercise includes efficiency losses/gains, environmental effects, government outlays and social consideration (e.g. benefits for specific population groups). When discussing subsidies in politics, also bringing forward the negative environmental effects from subsidies may prove to be just that extra dimension that affects the decision about whether to remove, keep or implement new subsidies.

A first step in removing subsidies with negative net effects could be to focus on perverse subsidies, as they are likely to be the most distorting ones.

Today, the problems of environmentally harmful and perverse subsidies are addressed by several institutions and organisations including NGOs. Changes and improvements are underway within several sectors, but there is still a long way to go with regard to reforming/removing harmful subsidies.

Resume

Formålet med denne rapport er at informere om de generelle sammenhænge mellem subsidier og deres potentielt skadelige virkninger for miljøet i særdeleshed, men også for samfundsøkonomien generelt. Subsidier, der er både skadelige for miljøet og for samfundsøkonomien, kaldes også for perverse subsidier. Sammenhængen mellem subsidier og deres skadelige virkninger beskrives hovedsageligt kvalitativt. Det skyldes, at der kun eksisterer meget få data på de kvantitative effekter på specielt miljøet. Den første del af rapporten beskriver nogle generelle definitioner og teori omkring subsidier og hvordan de kan have skadelige virkninger på miljøet og samfundsøkonomien. I den anden halvdel af rapporten beskrives nogle praktiske eksempler på sammenhængen mellem skadelige subsidier, miljøet og samfundsøkonomien indenfor seks forskellige sektorer: landbrug, fiskeri, energi produktion, transport, ferskvand og skovbrug. Disse eksempler indeholder hovedsageligt kvalitative vurderinger, men for at prøve at give et indtryk af problemets omfang er der foretaget en opgørelse af nogle estimater for hvor store beløb, der anvendes på subsidier på verdensplan. Rapporten er baseret på eksisterende litteratur og beregninger indenfor området.

Rapporten begynder med en definition på subsidier generelt. Eksternaliteter, der ikke er internaliserede, medregnes ikke under definitionen på et subsidie.

En generel sammenhæng mellem subsidier og miljøskadelige effekter er, når subsidier medfører øget produktion (af input eller output) og at denne produktion medfører skadelige effekter på miljøet. Prisstøtte og støtte til input/output er typer af støtte, som kan forventes at have relativt stor effekt på produktion og dermed også på miljøet. En anden konsekvens ved at anvende subsidier kan være den såkaldte ”lock-in” effekt, som medfører at gamle miljøskadelige teknologier ikke skiftes ud med nyere mindre skadelige og mere effektive teknologier.

Subsidiers skadelige virkninger for samfundsøkonomien skyldes hovedsageligt efficienstab, som påvirker vækst og BNP negativt. Endvidere vil subsidier, der påvirker input- eller produktionsmængden, ofte sive bort til andre industrier end de, der officielt modtager støtten.

Endelig vil subsidier også kunne påvirke den internationale handel og have globale konsekvenser for miljø og økonomi som følge af ændringer i de komparative fordele mellem lande eller regioner. De endelige konsekvenser for det globale miljø, ved at fjerne skadelige subsidier, kan dog være svære at forudsige og afhænger bl.a. af forhold som den geografiske fordeling af forurenende industrier, transport- og produktionsomfanget og om ændringer i produktionen foregår i miljømæssigt følsomme områder. Endvidere vil ny og eksisterende miljølovgivning i de forskellige lande have konsekvenser for den endelige miljøpåvirkning, når der sker ændringer i produktionen.
Der synes imidlertid at være mulighed for relativt store fordele for den globale samfundsøkonomi ved at fjerne subsidier, både for OECD-lande og lande udenfor OECD. Sådanne økonomiske fordele kan på længere sigt også resultere i miljømæssige gevinster, da øget indkomst i fattige lande kan medføre en øget miljøbevidsthed og betalingsvilje for miljøforbedringer.

En vigtig konsekvens af at fjerne subsidier i almindelighed, er de fordelingsmæssige effekter. Selvom samfundsøkonomien samlet set kan opnå en gevinst ved at fjerne de skadelige subsidier, er der stor sandsynlighed for at de konkrete modtagere af subsidierne vil opleve tab, når subsidierne fjernes. Sådanne tab kan der tages hensyn til fra politisk hold.

I diverse litteratur findes nogle grove estimater for hvor store beløb, der globalt anvendes på subsidier. Der findes også nogle endnu grovere skøn for hvor stor andelen af de perverse subsidier udgør.

Milliarder US$	Beløb anvendt på alle subsidier	Heraf beløb anvendt på perverse subsidier
Landbrug	376	207
Energi	85 – 244	64 – 216
Vejtransport	225 – 300	110 – 150
Vand	69	50
Skovbrug	35	35
Fiskeri	20	19
I alt	810 – 1044	485 – 677

Sådanne estimater kan give et indtryk af problemets omfang eller hvor store beløb, der kan spares, selvom det optimale ville være at angive størrelsen på de miljømæssige og samfundsøkonomiske effekter ved at fjerne de skadelige subsidier. Data og beregninger for disse effekter er dog yderst sparsomme i litteraturen, og det vil være nødvendigt med mere forskning inden for dette område i fremtiden.

Når effekten af at anvende subsidier skal analyseres, er det vigtigt at se på netto-effekterne (positive eller negative), både når ønsket er at implementere nye subsidier eller at fjerne gamle subsidier. Opgørelsen af netto-effekter inkluderer effi-cienstab og -gevinster, miljøeffekter, offentlige udgifter på subsidier og sociale effekter (fx omkostninger for forskellige befolkningsgrupper). Når subsidier diskuteres politisk, kan inddragelsen af de miljømæssige konsekvenser måske være den ekstra dimension, der påvirker beslutningen om at fjerne, beholde eller implementere nye subsidier.

Et første skridt på vejen til at fjerne eksisterende subsidier med negative netto-effekter kunne være at fokusere på de perverse subsidier, som med størst sandsynlighed vil være de mest forvridende.

I dag behandles problemerne ved miljøskadelige og perverse subsidier af flere institutioner og organisationer, herunder også NGO'er. Ændringer og forbedringer på området er på vej indenfor flere sektorer, men der synes stadig at være et stykke vej endnu med hensyn til at reformere/fjerne alle subsidier med skadelige effekter.

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1 Introduction

Subsidies are useful and powerful tools, which can be used to influence the economy in a certain direction. Subsidies can be used to promote growth and employment as well as increasing income in a particular sector. Furthermore, subsidies may be provided by governments in order to overcome market failures, help weak regions or weak groups of the population and can be used to promote resource-saving technologies that are not yet competitive on the market. However, it is well known that some subsidies can have adverse effects on the economy, which are most often efficiency losses as a result of relative market prices being distorted. These economic effects are usually expressed by means of a monetary value, e.g. changes in GDP. Furthermore, and perhaps less well known, some subsidies may have negative environmental effects. For instance when subsidies are used to keep prices artificially low, this may encourage overuse or wasteful use of the resources being subsidised. From the viewpoint of society these subsidies are unwanted if the negative effects outweigh the benefits from the subsidies. Estimating the net benefits can be difficult, though, especially because of inadequate knowledge about the linkages between subsidies and the environmental effects and also because environmental effects are often not valued in monetary terms.

Subsidies that are both harmful to the environment *and* the economy are here referred to as "perverse subsidies". Ideally, all benefits and costs of subsidies should be considered when analysing the effects of subsidies resulting in a calculated net benefit or cost of the subsidies in question. Thus, expected environmental, economic and social outcomes should be considered. Focus on removing perverse subsidies could be a first step in removing subsidies with negative net benefits (net costs) to society since perverse subsidies are more difficult to justify. Removing perverse subsidies is a potential win-win policy as it may benefit both the total economy in society, through reduced government outlays and improved economic efficiency, and the environment.

Despite pressures to reduce harmful subsidies their levels remain high in many OECD countries (OECD 1998a).

1.1 Purpose and delimitation

The main objective of this report is to explore the linkages between subsidies and the possible harmful environmental consequences. Largely based on secondary sources, this report synthesises and critically assesses the extent and impact of environmentally harmful subsidies in environmental policy.
Though focus is on the environmental harmful effects of subsidies, other effects are also described briefly, e.g. efficiency and equity effects, since they are important when analysing the justification for subsidies.
When discussing subsidies in politics, bringing forward the negative environmental effects from subsidies may prove to be just that extra dimension that affects the decision about whether to remove, keep or implement subsidies.

The intended audience is the parties that are involved in environmental policy making but have little or no knowledge of harmful subsidies. The report should be seen as an overview of some of the existing literature and knowledge in the area. Thus, if one wants to go into more detail with one or more subjects in the report, the list of references at the end of the report may be used as a starting point. It is our hope that the increased level of knowledge will positively influence the ongoing process in reducing subsidies that are harmful to the environment as well as to the economy.

1.2 Structure and outline of the report

The report is basically divided into two main parts.

I. Definitions and theoretical background
II. Empirical examples of the usage of subsidies in different sectors and the linkage to environmental damage

Part I introduces definitions and background knowledge on subsidies and the general linkages to the environment and the economy. The different types of subsidies that are, in general, harmful to the environment and the economy are described together with an identification procedure for picking out the harmful subsidies and the data needed for this. Finally, the report comments on the barriers to removing subsidies.

Part II describes empirical examples of concrete subsidies given in the areas agriculture, fishery, energy production, transport, water and forestry. The environmental – and to some degree – the economic consequences of giving subsidies in

the different sectors are described qualitatively and by means of empirical examples. Furthermore, policy options on how to approach the reduction of harmful subsidies are touched on.

Part I

Definitions and theoretical background

In this section the term subsidy is defined and the linkage between the subsidies given and their adverse environmental effect is described together with the possible adverse economic effects from subsidies. Next there is a more formal description of the types of environmentally harmful subsidies and how they work in theory. Finally the case of reforming harmful subsidies is addressed, by describing how the process of identifying the subsidies could operate in practise and the kind of data that would be needed. This section builds heavily on OECD work in the area of environmentally harmful subsidies since OECD has carried out much work in the specific area of environmentally harmful subsidies.

2 Subsidies in theory

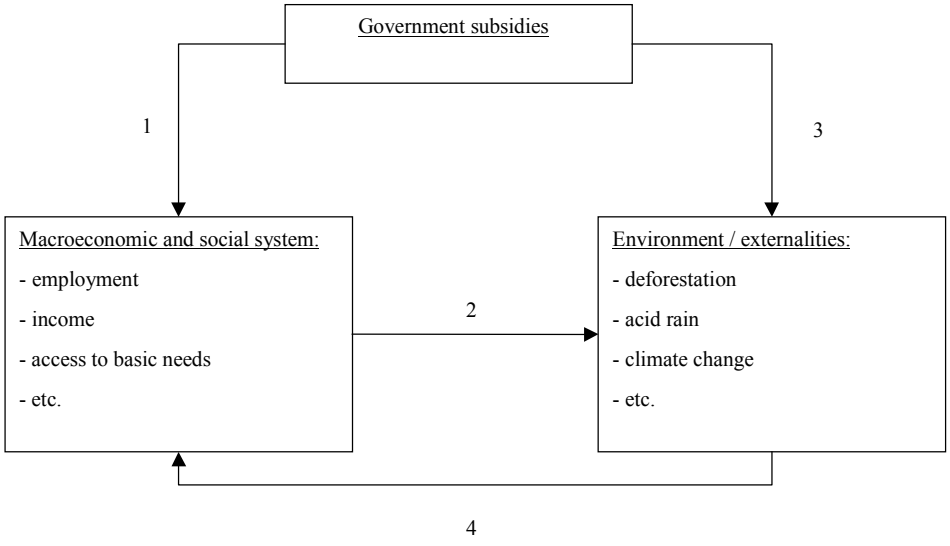
Box 1: Relevant definitions.

- **Subsidy:** Policy intervention that allows consumers to purchase goods and services at prices lower than those offered by a perfectly competitive private sector, or raises producers' incomes beyond those that would be earned without this intervention
- **Environmental harmful subsidy:** An environmentally harmful subsidy increases production or use of a product/substance with environmental harmful effects.
- **Perverse subsidy:** A subsidy that is harmful to the environment as well as to the economy, even though it may represent some benefits to the receivers of the subsidy.

2.1 Definition of a subsidy

As a starting point it is useful to describe the relationship between government subsidies, the macroeconomic and social system and the environment. This is shown in figure 2.1.

Figure 2.1: The relationship between government subsidies, the macroeconomic and social system and the environment.



Notes (see also text):
1. Conventional subsidies aimed at achieving economic and social policy goals.
2. Environmental damage (negative externalities[1]) from activities in the macroeconomic and social system.
3. Payments ("subsidies") aimed at maintaining/increasing environmental quality.
4. Effects of changes in the environment on production factors.

Source: Adapted from Van Beers & de Moor (2001)

Arrow 1 represents subsidies that can be defined as conventional, and that are aimed at achieving economic and social policy goals such as economic growth in a sector, employment protection and investment or support for low-income groups.

Arrow 2 represents the negative environmental effect (i.e. negative externalities) that, in general, is the result of activities in the macroeconomic and social system. A general linkage between subsidies and the environment is when subsidies lead to increased activities that cause environmental stress. Such subsidies are consequently defined as environmentally harmful subsidies.
Arrow 3 describes the public payments (or subsidies) in order to maintain or increase environmental quality, which has degraded as a result of pollution from the macroeconomic and social system. These payments thus have the opposite effect of the environmentally harmful conventional subsidies.
Arrow 4 consists of the negative or positive effects on the economy from changes in the environment. Environmental degradation can for instance result in negative effects on employment and productivity due to health problems.

Partly based on figure 2.1 above, subsidies can be divided into different categories. The literature distinguishes between two main categories:

1. Subsidies given to achieve economic and social aims that have an effect on government budgets (immediate and long-term). These subsidies are the result of policy intervention that *"...allows consumers to purchase goods and services at prices lower than those offered by a perfectly competitive private sector, or raises producers' incomes beyond those that would be earned without this intervention."*[2] This category of subsidies can be considered "conventional" subsidies, some of which are potentially environmentally harmful since they increase activities, which have environmentally harmful effects, to a level in excess of a level without subsidies[3].
2. Subsidies that are a result of market failures[4]. General market failures such as negative environmental externalities could be regarded as subsidies if not corrected by governmental intervention. For instance, this means that when a polluter is not compensating the losses he confers on others by his pollution, he actually receives an "implicit" subsidy in the form of saved expenses on compensation.

Both categories are encompassed by the following general definition of subsidies:

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[1] See chapter 2.1.2 for a definition of externalities.

[2] This definition by Looney (1999) is similar to definitions in other literature.

[3] The definition of environmentally harmful subsidies is described further in chapter 2.3.1.

[4] A market failure exists when prices of traded products do not reflect all costs and benefits of production or consumption or when certain inputs or outputs have no prices at all, i.e. markets are not maximising collective welfare (Pearce & Turner 1990).

"Subsidies comprise all measures that keep consumer prices at a level below that which reflects the true opportunity costs that would prevail in competitive markets if all external costs and benefits were internalised[5] *or all measures that keep producer prices above true opportunity costs in competitive markets if all external costs and benefits were internalised, or that reduce costs for consumers and producers by giving direct or indirect support".* [6]

The two categories and their sub-categories are described in further detail below.

2.1.1 Conventional subsidies – Direct and indirect subsidies

Conventional subsidies can take the form of government support to a sector, an institution, a business or an individual, generally with the aim of promoting an activity, which the government considers beneficial to the economy and to society. Subsidies are often divided into different types to allow for measurement and comparison of the different subsidy types and this also makes it easier to pin down the harmful subsidies.

When a subsidy is supplied directly to the industry or a sector (to achieve economic and/or social aims) in the form of a monetary payment, loans, tax preferences, border tariffs, or other transfer it is categorised as a *direct subsidy* (OECD 2003d). For this type of subsidy the literature often distinguishes between on- and off-budget support[7]. Both on- and off-budget support has budgetary effects[8], but on-budget support is financed directly by government (direct outlays) and will therefore have an immediate effect on the budget if removed. Off-budget support, on the contrary, will have longer-term effects if removed. On-budget subsidies are, for example, grants or payments to consumers or producers, while off-budget subsidies could be support through tax policies, infrastructure provision, preferential loans, price regulation and import/export tariffs.

There are *indirect subsidies* too. The indirect subsidies are those that reach producers through market transactions caused by direct subsidies, through higher prices for products or lower prices charged for input goods or services purchased from an upstream industry that is able to discount its prices because of the subsidies it receives itself. For instance, subsidies that lower agricultural prices are indi-

[5] Externalities are internalised when they are assigned a price and thus enter into the market on equal terms with other traded goods and services. See also appendix B.

[6] Source: Personal comment by Richard Damania (University of Adelaide) November 2004.

[7] See appendix A for an example on this classification and the different producer support measures that are included.

[8] Note that in principle, subsidies "for improving environmental quality" also have budgetary consequences, but these are "special cases" related to externalities, and are described in chapter 2.1.2.

rect subsidies to the food processing industry. Another example would be the reduction in the cost of diesel fuel sold to fishing vessels as a result of subsidies to oil refiners.

2.1.2 Market failures – Externalities

A negative externality exists when an activity by one agent causes a loss in welfare to another agent who is not compensated for the welfare-loss (Pearce & Turner 1990). By contradiction, a positive externality exists when an activity by one agent causes a gain in welfare to another agent who does not pay for this welfare gain. Important examples of negative externalities are typically damage to the environment and human health caused by the pollution from an activity (e.g. the emission of CO_2 to air caused by the production of energy). From a welfare economics perspective a negative externality can be regarded as a subsidy[9] when the externality is not internalised in the market[10] (OECD 2003c). For instance, this means that an individual, who is affected negatively by pollution and not compensated for this by the polluter, is actually subsidising the polluter. Thus, the polluter's saved expenses on compensation can be defined as a subsidy.

In this report, non-internalised externalities do not fall within the category of a subsidy. One problem of seeing externalities as subsidies is that it requires all the external effects to have been valued (in monetary terms) to estimate the size of (measure) this type of subsidies. Such valuation is often a difficult task and involves large uncertainty margins (Van Beers & de Moor 2001) and has, to our knowledge, not been done thoroughly in the literature. Furthermore, not all externalities are unwanted from society's viewpoint. For example, internalising externalities can be done by taxing the emissions that cause the externalities (see also appendix B). When reaching a sufficiently high level, the tax will result in higher societal costs than the achieved societal gains from the tax. Thus, one might argue that there is an "optimal level of externalities" (external effects), up to which point these externalities may be regarded as subsidies if not internalised. To measure this "optimal level of externalities"[11] requires a valuation of the externalities, which again is a very difficult task as stated earlier. Thus, when summing up estimates of

[9] Externalities defined as subsidies are in the literature also referred to as passive, hidden or implicit subsidies (Myers & Kent 2001; OECD 2003c).

[10] See Appendix B for a description of internalising externalities by introducing a tax on emissions.

[11] To our knowledge no such measurements have been conducted in the literature.

the size of subsidies in part II of this report, including externalities as subsidies is in reality not possible.

Instead, internalising externalities can be seen as a separate policy area to be targeted by appropriate measures, of which removal of harmful subsidies may be one out of several policies.

When governments intervene to internalise externalities, one way of doing this is to pay for (support) environmental improvements. Thus, strictly speaking – and from the definition of a subsidy from a welfare economic perspective – such payments are not subsidies, but policies that correct market failures – or as defined in Runge & Jones (1996), *"They are simply compensation for an external benefit"*.[12] Nevertheless, they are often included in estimations of total government outlays on subsidies in general, though not as environmentally harmful subsidies.

In this context, it should be ensured that the increased environmental quality resulting from these payments does not come at a higher or lower price (for society) than the value of the environmental benefit. Or put in more formal terms, if for instance, the internalised price on an environmental good is lower than the actual value of the good, it means that the externality is not fully internalised.

Resource rent

A concept related to externalities and natural resources (such as fisheries or forestry) is *resource rent* (or *economic rent*)[13], which is also sometimes considered a subsidy. *Resource rent* can be seen as the price that a producer would have to pay for renting the resource. If property rights are not defined (i.e., if there are no owners of the resource), which is often the case with publicly owned or managed resources, no "rent" is paid by the users of the resource, unless the government taxes the access to the resource.

[12] In Porter (1998) it is mentioned that "Most of the economists and government specialists convened by the OECD in 1995 to discuss subsidies and the environment agreed that the failure to reflect environmental costs in market prices does indeed constitute an implicit subsidy, even though they did not regard it as a high priority in terms of subsidy reform policy." Nevertheless, general focus on the negative environmental effects (externalities) and how to reduce such effects has emerged through the last few decades. For instance the "polluter pays principle" (see appendix B for definition) is now being used in the EU. As a result, environmental externalities are slowly being internalised to some degree, regardless of whether they are included in the definition of a subsidy or not.

Thus, this type of subsidy exists when a government does not collect payment for the removal of natural resources from the public domain by agents/firms (Porter 1998). The resource rent should reflect the social "costs" of managing the resource (Hanley et al. 1997) i.e. including the externality costs described above.

2.1.3 Summing up

Based on the above descriptions, externalities will not be treated as subsidies. Support measures that directly improve environmental quality are also not considered environmentally harmful subsidies, and thus are not described further.
In the rest of this chapter, focus is on the characteristics of conventional subsidies that have an effect on government budgets *and* are potentially environmentally harmful. These subsidies are direct market interventions by governments that cause changes in market behaviour and thus can entail environmentally harmful effects.

2.2 Reasons for giving conventional subsidies

Subsidies are introduced to achieve specific policy goals, which for instance can be motivated by economic, cultural, and social considerations. Some of the policy aims can be to stimulate economic growth in a sector, develop infant industries, protect employment and investment, reduce external dependency by safeguarding domestic supply, support low-income groups and provide access to basic living conditions.

Conventional subsidies have different policy goals in different sectors. Also, the subsidies used in developing countries differ from the ones that are most commonly used in developed countries. The reason for this is that the aim of the subsidies differs in the different countries. In developing countries the majority of the subsidies are consumer subsidies (to secure food supply), whereas in developed countries, producer subsidies (to maintain farm income) are most prevalent (Van Beers & de Moor 2001). Table 2.1 gives an overview of the main policy goals of subsidies in different sectors in both developing and developed countries. It is clear that many subsidies are given on equity grounds, meaning that the subsidies are aimed at improving the conditions for specific, vulnerable groups in society.

13 In Day (1998) economic rent is defined as; "*..the return earned by a factor over and above what it could earn in any other productive use in the economy. In terms of capital and enterprise these economic rents are known as superprofits."*

Table 2.1: Producer and consumer subsidies in developed and developing countries and their policy goals in different sectors[14].

	Developed Countries		Developing Countries	
	Consumer Subsidies	Producer Subsidies	Consumer Subsidies	Producer Subsidies
Natural resources				
Agriculture		Maintain farm income Maintain domestic supply	Support low-income groups Safeguard food security	
Water		Increase farm production	Access to drinking water	Increase farm production
Forestry		Sector development		Sector development
Fisheries		Maintain fisheries income	Support low-income groups Safeguard food security	
Energy and industry				
Energy	Support low income groups	Safeguard domestic supply	Support low-income groups Stimulate economic growth	
Road transport	Stimulate employment	Sector development	Access for low-income groups	

Source: Adapted from Van Beers & de Moor (2001)

2.3 Adverse effects from conventional subsidies

As mentioned above, subsidies in general are often given with the purpose of achieving particular economic/policy goals. Some of these subsidies can have adverse effects on the environment and/or the economy[15]. These two types of adverse effects – and how they are connected with subsidies – are described in the following.

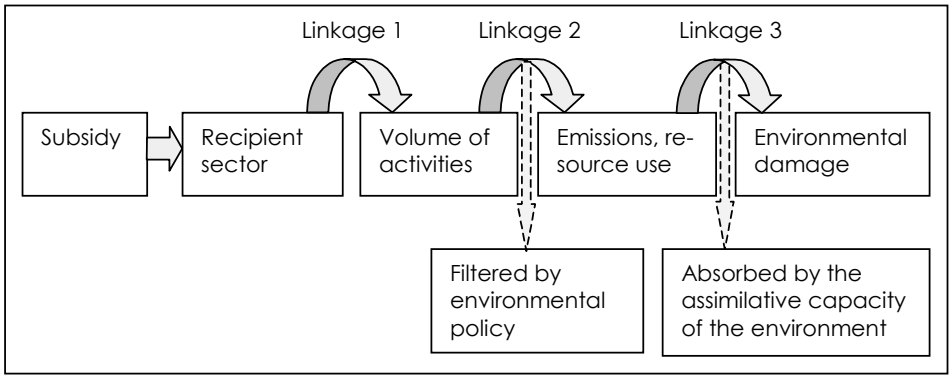
2.3.1 Adverse environmental effects

Adverse environmental effects are the negative consequences for the environment from using subsidies. As described earlier, these consequences are often characterised as being negative externalities. To be seen as relevant consequences, these must have a value to society – whether monetarised or not.

[14] The sectors in table 2.1 are the ones where subsidies with environmentally harmful effects are most pronounced (see also chapter 2.3.1 for a definition of environmentally harmful subsidies).
[15] The "economy" describes the societal level as a whole.

The main reason why a subsidy can be environmentally harmful is given by OECD (2003c) *"There is a prima facie case for supposing that subsidies which encourage more production will be environmentally harmful"*. It is thus assumed that the production (or activity) is connected with some kind of environmental harm (emissions or resource use) and that increased production leads to increased emissions or resource use. Thus, when describing *production* (or *activities*) in what follows, it is limited to production that leads to some kind of environmental harm. Changes in production/activity will result in lower or higher levels of potential emissions or resource use, but there is no straightforward link between size or type of subsidies and environmental damage, and the links can be complex (OECD 1998a). Based on OECD work, the linkages are described shortly in the following and are shown in figure 2.2.

Figure 2.2: Linkages between subsidies and the environment



Source: Adapted from (OECD 1998a)

A subsidy implies a transfer from one or more sectors of society to others. There are three main linkages between this transfer (subsidy) and its environmental effects:

1. It can lead to changes in the volume and composition of different activities/productions, which is described by *linkage 1*. Production (or output) consists of consumer goods as well as the intermediary products that serve as inputs in the different stages of production. Volume and composition of production depends, among other things, on conditionality of the subsidy, which means the target of the subsidy. In general, subsidies can be conditional on the main categories input, output, and profits and income (OECD 2003c). These categories and their effects are described further in chapter 2.4. Furthermore, one needs to know how and if the subsidy results in replacement of technologies or products and if these technologies or products have less environmentally harmful effects. Potentially harmful is the so-called "lock-in effect," where

a technology is not replaced by a new (less harmful) technology because support favours the old technology, which then has a competitive advantage. [16]

2. The impact of the changes in the level and composition of output on actual pollution, waste levels and resource use is *linkage 2*. The change in actual pollution levels or resource use will depend on how much is filtered out by environmental policy (with its associated costs). With a strict environmental policy, the change in the levels of pollution or resource use will not be as severe as without the policy.
3. The environmental damage caused by the changes in pollution and waste levels will depend on the assimilative capacity, or capacity to regenerate, of the affected environment, which is *linkage 3*.

Thus, the linkages between subsidies and the environment can be rather complex.

2.3.2 Adverse economic effects

There can be negative economic effects for society as a whole. Subsidies can result in economic efficiency losses as a result of the relative market prices being distorted and resource allocation becoming less efficient (Steenblik 1998). For instance, if inefficient industries are kept artificially alive because of subsidies, then growth or GDP in society might be less than it would have been without the subsidy.

Another example of inefficiency is when taxes are raised to finance a subsidy, and since almost all taxes have deleterious efficiency effects, the adverse effects of the tax can be expected to lower any economy-wide growth benefits arising from the subsidy[17]. Economic inefficiency can also be the result when a subsidy does not reach the intended recipient effectively (the transfer efficiency is low)[18], or when the "lock-in effect"[19] results in inefficient technologies not being replaced by more efficient ones. The described efficiency losses for society also affect global efficiency where the comparative advantages in the global market are distorted. This means that production does not take place in those countries where production is most efficient (see also chapter 2.5 on trade and environment).

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[16] The "lock-in" effect is similar to "technical inefficiency" (or "X-inefficiency"), which is due to a lack of effort to minimise costs, created by support and lack of competition.

[17] Source: Correspondence with Richard Damania (University of Adelaide) November 2004.

[18] The amount of the subsidy that actually reaches the intended recipient is expressed in terms of transfer efficiency.

A note on equity effects

In the text above, changes in efficiency are described from the level of overall society, expressed by e.g. changes in a country's GNP. Removing or reforming subsidies, and thereby achieving efficiency gains, might have distributive consequences and lead to equity concerns. This is the case when subsidy reform results in a financial loss to the receivers of the subsidy, though at the aggregated (societal) level, these losses may be too small to outweigh the benefits. These equity concerns will then have to be addressed by policymakers, e.g. if and how compensation is to be given, and using measures that do not link the transfers to particular practices or the use of particular inputs or factors of production (capital or land).

A win-win situation

If a subsidy generates societal benefits (even after accounting for efficiency losses) that are bigger than the environmental damage it results in, there is reason to maintain the subsidy. If, on the contrary, a subsidy results in environmental damage, the value of which is bigger than the societal benefits from the subsidy, there is reason to reform the subsidy. Finally, a subsidy might have adverse effects on both the economy *and* the environment – in which case there is no doubt that net benefits are negative. Consequently it is important to look at the net benefits (benefits minus costs) from subsidies. This argument also holds for decisions about implementing new subsidies; expected environmental, economic and social outcomes should be considered and not just the availability of financial resources. One problem with the approach is that to calculate net benefits, environmental consequences must have a (monetary) value, which can be very difficult to estimate. Such a valuation is less important when a subsidy also has adverse economic effects, since the removal of the subsidy will generate benefits for the economy as well as for the environment – a win-win situation. In this report "perverse subsidies" are defined as subsidies which have adverse effects on both the economy *and* the environment, even though in some literature the term appears with slightly different definitions.

2.4 Types of subsidies and how they work in theory

Subsidies can be given in many ways and both to producers and consumers. A general typology of subsides and their usage as producer and consumer subsidies is illustrated in table 2.2.

[19] See description in chapter 2.3.1

Table 2.2: A general typology of subsidies.

	Producer subsidies	Consumer Subsidies
Budgetary money handouts	X	X
Capital costs subsidies	X	
Public provision of goods & services below cost price	X	X
Policies creating transfers through the market	X	X
Regulations	X	X
Price subsidies	X	X
Export subsidies	X	

Source: Adapted from Beers & van den Bergh (2000).

Producer subsidies are in general given in form of direct payments, support that increases revenues or support to inputs in production (see also appendix A). The types of consumer subsidies are in general analogous to producer subsidies (Steenblik 1995), e.g. direct payments or support that lowers prices on specific products. The different reasons for giving these two types of subsidies have already been described in chapter 2.2.

Different subsidy mechanisms are described in the following in relation to how they work, their effectiveness of achieving their goals, and their environmental effects. Focus will be on producer subsidies since consumer subsidies in general are analogous to producer subsidies as already mentioned. Also, producer subsidies in general are more difficult to justify than consumer subsidies since they are targeted at a limited interest group (World Energy Council 2001)[20]. However, it is worth noting that certain consumer subsidies may have just as harmful effects as some producer subsidies. Graphic examples are used to describe the partial effects of subsidies on supply and demand. Usually it is necessary to use general equilibrium models to describe all the dynamic effects on production and consumption in society, and the descriptions in this chapter are thus rather simplified. Finally, there is a note on the effect of subsidies on trade, as the efficiency losses from subsidies in general are also valid on the international markets.

2.4.1 Subsidies that increase revenue

In this category, subsidies are in general granted to output from production. One type of support here is market price support[21]. Market price support is often used

[20] This is probably also one reason why one result of the "Uruguay Round Agreement on Agriculture for developing countries" was to target and reduce usage of producer subsidies, while the Agreement was neutral regarding consumer subsidies.

[21] Market price support guarantees a minimum price level, above the market price, for the producer and provides accompanying regulations to ensure guaranteed sales of a certain level of excess production.

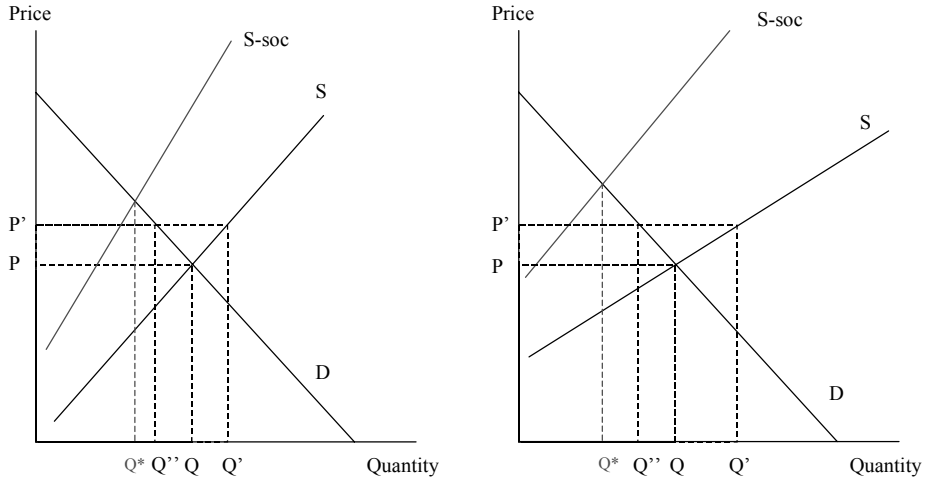
either to maintain income levels as is the case in the agricultural sector or ensure a desired level of employment in the subsidised sector, such as with coal mining (OECD 1998b). This type of subsidy allows producers to increase their income by increasing the level of profitable production. For producers to sell more, they will need to produce more, and in order to produce more, a higher input level is required. The quantity of extra inputs required depends on the marginal productivity of the inputs. The marginal productivity of inputs often decreases as output expands, leading to increased input requirements per unit of output. This means that some of the subsidy is spent on inputs, leaking away to the input suppliers rather than staying within the recipient sector. The increased demand for inputs may in turn push the price of the inputs up. This will increase the leakage effect but also adversely affect other users of the input who will suffer from the increased prices.

If the political objective is to maintain income levels in the intended recipient sector, as with most agricultural support in OECD countries, regulation which set minimum prices is clearly a cost-inefficient mean of obtaining this objective. As an example, it is estimated that as much as 75% of total agricultural price support leaks away from the intended recipients – primarily to input suppliers (Dewbre 2002), meaning that the transfer efficiency is very low. Therefore, market price support is a very cost-inefficient way of increasing farm incomes. The minimum price regulations will increase the product price for the downstream market, which thus faces a decrease in competitiveness and perhaps requires political implementation of measures to support the downstream industries.

In figure 2.3, the effect on demand *D* and marginal private costs (private supply) *S* from an output subsidy is illustrated. Furthermore, as an example of the linkage between a subsidy and environmental effects, marginal social costs (public supply) *S-soc* is shown, which consists of private marginal costs plus externality costs. *P* is the price before and *P'* the price after introducing the minimum price regulation. The quantities produced before and after the minimum price regulation are *Q* and *Q'* respectively. The price support results in higher consumer prices that in turn leads to lower demand *Q''*. The surplus production (*Q' - Q''*) will have to be dealt with through other measures, e.g. by governmental purchase.
Since the subsidy results in increased production and thereby an increase in the use of inputs, the associated externalities (*S-soc*) will also increase. Note in the figure that the optimal production level for society is *Q**. The graph on the right-hand side in figure 2.3 shows what happens when the price elasticity of supply is

larger (than in the left-hand figure). For a given demand curve, a shallow supply curve (reflecting a large price elasticity of supply) will yield larger volume effects in response to a certain change in price compared to a steep supply curve. This results in a larger quantity of production and consequently also more associated waste and pollution. A shallower supply curve will increase the governmental burden of coping with the environmental problems, especially in the long term as supply curves in general can be expected to be shallower in the long term (OECD 1998b).

Figure 2.3: Effects of price support on output and the role of price elasticity.



Notes:
P is the price of the good before the subsidy; P' is the price after support; *D* is the demand curve; *S* is the supply curve (marginal private costs); *S-soc* is the marginal social cost.
Source: Adapted from OECD (1998b)

Furthermore, this type of subsidy can have a negative influence on technological innovations if the subsidy is made contingent on output levels. If a producer is guaranteed a minimum price and quantity sold for a particular product, the incentive to consider new unsupported products or processes will be reduced. This is the case even though the unsupported products may prove more cost-effective if the support was not available (OECD 1998a).

2.4.2 Subsidies that lower the cost of production

Subsidising inputs in the production is one way to lower the producer's average costs. When considering supports to inputs, the relative elasticity of supply and demand for the subsidised input will determine how much of the subsidy that is leaked to the input supplier and how much goes to the producer, who is the intended recipient. If the producer has a low elasticity of demand, meaning that he will not change the quantity of input used in the production process in response to

a change in the input price, the input supplier (upstream market[22]) can raise the input prices and thereby capture a larger proportion of the subsidy. The larger the elasticity for supply and demand of input (the more responsive supply and demand are to changes in the price of the input), the larger quantity of input used for a given level of support, and therefore the associated environmental damage from use of the input will also be increased. The effects on the downstream consumers will be parallel to those in the upstream market. The subsidy given to the producer (that has not leaked to the input suppliers) will reduce production costs, thus enabling the producer to lower the prices to the downstream consumers. The extent to which the subsidy is translated into reduced product prices will depend on the relative market bargaining powers of the producer and the consumers. Reduced prices will stimulate demand. The increased production that results from the subsidy will most likely increase the environmental damage generated by the production process (OECD 1998a).

When analysing input subsidies, it is important to consider the transfer efficiencies of the subsidy and the price elasticity of supply and demand on the finished product. The transfer efficiency can be revealed by comparing the change in prices relative to the amount of total support. This will indicate support leakage to non-target recipients. If the objective is to support the finished product-producing sector there will be a leakage of support to consumers as measured by any reduction in price of the finished product, and a leakage to the input producers indicated by any increase in the price of inputs. Conversely, if the intention is to support the input producer, then any reduction in the selling price of the inputs to the downstream producer will constitute a leakage to this downstream industry. Some of these effects are illustrated in appendix C.

Input subsidies can also discourage technological development, in that if an input is supported the producer will try to use a higher proportion of this input relative to other unsupported inputs. Therefore, development of more efficient and perhaps more environmentally sound alternatives is not encouraged (OECD 1998a). This is the previously mentioned “lock-in” effect.

[22] When considering a producer in the flow of producing of a good, generally speaking, the upstream market is the suppliers of input to the producer, and the downstream market is the buyers of the output from the producer.

In general, the magnitude of the price, volume and leakage effects of an input subsidy depends on the slopes of the supply and demand curves. If the elasticity of the two curves differs the support will be distributed unevenly between the producer and the consumer. The relative elasticity of supply and demand will determine the transfer efficiency of the subsidy. See the table below for the effects of price elasticity on transfer efficiency of a subsidy which reduces the costs of inputs (OECD 1998b).

Table 2.3: Transfer efficiency and environmental effects of an input measure.

	Small price elasticity of demand		**Large** price elasticity of demand	
Small price elasticity of supply	Small environmental effect	Moderately effective transfer	Moderate to small environmental effect	Effective transfer
Large price elasticity of supply	Moderate to small environmental effect	Ineffective transfer	Large environmental effect	Moderately effective transfer

Source: adapted from (OECD 1998b)

The effects identified in the table above are based on the assumption of a closed economy with no external impacts. In reality, many products are traded internationally, and once foreign buyers and suppliers come into play, the price elasticity will generally become larger. Increased elasticity will in turn correspond to an increased pollution level effect.

Using these characteristics of the elasticity it is possible to scan subsidies to determine which ones are unlikely to effectively reach the intended recipient sector but are likely to have strong effects on the environment. This type of analysis will enable a rough identification of the subsidies that are ineffective (low transfer efficiencies) and environmentally harmful (OECD 1998b).

2.4.3 Subsidies that are not linked to production or input

Examples of subsidies that are not conditional on production or input levels are direct income support or unconditional lump sum support to an industry. This type of subsidy does not have a direct effect on the input or output markets which is why there is little or no upstream or downstream leakage effect[23]. A greater proportion of the subsidy will accrue to the intended recipient sector compared to the other subsidy mechanisms. Also, the subsidy should not have a distorting impact on the market (OECD 2003d). Furthermore, because the subsidy is not dependent on increased production or consumption levels, it will generally not increase the envi-

ronmental damage associated with these activities – it is decoupled from production. On the other hand, the increase in profitability in the recipient sector will indirectly have an effect on production and consumption decisions by stimulating the recipient's expenditures. One possible result of this effect could be that production is kept in existence when it might have been optimal to cease production (Pearce 2003). This might have negative economic effects, but the consequences for the environment are less clear. However, in OECD (1998a) it is stated that since the subsidy is not conditional on specific output or input levels or particular processes its effects will be less detrimental for the environment than the other above-mentioned subsidy mechanisms. Finally, this type of subsidy may increase the number of producers in the particular industry who receive the subsidy, resulting in increased aggregate pollution (Mayrand et al. 2003). To further highlight some disagreement in this area, Baffes & de Gorter (2005) argue that, for instance, decoupled support programs in agriculture can have just as distorting effects as coupled subsidies.

2.5 Subsidies, trade and the environment

Market price subsidies and input subsidies may distort trade. With the market price subsidy, the government chooses to have higher domestic prices for a particular commodity than the world price. This type of subsidy is maintained through import restrictions. Input subsidies, on the other hand, lower the costs of downstream input-purchasing activities, giving them a competitive advantage on domestic and foreign markets alike. As a consequence, the comparative advantages in the global market are distorted, meaning that goods are not produced in the countries with the most efficient production. This means that resources are wasted globally. If subsidies are given to the same sector by a number of countries, the trade distortions caused by the subsidy will be small. Furthermore, the subsidy will diminish the incentive to reduce material and energy inputs, and it will delay or prevent the entrance of other technologies or products into the market. Therefore, it will increase the exploitation of resources and may cause significant environmental damage. Thus, the gain from removing trade barriers or subsidies worldwide is usually described by an increase in world GNP.

Whether the removal of subsidies or liberalisation of trade will lead to environmental gains worldwide is not straightforward. As a consequence of the compara-

[23] In other words only little or no money go to the consumers or to the input producers.

tive advantages, liberalising trade globally will result in industries being redistributed globally. According to trade theory, local pollution will be redistributed from countries with comparative advantages in industries that are relatively less polluting to countries with comparative advantages in industries that are relatively more polluting (WTO 1999). The problem is if the redistribution leads to pollution-intensive industries moving to countries where environmental standards are lower, which most often is the case in developing countries. According to WTO (1999), empirical results show that pollution-intensive industries in general move to developed countries. This is because the most polluting industries are capital-intensive and developed countries have a comparative advantage in capital-intensive production, while developing countries have a comparative advantage in labour-intensive production. Furthermore, different environmental standards do not seem to be important factors of comparative advantages. The net effect on the environment also depends on a scale effect and a technique effect. The scale effect is the increase in environmental damage from enhanced economic activity for given pollution per unit and production composition. The technique effect is the reduction in pollution per unit of output following from increased income, which describes the increased willingness to pay for goods that are produced according to stricter environmental standards. Thus, even if pollution-intensive industries move to developed countries, with high environmental standards, total emissions might still increase if the scale effect is big enough. An example of a scale effect is the increased transport following from increased trade, when trade barriers and subsidy levels are reduced globally (Kirkpatrick & George 2005).
Another effect with consequences for the environment is the potential influence on poverty in developing countries that trade barriers or subsidies may have. It is generally accepted that poverty is a major cause of environmental degradation (WTO 2004). Thus, when trade barriers result in income losses, this will impact on poverty in the developing world (Pearce 2003), and therefore ultimately also on the environment.

Finally, in the context of global environmental effects the (monetary) value of these effects may be of importance. For instance, a reform of subsidies worldwide might result in economic benefits for all countries, but at the same time emissions might be reduced in developed countries and increased in developing countries, resulting in a sum of emissions larger than before the subsidy reform. Assigning values to the emissions may give a different result. If, for instance, the value of a unit of environmental gain is smaller in developing countries than in developed countries, the

net environmental effect (value) globally may actually be positive. A lower environmental value in developing countries can be explained by the different trade-offs between the environment and other (basic) needs, caused by (big) differences in income. Valuation is not so important if there are all positive economic as well as all positive environmental effects (in units of emissions) from reforming (perverse) subsidies world-wide.

2.6 Conclusion

The main focus of this report is subsidies that are environmentally harmful. Investigating the linkages between subsidies and the environment and identifying the environmentally harmful subsidies require first of all a definition of subsidies in general and of environmentally harmful subsidies in particular. In the literature, the definition of subsidies often depends on whether non-internalised externalities are included or not. In this report, externalities are not included in the definition of a subsidy. In this context, a subsidy is a result of policy intervention, given to achieve economic and social aims, with an effect on government budgets (immediate and long-term). However, these subsidies can have harmful effects on both the environment and to the economy. The linkages between subsidies and their environmental effects can be complex. A very general link is when subsidies cause increased production (of output or input) and this production has environmental harmful effects. Price support and input/output support are types of subsidies that can be expected to have relative large effects on production and thus be harmful to the environment and the economy. Another link is when a subsidy results in old, environmentally harmful technologies not being replaced by new more efficient ones, because support favours the old technology – this is the so-called “lock-in effect”. Furthermore, the strictness of environmental policy and the environment’s assimilative capacity will also affect the final environmental damage.

The harmful effects on the economy are mainly efficiency losses where GDP and growth is affected negatively. Furthermore, the effectiveness of a subsidy in benefiting the intended recipient can often be low, depending on the type of subsidy in question. This is due to a high level of leakage to upstream and downstream industries. If the subsidy is conditional on the levels of input use or production levels, leakage effects may be expected in general. In general, subsidies that are not conditional on production or input levels have relatively little leakage effect with limited increase in environmental damage.

Subsidies that have adverse effects on both the economy *and* the environment are defined as "perverse subsidies".

Finally, analysing the adverse effects of subsidies on the economy and the environment should include effects on trade and global consequences, as these effects may be important to the overall result, especially regarding the environmental consequences. This is particularly important if the approach involves an analysis of the usage of subsidies in bigger regions (e.g. the OECD), and not just in one country. This means that removing an environmentally harmful subsidy in one country will result in some level of environmental gain for that country, but not have a global environmental effect. If the same (type of) subsidy were to be removed on a regional or global level, this would have an effect on global trade and production, thus affecting the global environmental outcome in a more complex way.

All these negative effects should be compared to the potential positive effects of granting the subsidy, which could be social, economic and etc. Thus, looking at the trade-offs would be essential when decisions are to be made about the usage of subsidies. Looking at the availability of financial resources is not sufficient.

3 Reforming harmful subsidies

A logical consequence of the negative effects from harmful subsidies is of course to remove them or reduce their usage. Reformation or removal of especially the perverse subsidies will have various positive effects. It will result in decreased government spending, reduced pollution and cost of applying environmental policies together with an increased overall efficiency of the economy, thus leading to higher governmental revenues. It can also stimulate technological change in directions that are crucial for future environmental quality, through increasing resource productivity and curbing pollution from non-point resources (OECD 1998a). Of course it should be borne in mind that there are also negative effects from removing subsidies, especially the potential consequences for equity, which should also be addressed. Perverse subsidies constitute an obvious first category to focus on in the process of reforming harmful subsidies. It is not always simple to identify the effects from the different types of subsidies, though, and certain data are needed. These aspects, as well as barriers to reforming harmful subsidies, are described in the following.

3.1 Identification

To identify the environmental effects of subsidies, as well as the employment, income and growth effects, the first step is to thoroughly analyse *linkage 1* in figure 2.2 (see chapter 2.3.1). This will provide an indication of the direction and magnitude of the environmental effects of subsidy removal. However, in order to fully determine these effects, it would also be necessary to analyse *linkage 2* and *3*[24]. When analysing the costs and benefits of removing subsidies, it is furthermore important to include the effects on preceding and subsequent stages of production. To take all of them into consideration, ideally an analysis of the whole economy would need to be performed, including all the intermediate deliveries between sectors. Such analysis requires the use of general equilibrium models, not just partial analysis. But examination of some of the key characteristics of the subsidy and the markets on which it operates on may often provide a rough indication on the direction and magnitude of the economic and potential environmental effects (OECD 1998a).

[24] Because of the complexity and data requirement difficulties associated with establishing linkages 2 and 3, the OECD report from 1998 primarily examines *linkage 1*.

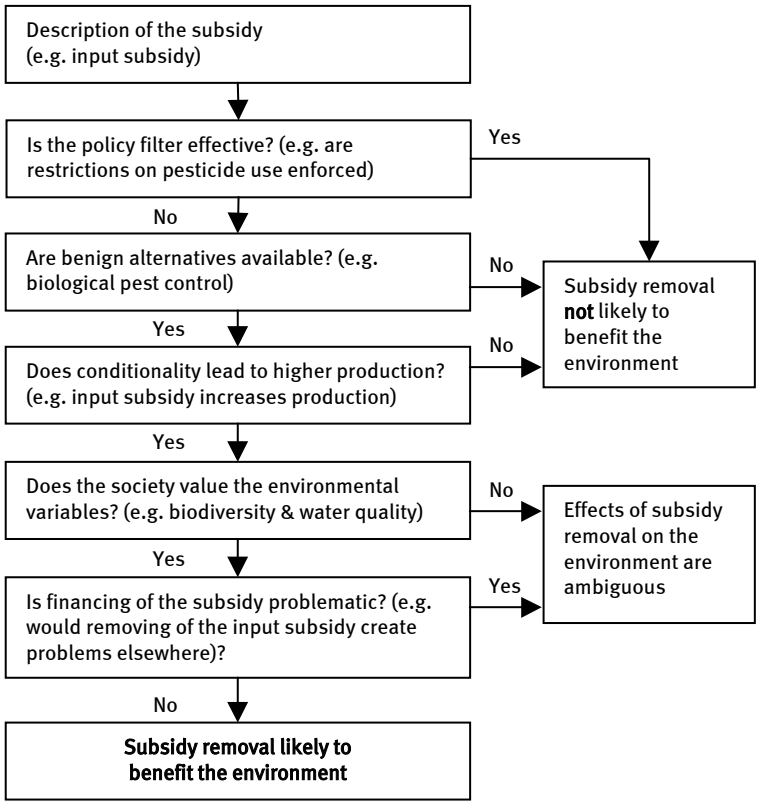
To identify the subsidies that are economically inefficient and environmentally damaging, OECD (1998b) suggests that an evaluation should concentrate on subsidies aimed at the recipient sectors which:

- operate on markets for their finished products that are characterised by either
  - a relatively small price elasticity of demand and a relatively large price elasticity of supply, since these support measures tend to be ineffective in transferring income to the intended sector; or
  - a relatively large price elasticity for both supply and demand, since these support measures are only moderately effective in transferring income to the intended recipient sector and at the same time have potentially large adverse effects on the environment.
- are relatively material or energy-intensive.

This scan will not, however, automatically identify all subsidies that should be reformed or removed. This is because there are other policy decisions involved, notably whether governments prefer to bear the associated higher costs of environmental policy implementation rather than reduce the subsidies which encourage the environmental damage (for example, subsidies that are given for social reasons). Furthermore, the final political judgement must take into account the wider implications of market distortion as well, including its long-term effects on economic efficiency, competitiveness, incomes, employment and equity. However, the quick scan may enable a rough indication of subsidies whose reform or removal might result in win-win situations for both the economy and the environment (OECD 1998b).

Pieters, in OECD (2003c), has suggested a useful checklist to explore which subsidies do the most *environmental* damage and are most easily removed (see figure 3.1). The checklist is intended to identify significant instances of environmentally harmful subsidies. The checklist is being actively developed and remains under review.

Figure 3.1: Checklist to identify environmentally harmful subsidies.



Source: OECD (2003c)

3.2 Required Data

In order to identify the harmful subsidies it is necessary to examine the input and output markets of those sectors that generate the largest volumes of polluting emissions and wastes while also enjoying substantial subsidy levels. Therefore, the following data is relevant:

- The elasticity of supply and demand on both the input and output markets. What are the volume responses to price changes? How much of the subsidy leaks to other sectors?
- The upstream and downstream environmental effects associated with the flows in the economy generated by the subsidy.

Such analysis should, of course, be complemented by an analysis of the effects of subsidy removal on equity and the income of the intended beneficiaries of the subsidy. This analysis will improve the understanding of the mechanisms at work but will not be able to fully predict the effects of subsidy removal. This is due to the fact

that technological, organisational and institutional changes in response to subsidy removal are difficult to predict, especially in the long run (OECD 1998a).

3.3 Barriers to the removal of harmful subsidies

Even though data indicate that support measures are declining, this happens at a slow pace, and the level of support is still significant (OECD 1998b). The main obstacle to reducing or eliminating even perverse subsidies seems to be political and institutional (Anderson 2004; Barg 1996; Myers & Kent 2001). To explain this argument it is instructive to divide government spending programmes into two general categories: (*i*) expenditure on *broadly* targeted public goods such as defence, health, and education, and (*ii*) expenditure on *narrowly* targeted programmes, such as agricultural support or fishing subsidies. The benefits of a *broadly* targeted programme, and the tax costs of funding these programs, are widely dispersed throughout the economy. Moreover, because of their (public good) nature, the benefits of these programmes cannot easily be tailored to the needs of specific groups. Hence, the scope and details of these programmes are likely to be determined and debated in election campaigns.

In contrast, the benefits of a *narrowly* targeted programme are concentrated, while the tax costs are by and large thinly diffused throughout society. Thus, the general tax-paying voter may not worry about these targeted programmes, since each bears only a small fraction of the supply cost. On the other hand, because of the more concentrated payoffs that are involved, the beneficiaries have a greater incentive to be politically active and lobby the government to defend the policy. It follows that the size and style of targeted programmes could be seen as reflecting features such as lobbying intensity and political priorities, rather than voter preferences[25].

Regarding the problem of distorting subsidies, which often seems to be concentrated and accrue to specific groups in the population, lobbying is highly profitable for these groups. However, the financial burden of supplying these benefits as well as the environmental damage involved is widely diffused across society at large. Hence, there is little countervailing lobbying pressure, or electoral pressure, for the elimination of these distorting subsidies. Political resistance to these subsidies is made even more difficult since the environmental consequences are usually less visible, eventuate with a lag, and are thus harder to attribute to a specific policy concession. Consequently, it is difficult to demonstrate the economic and environmental costs of subsidies, whereas beneficiaries can more easily provide concrete

[25] Source: Personal comment by Richard Damania (University of Adelaide) November 2004.

anecdotes of the direct social benefits (e.g. employment, regional growth, etc), while ignoring all the indirect effects (costs) see also OECD (1998a).

These social benefits (equity concerns) of course matter. But if the aggregate wealth of society increases because of subsidy removal, then the specific interests of these groups (e.g. income compensation) might be met with instruments that are less damaging to the environment and/or more effective in reaching the specific target of interest *(Barg 1996)*.

There may also be some political uncertainty about the actual benefits of eliminating perverse subsidies. Even though theoretical analysis results in positive consequences for the economy and environment, the practical consequences remain uncertain.

However, not all interest groups object to reforming subsidy systems, even though they do not gain from subsidy removal. But the opinions often vary among interest groups in different countries which makes it difficult to reach international agreement. International co-operation is nevertheless preferable, since some interest groups argue that national reductions might harm competition in the particular country to a degree that is unacceptable. This argument is disproved in several literature sources, e.g. OECD (1998b) and (2001) who argue that a unilateral (national) reduction in subsidies will often increase the country's welfare notwithstanding the actions of other countries[26]. Furthermore the larger the number of countries that agree on removing subsidies, the larger the positive effects will be both nationally and globally (Anderson 2004; Bhagwati 2001). If environmental gains are added to the equation, the case for unilateral action may become even stronger.

More extensive and accurate information about the benefits from eliminating harmful subsidies will increase the knowledge of the population (voters) and counterbalance the arguments from interest groups (Anderson 2004). In addition, information that makes support measures more transparent can benefit the policy debate on the elimination of harmful subsidies by focusing on the full costs of the support and the effectiveness of the measures in achieving their goals. Such transparency requires internationally comparable data on support levels and -types for all sectors, but such comprehensive information is not yet fully available. Further, interna-

[26] New Zealand serves as a good example (see description in chapter 2.4).

tionally comparable data is essential for co-operation on an international level (OECD 1998b).

3.4 Conclusion

Any analysis of the harmful effects from subsidies must place high requirements on data availability. Unfortunately, data is often scarce and especially the environmental effects from subsidies are rarely estimated quantitatively. Thus, future work must concentrate on obtaining the required data in order to be able to make thorough and valid analyses of subsidies, as concluded by OECD (2003c). The more information available on the size and effects of subsidies may make the problem with harmful subsidies more transparent to the public.

Part II Subsidies in practice

This section describes empirical examples of the linkages between distorting subsidies, the environment and the economy for different sectors. Environmentally harmful and perverse subsidies are usually found within six areas: agriculture, fishery, energy production, transport, water and forestry. Quantitative data material on the size of harmful subsidies and the subsequent environmental effects is very scarce. Therefore the environmental and, to some degree, the economic consequences of giving subsidies in the different sectors will mainly be described qualitatively and by means of empirical examples.

To give an impression of the magnitude of the problem, estimates of total subsidies granted worldwide are represented based on existing literature. In some areas, such as agriculture and energy, data is readily available, whereas for the forestry and transport sectors, the data is rather scarce. This means that the quality of data varies a lot among the different sectors, and this should be kept in mind when reading this part of the report. For instance, the dates of the estimates vary considerably, with some data going back to the beginning of the 1990s, which expresses the lack of updated data in the area. Furthermore the estimates have not been corrected for inflation, as many of the estimates are already very uncertain, but also to keep the estimates on the low side.

Furthermore, some very rough estimates of the share of perverse subsidies out of total subsidies are presented. These estimates are, however, based on a single source, which itself describes the estimates as very rough and uncertain. Thus, they may be characterised as guesstimates rather than estimates. To our knowledge, there are no other estimates of the size of perverse subsidies in isolation.

Optimally, the distorting subsidies and their effects should be identified according to the procedure described in chapters 2 and 3, but this specific method has not been used in the literature. Using the method may be a comprehensive task and is not within the scope of this report. Therefore, such analysis is left for future exploration.

It should be noted that the described negative effects on environment are general effects from the overall existence of activity in the sector, and not just results of using harmful subsidies. The problem is that the harmful subsidies may increase these negative effects compared to a situation without subsidies.

4 Agriculture

Agricultural subsidies have existed for a long time, and for various reasons. Agriculture is by far the most heavily subsidised sector in the world. About one third of agricultural production is subsidised (OECD 2003a; Van Beers & de Moor 2001) and approximately 85% of the total amount of agricultural subsidies can be found in OECD countries.

About two-thirds of direct farm subsidies are estimated to be perverse, meaning that they are harmful to the environment as well as to economic development in society. Removal of these perverse subsidies will therefore result in a "win-win" situation for society (Humphreys et al. 2003).

Table 4.1 and 4.2 give an overview of the different types of subsidies and their negative environmental effects. These will be described in the following.

Table 4.1: Types of agricultural subsidies.

Types of subsidies	Example
Output support	▪ Market price support ▪ Other output support
Input subsidies - Explicit (production) - Implicit (services)	 ▪ Fertiliser, pesticides, energy ▪ Research and development, extension services, schools
Direct payments	▪ Land set-asides, insurance, disaster payments and area payments

Table 4.2: Examples of environmental damage from agricultural subsidies.

Production change	Pressure on environment	Environmental effect
Increased output, increased input (intensified production)	▪ Increased emissions of e.g. pesticides, nitrogen, phosphorus, greenhouse gasses	Eutrophication, contamination, global warming, biodiversity effects, water quality.
Increased monoculture	▪ Increased soil exhaustion, increased pesticide usage	
Increased usage of marginal land	▪ Increased erosion (e.g. from deforestation)	
Increased subsistence practice in developing countries due to lower world market prices	▪ Increased deforestation and erosion	

4.1 Types of subsidies and their goals

The different types of agricultural subsidies and the effects on prices, production and trade are very complex, and will not be treated further in this context. In general, it can be said that subsidies leading to an increase in profits will often be capitalised[27] into land values (OECD 2002b) and decrease transfer efficiency. Based on Van Beers & de Moor (2001) and OECD (2004b) agricultural subsidies in the OECD can in general be divided into three types:

1. *Output support*. Market Price support[28] makes up the largest share of this group and comes in various forms, but in general it guarantees farmers a fixed price, usually higher than the world market price. The higher price on products will induce producers to produce more, which will increase exports and/or decrease imports. Price support measures are thus linked to output levels. Securing farm income through price support measures is not very effective, as the transfer efficiency ratio is only 0.24 (Dewbre 2002), which means that only 24% of the monetary transfers goes to increasing net farm income. Out of this, a little more then one half may be expected to be capitalised into increased land values (Dewbre 2002). Furthermore, around 36% of the total transfers go to input suppliers (Dewbre 2002). Approximately 60% of producer support (PSE)[29] in the OECD consists of price support measures (OECD 2005).
2. *Explicit and implicit input support. Explicit* input support is given directly to the production/input factors (e.g. energy, fertilisers and capital) results in lower production costs to the farmer, resulting in increased usage of the input factors. Explicit input support is intended to ensure stable supplies and prices for products and be a safeguard to farmers (Robin et al. 2003). Farmers will not receive the full effect from this support, though, as the prices on the supported inputs will rise because the demand rises (Kjeldsen-Kragh 2000). In Dewbre (2002), the transfer efficiency is estimated to be 0.17 of which 50% will be capitalised into prices of land. Around 67% of the total transfers go to input

[27] The capitalisation effect means that the value of land increases as a result of the increased revenue induced by the subsidies. Increased land values raises costs for farmers leasing or buying land and thus reducing the income effect further.

[28] In OECD (2004b), Market Price Support is defined as the gap between domestic market prices and border prices of commodities.

[29] Total support to producers can be expressed by the Producer Support Estimate (PSE), which measures the total costs to consumers and taxpayers of support to agriculture at farm gate level, i.e. to individual farmers and not to the agricultural sector as a whole. The PSE is relevant when analysing the efficiency of income transfers to farmers.
Another support estimate is the Total Support Estimate (TSE), which measures the total costs to consumers and taxpayers of support to the agricultural sector as a whole, i.e. including general services and consumer support and not just to individual farmers. The share of price support measures out of total support (TSE) is around 45%.

suppliers. *Implicit* input support (or general services support) is support not directly to the individual farmer, but other monetary transfers to agricultural services such as research and development, extension services, schools etc.

3. *Direct payments* (land set-asides, insurance, disaster payments, and area payments). In general these subsidies do not influence input and output prices and farmers therefore face market prices (if these are not distorted through other support measures). These subsidies are therefore mostly decoupled from production and input use. Some of these measures (e.g. land set-asides) are implemented to reduce the negative effects of overproduction caused by price support (Kjeldsen-Kragh 2000). An area payment is one example of a direct payment. The transfer efficiency of area payments is by Dewbre (2002) estimated to be 0.47 of which almost all (98%) is expected to be capitalised into land values.

In developing countries, the situation is a little different. Because governments in developing countries have been focusing more on low food prices for urban consumers, agriculture has been indirectly taxed through artificially low prices and directly via export taxes on agricultural products (Haug & Øygard 1999). Overvalued exchange rates and policies to stimulate industrialisation have further resulted in income transfers out of agriculture (Van Beers & de Moor 2001). To compensate farmers, support has been given through farm credit programs and input support measures. Fertiliser and pesticide subsidies are especially common in the developing world (Humphreys et al. 2003). In the last decade, it seems that developing countries in general have shifted from taxing agriculture to protecting it, though some developing countries are still taxing agriculture (Baffes & de Gorter 2005; Jensen et al. 2002).

Consumer subsidies are in outline analogous to producer subsides as mentioned earlier.

4.2 Environmental externalities from agriculture

The distortion on environment and economy varies with the different types of agricultural subsidies, where market price support, payments based on output, and input subsidies potentially have the most distorting effects, both economically and environmentally. These support measures accounted for 75% of support to agricultural producers (PSE) in OECD countries[30] during 2001 - 2003 (OECD 2004b). The

[30] The share out of total support to the agricultural sector as a whole (TSE) was around 60%.

support measures that potentially have the least distorting effects are some of the "direct income support measures" where, in particular, payments based on input constraints (e.g. withdrawal of input) and payments based on overall farm income are relatively less distorting (OECD 2002a).

It should be noted that agriculture might also have positive externalities, e.g. to the environment, landscape, and biodiversity (OECD 2002b). Examples of positive environmental effects might include the conservation of the rural landscape (people may have positive preferences for a rural landscape), preservation of biodiversity and ecosystems (de Moor 1997). Subsidies that enhance positive externalities cannot, of course, be categorised as perverse. In addition, many countries link support directly to environmental goals, which will further enhance positive environmental effects. Less than 4% of total support to agriculture in OECD countries today is targeted at environmental objectives (OECD 2003b).

In the following, focus will be on the distorting effects on the environment. In general, subsidies shift resources away from their optimal use, and this often causes damage to the environment (Humphreys et al. 2003).

Subsidies to production encourage farmers to raise output and/or the use of inputs, since the subsidy will increase the profitability of producing. Increased profitability will induce a rising demand for land (marginal land will be cultivated) and a more intensified production with an increased use of pesticides and fertilisers, which can have negative environmental effects (Van Beers & de Moor 2001). Furthermore, subsidies reduce production risks, and diversified production is not necessary to the same extent as without subsidies (Mayrand et al. 2003). There will be a tendency towards monoculture[31], which makes production more rational and thus more efficient. Monoculture may contribute to soil exhaustion (reduced fertility), decreased agro-biodiversity and to a greater use of pesticides, as monoculture makes crops more sensitive to disease. Subsidies within the OECD may also influence the environment in developing countries. Subsidies (especially when targeted at production levels) result in overproduction, and when the surplus is dumped on the international market, market prices are pushed down. This results in a less profitable agriculture in developing countries, thus discouraging production and investments. In particular, poor, small scale farmers (marginal workers) are ex-

[31] Monoculture means that there is only one crop (or very few crops) in the rotation of crops over time.

cluded from market transactions and have to use marginal and often ecologically fragile lands (Van Beers & de Moor 2001, s.37) for subsistence practices. This also partly explains the generally accepted assertion that poverty is a major cause of environmental degradation (WTO 2004). As previously described, governments in developing countries often reduce prices on farm products to ensure low food prices for the population in general, which leads to a further burden on agriculture. The subsistence practices often take place on marginal and ecologically fragile land, leading to erosion (see also below).

Hence, there are several negative effects (externalities) from agricultural production that may be reduced by the removal of harmful subsidies:

- *Emissions* (pesticides, nitrogen, phosphorus, greenhouse gasses); the usage of fertiliser and manure leads to emissions of nitrogen and phosphorus, which causes eutrophication of lakes, oceans, groundwater/public water supplies, and affect vulnerable ecosystems on land. Pesticides can also contaminate lakes, rivers, and groundwater, as well as cause direct poisoning of people, which is especially the case in developing countries (Myers & Kent 2001). The emission of greenhouse gasses stems from crops, livestock and machinery, and typically includes methane (CH_4), nitrous oxide (N_2O) and carbon dioxide (CO_2).
- *Soil erosion*; soil erosion is when land is destroyed or exhausted[32] (OECD 2001c). Subsidies increase the usage of marginal and ecologically fragile land that would otherwise not have been profitable to cultivate. This is done through land clearing (e.g. cutting down forest) where the land is most often not very fertile and more susceptible to erosion. Monoculture and shorter rotations also accelerate erosion (OECD 2001c). However, one quarter of degraded soils are the result of poor agricultural practices (de Moor & Calamai 1997). Intensified production (e.g. overstocking) on existing cultivated land will also cause increased erosion. Erosion constitutes a cost to society in the form of higher food costs.
- *Water use*; Subsidies for irrigation are treated in chapter 7 describing *water* in general. It should, however, be mentioned that agriculture accounts for around 70% of global freshwater extraction (OECD 2001c).

[32] Soil exhaustion is for instance when nutrients in the soil decline.

- *Biodiversity effects*; many of the above-mentioned effects impact negatively on biodiversity by affecting wild plants, animal species, natural habitats, genetic wipe-out etc.

Again, it should be noted that all these negative effects stem from agriculture in general, and are not only present because of (direct) agricultural subsidies. Removing (direct) perverse subsidies therefore will not solve all the problems of negative effects from agricultural production (externalities). But the removal may contribute to reducing the problems.

When models show reductions in fertiliser and pesticide use, this does not imply an equivalent reduction in environmental effects. Modelling the environmental consequences of subsidy removal is not a straightforward exercise, as environmental conditions at the point of reception of the emissions are important (OECD 1998b). For instance, ground structure and weather affect the amount of nitrogen that actually leaks out of the soil, and geographical location influences the degree to which nitrogen damages the environment. Thus, regional/local considerations have to be taken into account when modelling environmental consequences, which complicates the analysis.

4.3 Subsidies worldwide

In general, there has been a decrease in the level of support in the OECD countries. Nevertheless, support still accounts for one-third of farm income (OECD 2003a). For 2001, the estimate was around $305 billion for all OECD countries, where the EU and the United States represent the largest amounts. In table 4.3, the total level of support (TSE) in the different OECD countries is illustrated as an example of how the level of support differs between countries. The TSE is also calculated as a percentage of the GDP, which gives an indication of the burden on the country's economy. Finally, TSE is shown per capita. As illustrated in table 4.3 there are considerable differences between countries.

Table 4.3: Total support estimate (TSE) in OECD countries, 2001

Country/region	TSE USD million	TSE, percentage of GDP	TSE per capita
Australia	1,171	0.3	60
Canada	5,308	0.8	171
Czech Republic	975	1.7	95
European Union [1)]	98,921	1.3	268
Hungary	1,258	2.4	127
Iceland	124	1.6	436
Japan	57,338	1.4	451
Korea	19,347	4.6	409
Mexico	8,142	1.3	84
New Zealand	126	0.3	33
Norway	2,354	1.4	522
Poland	2,388	1.4	62
Slovak Republic	268	1.3	50
Switzerland	4,927	2.0	681
Turkey	5,410	3.6	79
United States	97,442	1.0	342
OECD	**305,501**	**1.2**	**271**

Source: (OECD 2003a)
Note: 1) EU-15

There are no official estimates for the support level in non-OECD countries, but Myers & Kent (2001) suggest that $25 billion could be a conservative guess, also suggesting that at least $50 billion would be more realistic. By comparison, Van Beers & De Moor (2001) estimate subsidies in non-OECD countries to be $38 billion[33]. Thus, a conservative guess could be $30 billion in non-OECD countries.
For the years 2002 – 2004, TSE in the OECD countries was $346[34] billion (OECD 2005). Based on this figure and $30 billion in non-OECD countries, $376 billion per year thus constitute an estimate of total agricultural subsidies worldwide.
As mentioned earlier, not all subsidies are perverse, and Myers & Kent (2001) estimate that the total for perverse subsidies is around two-thirds of the direct subsidies. OECD (2002a) defines the most distorting subsidies as being market price support and support based on output and input use, which together constitute around $190 billion in years 2002 – 2004, and which is equal to 55% of the TSE[35].
In the following, this percentage is used as a conservative estimate of the share of perverse subsidies worldwide, which then would be around $207 billion. The figures are listed in table 4.4.

[33] Based on figures from the late 1990s.
[34] TSE for 2002-2004 differs so much from the $305 billion in 2001 partly due to the range of new member states in EU (OECD 2004b).
[35] These types of subsidies amount to 75% out of the direct support to producers (PSE) of $254 billion (OECD 2005).

Table 4.4: Total agricultural subsidies and perverse subsidies globally

	Billion USD
Subsidies in OECD countries (1) *	346
Subsidies in non-OECD countries (2) **	30
Total direct agricultural subsidies	376
Perverse subsidies out of total direct subsidies	207

Sources: 1) OECD (2005), 2) Myers & Kent (2001) and Van Beers & De Moor (2001)
Notes: *) figures for 2002-2004 **) Figures from late 1990s

4.4 Policy options

Since the beginning of the 1990s most OECD countries have begun reforming agricultural policies with the aim of reducing direct support and trade distortions (OECD 2001b). Based upon the information above, however, there is still a long way to go. Furthermore when negative environmental externalities are to be reduced (internalised), it is not only a matter of removing existing measures, but also to introduce new policies/measures that internalise these externalities. The latter is treated briefly at the end of this chapter.

A practical experience of removing subsidies – New Zealand

One often-cited example of the positive consequences of removing subsidies in general is the case of New Zealand. During the 1980s, New Zealand phased out subsidies to agriculture and to irrigation. Before that, agricultural support had risen to about 40% of farmers' gross income and to 6% of the GNP. The types of subsidies used covered a wide range of "typical" subsidies in OECD countries, e.g. minimum prices and input subsidies. The adjustment process took seven years. In the beginning it resulted in a 60% drop in farmland prices. The government of New Zealand recognised that subsidies were capitalised into land prices and other farm fixtures and they therefore introduced a Structural Adjustment Package to compensate farmers for the inevitable losses that followed[36]. The most important form of compensation was debt restructuring. About 20% of the total farm sector debt was written of and the result was that only 5% of farms were sold (Bell & Elliot 1993). After the adjustment process however, farmland prices recovered to 86% of their initial value in real terms, fertiliser prices returned to the pre-reform levels and the value of farm output once again increased. Big efficiency gains have been achieved and farming has become more diversified and competitive (Myers & Kent 2001). The immediate environmental effects were a halt to land clearing and overstocking.

[36] Source: Personal comment by Richard Damania (University of Adelaide) November 2004.

Soil erosion has declined and plantations[37] have expanded by 50%. There has been a significant decline in the use of fertiliser (50%) and agro-chemicals. During the last decade though, the use of fertiliser and agro-chemicals has risen to previous levels because of price changes and shifts in production structure. For instance, the use of agro-chemicals has risen because there has been an increase in specialised horticultural products (Mayrand et al. 2003), and the use of fertiliser has risen, not least because of increased usage in dairying[38], which has also expanded (Taylor et al. 1997). But the use of fertiliser has become more efficient, which underlines the fact that usage and emissions are not proportional.

Apart from the example of New Zealand, not many empirical examples exist that describe a complete removal of subsidies. Myers & Kent (2001) describe the many positive cases, where pesticide subsidies have been cut and replaced with "integrated pest management" (IPM), which is a strategy with minimum use of pesticide and a focus on alternative ways to fight pests (e.g. mixed crops, natural enemies of pests). In these examples, significant savings on support have been made, and some of the savings are used to fund the IPM program.

In the following, the consequences for the economy, equity and the environment, of removing subsidies are described from a theoretical viewpoint and model simulations.

Economic consequences

Removing subsidies worldwide is in many ways similar to trade liberalisation, where the goal is to eliminate/reduce export subsidies, import protection, and national support. Simulations[39] have been made to model worldwide liberalisation of agricultural trade. The economic gains from full liberalisation of agricultural trade have been estimated to $400 billion (1991 values) a year (Myers & Kent 2001). Estimates in different analyses vary, however, as a result of different assumptions in modelling. Anderson (2004), for instance, refers to several different

[37] Subsidies encouraged raising stocks onto erodible hills. After the subsidy removal stock raising was intensified on better lands, and the hills were instead planted with trees (plantations), which prevent soil erosion.

[38] Dairy farmers have begun applying more nitrogen fertiliser to pasture as pasture use has intensified.

[39] The results described in this chapter are based on Computable General Equilibrium (CGE) models. These models rest on different assumptions of which some are arbitrary and thus highly uncertain. Therefore the results should be interpreted with care. It would be useful to offer explanations of the results and assumptions would be useful, but this would be too comprehensive for the purposes of this report.

analyses of the potential gains from full trade liberalisation and removal of all agricultural subsidies. The estimates vary from $254 to $2080 billion a year (costs not included) of which agricultural benefits account for 65-70%.

The consequences for many developing countries can be more complex. The economic outcome of trade liberalisation depends on many other factors. Food importing developing countries might experience a short-term negative effect as world market prices increase (imports become more expensive) and food aid is reduced (as the aid most often is a result of excess production in developed countries). Furthermore, it can take a considerable period of time for some of the least developed countries to become net exporters since there are prevailing constraints that make rapid response to new relative prices difficult (e.g. poor infrastructure). Therefore, it will be necessary to instigate national policies to obtain the positive effects from trade liberalisation (Haug & Øygard 1999). These arguments are supported by model calculations on the multilateral liberalisation of trade in agricultural commodities under the DOHA agenda of the WTO (World Trade Organisation). The results show economic gains in most developing countries, but some poor developing countries and small island states where domestic agriculture has the least capacity to expand will derive the least benefit, and may even incur losses (Morrissey et al. 2005). In general, developing countries will gain from trade liberalisation in the long term, and little over a quarter of the gain will come from liberalisation in developed (high-income) countries. The rest will come from the developing countries' own liberalisation (Humphreys et al. 2003)[40]. Growth in rural agriculture also seems to be a relatively good way to reduce poverty, which often contributes to environmental degradation in the least developed countries (Haug & Øygard 1999).

Equity

The consequence for equity may also be different for developed and developing countries. In the analyses in Morrissey et al. (2005), the general economic gains in developing countries are reflected in increased income in agriculture and lower consumer prices, both conditions likely to benefit the poor. Thus, there should be a potential to reduce poverty and inequality, especially rural-urban inequality. In

40 This view is also supported by Anderson (2004): *"Changes in policies in developing countries make a more substantial contribution to other developing countries' economic welfare, and almost half of that gain comes from policy changes in their agricultural sector. This reflects the importance not only of own-country reform but also of expanding South-South trade."*

developed countries, producer losses will most likely occur, but as put forward in Morrissey et al. (2005) *"agriculture is a relatively low share of the economy and these countries have the resources to accommodate the adjustment"*. For instance, some of the gains for society could be used to reduce the negative effects on equity.

Environmental consequences

Environmental effects are not simulated as often as economic effects. A modelling simulation carried out on the removal of agricultural subsidies in OECD regions by 2020 estimates a 7% reduction in nitrogen loads and a 10% reduction in irrigation water usage (OECD 2001c). An analysis of the effect of liberalising the global trade market has been carried out for the Danish agricultural sector (Food and Resource Economics Institute 2000)[41]. Removal of subsidies will have a variety of effects, for instance on the composition of crops that are cultivated, as some of the traditional crops will be reduced and new crops will emerge. Furthermore, removal of subsidies will also have a negative effect on employment within the sector. There will be a decrease in the use of fertilisers (decrease of 17%) and pesticides (decrease of 9%). While the environmental effect of this has not been quantified in the analysis, environmental benefits are expected. All in all, the liberalisation of the agricultural sector in Denmark will bring large macroeconomic benefits in the form of an increase in GNP of 0.5%. Furthermore, private consumption is expected to increase by 3.1%.

Whether the global environmental consequences will be positive probably depends on several factors. If world market prices rise (e.g. as a consequence of free trade), agricultural production in developing countries would be more profitable, which may lead to more intensified and increased production. With less access to technology, it might be expected that more pollution per unit value is added than in developed countries. Positive net environmental consequences on a global level from trade liberalisation thus depends on the possibility that increased environmental costs from the rise in production in developing countries are smaller than the environmental benefits from reduced production in developed countries. A global, negative environmental impact from trade liberalisation is supported by Morrissey et al. (2005), who argue that a net increase in global production will bring more land into use for agriculture (encouraging deforestation) and/or there

[41] Based on a model using data from 1995.

will be increased intensity of use of agro-chemicals. Though the adverse impacts to some extent will be offset by technological and resource management improvements and by global shifts from less to more efficient producers, the net increase in volumes traded implies increased transport and thus increasing emissions of pollutants (Morrissey et al. 2005).

Anderson (2004) argues that if trade reforms (subsidy removal included) reduce poverty, environmental damage will also be reduced, since much environmental damage in developing countries is a direct consequence of poverty. A rise in income (and thus reduced poverty) would therefore result in greater demand for clean environment and abatement practices will spread fast enough to compensate for the more pollutive products that are consumed (see also chapter 2.5). Furthermore, openness to trade accelerates the spread of abatement technologies, making implementation in developing countries affordable at an earlier stage (Anderson 2004; WTO 1999).

Increased profitability and production might also increase the demand for farm labour and thus attract marginal workers away from subsistence practises on hillsides, leading to less deforestation and soil degradation (Lingard 2002). In addition, where farming occurs on the extensive frontier (forest margin), higher prices may (or may not) prompt further deforestation. This will occur if the payoffs from raising productivity through increasing farm size (through felling forests) exceed the payoffs from intensification.[42]

It has been shown that low agricultural yields are likely to be associated with more deforestation for profit-seeking commercial farmers if subsidies are guided by political economy and corruption (Bulte et al. 2004). This is the case for Latin America where subsidies to ranchers have contributed to backwardness rather than development. Despite large subsidies, agricultural yields have remained low (especially among large farms), and agricultural growth has arisen predominantly because of area expansion (usually into forestlands). The results in Bulte (Bulte et al. 2004) show that agricultural productivity falls as governments spend more on subsidising farmers.

Mayrand et al. (2003) address the environmental consequences in developing countries from agricultural trade liberalisation and argue that a positive global effect on the environment depends on the existence of environmental policies in developing countries. Since developing countries are drawing on already stressed

[42] Source: Personal comment by Richard Damania (University of Adelaide) November 2004.

environments, global environmental costs could be greater than the global benefits if such policies are not implemented (Mayrand et al. 2003).

Strategy for the future

Often, national governments use the argument that trade liberalisation should be effected at an international level, where all countries commit to reducing their support, thus avoiding the risk of unfair advantages. Humphreys et al. (2003) argue that international trade models indicate that a national/domestic subsidy reduction will also benefit the country in question, even when other countries do not reduce their support. The argument depends on the point that the market prices are not influenced by the reduction in subsidies in the particular country (OECD 1998b). The chance of success will nevertheless be greater if the biggest agricultural subsidisers (EU, US, and Japan) embark on a united reform (de Moor & Calamai 1997)

When immediate removal of subsidies is politically (or otherwise) unacceptable, a first step could be to decouple the subsidies from production levels. As described, market price support and subsidies based on input/output are amongst the most distorting subsidies, both economically and environmentally, i.e. they are most likely perverse. The OECD countries have seen a shift from measures linked to output levels or input use towards measures that are decoupled from production and input use, though the former still dominates (OECD 2001c). [43]

A shift in subsidies is also put forward by Mayrand (2003), who suggests that further environmental benefits can be reached by redirecting perverse subsidies towards more environmentally neutral subsidies, e.g. direct income payments, if there are social or economic (e.g. equity) reasons to use subsidies. As mentioned earlier, subsidies may also be linked directly to environmental goals as has already been the case in many countries. Another type of subsidy, which can be beneficial, is support to research and development (R&D). Often, more R&D will result in more efficient use of resources and better environmental outcomes as less harmful ways to use resources are discovered (Humphreys et al. 2003).

The decoupling of subsidies is mentioned as a first step to remove subsidies. However, there is also reason to be critical towards the decoupling of subsidies. First of all, decoupling will not bring about an immediate change in production methods,

[43] For EU it is estimated that the share of market price support will fall from 58% to 53% as a consequence of the new CAP-reform from 2003 (OECD 2004a).

since replacement of old, wasteful or dirty technology will occur over time[44]. Subsidies that are decoupled from production might also lead to some degree of environmental harm. This is the case when they result in increased wealth for farmers, which can lead to an increased level of activity (Mayrand et al. 2003) and thus cause the scale of production to exceed the optimal level. In addition, the risks linked to production might be reduced, which could lead to less diversified production (see also chapter 4.2).

Decoupled subsidies have the potential to be much less perverse, but Baffes & de Gorter (2005) argue that decoupled support programs can have just as distorting effects as coupled subsidies. If decoupled support is to have no (or the least) distorting effects it is important to address aspects such as time limits of the subsidy program, harmonisation with other support programs, government credibility and constraints on input use.[45] The authors suggest a one time unconditional and non-transferable payment as a simple and minimally distorting scheme.

Targeting environmental externalities

The negative effects from agriculture mentioned earlier can be defined as negative externalities, as the parties inflicting the costs do not pay for these costs. One efficient way these costs can be internalised in the market prices is, for instance, to levy a tax on the emission that causes the externality as described in chapter 2.1. Taxes on emissions from agriculture or inputs that cause emissions have not been widely used to date, and when they are used they are not great enough to alter behaviour, but instead the purpose is to generate revenue for environmental programmes (Horan & Shortle 2001).

There are other instruments to target externalities from agriculture, e.g. quotas, emission standards, and even subsidies can be used as mentioned earlier (subsidies linked to environmental goals). The theory regarding effects and implementation of all these instruments is comprehensive and shall not be treated further in this context. However, the general conclusion regarding externalities is that they should be targeted by appropriate measures to some extent.

[44] Source: Personal comment by Richard Damania (University of Adelaide) November 2004.

[45] Programs should be limited in time. Other coupled support programs may maintain incentives to overproduce. Government credibility is maintained through clearly defined credibility rules that are not allowed to change, and there should be no production requirements (Baffes & de Gorter 2005).

4.5 Conclusion

Agriculture is the most heavily subsidised sector in the world when looking at conventional subsidies. These are estimated to be approximately $335 billion per year. Perverse subsidies are roughly estimated and could be around $220 billion. But, not all subsidies are harmful. Subsidies are least harmful for example when they are linked to environmental goals, research & development, or go directly to the individual farmer as direct income payments (decoupled from production), though care should be taken when designing these support system if not they are to be distorting too. This means that perverse subsidies could be redirected to subsidies that are targeted more directly (e.g. the environment or distributive effects) to avoid unintended consequences. It is worth noting, though, that improvements have been made in many countries as concerns redirecting more harmful subsidies to less harmful subsidies, i.e. decoupling subsidies. In a longer time perspective, this can be seen as one step closer to the removal of subsidies altogether. But there is still a long way to go.

From the different analyses performed in literature, there seems to be no doubt that economic gains can be achieved globally by removing subsidies. Distribution effects (equity) seem to be more positive in the developing countries in general than in developed countries. The outcome for the global environmental effects is more uncertain, depending also on environmental measures and technology development. In so far that subsidy removal in developed countries reduces production levels, environmental gains are likely to be achieved in these countries. This may be counteracted by production increases in developing countries, though. Removing perverse subsidies will also make the current environmental policies more effective, if the removal reduces production levels and thus externalities. The negative externalities from agriculture could thus be reduced by the removal of perverse subsidies, but the implementation of environmental policies targeted directly at these externalities will most likely be necessary to increase the fulfilment of environmental goals.

5 Energy production

Energy production and consumption have increased steadily over the past decades. And global demand is expected not only to continue to grow, but even to accelerate as commercial energy consumption in low and mid-income countries closes the gap with the richer nations. There are two main environmental issues associated with energy. One is specific pollution problems from energy use and the other is the depletion of non-renewable resources (de Moor & Calamai 1997).

Energy is among the most heavily subsidised sectors in the world. Governments in both developing and developed countries intervene heavily in their energy sectors in many ways, from direct grants to mandatory regulations, and from training assistance to price controls and guaranteed markets (de Moor 1997; Van Beers & de Moor 2001). Many tax policies may have served a productive purpose when they were first introduced, but many have now outlived their usefulness. For example, in the US, depletion allowances were introduced to promote oil production during World War I, which was a valid reason at the time, but it has long run out of rationale, even though the tax subsidy persists. The fossil-fuel industry is, in fact, the third most heavily subsidised economic sector after road transportation and agriculture. Fossil fuels and nuclear energy receive the great bulk of subsidies. Energy production and distribution are often controlled by the state, which means that governments play a central role in setting energy prices. The failure of governments to price energy properly results in consumption and production that are higher and thus more polluting than they should be (Myers & Kent 2001).

Tables 5.1 and 5.2 give an overview of the different types of subsidies and their negative environmental effects. These will be described in the following.

Table 5.1: Types of energy subsidies.

Government Intervention	Example
Direct financial transfers	▪ Grants to producers ▪ Grants to consumers ▪ Low-interest or preferential loans to producers
Preferential tax treatments	▪ Rebates or exemption on royalties, duties, producer levies and tariffs ▪ Tax credit ▪ Accelerated depreciation allowances on energy supply equipment
Trade restrictions	▪ Quota, technical restrictions and trade embargoes
Energy-related services provided by government at less than full cost	▪ Direct investment in energy infrastructure ▪ Public research and development
Regulation of the energy sector	▪ Demand guarantees and mandated deployment rates ▪ Price controls ▪ Market-access restrictions

Table 5.2: Examples of environmental damage from energy subsidies.

How the subsidies work	Pressure on environment	Environmental effect
Lower cost of energy increases production and uses of fossil fuels.	▪ Increased air pollution (sulphur dioxide, nitrogen oxide, particulates)	Health problems, corrosion damages, eutrophication
Lower energy prices for consumers increase consumption.	▪ Increased CO_2 and methane in atmosphere	Global warming
	▪ Waste and spills	Declining water quality

5.1 Types of subsidies and their goals

Governments have justified financial intervention in the energy sector with one or more of the following aims.

Security of supply: Since the oil crisis of the 1970s, governments have used subsidies to ensure adequate domestic supply. Subsidies have been provided to support indigenous fuel production in order to reduce import dependency. Energy subsidies have played an important role in a wider geo-political context, often to support overseas activities by national energy companies.

Environmental improvement: Energy subsidies have also been used to reduce pollution (SO_2, NOx, particulates and greenhouse gas emissions) and to fulfil responsibilities under related international protocols and treaties. While these subsidies do not internalise external costs, they compensate for imperfections in market pricing.

Economic benefits: Energy subsidies in the form of reduced prices are used to stimulate particular sectors of the economy or segments of the population. They can also build domestic industrial sectors and provide opportunities for growth and exports in energy technology markets.

Employment and social benefits: Energy subsidies are often used to maintain local employment, especially in periods of economic transition. The political imperative to protect jobs has been a major factor in the aid provided to the German and Spanish coal industries (European Environment Agency 2004).

Subsidies can be classified in many ways, but one major economic issue is whether they are orientated towards production or consumption (European Environment Agency 2004). The subsidies given to the energy sector in developed countries have two purposes. When the support is in the form of consumer subsidies, the purpose is to support low-income groups. When it is given as producer subsidies, the goal is to encourage sector development. In developing countries, the subsidies are usually given to the consumer to support low-income groups, but also to stimulate economic growth. The two categories – subsidies to energy production and subsidies to energy consumption – have quite different effects. Consumer subsidies through low energy prices encourage overuse and hence stimulate pollution. Furthermore, underpricing also hurts energy producers whose profits are insufficient to replace and modernise existing equipment. The existence of old energy equipment, as for instance in many formerly centrally planned economies, causes an enormous waste of energy between the points of production and consumption. Producer subsidies encourage overproduction, since they reduce production costs artificially. This type of subsidy is usually accompanied by protection and quantity regulations that generate further distortions in the domestic economy (Van Beers & de Moor 2001). Table 5.3 gives examples of government intervention in the energy sector.

Table 5.3: Examples of government intervention and how they work.

Government Intervention	Example	How the subsidy usually works		
		Lowers cost of production	Raises cost of production	Lowers price to consumers
Direct financial transfers	▪ Grants to producers	√		
	▪ Grants to consumers			√
	▪ Low-interest or preferential loans to producers	√		
Preferential tax treatment	▪ Rebates or exemption on royalties, duties, producer levies and tariffs	√		
	▪ Tax credit	√		√
	▪ Accelerated depreciation allowances on energy supply equipment	√		
Trade restrictions	▪ Quota, technical restrictions and trade embargoes		√	
Energy related services provided by government at less than full cost	▪ Direct investment in energy infrastructure	√		
	▪ Public research and development	√		
Regulation of the energy sector	▪ Demand guarantees and mandated deployment rates	√	√	
	▪ Price controls		√	√
	▪ Market-access restrictions		√	

Source: UNEP (2004)

5.2 Environmental externalities from energy use

Energy production and consumption have an impact on the environment. Therefore, subsidies that either induce an increase in the production or consumption of energy might result in further deterioration of the environment.

The main types of pollution are sulphur dioxide, nitrogen oxide, particulates and carbon dioxide all of which stem primarily from the use of fossil fuels. This pollution has an impact on the local ambient air quality, and the emission of greenhouse gases contributes to global climate change. Water systems are affected by the deposition of acid rain and hazardous air pollutants, accidental oil spills, and potential nuclear waste leakages. Furthermore, the development of dams for hydroelectric[46] power generation and the pollution of water used in the processes of energy production and refining also influences water systems. Energy production also has an impact on land use and soil pollution because of the siting of mines and energy related facilities, the deposition of acid rain and hazardous air pollutants, and the disposal of large amounts of solid waste leakages. (de Moor & Calamai 1997; OECD 2002c).

[46] Hydropower is a renewable energy form.

It should be noted that renewable energy forms could also have negative environmental impacts even though they do not contribute to global warming. For instance, the building of dams can result in the loss of forests, wildlife habitat, species population, aquatic biodiversity, etc. In addition, there can also be effects such as displacement of people and negative effects on communities downstream (The World Commission on Dams 2000). These effects, of course, need to be compared with benefits such as power, irrigation and flood control. Another example is subsidies on biofuels, usually resulting in greater use of fertilisers and pesticides (UNEP & IEA 2002). Thus, it is important to consider the total costs and benefits when investing in (or subsidising) different renewable energy forms.
The pollution from fossil fuels has serious effects on human health (AEA Technology 2002; Eyre et al. 1998). In particular, the fine airborne particles that result from the use of fossil fuels cause severe health problems such as respiratory infections (Pope et al. 1995). As an example, Cohen et al. (2005) estimate the number of premature deaths worldwide caused by outdoor particulate matter air pollution to be at least 800,000 every year. Myers & Kent (2001) estimate that relatively small reductions in fossil fuel emissions world wide, together with their fine particles, could save around 700,000 lives annually by 2020. While four out of five of these saved lives would be in developing countries, the number in developed countries would equal the number of projected deaths from traffic injuries or infection by HIV. It has not been estimated, though, how many of these lives could be saved by a reduction of conventional subsidies.

Another problem is sulphur dioxide, the air pollutant produced when fossil fuels containing sulphur are burned. Sulphur dioxide is a precursor to acid rain, which causes acidification of lakes, streams and groundwater, damage to forests and agricultural crops as well as deterioration of man–made materials (OECD 2002c). Acid rain is a serious consequence of the pollution from the use of fossil fuels. While the environmental harm caused by acid rain is well known, there are only a few estimates of the economic costs and no proper estimates of the saved costs associated with removal of harmful subsidies.

Global warming is the biggest environmental externality from energy production/use (Froggatt 2004). Estimating the economic costs is difficult. According to Myers and Kent (2001), a conservative estimate is that the costs could readily reach $1 trillion per year and probably much more. This estimate is based on preliminary assertions that it could cost the US 1-2% of the GDP, which is extrapolated

to the rest of the world. Consequently, this is a very uncertain figure. In another report by the insurers group for the UNEP Financial Services Initiative, the costs of climate change is estimated to reach $300 billion per year if current trends continue unabated (Froggatt 2004). In another study by Tol (2002), the impact of global warming on the world as a whole leads to a positive impact of about $ 448 billion per year. This range of estimates also shows the uncertainty connected with estimating the costs of global warming. Again, it should be noted that the costs described are global costs from global warming in general and not the potential savings from removing subsidies. There are analyses, though, estimating reductions in emissions from removing energy subsidies in general. These are mainly conducted at national levels. In table 5.4, some of these estimates are illustrated.

Table 5.4: Examples of estimated changes in emission from subsidy removal.

Study	Nature of scenario	Environmental impacts (national impacts)
Cristofaro et al. 1995 US	Removal of USD 8.5 billion energy subsidies. Removal of USD 15.4 billion energy subsidies.	- 10 mtC[1)] by 2010 - 37 mtC by 2035 - 64 mtC by 2010
Gurvich et al. 1995 Russia	Removal of energy subsidies: effects in 2010	76% reduction in TSP 39% reduction in CO_2 43% reduction in NOx 66% reduction in SOx
IEA, 1999	Removal of consumer subsidies in Russia, China and six 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 in subsidising countries 9% reduction in CO_2 worldwide
DRI in Michaelis, 1996b	Removal of coal subsidies in Europe and Japan	- 10 to –50 mt CO_2

1) Million tonnes of Carbon (mtC)
Source: Adapted from Pearce (2003)

In table 5.4, the study by Larsen & Shah (1992) is particularly interesting as it analyses the removal of world energy subsidies, which would result in a worldwide reduction of carbon emissions of 9%. A similar study by Larsen (1994) estimates a 7% reduction in carbon emissions from a removal of energy subsidies of $210 billion worldwide. The results should be interpreted with care because the data for the amounts of subsidies are from the early 1990s.

5.3 Subsidies Worldwide

The fossil fuel industry is receiving substantial subsidies. Unfortunately, there is a lack of continuos and accurate data over time and a lack of detail, which makes it difficult to give estimates of total global subsidies. Furthermore, there is a considerable range in the results of the existing studies, depending on approach used and the definition of what constitutes a subsidy.

5.3.1 OECD

De Moor & Calamai (1997) estimates that OECD countries as a whole subsidised energy by at least $70-80 billion a year in the mid-1990s. According to van Beers and De Moor (2001), the costs of energy subsidies in OECD were $82 billion per year (1995 – 1998 figures). This is in contrast to an OECD study from 1998, in which it was estimated that member countries' energy subsidies amounted to $19-24 billion per year (OECD 2002c). Furthermore, in UNEP & IEA (2002) it is mentioned that perhaps $20 – $30 billion are used every year on energy subsidies. Thus, there seems to be a rather big difference in the estimates, which may be due to differences in definitions and methodologies. In OECD (2002c), it is argued that gross energy subsidies in OECD countries are generally much smaller than in developing countries and the transition economies and that they are more than offset by taxes in most OECD countries[47].

European Environment Agency (2004) analyses several studies which assess the energy subsidies given in the EU. These indicate a total subsidy (excluding external costs) to the energy sector of about $25 billion per year in the period 1995-2001. The greatest recipients were France, Germany, Spain, and the UK. Oosterhuis (2001) estimates annual support (excluding external costs) to be in excess of $33 billion and European Environment Agency (2004) gives an estimate of more than $35 billion. The different estimates indicate that subsidies in the EU aggregate about $25-35 billion.

In OECD (2002c) estimates of fossil fuel subsidies awarded in the US are at $2.6-$121 billion. When aggregate subsidies were estimated (including externalities

[47] In the literature, measuring energy subsidies sometimes includes taxes, which offsets the effects of subsidies. Thus, the literature distinguishes between gross subsidies and subsidies net of taxes. This report deals with gross subsidies. Even though taxes may offset subsidies in some cases, which is the case especially in the OECD countries, they rarely account for full external costs (UNEP 2004), and therefore removing harmful subsidies may still result in reduced externality costs.

and roadway construction, maintenance and operation, etc) the range became even wider- from $200 million per year to $1.7 trillion.

As already mentioned there are significant differences in the estimates of subsidies to the energy sector, and thus the figures should be treated with great caution.

5.3.2 Non-OECD

Developing countries and transition countries are expected to account for two-thirds of the world's increased energy demand between 1999 and 2020. In the late 1990s, despite many subsidy cuts, the energy prices in eight major non-OECD countries; China, India, Indonesia, Iran, South Africa, Venezuela, Russia, and Kazakhstan averaged 21% below world market prices. If these countries were to eliminate fossil fuel subsidies it is estimated that their energy consumption would be reduced by 13% per year. Furthermore, their GDPs would be increased by 1%, their CO_2 emissions would be reduced by 16% (see table 5.4 above), and the local air pollution, such as from NOx and SO_2 would also be drastically reduced. At a global level, their efforts would reduce energy consumption by 3.5% and reduce CO_2 emissions by 4.6% (International Energy Agency 1999).

Russia and other Former Soviet Union (FSU) countries have removed many of their subsidies together with their energy controls and regulations (de Moor & Calamai 1997). However, FSU is still the second largest energy producer after the US. In the periods from 1990-91 and 1995-96, the price supports for fossil fuels in Russia were greatly reduced. These, together with the country's financial troubles, led to a 45% drop in energy consumption from 1990-97. Today, energy prices for the industry are approaching world market levels. According to Van Beers and de Moor (2001), the total subsidies of FSU and Eastern Europe amount to $89 billion per year (1995 – 1998) given as consumer subsidies. It is difficult for Russia to reduce subsidies much further, because it would mean that household costs for heating and gas would have to be raised ten times over the 1994 level (Myers & Kent 2001; Van Beers & de Moor 2001).

China is a fossil-fuel giant like Russia, mainly because of coal consumption, which provides 74% of Chinas commercial energy. From 1971-95, energy use in China increased fivefold, and end users were not encouraged to conserve energy because of the artificially low prices. However, since the mid-1980s, fossil fuel prices have generally increased because of subsidy cuts. In fact, the fossil fuel price increase has been more rapid than increases in prices for food, clothing, etc. In some sec-

tors and regions, China's energy prices are now comparable to those in other OECD countries. But the fossil-fuel deposits in China are extensive and planned to be exploited, which brings about a projected three fold expansion in energy use between 1990 and 2025. India also reduced its fossil-fuel subsidies from $4.2 billion in 1990-91 to $2.7 billion in 1995-96 (World Bank 1997). However, subsidies still set prices 14% below the world market prices (Myers & Kent 2001; Van Beers & de Moor 2001). According to Van Beers and de Moor (2001), China and India are major subsidisers, accounting for $44 billion in 1997. This figure is much larger than the one ($13 billion) suggested in Myers and Kent (2001).

Myers & Kent (2001) estimate total fossil-fuel subsidies in non-OECD countries to $60 billion per year (1995 – 1998). This is probably an underestimate since according to OECD, the subsidies in developing countries exceeds those in the developed countries. According to Van Beers and de Moor (2001), the energy subsidies in non-OECD countries total $162 billion per year out of which $94 billion are fossil-fuels subsidies (1995 – 1998). By comparison, UNEP (UNEP 2004) refers to an estimate of energy subsidies of around $95 billion (in 1998) in eight of the largest non-OECD countries covering almost 60% of total non-OECD energy demand.

5.3.3 Nuclear energy

In the late 1950s and early 1960s many governments subsidised nuclear energy through research and development outlays, public indemnification of nuclear facilities from accidents and public management of both the production of nuclear materials and the disposal of nuclear waste. In industrialised countries, governments still spend over half their energy research budgets on nuclear power corresponding to around $4 billion in 2000 (UNEP 2004). According to Myers & Kent (2001) the nuclear subsidies in OECD countries total $12 billion per year, based on data from the beginning of the 1990s, of which a large part consists of producer subsidies in the US. Data on nuclear subsidies for non-OECD countries doesn't exist, but this is insignificant, as there is only a small amount of nuclear power in these countries. At present, nuclear energy only comprises one-tenth of the lowest official forecasts made a quarter of a century ago.

5.3.4 Summary

Myers and Kent (2001) estimate the annual total for fossil fuel and nuclear conventional (direct) subsidies worldwide to an approximately $131 billion (range $126-135 billion). Estimates in Van Beers and de Moor (2001) are approximately $244

billion a year (1995 – 1998 figures), based on a subsidy level in the early 1990s of around $350 billion, which the authors estimate could have been reduced with $100 billion up to the late 1990s. These figures are used in table 5.5, since they do not seem unrealistic compared to the figures from EU and the US in chapter 5.3.1, and the figure of $210 billion in the analysis by Larsen (1994). Together with the previously mentioned low estimate of $25 billion in OECD countries, the range of subsidies becomes quite wide, which expresses the uncertainty, or difference in definitions, in the area of estimating the size of subsidies.

There does not seem to be any official estimates of how big a share of this sum are perverse subsidies. Nevertheless, Myers and Kent (2001) gives a rough estimate of 75% (within a range of 60 – 90%), but this estimate is highly uncertain and research needs to be done. Using the estimated percentage gives a sum of perverse subsides of $64 – $216 billion.

Table 5.5: Total energy subsidies and perverse subsidies globally (1995 – 1998).

	Billion US$
Subsidies in OECD countries	25 – 82
Subsidies in non-OECD countries	60 – 162
Total conventional (direct) energy subsidies	85 – 244
Perverse subsidies out of total direct subsidies	64 – 216

Sources: Myers & Kent (2001) and Van Beers & De Moor (2001)

Subsidies can have adverse effects both on the economy and the environment. For instance, according to the International Energy Agency (1999), economic efficiency costs in eight non-OECD countries (with 30% of world CO_2 emissions) total $17.2 billion due to energy subsidies. However, subsidies can also have a positive effect on the economy. The effect of the subsidy depends on the type of energy and support. Nevertheless, subsidies for fossil fuels tilt the energy playing field in favour of energy sources that are heavily polluting, artificially cheap and non-renewable. Subsidies for fossil fuels furthermore inhibit energy efficiency and conservation and defer a shift to renewable forms of energy.

5.4 Policy options

One of the biggest barriers concerning energy subsidies and their removal is a lack of up-to-date empirical data and analyses (European Environment Agency 2004). This barrier makes it difficult to assess which subsidies within the energy sector should be reformed or completely removed and how big the effects from removing them will be.

It is expected that energy subsidy reforms in developing countries and transition economies where subsidy levels are higher and prices not maintained at market levels could have profoundly greater environmental benefits than reforms in OECD countries. Again, it is important to notice that not all energy subsidies are environmentally harmful. Renewable energy support mechanisms and R&D programmes for energy-efficient technologies are examples of subsidies that may not be environmentally damaging and may in fact help reduce emissions. However, subsidies may not be the most efficient approach to achieve this goal. While energy subsidy reform involving a reduction in certain types of subsidy to fossil fuels may yield environmental benefits, it can also have significant social impacts. Dealing with distributional effects is often a major element in overcoming political obstacles to subsidy reform. Energy security may be affected. This is one of the difficulties governments face when trying to reform the remaining environmentally damaging subsidies (OECD 2002c).

A strategy of getting the prices right would revitalise energy industries, discourage waste, stimulate development and adoption of new technologies. Removing both producer and consumer subsidies would provide better incentives for a more efficient resource allocation and would yield a negligible to positive economic impact (Myers & Kent 2001; Van Beers & de Moor 2001).

The effects of a potential liberalisation of fossil fuel trade on environmental quality were investigated by using modelling in OECD (2001a). The modelled energy policy reforms based on 1995 data indicate net reductions in global carbon emissions and reductions in CO_2 output for some countries with emission commitments under the Kyoto protocol. Reductions in CO_2 -emissions are estimated to be approximately 6% in average by 2010. Aggregate welfare as measured by real incomes would remain largely unchanged. While small in terms of net global shifts in energy trade, the reform would stimulate significant shifts in the import/export patterns for particular fuels and regions. The conclusion to the analysis is that the current distortions are due to a large number of policy instruments and imperfect market structures. Trade liberalisation, regulatory reform and subsidy reforms at national and international levels are some of the means to move towards market-oriented pricing.

The removal should be concentrated first on specific support measures rather than broad based support measures since in many cases the environmental effects per

unit of subsidy removed will be larger in the first case. Furthermore, removing subsidies to industrial consumers is much more effective in terms of reducing associated environmental damage than removing subsidies to households (OECD 1999). Still, the removal of direct subsidies does not eliminate all negative environmental externalities from energy production in general. The externalities can be targeted by internalising externality costs in the energy prices, for instance by using taxes/charges.

5.5 Conclusions

Energy consumption and production have increased steadily during the past decades and will continue to rise in the future. The energy sector is one of the most subsidised sectors in the world. The total direct subsidies are estimated to be approximately $131 - 244 billion per year. Perverse subsidies could make up $80 - 216 billion per year of this figure.

It is expected that energy subsidy reforms in developing countries and transition economies where subsidy levels are higher and prices not maintained at market levels could have profoundly greater environmental benefits than reforms within OECD. Removing both producer and consumer subsidies would provide better incentives. Furthermore removing subsidies to industrial consumers is much more effective in terms of reducing associated environmental damage than removing subsidies to households for a more efficient resource allocation and would yield a negligible to positive economic impact.

6 Transport

Transport is an essential service in any society. The benefits of transport are many and varied. An efficient transport system is in fact a major contributor to economic growth, competitiveness and employment (European Commission 1995). Without an efficient transport system, there would have been far less geographic specialisation in production and economies would not have grown nearly as much. Transportation therefore helps to allocate capital efficiently across a region and between regions leading to savings in time and costs.

The demand for transport derives from the demand for access to people, places, goods and services in modern society. The demand for personal mobility is closely related to income levels, location, and distance from home to employment as well as educational services, shopping and recreational opportunities. The demand for freight transport is closely linked to economic growth and international trade, to the overall development of the various sectors of the economy and to land-use planning and infrastructure. There has been a strong correlation between economic growth and the demand for passenger and freight transport in OECD countries (European Commission 1995). While GDP in OECD countries has grown by 46% from 1980 to 1995 the number of motor vehicles has increased by 59% and vehicle kilometres travelled by 72% from 1980 to 1997. Growth rates in air traffic have been much higher in the past decades increasing by around 10% annually (OECD 1998b).

Thus a main characteristic feature of the transport sector is rapid growth, both in distance travelled and in the number of vehicles. However, the projected worldwide increases in transport will have serious health and environmental impacts. The most troubling issues are climate change, air pollution, noise and land use (OECD 2001c).

Tables 6.1 and 6.2 give an overview of the types of subsidies and their negative environmental effects. These will be described in the following.

Table 6.1: Types of transport subsidies.

Government Intervention	Example
Transport-related services provided by government at less than full cost (costs exceed revenues)	▪ Direct investment in transport infrastructure ▪ Provision of traffic control services and police and emergency services
Tax exemptions	▪ Tax breaks for commuters or tax deductions for business cars
Other regulation	▪ Free provision of parking space
Direct financial transfers	▪ E.g. risk compensation to private motorway concessionaires

Table 6.2: Examples of environmental damage from energy subsidies.

How the subsidies work	Pressure on environment	Environmental effect
The subsidies result in increased traffic	▪ Increased air pollution	Health problems, corrosion damages, eutrophication, global warming
	▪ Waste	Declining water quality, Land use
	▪ Noise	Well-being of people, Health problems

6.1 Types of Subsidies and their Goals

Any transport activity creates benefits as well as costs. Not all of these costs and benefits accrue only to those who pay for this transport activity. Some of the costs are incurred by other persons or society as a whole. There are the user costs borne by the person engaged in the transport activity and the non-user costs that are imposed on others. See table 6.3 for cost categories of transport.

Table 6.3: Cost categories of transport

Cost Categories	Social Costs	
	User Costs	*Non-user Costs*
Transport Expenditure	▪ Fuel and vehicle costs; tickets/fares	▪ Costs paid by others (e.g. free provision of parking spaces)
Infrastructure Costs	▪ User charges, vehicle taxes and fuel excises	▪ Infrastructure costs not covered by revenue
Accident Costs	▪ Costs covered by insurance, own accident costs	▪ Accident costs (e.g. pain and suffering imposed on others) not covered by revenue
Environmental Costs	▪ Own disbenefits	▪ Environmental costs (e.g. noise disturbance to others) not covered by revenue
Congestion Costs	▪ Own-time costs	▪ Delays/time costs imposed on others

Source: Adapted from (European Commission 1995)
Note: Environmental, congestion and accident costs (not covered by revenue) can be defined as externalities. Based on existing studies, it appears that external congestion costs are the largest individual externality, followed by accident and environmental problems (air pollution and noise) (European Commission 1995).

One way in which transport subsidies can be defined is the net balance between the governmental costs and revenues from road transport (de Moor & Calamai 1997; Porter 2002).[48] This reflects the costs of providing road users with the infrastructure, space and complementary traffic services to drive their cars, not covered by the government's revenue (cost recovery). The costs include road building and maintenance and traffic management. For example building and repairing roads, bridges, tunnels, the provision of traffic control services and police and emergency services but also tax breaks for commuters or tax deductions for business cars and the free provision of parking space. Explicit subsidies such as direct grants (for instance risk compensation) play an insignificant role for road transport (Nash et al. 2002). Governments collect revenues from the road-system users by collecting taxes, license fees, tolls and road pricing.

There is also a broad range of externalities in connection with transport. These refer to a situation in which a transport user either does not pay for the full costs of his/her transport activity or does not receive the full benefits from it (European Commission 1995). Examples of externality costs are congestion costs, accident costs and several environmental costs (see chapter 6.2 below).

[48] This is what Sansom et al. (2001) calls a "fully allocated cost analysis" where government expenditures are compared with revenues. From an efficiency perspective, *marginal* costs and *marginal* revenues should be compared. Such analysis might result in different conclusions regarding whether costs

Road-related taxes have increased in the OECD countries, and this reflects an attempt to recover the costs of infrastructure and road services as well as the externalities of road usage. In some cases, car-users are not taxed enough to pay back the different costs, and especially not if externality costs such as for instance health problems caused by the pollution from cars or the waste of time caused by congestion are included.
The revenue-to-cost ratios, with and without externalities, for three OECD countries are shown in table 6.4 as examples.

Table 6.4: Road transport cost coverage for selected OECD countries.

1991	France		Japan	USA
	Urban	Rural	Total	Total
Revenues as% of costs	129	164	82	80
Revenues as% of costs including externalities	42-57	92-105	66	64

Source: (OECD 1998b)
Note: Congestion costs (externality) is not included in data for Japan. Many European countries have positive net-balances when not including externalities (Nash et al. 2002).

All the costs – including externality costs – not covered by revenue are often considered as subsidies, but as outlined in the beginning, externalities are not defined as subsidies in this report, even though they are important costs in the transport sector and should be targeted through policymaking.

There are two main reasons for subsidising road transport. One is to stimulate economic growth. This is accomplished by efficient transport, directly through time and cost savings and indirectly through a regionally efficient allocation of physical and human capital. Economic growth in turn also increases the demand for transport. However, some of the subsidies have been rather ineffective in promoting economic development. Some of the explanation is found in user coverages below 100% and free parking, which both provide disincentives for efficient car use and in fact induce overuse. The overuse increases pollution, accidents, congestion and finally results in economic costs such as lost worker productivity. In developing countries, under-pricing results in insufficient revenue for governments to maintain a good infrastructure. The more socially motivated reason to subsidise road transport is to provide access, particularly to low-income households to enhance their employment opportunities. However, the road transport subsidies are also ineffec-

equal revenues/benefits. See for instance Sansom et al. (2001) or Porter (2002) for information on this subject.

tive in fulfilling the social purpose, since in developing countries the subsidies mostly benefit the high income groups, the car owners (Van Beers & de Moor 2001).

6.2 Environmental externalities from transport

The negative health externalities arising from transport impose a high cost on society. In fact, road transport has been shown to be the most important source of human exposure to air pollution and noise. The aggregate external costs of land transport have been estimated in various OECD studies to up to 5% of GDP (European Commission 1995). Because transportation is subsidised externalities are only getting worse. The major environmental externalities from transport are air pollution, land use, waste and noise. These are briefly described below.

6.2.1 Air pollution

One of the biggest environmental problems associated with transportation is air pollution from the combustion of fossil fuels in engines. The transport sector contributes with carbon monoxide (CO), nitrogen oxides NOx, non-methane volatile organic compounds (NMVOC), particulate matter and a minor share of sulphur dioxide (SO_2) emissions. Secondary pollutants are formed as a result of complex chemical reactions that the primary pollutants undergo in the atmosphere. The main secondary pollutants attributable to transport activity are nitrogen dioxide (NO_2) and ground-level ozone. Other air pollutants of concern come from fuel substances such as lead and benzene in gasoline, are directly emitted from diesel vehicles such as particulate matter or are linked to the fuel combustion such as emissions of carbon dioxide. The air pollution from transport can have local, regional or global impact. Local and regional air pollution impacts on health and causes material damage to buildings and vegetation. Long term exposure to air pollution from motor vehicles causes a large number of premature deaths annually due to respiratory or heart diseases. It is estimated that 288.000[49] of European citizens die each year from just one form of air pollution; particulate matter (Watkiss & Pye 2005).

Global impacts are related to the progressive accumulation of greenhouse gases and their role in the gradual warming of the earth's atmosphere. Transport sources are major contributors to the greenhouse effect through CO_2 and CFCs[50] but also

[49] The number of premature deaths is for 2000.

[50] CFC: Chlorofluorocarbons, emitted from the air conditioning of vehicles.

through other air pollutants. Global CO_2 emissions from motor vehicles are projected to increase by approximately 83% from 1995 to 2020. Besides their impacts on local air pollution, VOCs and NOx emissions contribute to ozone formation and indirectly to global warming (European Commission 1995).

Compared to road transport, aviation represents a relatively small but rapidly growing source of environmental impacts including global climate impacts from its growing CO_2 emissions. Commercial aviation releases more than 500 million tonnes of CO_2 annually, equivalent to approximately 2.5% of global greenhouse gas emissions and representing 12.4% of transport emissions of CO_2 (OECD 2001c). These numbers are likely to worsen in the future if transportation growth continues. Especially in developing countries, uncontrolled traffic growth may cause an outburst of environmental and health problems (de Moor & Calamai 1997).

6.2.2 Land use

Land use for transport is both a factor in generating transport activity and a contributor to environmental stress. In the light of the expected increase in economic and transport activities, the area of land used for transport infrastructure is likely to grow over the next decades. This will put a growing pressure on biodiversity because of habitat fragmentation and destruction and the contribution of transport to acidification and eutrophication. As infrastructure may act as barriers to movement and interchange between animals, this can affect habitat and biodiversity (OECD 2001c). Additional road-building opens up for settlement along the roads, which leads to deforestation and thus habitat loss when, for example, logging and agriculture spreads (OECD 2003d).

6.2.3 Waste

Waste is another environmental problem created by the increased demand for transportation. The production, maintenance and use of transport infrastructure contribute to the generation of solid and hazardous waste. Some 50 million cars are scrapped annually, generating large waste streams of metals, plastics, tyres and used oil. However, within the OECD, requirements for recyclability of vehicle parts aim to close the loop of material flows in order to save energy, materials and scarce resources (OECD 2001c). Therefore, the biggest waste problems in the future are in non-OECD countries.

6.2.4 Noise

Transport noise, particularly from road traffic and aircraft movements, is the prime source of external acoustic nuisance in urban areas. Low-level noise affects the well-being of people, while at levels higher than 65 db it is detrimental to health. Despite technological progress to reduce noise at the source and the introduction of low-noise technologies (road surfaces, tyres, protection walls, etc) future prospects is less promising. Noise problems are expected to worsen due to projected increases in vehicle traffic and in aviation (OECD 2001c). Noise problems have been monetarised in a number of studies by using different valuation methods (see, for example, Bjørner et al. (2003). In a review of studies from 1993, the estimated costs of noise pollution vary between 0.1-2% of GDP (European Commission 1995).

6.3 Subsidies worldwide

It is a difficult task to estimate the subsidies given to transportation. This is because many indirect subsidies are associated with the transport sector, and these cannot easily be monetarised. Therefore, the estimation of total subsidies varies in different reports as they do not focus on the same subsidies.

Myers and Kent (2001) estimate total conventional subsidies to road transportation to be approximately $800 billion per year. This figure contains externality costs such as congestion and accidents, however. For the U.S. alone, the authors estimate transport costs without externalities to be around $300 billion based on calculations from the early 1990s. Van Beers & de Moor (2001) estimate total transport costs for the U.S. to be around $125 billion, also based on data from the early 1990s. In Delucchi (2000) the total subsidies for passenger gasoline is estimated to $0.043 per kilometre and according to OECD (2001c), the total kilometres travelled by passenger cars in year 2000 was 6,000 billion km. This gives a total subsidy of $259 billion, but this figure does not include busses and trucks, etc. The subsidies to public transport are generally much greater (Delucchi 2000). Based on different studies, Van Beers & de Moor (2001) estimate total transport costs worldwide to be a minimum of $225 billion (in the early 1990s) without externality costs, allocated mainly in the developed countries and out of which more than half are in the US. Thus, there is some uncertainty connected to the actual level of subsidies in road-transport. Subsidies in non-OECD countries are difficult to estimate because of lacking data. From the available data, both Myers & Kent and Van Beers & de Moor estimate the transportation subsidies outside OECD to be around 6-7%

of total subsidies worldwide. However it is important to emphasise that this number is very uncertain, but according to the authors this is surely a low conservative estimate. Furthermore, it is a problem that data on the size of transport subsidies in general is not up to date, but to our knowledge there is no newer data available.

Some of the conventional subsidies can be considered beneficial or neutral as they for instance promote and enhance economic development. Myers & Kent propose that the proportion of the conventional subsidies that are considered perverse is 50% and that this is an arbitrary but conservative estimate based on comments by transportation experts. In table 6.5 the estimated totals of subsidies for the different regions are presented.

Table 6.5: Total conventional subsidies and their share of perverse subsidies globally (Early 1990s)

	Total subsidies ($ billion)	Perverse subsidies ($ billion)
Total OECD	210 – 285	
Total non-OECD	15 – 18	
Grand totals (rounded)	225 – 300	110 – 150

Source: Van Beers & de Moor (2001)

Though negative externalities from road-transport are not considered as subsidies in this report they are a very large and important factor from society's point of view. If externalities were to be included, the numbers would get very high, uncertain and vary considerably. For instance, Myers and Kent (2001) mention estimates of up to $1700 billion for total transport subsidies in the US including externalities. Other studies from the early 1990s give estimates up to $2100 billion (Holtzclaw 1996). Lastly Van Beers & de Moor (2001) mention that different reliable studies suggest that total external costs from road transportation in the OECD-region could be between $315 to $1300 billion.

6.4 Policy Options

Since the major part of conventional road-transport subsidies can be defined as the not covered costs of providing road users with primarily infrastructure and other traffic services, the immediate solution would be to charge the users for these costs – i.e. using pricing policies. Such policies should be carefully targeted at each mode of transport and type of problem (Van Beers & de Moor 2001). This is the same type of policy that would be used when internalising the externality costs from transport, and especially in many OECD countries today, transport charges are inextricably connected to externalities. Further, there are links between conven-

tional subsidies (not covered costs) and external costs. Congestion implies, for instance, that infrastructure is used beyond the designed capacity. Because of this overlap of usage of policy measures, the policy options described below are referring to the not covered government spending as well as to the external costs.

A key step in reforming transport subsidies is to use the polluter-pays-principle (European Commission 1998). Road users must be charged the full costs of roads, externalities and traffic services provided. Therefore, the size of subsidies should be known, so that the road users can be charged the full costs of their actions. Pricing on the basis of full social costs is a key element of an efficient and sustainable transport system. Government measures should aim at curbing the transport externalities, both for reasons of economic efficiency and equity (European Commission 1995). This would mean greater reliance on road pricing, vehicle and fuel taxes, as well as removal of subsidies. Such changes in taxation can ensure that prices fully reflect the social and environmental costs of growing motor vehicle use and should be structured so they encourage optimal changes in behaviour (OECD 2001c). According to Myers & Kent (2001), by cutting back the underpricing of car travel, vehicle use could be reduced by 33% or more, which would reduce both air and noise pollution.

The transportation playing field could be levelled or even tilted in favour of bus and rail transport- since these are less environmentally harmful. Also, the use of bicycles could be promoted. For example, in the city of Copenhagen, bicycles are provided free of charge for people to use in the inner city. Furthermore, subsidies can be used to promote green cars. In Sweden, for instance, taxes on electric cars, hybrid cars and cars that run on other fuel than petrol have been lowered. The problem of congestion may also be solved by various means. Solutions include roadpricing, levying tolls in city areas, or encouraging carpooling. Another option is to increase car efficiency, such as using the new hybrid electric cars.

In OECD (2001), it is concluded that environmental and health goals can be met through a combination of measures ensuring technological advancements and especially influencing transport demand. Measures for influencing transport demand generally fall into three categories; incentives for using a particular mode of traffic; providing an alternative mode; and introducing charges to influence transport organisation. A more effective use of existing infrastructure as well as more innovative approaches for passenger and freight transport could result in consider-

able cost savings and reduce environmental impacts. Examples of these are listed below:

- Better user of existing infrastructure: Introducing road user charges to increase vehicle occupancy and load factors and reduce the number of empty freight runs. Also, bundling freight movements to improve efficiency and reduce dead weight. Furthermore, enforcing speed limits to harmonise traffic flows, reduce congestion and save fuel. And finally promoting non-motorised transport by expanding walking and cycling infrastructure.
- Increasing the use of public transport in locations where it can serve passenger demand efficiently as well as environmentally by increasing frequency, reliability comfort and safety.
- Encouraging dual or hybrid systems that combine public-private partnerships and organising transport to provide better access to both public transport and individual car use.
- Developing combined road-rail transport where this can help serve markets in environmentally friendly and efficient ways by applying transport chains and total time management for ordering, producing and delivering products.

Source: OECD (2001c)

6.5 Conclusion

The estimate of $225-$300 billion in global road-transport subsidies seems to be very conservative. This figure mainly contains the costs of providing infrastructure and traffic services not covered by revenues and tax breaks for commuters or tax deductions for business cars and the free provision of parking space. These types of subsidies are most pronounced in OECD countries, and especially in Europe it seems that the costs in general are covered by revenues. The costs not covered can lead to overuse, which in turn may lead to increased pollution, accidents, congestion, and finally result in economic costs such as lost worker productivity. In developing countries, under-pricing results in insufficient revenue for governments to maintain a good infrastructure. The estimate that perverse subsidies account for half of the conventional subsidies is very uncertain.

Even though the external costs (congestion, accidents and environmental) are not contained in the subsidy definition in this report they are very important and big costs to society, and at the same time connected to the conventional subsidies. Therefore the next step, after securing recovery of infrastructure costs and the like, is to internalise the external costs.

7 Fresh water

Fresh water is essential to life, health, economic activities and social development. Since 1950, there has been a reduction in global per capita availability of fresh water from 17,000 m^3 per capita per annum to 7,300 m^3 per capita per annum in 1995 (OECD 2001c). This trend is due to a fourfold increase in global water use, mainly caused by population growth and decreasing availability of uncontaminated water. Out of the 7,300 m^3 per capita (40,000 km^3 worldwide total), around 2,500 m^3 per capita (14,000 km^3 worldwide total) can be considered as stable, renewable, easily accessible supply for human activities, without adjusting for polluted water resources (Van Beers & de Moor 2001). Plants and trees take up the rest (26,000 km^3), and some is also geographically too remote to be of any use (de Moor & Calamai 1997). The total use of fresh water globally was around 620 m^3 per capita per annum (or 3,400 km^3 total world use) in 1995 (OECD 2001c). Thus, freshwater resources at the moment seem abundant globally. But in a number of countries and local regions, fresh water is very scarce and it is expected that by 2020 around 250 million people will be living under high water scarcity[51], which is an increase of 75% from 1995 levels (OECD 2001c).

There are different reasons why freshwater resources are under pressure:

- Growing population and economic growth results in rising demands for water.
- Pollution of water resources reduces the usable part of total water resources.
- Underpriced/subsidised water causes inefficient use of water resources with a lot of water being wasted.

The last item will be dealt with in this chapter, but all the items should be targeted, of course, when one wants to reduce pressure on water resources in general.

Users of the total global water supply can be divided into three groups: irrigation uses 65%, industry 25% and households use 10% of total water supply (Van Beers & de Moor 2001).

Tables 7.1 and 7.2 give an overview of the different types of subsidies and their negative environmental effects. These will be described in the following.

[51] Countries with an annual supply of water of below a 1,000 m^3 per person are considered water-scarce (de Moor & Calamai 1997).

Table 7.1: Types of freshwater subsidies.

Types of subsidies	Example
Direct financial transfers	▪ Grants or low-interest/preferential loans for investments in irrigation
Tax exemptions	▪ Tax exemptions on supply and sewerage ▪ Tax exemptions for farmers from water taxes
Regulation	▪ Lower public prices for drinking water than the actual costs of supplying the water

Table 7.2: Examples of environmental damage from freshwater subsidies.

How the subsidies work	Pressure on environment	Environmental effect
In general, the different subsidies result in under-priced water, which will then be used inefficiently, resulting in water being wasted.	▪ Increased water scarcity	Water pollution intensified, resulting in increased diseases. Rivers running dry, siltation of water bodies, depletion of fish stocks.
	▪ Salinisation and waterlogging	Reduced farmland productivity, increased pressure on marginal/ecological fragile land.

7.1 Types of subsidies and their goals

Subsidies to water use come in different forms. Examples are lower public prices for drinking water than the actual costs of supplying the water, no tax on supply and sewerage, tax exemptions for farmers and grants or low-interest loans for investments in irrigation systems (Van Beers & de Moor 2001).

Many countries subsidise water – or do not apply full cost pricing – because of social equity concerns (OECD 2001c), or – in other words – to support the poor. This is especially the case in developing countries where also irrigation subsidies have this purpose. However, when the subsidies lower water prices generally, the subsidies do not benefit (all) poor people. This is mainly due to the fact that many poor people are not connected to public water systems and therefore must buy water at relative high prices (Van Beers & de Moor 2001). Subsidies to public water systems thus often benefit higher-income groups. Many irrigation subsidies have the same effect, since many of them are based on the irrigated area and not on amounts of used water. Farmers with higher incomes usually have large areas and therefore benefit from irrigation subsidies.

Another reason for irrigation subsidies is to secure and increase food supply. Even though food supply has increased, this has often been achieved at high costs (Van Beers & de Moor 2001), since the lack of efficiency in the use of irrigation water (too much water is applied) have often resulted in negative effects to agricultural productivity. This is discussed in further detail below.

7.2 Environmental externalities from water use

Many of today's water subsidies cause or intensify several problems such as excess demand for water, poor operation of water systems, less/no scope for water conservation, inequality and finally negative effects on the environment (Myers & Kent 2001). In general, water subsidies cause inefficient use of waters meaning that too much water is being wasted. This not only causes pressure on water scarcity in some regions, but also causes some environmental/economic effects such as salinisation, waterlogging and negative biodiversity effects.

Salinisation is a build-up of salts in soils that eventually will be toxic for plants. Salinisation is most common with excessive water application on poorly drained soils or where the groundwater level is high. The salts come from the water supplied by irrigation or rain and will be left in the soil when water evaporates from the surface. Irrigated soils that get well flushed (e.g. during winter in some regions) will usually not have salinisation problems. Salinisation is likely to become acute in semi-arid areas where lots of irrigation is used, where soils are poorly drained and never get well flushed. Around 20% of the world's irrigated acreage[52] (2% of total agricultural area) is estimated to be affected by salinisation (Worldwatch Institute 2000).

Waterlogging is when water can not penetrate deeper down in the soil, which gets saturated with water. Air pockets in the soil then fills up with water and causes suffocation of plants. Waterlogging is also associated with excessive irrigation of poorly drained soils. Around 10% of the world's irrigated acreage is estimated to suffer from waterlogging, and productivity in these areas has fallen 20%.

Both salinisation and waterlogging are consequences of irrigation and result in reduced productivity or even in farmers giving up farmland, which increases the demand for new land, and since land is often a scarce resource more marginal and ecological fragile land will be cultivated.

[52] Irrigated area in 1995 amounted to around 255 million hectares, with large variation between countries (Worldwatch Institute 2000).

Decline in water tables (aquifers) and rivers running dry can be caused by heavy use of water in some areas. Rivers/lakes running dry or decreasing water levels will affect both the availability of water for future human use and the ecosystems in the rivers/lakes. This will occur when using more water than is replenished, eventually reducing the future availability of water. In coastal areas, freshwater aquifers can be destroyed by seawater being sucked in to the aquifers.

Biodiversity effects – are caused by disruptions of river hydrology (e.g. rivers running dry), siltation of water bodies, draining of wetlands and depletion of fish stocks. All these effects have consequences for ecosystems that depend on water.

Water pollution and disease. One of the most important effects from water use in general is water pollution (industrial sources and human waste). It is estimated that around 5 million deaths could be avoided if there were safe and adequate water and sanitation supplies around the world (UNEP 2002). In Myers & Kent (2001) the global costs for water-related diseases are estimated at around $125 billion a year. Water subsidies are not the main cause of these effects, though (e.g. agricultural subsidies can cause some of the pollution), but when water subsidies increase water shortage, the problems of access to clean water are intensified. However, in World Bank et al. (1998) it is stated that; *"...more than 30 diseases have been linked to irrigation, and the health toll from these can be quite significant regionally . …. Although it is impossible to quantify the additional toll of diseases related specifically to irrigation systems, it is fair to say that in agricultural areas these systems are important contributing factors to the overall burden of water-related diseases."* There does not seem to be any findings of how much water subsidies contribute to increasing these problems.

Thus the major problem with water subsidies is the inefficient and wasteful use of water, which is because the water comes at no or only a small cost for the user. In developing countries, 40-60% of water delivered by utilities is lost due to leakage, theft and poor accounting. The loss of irrigation water amounts to half the water supplied (both in developed as in developing countries) and is caused by seepage and evaporation (Myers & Kent 2001). For example, certain Asian and Middle East countries have water losses of 50% or more. Nearly two thirds of all water loss in these countries could be avoided, which would be equal to increasing water supply by one quarter (de Moor & Calamai 1997). Out of the irrigation water supplied today to fields, 40% is available to plants in general. With efficient irrigation systems 60-90% can be made available to plants (Myers & Kent 2001).

7.3 Subsidies worldwide

It is useful to look at developed countries (OECD countries) and developing countries separately.

In **OECD countries**, grants and low-interest loans to capital expenditures are the primary way to subsidise water. In some Western industrialised countries, user charges are often high enough to cover operating and maintenance costs (de Moor & Calamai 1997). But for OECD as a whole, there are still many countries where operating and maintenance costs are not covered (OECD 2001c). In OECD countries subsidies through grants have accounted for 20 – 40% of the total financing requirements, but rates for irrigation projects have been up to 80% (Van Beers & de Moor 2001). Both Myers & Kent (2001) and Van Beers & de Moor (2001) estimate total water subsidies in OECD countries at around $15 billion[53], which they argue is a very conservative estimate. By far the majority of these subsidies are irrigation subsidies.

In **developing countries** total subsidies are estimated to be somewhat higher. The cost recovery[54] of providing water for household use is around 35% and this underpricing amounted to a financial burden (subsidy) of around $13 billion in 1993 (Van Beers & de Moor 2001). Eliminating illegal connections and increasing efficiency is estimated to be worth $9 billion. Since these figures are relatively dated (from 1993), Myers & Kent (2001) estimate total costs from water supply (exclusive of irrigation) at a minimum of $25 billion[55]. Subsidies for irrigation are by Myers & Kent (2001) estimated at around $29 billion[56] when taking into account the population increase over the last 10-15 years. Van Beers & de Moor (2001) estimate irrigation subsidies at $20-$25 billion based on a World Bank study in 1994. The majority of these grants are given in Asia. This estimate should also be considered very conservative. Brown et al. (2000) gives an estimate at $33 billion for total global irrigation subsidies in both developed and developing countries. Thus, a rough conservative estimate of total water subsidies in developing countries today could be around $52 billion, which is also illustrated in table 7.3 below. One reason for the estimate being conservative is that not all forms of subsidies are considered, e.g. subsidies for water use in the industry.

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[53] Estimates are based on data from the early to mid-1990s.

[54] "Cost recovery" is defined as the portion of the costs of providing the water that is covered by users, e.g. through user charges.

[55] The estimate is based on a $22 billion estimate put forward in World Development Report 1994 (World Bank).

Table 7.3: Total water subsidies and perverse subsidies

	Subsidies (US$ billion)
Developed countries	15
Developing countries:	52
- irrigation	30
- underpricing	13
- other	9
Total formal subsidies	69
Perverse subsidies out of total formal subsidies	(50)

Note: Estimates are based on data from the first half of the 1990s.
Source: Myers & Kent (2001), Van Beers & de Moor (2001)

Out of total formal subsidies Myers & Kent (2001) estimate $50 billion to be perverse subsidies. The estimate builds on opinions from different water management experts on different continents, and is thus a very rough estimate without a specific underlying analysis. It would appear that there are no alternative estimates, though.

The subsidies discussed thus far are subsidies given directly to the sectors using water, without taking costs of externalities into consideration. Subsidies lead to overuse of water, and thus externalities connected to water shortage are intensified, e.g. water-related diseases and environmental effects. Since it is difficult to estimate to what degree water subsidies increase these effects it is also difficult to value them.

7.4 Policy options

The goal should be to phase out water subsidies that cause a large waste of water. More efficient water use is needed in irrigation as well as in public water systems (especially in developing countries).

Irrigation in general is necessary in order for food production to keep up with the increasing world population. But as subsidised (distorted) prices lead to overuse of water, irrigation needs to be more effective so that less water is used while still fulfilling the crops' (and man's) demand for water. If irrigation is to be more effective outdated irrigation systems and also some of the more efficient systems of today should be replaced by new effective systems. One way to induce better efficiency is to get the water prices right, meaning that they should at least reflect the full costs of water provision. More efficient (and some times more costly) irrigation systems will then become attractive, and this trend could be further intensified

[56] In table 7.3, this figure is rounded to $30 billion.

through increasing research into and development of more cost-effective systems (OECD 2001c). By and large the same principles apply with regard to other water supplies as well, i.e. getting the prices right will increase efficiency and thus reduce water scarcity. Many countries are opposed to applying full cost pricing because of social equity concerns, but studies have demonstrated that both targets – equity and full cost recovery – can be achieved at the same time (OECD 2001c).
As mentioned above, today's water subsidies do not always benefit the poor, even though this is a reason for maintaining subsidies. It is important that subsidies are targeted to the needs of the poor in a cost-effective (de Moor & Calamai 1997) and non-distorting manner.

Box 2: Forecasts of the impact of removing subsidies.

- A modelling simulation made of the removal of all agricultural subsidies (including irrigation subsidies) in OECD regions to 2020 estimates a 10% reduction in irrigation water use (OECD 2001c).
- In UNDP (1998) it is estimated that removing water subsidies would reduce world water use with 20-30%, and in parts of Asia by 50%.

Removing water subsidies and getting the prices right can help to reduce water scarcity (see box 2) and at the same time benefit the country's financial budgets, thus leading to better ability to solve other water-related problems, e.g. sanitation and water quality issues. The economy will benefit since water scarcity impedes the development of various economic activities (OECD 2001c). Removing subsidies could relieve much water stress and scarcity by providing an incentive to invest in infrastructure that extends coverage and reduces leakage. Moreover, pricing of water to reflect costs will reduce household water use and the need for waste treatment (UNDP 1998).

7.5 Conclusion

It is estimated that water subsidies amount to some $70 billion. Types of subsidies are under-priced water, direct grants and tax exemptions especially for irrigation water. The only estimate of the share of perverse subsidies is around $50 billion, which is a very uncertain estimate.
The major problem with water subsidies is the inefficient and wasteful use of water that is a consequence from the water having no or only a small price for the user. Subsidies lead to overuse of water and thus externalities connected to water shortage are intensified, e.g. water-related diseases and environmental effects such as salinisation, waterlogging and negative biodiversity effects. One way to induce

better efficiency is to correct the water prices, meaning that at least they should reflect the full costs of water provision. Getting the prices right will increase efficiency and thus reduce water scarcity. Study examples furthermore show that both equity and full cost recovery can be achieved at the same time.

8 Fisheries

Fishery production has increased dramatically over the last 50 years and in 2001 amounted to 130 million tonnes globally of which 38 million tonnes came from aquaculture (Vannuccini 2003). In 1950, the total fishery production was around 18 million tonnes and production from aquaculture was insignificant. Thus, capture fish production has risen from 18 million tonnes to 92 million tonnes since 1950, an increase of 400%. Since 1995 global capture production has been fairly constant. Future growth in production is expected to be slower, and the growth is expected to take place mainly in aquaculture production, whereas capture fish production is expected to be stable. The big rise in fishing levels has had negative effects on fish stocks and marine ecosystems. Without appropriate policies to ensure better management of currently over-exploited resources, the harvest from capture fish production is expected to decrease by 10% before the year 2020 (OECD 2001c). Furthermore, the demand for fish and fish products is expected to continue rising in the future, for instance due to rising population-levels, altered eating habits and available disposable income (OECD 2001c). The rising demand puts further pressure on the fisheries resource.

Tables 8.1 and 8.2 give an overview of the different types of subsidies and their negative environmental effects. These will be described in the following.

Table 8.1: Types of fishery subsidies.

Types of subsidies	Examples
Direct assistance to fishers and fisheries workers	▪ Income support programs ▪ Unemployment insurance
Lending support	▪ Loan guarantees ▪ Subsidised loans – loans at below market rates ▪ Loan restructuring
Tax preferences and insurance support	▪ Fuel tax exemption – for fishing vessels ▪ Income tax deferral – for fishers ▪ Accelerated depreciation – for taxation of fishing vessels and gear ▪ Favourable tax rates on specific inputs or outputs ▪ Vessel insurance and reinsurance programs
Capital and infrastructure support	▪ Development grants – for fisheries enterprises ▪ State investments – in state-owned enterprises and co-operatives ▪ Fleet renewal and modernisation ▪ Foreign access payments – for deep-sea fishing access ▪ Provision of fish auctions or other sales facilities and services ▪ Aid to shipyards – to support fishing boat construction ▪ Fishing port infrastructure enhancement ▪ Harbour facilities and moorage

Types of subsidies (continued)	Examples (continued)
Marketing and price support	▪ Export marketing programs – to enhance seafood exports ▪ Fish product promotion programs ▪ Market price support
Fisheries management, research, effort reduction and conservation	▪ Worker adjustment programs ▪ Fisher retraining ▪ Buybacks of vessels, permits or licenses ▪ Stock enhancement programs ▪ Fisheries management programs ▪ Programs to assess fish stocks ▪ Programs to identify and develop new fisheries ▪ R & D – to develop new fisheries technologies ▪ Other Fisheries Management, Research, Effort Reduction and Conservation Programs

Source: Adapted from WWF (2001)

Table 8.2: Examples of environmental damage from fishery subsidies.

How the subsidies work	Pressure on environment	Environmental effect
Subsidies encourage excess capacity Subsidies ensure enough profits to encourage wastage of fish	▪ Overfishing ▪ By-catch problem	Depletion of species Damage to marine ecosystems/biodiversity Reduced gene-pool

8.1 Types of subsidies and their goals

In recent work, subsidies in the fishery sector have been divided into several types of subsidies (FAO 2002). There seems to be a consensus that government interventions of any kind that reduce costs and/or increase revenues of producers are to be regarded as subsidies (Cox & Schmidt 2002). Some experts argue that market imperfections (e.g. environmental and natural resource costs) that are not corrected by governments should also be regarded as subsidies (see also chapter 2.1.2). Government interventions come in many forms, ranging from direct support to fleet modernisation to more indirect support in the form of deferral of income taxes for fishermen and shoreline preservation (Van Beers & de Moor 2001). The general argument for subsidising fisheries has been to preserve fishermen's jobs and incomes (Myers & Kent 2001; Van Beers & de Moor 2001).

8.2 Environmental externalities from fisheries

The significant increase in global fishing production has led to the overfishing of some species. Within the OECD (2001c), it is estimated that 50% of fish stocks are fully exploited, 15% are overfished, 7% are depleted and 2% are recovering. Whether subsidies are the primary reason for overfishing, as Myers & Kent (2001) argue, is not clear from other literature, but it seems that subsidies are part of the

reason for the problem. The main reasons for overfishing are the "problem of the commons"[57] (in combination with fish being a renewable resource with biological constraints on supply) and excess fleet capacity (OECD 2001c)

The "problem of the commons" is characterised by fish, or open sea fishing, being common property to all and thus a resource with open access to exploitation. Since no fisher has exclusive property rights and competes with other fishers for shares of the same resource, there is no assurance of a given share of the allowable catch[58]. Actually, one fisher harvesting from the resource base imposes a negative externality on other fishers, as there will be less fish available for harvesting. To maximise the catch per unit of effort, they must increase their fishing power (Porter 1998), which is done by increasing the fleet capacity and using more efficient harvesting technologies. As a result, there is no incentive among fishers to conserve the resource for future use. In combination with modern effective fishing technologies, the result is overexploitation of marine fishery resources, and excess fishing capacity. There is some discussion about the size of this over-capacity in the world's fishing fleet in relation to the maximum sustainable yield. In Myers & Kent (2001) excess capacity is estimated as being approximately twice as big (100%) as needed to catch the maximum sustainable yield of fish. McGinn (1998) estimated an excess capacity in 1989 of about 30% for high valued species rising to 50% in 1998, while FAO (1999) argues that excess capacity has remained at approximately 30% since 1989 for high valued species, and 0% for all resources globally. These differences can be due to the regions and species in question. The 0% global over-capacity covers high levels of over-capacity (above 30%) for some stocks and low levels for others (FAO 1999). The relative lack of mobility of the global fishing fleet means that over-capacity can not be shifted to areas/resources with under-capacity.

Subsidies to fishery traditionally come in forms that encourage excess capacity and overfishing, thereby exacerbating the problems connected to the "problem of the commons"(Porter 1998). Empirical studies have indicated that subsidies for capital costs given in a phase when the fishing fleet is already growing do have a clear effect on the rate of capacity growth (Porter 2002). During the 1990s, the capacity of most major states' fishing fleets began to level, which indicates that the maximum level of aggregated world landings may have been reached[59] (FAO 1999).

[57] Often, this term is also referred to as the "tragedy of the commons".

[58] See also Hanley et al. (1997) for a description of the problem.

[59] Within this level some stocks are overexploited and others underexploited.

Subsidies that should have benefited the fishery sector's jobs and income have contributed towards creating the opposite effect as the reduction in fish stocks has undermined the profitability (Myers & Kent 2001). In the long term, the damage from overfishing might in fact be mostly economic, although environmental consequences dominate in the short term (Van Beers & de Moor 2001). As an example, the catch in US federal waters is only 60% as valuable as it could have been if fish stocks were allowed to recover (Myers & Kent 2001). Furthermore, in 1995 it was estimated that proper management of depleted stocks globally could increase fishing revenues by $15 billion annually (Porter 1998).

Apart from overfishing, destructive fishing methods and excessive by-catch also damage marine ecosystems (OECD 2001c). When fishing for certain fish species, it is unavoidable to also catch some non-target fish (by-catch). The marine by-catch is estimated at around 27 million tonnes per year, which is almost one-third of the total reported catch from marine capture fisheries (OECD 2001c). By-catch is thrown back dead or in a very weakened condition (Myers & Kent 2001). Destructive fishing methods such as dynamite fishing and bottom trawling contribute to the destruction of marine species' habitats.

These effects are connected to fishery subsidies as increased fishing (overfishing) also increases by-catch. By-catch and destructive fishing methods are mainly caused by the choice of fishing gear and fishing methods (OECD 2001c). Part of the by-catch problem is caused directly by subsidies as they ensure enough profit to fishermen to encourage a big wastage of fish that could have been marketed but are not as they will not attain the best prices (Myers & Kent 2001; OECD 2003d).

From the description above, overfishing and fishing methods do not cause environmental effects that directly influence human health, but instead the marine environment in itself is damaged. There are some indirect effects on humans, though, (apart from less fish from capture fisheries in the diet). These could be the potential value of the marine ecosystems' gene pool from which valuable information on e.g. medical issues could be retrieved. People also seem to value the mere existence of fish species and ecosystems even though they do not directly use these. These values are, of course, difficult to monetarise.

8.3 Subsidies worldwide

Milazzo (1998) has estimated global fishery subsidies at between $15 billion and $20 billion in 1996 by extrapolating from an examination of six of the largest fishing nations in the world. Milazzo (1998) argues that this might be an underestimate, perhaps even by a considerable margin, since some national types of subsidies are not estimated. Myers & Kent (2001) estimate global fisheries subsidies at $25 billion and estimates in Van Beers & de Moor (2001) are around $22 billion in 1998, both sources based on data in Milazzo (1998). These numbers include what Milazzo calls 'Resource-Rent Subsidies', which are defined as a country's failure to capture from the fishing industry the costs of managing the fisheries resource[60]. Milazzo considers this failure to be a government subsidy and estimates it to be around $5 billion on average. WWF (2001) argues that there have been no similar reports or estimates of such subsidies, and instead estimates that worldwide (conventional) fishing subsidies without 'Resource-Rent Subsidies' are at least $15 billion, if not substantially more. Thus, depending on the definition of a subsidy, the subsidy level was between 20 and 30% of world revenues from global ex-vessel sales (of about $80 billion) in the late 1990s. Myers & Kent (2001) argue that practically all subsidies in fishery are perverse. McGinn (1998) estimates that around $500 million of the subsidies are budgeted to reduce fishing capacity and therefore can not be defined as perverse. Further, Milazzo (1998) estimates subsidies that support conservation to be around 5% out of total subsidies – meaning that $1 billion subsidies are not perverse. Thus, it can be concluded that nearly all subsidies in the fishery sector are perverse and probably amounts to a minimum of $15 billion and an average of around $20 billion, see table 8.1. In Pearce (2003), there is an estimate of 50% of the subsidies to be found in OECD countries. By comparison, (Le Gallic et al. 2003) estimate that government financial transfers to fisheries in the OECD countries were around $6 billion in 2000.

Table 8.1: Total fishery subsidies, Perverse subsidies and Externality costs globally (late 1990s)

	Billion US$
Formal subsidies to fishery	20
Perverse subsidies out of total formal subsidies	19

[60] Meaning that society should impose user fees (charges) on users of publicly managed natural resources to better manage those resources and recover society's costs. See also the description of resource rent in chapter 2.1.2.

8.4 Policy options

As mentioned, overfishing and other environmental consequences are mainly results of "the problem of the commons", but many of the subsidies in the fishery sector reinforce these problems. At the same time, the reduction in fish stocks has led to reductions in fishers' income and jobs, even though the intention with many subsidies is to maintain income and jobs. Thus, the focus can be divided between two main areas towards which future fishery policy could be directed.
One area is the "problem of the commons", where governments/authorities could interfere to regulate the fishing effort. Policy initiatives could be to put taxes or charges on fishers' rights to fish off the country's shore or to set up restrictions on fishing (e.g. quotas, bans on fishing gear etc.). Since 90% of world marine capture fishery is within national waters[61] (OECD 2001c), governments have the potential to regulate these waters. Despite this, "the problem of the commons" is still an issue in some of these areas even though international bodies, such as the UN and FAO, have made recommendations on global governance of fisheries by adopting policies to provide a framework for fisheries governance (OECD 2001c).

The second area is the case of perverse subsidies that harm the environment as well as the overall economy to fishers. Most governments recognise that harmful fishing subsidies are a major problem and some have begun to take action against the problem, but the improvements are slow and less than required (Myers & Kent 2001). Once subsidies are given, they can be difficult to withdraw. Apart from helping the protection of fish stocks, removing subsidies will save governments' and taxpayers' money that eventually could be used to improve fishery management. Porter (2002) argue that the effect on fish stocks from removing subsidies is not always clear. For instance, when severe over-capacity already exists in fisheries, the removal of subsidies should in general lead to reductions in this over-capacity since production costs are increased. But the immobility of capital in the fisheries sector will limit the effect, and vessels that do leave the fishery are the least profitable ones while the most profitable (effective) ones stay.

One of the difficulties of subsidy removal in international waters is that strategic factors take centre stage. A country gains from subsidising its fleet and increasing its catch whenever a rival nation lowers its subsidies and catch. Therefore, even though each country would gain from lowering subsidies, neither of them has an

[61] Within 200 nautical miles of some country's shoreline.

incentive to do so since the rival has an incentive to free ride[62] on the regulations of the others.[63] This then calls for international intervention through an international organisation.[64]

Reducing overcapacity either by regulation or removing subsidies will eventually lead to employment problems (McGinn 1998). The savings from foregone subsidies could also be used for short-term economic aid to job retraining or other economic aid for fishery workers having to leave the industry. In some industrial countries, such retraining programmes have been implemented, but with limited success since the subsidies that motivate people to stay in business have not been reduced (McGinn 1998). In developing countries and some coastal communities where fishery is "a way of life", finding new jobs for displaced fishers can be more difficult than in developed countries. This is because more people rely on fishing, new jobs are limited and the financial resources are generally scarce. There are alternatives to creating new jobs in other sectors, though. For instance, regulation that seeks to keep large boats out of coastal waters (so that there is room for the local fishers with their small and labour-intensive boats) or other restrictions on boat types or fishing methods in specific regions.
Some countries have also used subsidies for capacity reduction (vessel or license buy-outs), but case studies have shown that although there is an effect in the short run, in the long run the remaining fishers tend to increase their capacity or effort by means of technological improvements (Porter 2002). This will happen as long as there are no property rights in fishery (i.e. the problem of the commons).

OECD (2001c) estimates that better fishery management could increase the fish harvest by 18 million tonnes. Apart from removing perverse subsidies and establish restrictions on fishing quantities, better fishery management also includes enforcement and monitoring of agreements and bans, which have not been very effective in all countries.

[62] A free-riding person/country receives the benefits from others actions, without participating in, or paying for, these actions.
[63] This situation is a so-called prisoner's dilemma.
[64] Source: Personal comment by Richard Damania (University of Adelaide) November 2004.

8.5 Conclusion

Subsidies to fishery are estimated to be $20 billion. However, this probably can be considered a minimum since data is lacking in the area. Practically all the subsidies can be considered perverse. The main cause to the environmental problems from fishery, such as overfishing and excessive by-catch, seems to be “the problem of the commons”, though conventional fishery subsidies reinforce the negative environmental effects from fishery. Subsidies nevertheless could be between 20 and 30% of world revenues from global ex-vessel sales in the late 1990s.

Most governments recognise the harmful effects from fishery subsidies, but progress in removing them seems to be slow. One problem for decision-makers is the equity effect in the form of lost jobs, though better fishery management in general could increase the fish harvest.

9 Forestry

The forests of the world provide a wide range of services to society. These include economic benefits (from timber, pulp for paper and rubber), environmental benefits (such as biodiversity, carbon sinks and erosion control) and social benefits (recreational opportunities and cultural values), depending on the size, structure and density of the forest.

A little less than one third of the world's land area is covered with forests (see table 9.1), of which 95% is natural forests and the rest is planted forest.

Table 9.1: Change in forested land 1990-2000 by region.

	Total land area (million ha)	Total forest 1990 (million ha)	Total forest 2000 (million ha)	% of land forested in 2000	Change 1990-2000 (million ha)	% change per year
Africa	2 963	702	650	22	-53	-0.7
Asia and the Pacific	3 463	734	726	21	-8	-0.1
Europe	2 359	1 042	1 051	45	9	0.1
Latin America and the Caribbean	2 018	1 011	964	48	-47	-0.5
North America	1 838	467	470	26	4	0.1
West Asia	372	3.6	3.7	1	0	0.0
World	**13 014**	**3 960**	**3 866**	**30**	**-94**	**-0.24**

Source: Adapted from UNEP (2002)

Around 47% of the world's forests are tropical. During the 1990s, 16.1 million hectares of natural forests were converted (of which more than 90% was in tropical forests) into other uses every year, primarily into agricultural usage (70%). Consequently, the tropical natural forests in particular are subject to deforestation, and at a rate of approx. 1% a year. Furthermore, the forest quality is degrading in many areas in both OECD and non-OECD regions as natural forests are replaced with monoculture, intensively produced plantation forests (OECD 2001c).

Subsidies that foster deforestation have been part of the cause of the decrease in forest area, especially in earlier years. Forest subsidies are not on the scale of those in agriculture and road transportation, but they still deserve consideration. They show how a renewable resource can become non-renewable due to the subsidies' distortional impacts.

Tables 9.2 and 9.3 give an overview of the different types of subsidies and their negative environmental effects. These will be described in the following.

Table 9.2: Types of forestry subsidies.

Types of subsidies	Examples
Direct financial transfers	▪ Grants or low-interest/preferential loans for investments
Tax subsidies	▪ Tax exemptions on supply and sewerage
Under-pricing	▪ Low stumpage fees ▪ Log export restrictions

Table 9.3: Examples of environmental damage from forestry subsidies.

How the subsidies work	Pressure on environment	Environmental effect
Subsidies encourage excess logging.	▪ Deforestation/degradation	Flooding, Groundwater quality, Erosion, Global warming, Less biodiversity (reduced gene-pool)
	▪ Monoculture/plantation forestry	Less biodiversity

9.1 Types of Subsidies and their Goals

Most of the subsidies are indirect rather than direct and are not intended to promote deforestation. Rather, they support activities that inadvertently lead to deforestation. For instance, forestry subsidies may have led to commercial logging in previously inaccessible areas. The subsequent road building (which may also be subsidised) has opened up land for conversion into other uses, e.g. agriculture (OECD 2001c). Thus, subsidies to activities in other sectors than forestry also lead to deforestation and biodiversity loss. Subsidies for agriculture encourage farmers to clear-cut forests, for instance, subsidies to cattle ranching[65] has lead to deforestation in the Amazon (Myers & Kent 2001). The same goes for mining subsidies, and as described earlier (chapter 6.2.2) subsidies for road-building opens up for logging and agriculture, which leads to deforestation. Dealing with the negative effects of lost forests, therefore, requires adjusting the policies that have been put in place for sectors other than forestry (OECD 2003d).

[65] Subsidies to cattle ranching in Brazil are much lower today as what they were in the 1980'ies. Nevertheless cattle ranching is still a threat to the natural forests in Latin America, but also because of other factors than subsidies (see for instance Kaimowitz et al. (2004))

Nevertheless, subsidies to logging do contribute to deforestation to some extent, since commercial logging methods are often destructive and thus directly or indirectly contribute to deforestation (UNEP 2002). Many forestry subsidies are partially concealed and are therefore difficult to recognise (Myers & Kent 2001). Two kinds of indirect subsidies stand out in particular: failure to capture full economic rents[66] on logging concessions and protectionist trade policies that have the effect of underpricing raw logs as an input into processed wood products for export (Porter 1998). These are described next.

Low stumpage fees

The failure to capture full economic rents on logging concessions is a major source of subsidy for the timber industry. Economic rent in forestry is also referred to as the stumpage value (Whiteman 1999). The stumpage value is the value of the tree standing in the forest, i.e. the value that would be obtained if it were sold in competitive markets. It is also what the user of the forest would be able to pay to the owner of the forest for renting it. Stumpage *fees* are the taxes or fees (rent) that are levied by the owner of the forest (e.g. the government) to capture the economic rent in forestry production. Too low stumpage fees have a distorting effect on markets by making timber cheaper to cut than would have been the case with adequate stumpage fees. Therefore, low stumpage fees have an overcapitalisation effect, in that some proportion of the capital attracted to timber concessions by low stumpage fees would otherwise flow elsewhere. Where harvest levels are a function of market forces, low stumpage fees encourage higher levels of harvesting and higher level of consumption of wood products. Over consumption occurs because some trees that would otherwise be unprofitable to cut because of the costs involved, will become profitable at the lower marginal cost created by stumpage fees that are lower than the full market value (Myers & Kent 2001).

An important problem of low rent capture of forests is the public resource deprivation effects. By transferring most of the rents to the private sector, governments deprive the state of significant resources that could be used to protect forests through strict enforcement of logging concession requirements and projects that promote sustainable management of forests. Low stumpage fees can also distort international trade. They permit the export of timber at prices lower than these on

[66] An accessible description and definition of economic rent in forestry can for example be found in Whiteman (1999) and Day (1998).

timber from countries where producers must pay the full economic rent of the timber they cut (Porter 1998).

Many countries, including leading exporters of logs and wood products, have captured less than half of the stumpage value of the timber in their systems of taxes and charges on logging and log exports according to a number of case studies. A World Bank study estimated that Indonesia only captures 20-33% of economic rents from timber concessions and Malaysia between 35 and 53% in 1991. These estimates show the seriousness of the failure of governments to capture economic rents (Porter 1998). In Ross (2001) another example of a policy failure is described as when state actors (public officials) try to gain the right to allocate economic rents from forestry to others, being major campaign donors, influential constituents, friends and relatives. This seems especially to be the case in developing countries when a state receives an economic windfall in timber production. Thus when there is a rise in timber prices and property rights are weak and subject to political influence more harvesting (deforestation) is induced.

The majority of the world's forests are state-owned. In theory, the state ought to be a better owner of forests than the private individual or company, since its time horizon can and should be longer than that of the private owner. However, in practice a forest may be managed by political appointees whose time horizon is short and who may neglect deforestation for various reasons. As a result, logging fees are often set too low (Myers & Kent 2001; Ross 2001; Seymour & Dubash 2000).

Log export restrictions

Log export restrictions have the potential for major distortions of international trade in wood products. Many timber producing countries have restricted exports of raw logs or semi-processed logs in order to stimulate value-added processing for export and thereby increase foreign exchange. The trade restrictions depress domestic log prices compared with international prices and provide cheap raw logs to the domestic wood processing industry. They are then able to export wood products at artificially low prices, which may help the industry to capture foreign markets from producers that are not similarly subsidised. Log export restrictions have in several cases proven to encourage overcapacity and maintain inefficiency in the wood processing industry- which both increase the pressure on forests (Porter 1998).

9.2 Environmental externalities from forestry

Forests provide other goods and services not directly connected to timber production. These can be other economic services (fuelwood, fruit and nuts) but also environmental and social services are provided. Table 9.4 presents some economic values of the different goods and services provided by forests.

Table 9.4: Economic values of forests.

Direct use values	Timber production, nonwood forest products, recreation, etc.
Indirect use values	Soil conservation, watershed protection, flood protection , carbon sequestration, etc.
Existence value	Ensuring the survival of a resource.
Option values	Potential values of future use

Source: Myers & Kent (2001)

When timber extraction or deforestation in general results in these values being lost, and when the values are not reflected in the price of timber, negative externalities exist. In Porter (1998), it is argued that the difference between the timber prices in the market and prices that reflect the full social costs of production would be very large in many cases. To give an impression of the size of the monetary value of some of these goods and services, some estimates are given in the following[67].

Other economic services than timber: Tropical forests provide fuelwood for 3 billion people in developing countries as the source of household energy. Myers & Kent (2001) estimate the total value of forests as sources of fuelwood to be $28 billion per year, based on the opportunity cost from time used on collecting the wood. Then there are nonwood products from forests such as wild fruits, latexes, essential oils, waxes, tannins and medicinal products. One estimate of the total value of non-wood products from tropical forests only is around $90 billion a year (Pimentel et al. 1997). Furthermore, natural forests are rich in biodiversity and are estimated to contain at least 50% of the Earth's species (UNEP 2002). As the forests disappear (or are converted into plantation forestry)[68] so do their species. The loss of species includes genetic material that may be needed to provide disease and pest resistance for food crops and to create new drugs. For example, in India the introduction of a wild rice strain led to resistance against viruses and increased yields by at least $75 million a year (Myers & Kent 2001). Drugs (pharmaceuticals)

[67] It should be noted that these estimates are more or less uncertain and, for instance, depend on the estimation-methods used.

[68] Forest plantations typically contain only one, or a few, species. Plantation forests thus contain less biodiversity and are more sensitive to diseases and other disturbances than natural forests (UNEP 2002).

against some diseases are manufactured from materials derived from tropical plants. Myers & Kent (2001) have reviewed the literature and found estimates of the value of these drugs between $147 billion and $900 billion. The different values cover highly varying figures per hectare depending on geographical location, among other factors (Pearce 1997).

Other environmental services are protection of soils by helping to retain their moisture and to store and cycle nutrients, regulation of water flows in terms of both quantity and quality helping to prevent flood and drought regimes in downstream territories. Finally, forests affect global warming through their carbon stocks. This means that when forests are cut and burned CO_2 is released contributing to the greenhouse effect. The value of the carbon stock is the largest of the use values of tropical forests (Pearce 1997). The value of the carbon storage function in forests depends on which method is used. General estimates could be between $10 per tonne CO_2 [69] (Secretariat of the Convention on Biological Diversity 2001) and $70 per tonne CO_2 [70] (Clarkson & Deyes 2002). Based on estimates in Pearce (1997) on changes in carbon storage from tropical forest conversion and with a value of $20 per tonne of CO_2, the value of released CO_2 could be between $600-$4400 per hectare. For tropical forests, this would give a total value of between $1 and $8 trillion.

Thus, the above-mentioned monetary values of some of the externalities from timber production and especially from deforestation are probably even as important as the timber goods they supply – if not more so. Furthermore, it is fair to conclude that estimating the monetary costs to society of the direct and indirect environmental consequences of timber extraction in a particular country requires a thorough and systematic research effort (Porter 1998). Pearce (1997) estimates that non-timber values in natural tropical forests might be insufficient to justify the prevention of deforestation and planting of new forests from an economic point of view. However, when recreational values are high and carbon storage values are included, this could outweigh timber values.

[69] This calculation method is more practical and is the value that CO_2 is likely to be traded at in the market of carbon, and the estimate is rather conservative (Secretariat of the Convention on Biological Diversity 2001).

[70] These are the social costs of climate change from CO_2. The social costs are the costs of damage to the environment and humans to be expected from global warming. There is an upper value of $140 and a lower value of $35 per tonne CO_2. This is to be compared with the findings by IPCC's Working Group III in 1996 where the range is $9 to $197 per tonne CO_2 in 2000 prices (Clarkson & Deyes 2002).

9.3 Subsidies worldwide

Subsidies are present in forestry in all three main forest zones, tropical, temperate and boreal, both in developed and developing countries. It is worth noting that subsidies can also contribute to rational forest management through provision of funds to stimulate plantation forestry or safeguard watersheds with tree cover. Myers & Kent (2001) argues that these are rare and are of too little a scale to make a marginal difference in the overall picture, and thus the forest subsidies described may be considered perverse.

The data available on the subsidies in the forest sector are scarce. However, based on different literature Myers & Kent (2001) give rough estimates of subsidies in different regions. They estimate a total for tropical forests, the US, Canada and Russia of around $14 billion yearly in the late 1990s, but these figures do not include rent capture[71]. The fact that there is no economic documentation of other leading forestry countries such as Sweden, Germany, Japan, India, Thailand, Papua New Guinea, Philippines, Ivory Coast, Nigeria, Guyana and Suriname make the estimate very crude. Van Beers & de Moor (2001) give estimates for OECD and non-OECD countries and include rent capture. Their estimate of total world subsidies is $35 billion in the mid-1990s of which $30 billion are in developing countries – see table 9.5 – and between $20 and $30 billion from inadequate rent capture.

Table 9.5: Forestry subsidies worldwide

Region	Subsidies, $ billion per year
OECD countries	5
Non-OECD countries	30
Total	**35**
Perverse subsidies out of total formal subsidies	35

Note: Estimates are from mid- to late 1990s.
Source: Van Beers & de Moor (2001)

$35 billion might seem a small sum. But in relation to the value of the forest products sector of about 1% of world GDP (FAO 2003), corresponding to $300-$400 billion, subsidies account for approximately 10% of the share of GDP from forests.

As forests disappear so do their environmental goods and services and these are very important in the case of forestry. Myers & Kent (2001) gives a rough estimate of environmental externality costs being more than 5 times larger than formal subsidies. The question will be whether the costs of logging and conversion of natural

forest to other uses (e.g. plantation forest or agriculture) exceed the benefits of logging.

9.4 Policy Options

Currently, forest management policies are dominated by subsidies in OECD countries, but should move in the future towards charges and fees in order to reflect the Users Pays Principle for the use of publicly owned natural resources. Such charges could help to increase the efficiency with which forest products are used, although policy simulations indicate that they may not have a significant effect on the demand for forest products and the sector (OECD 2001c). Support to forest activities remains significant in OECD countries and has been the main driver in the expansion of forest resources. While originally the underlying objective was to raise wood production, the emphasis is shifting towards payment for ensuring that forests provide social and environmental services. Direct subsidies of this type can be essential in reducing the profitability gap between sustainable and unsustainable forest techniques by forest managers. Thus, payments can be given to forest owners for income loss resulting from biodiversity protection activities or for ensuring soil protection. These measures should be geared to maximise the social, economic and environmental services provided by forests. At the same time, it is essential to remove any implicit and explicit subsidies which promote logging and access to natural forests (e.g. low stumpage fees, provision of roads through forested areas, support to agricultural expansion). Perverse subsidies should thus be eliminated or converted into subsidies directly targeted at the problem they intend to solve, as mentioned above. The main obstacle to remove such subsidies seems to be highly political and based on fears and uncertainty about the consequences from the removal of subsidies (Sizer 2000).

It will be important to reform natural resource management policies and practices that, directly or indirectly, subsidise extraction of the resource and contribute to resource depletion and distort trade. These problems can be addressed in several international forums such as WTO, the Convention on Biological Diversity (CBD), the Intergovernmental Panel on Forests (IPF) and the Asia-Pacific Economic Co-operation (APEC) forum. Better co-ordination of subsidy policies is needed to minimise the risk of conflicting policies and strengthen the incentives for sustainable management. International co-operation on adverse subsidy removal through the

[71] See chapter 2.1.2 for a description of resource rent

World Trade Organisation can help alleviate any potential competitive effects (OECD 2001c).

Policies to ensure the production of environmental, social and economic services from forests are needed. Eco-labelling for sustainable forest management and carbon sequestration schemes can complement existing regulatory frameworks and provide incentives for more sustainable forest management (OECD 2001c).

9.5 Conclusion

With a value of $35 billion forest subsidies are not on the scale of agriculture and energy subsidies. They are nevertheless quite large, especially when looking at their 10% share of the contribution of forests to GDP. There seems to be no doubt that subsidies to logging contribute to deforestation, and the major challenge in the future will be to ensure sustainability in forestry. International co-operation on adverse subsidy removal can help both to reform natural resource management policies and alleviate any potential competitive effects.

Externalities such as environmental goods and services are also of relatively big importance in forestry since they might be of bigger value than the actual timber values.

Finally, with respect to deforestation, it is probably just as important to regulate subsidies in other sectors that – through their expansion – lead to deforestation (e.g. removing perverse subsidies to agriculture and road-transport) as it is to regulate subsidies in forestry.

10 Discussion

In the preceding chapters, estimates of the size of total conventional subsidies and the share of perverse subsidies in six important sectors has been presented. All estimates are extracted from the literature. The amounts and the total sums are shown in table 10.1 below, which summarises the figures from the preceding chapters. The total sum of conventional subsidies is roughly estimated at $800 – $1000 billion. Approximately 60% of the total direct subsidies are estimated to be perverse subsidies, which gives an estimate of around $500 – 700$ billion. The share of total conventional subsidies given in the OECD is also shown in the table.

Table 10.1: Total conventional subsidies, the share of these in OECD countries and perverse subsidies globally

Billion US$	Total conventional subsidies	Share of OECD Subsidies	Perverse subsidies out of total conventional subsidies
Agriculture	376	92%	207
Energy	85 – 244	33%	64 – 216
Road transportation	225 – 300	94%	110 – 150
Water	69	22%	50
Forestry	35	14%	35
Fisheries	20	50%	19
Total	**810 – 1044**	**73%**	**485 – 677**

It is important to note that all the estimates, and especially the ones for perverse subsidies, are rather uncertain and not adequate in all areas. According to literature this is due to the lack of statistics describing both the conventional subsidies – which are often difficult to calculate because they are hidden and governments' reluctance against publicising them – and the perverse subsidies, whose share of the total conventional subsidies can be difficult to estimate. In fact, estimates of the share of perverse subsidies seem only to have been carried out by Myers & Kent (2001), and their estimates of the share of perverse subsidies can probably best be regarded as guesstimates.

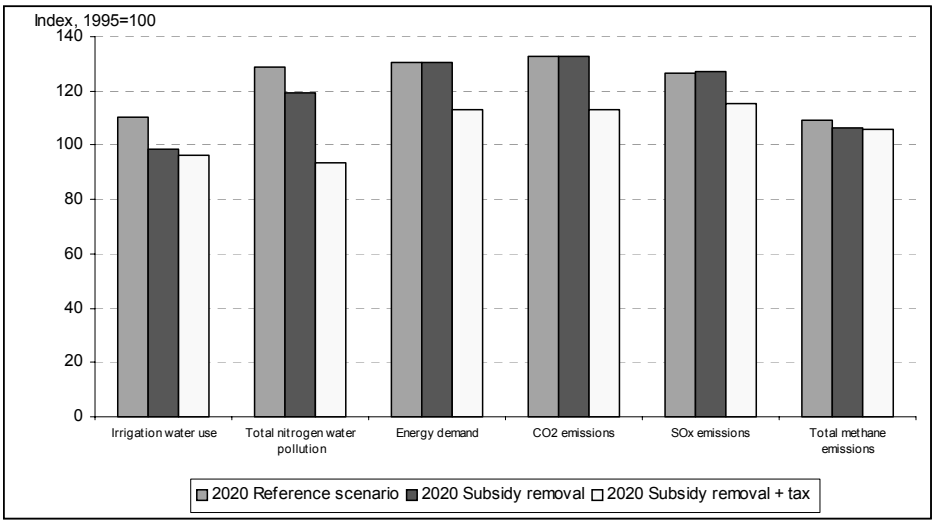
Environmental effects

The definition of a perverse subsidy is that it is harmful to the economy as well as the environment. Thus, the removal of perverse subsidies should result in environmental benefits, but it is beyond the scope of this report to attempt to estimate the size and value of the direct environmental consequences globally of removing only the perverse subsidies, and these are therefore only commented upon. Nevertheless, those subsidies that, in general, seem to be most harmful to the environment

are the ones that increase production or use of a product/substance with environmentally harmful effects. These types are, e.g., subsidies to output (e.g. price support) and to input (lowering production costs). Subsidies that are not conditional on production or input levels (decoupled from production) are less distorting.

Studies that have in fact been investigating environmental effects have mainly considered the removal of all types of subsidies and not just those that can be expected to be environmentally harmful or perverse. The removal of other than perverse subsidies might result in some negative consequences for the environment. Anderson (2004) argues that because of the lack of quantification of the environmental effects from reducing subsidies, these should be set to zero. There are indications, though, that environmental gains can be obtained from removing all conventional subsidies. This can be seen from figure 10.1, based on an OECD study, where effects from removing all subsidies in all sectors in OECD countries and applying a fuel tax and a chemical use tax are analysed.

Figure 10.1: Effects in 2020 on some environmental indicators of removing subsidies, applying a fuel tax and a chemical use tax in OECD regions.



Source: (OECD 2001c)

It is evident that the removal of subsidies only reduces some emissions and only to a small degree compared to a situation with both subsidy-removal and taxes[72]. It should be noted, though, that the model, which simulates the effects, is based on a level of subsidies much lower than the estimates given in this report. Therefore the

effects could be larger than shown in the figure. More importantly, the figure also demonstrates the fact that removing environmentally harmful subsidies alone is not sufficient to address the environmental impacts in general. Thus, targeted environmental policies should also be used to address these negative environmental externalities, i.e. internalising the externalities.

Figure 10.1 only describes effects for OECD regions. The consequences for developing countries and the total global situation might be quite different. Models of trade liberalisation have shown that there can be local negative environmental consequences in countries with a comparative advantage in polluting industries (WTO 1999). In the same study, empirical results show that pollution-intensive industries in general move to developed countries (with higher environmental standards) because these industries are capital-intensive, and developed countries have a comparative advantage in this aspect. Thus, this should result in reduced environmental damage. This advantage could be counteracted by a scale effect where the increased economic activity from trade liberalisation leads to larger production and thus more environmental damage, and this might be bigger than the environmental damage before trade liberalisation (see also chapter 2.5).
A new study analysing the impacts of reduced trade barriers and subsidies (as in the proposed WTO negotiations on the DOHA agenda) in the agriculture, distribution services, and forest sectors, show overall negative effects for the environment (Kirkpatrick & George 2005). This is mostly due to scale effects from increased trade and production resulting in increased transport and increased agricultural production in biologically sensitive areas. The authors also conclude that technology or regulatory effects could counter these negative effects.
When including trade effects of removing subsidies the conclusion must be that the net environmental effects can be difficult to foresee, and that results differ according to whether one analyses regional consequences or global consequences.

Another positive relationship between trade liberalisation and the environment is the link between increased income (poverty reduction) and increased environmental standards. Reducing poverty through increasing income in poor countries can lead to higher environmental awareness and willingness to pay for environmental improvements. Removing subsidies (trade barriers) globally can contribute

[72] The model calculation found the economic costs of the policies (including levying taxes) to be less than a one% reduction in GDP.

to this positive effect in the longer term through the increased incomes in many low-income countries.

Economic effects

The immediate gain from removing perverse subsidies is first of all financial and the burden on taxpayers can then be reduced or the amounts could be used for other purposes. Apart from the fiscal effects, removing perverse subsidies will also have a positive effect on the economy in general because of the distorting effects of these subsidies. There have been different studies that estimate the economic gains from removing/reducing subsidies in general and/or liberalising trade. Especially energy and agriculture have been analysed, where the removal of subsidies and trade barriers has resulted in increased GNP worldwide. As an example, some estimates of the economic gains from removing trade barriers in different sectors and regions are shown in table 10.2. There seems to be a potential for considerable economic gains for OECD countries (high income countries) as well as for non-OECD countries from removing subsidies[73]. Interestingly, low income countries (developing world) obtain more from eliminating trade barriers in the developing world ($65.1 billion) than from only eliminating trade barriers in the developed countries ($43 billion). It should be noted that the estimates in the table probably cover large variations between the different nations, where some developing countries may lose from removing trade barriers.

Table 10.2: Sectoral and regional contributions to economic gains from removing trade barriers globally (1995 US$ billion).

Liberalising region	Benefiting region	Agriculture and food	Other Primary Markets	Textiles, clothing	Other manufactures	Total
High income	*High income*	110.5	0.0	-5.7	-8.1	96.7
	Low income	11.6	0.1	9.0	22.3	43.0
	Total	**122.1**	**0.1**	**3.3**	**14.2**	**139.7**
Low income	*High income*	11.2	0.2	10.5	27.7	49.6
	Low income	31.4	2.5	3.6	27.6	65.1
	Total	**42.6**	**2.7**	**14.1**	**55.3**	**114.7**
All countries	*High income*	121.7	0.1	4.8	19.6	146.2
	Low income	43.0	2.7	12.6	49.9	108.2
	Total	**164.7**	**2.8**	**17.4**	**69.5**	**254.4**

Source: Anderson (2000)

Despite the uncertainties of the figures in the tables, there is an indication of considerable amounts being used on conventional subsidies and that a removal of

[73] The economic benefits from liberalising trade are also supported by Kirkpatrick & George (2005).

these could increase the environmental quality and in any case lead to economic gains. From the descriptions of the different sectors in the preceding chapters, especially agriculture, transport and energy stand out as important sectors to analyse in further detail. The more sectors and the more global the liberalisation is, the larger the positive economic effects will be. In order to guarantee positive environmental effects, it would be necessary for accompanying environmental policies to be in place. If focus were only on perverse subsidies positive effects to environment and economy would also be a very likely outcome.

Equity effects

In removing harmful subsidies, it is also important to consider the potential equity effects. The beneficiaries from subsidies will in most cases face some kind of economic loss which needs to be taken seriously. It may be a question of compensation or using other types of subsidies that are less harmful. Decoupling subsidies from production levels and prices is an alternative to the harmful subsidies, but even these types of subsidies can lead to an increased level of activity and thus cause the scale of production to exceed the optimal level. It seems important that decoupled subsidies be implemented with care and with certain conditions attached. An alternative solution may be to compensate the losers with a one time unconditional and non-transferable payment.

Equity problems may also be an obstacle to subsidy reforms – affecting the political and institutional barriers. The beneficiaries from subsidies have greater incentives to be politically active and lobby the government to defend the policy than the general tax paying voter, who bears only a small fraction of the supply cost.

Thus, it seems necessary that a reform of harmful subsidies is followed up by policies or measures which reduce the potential negative consequences on equity/income and environmental degradation. The former might be in the form of compensation and the latter in the form of policies that internalise environmental externalities. Removing harmful subsidies is a policy that seems relevant in a wide political context where social effects are also taken into consideration. For instance in the EU, the Lisbon Agenda focuses on growth, jobs and environment, making the removal of harmful subsidies an obvious target area.

11 Conclusion

The amounts of money given as subsidies are huge. Though some of the figures are not up to date, there is reason to believe that the amounts given today are still considerable. Usually, there are the best intentions behind giving subsidies, but some subsidies have harmful effects on the environment as well as the economy. Focus in this report is basically on the linkages between subsidies and their environmental effects which are described from a theoretical and qualitatively approach. It is clear that more analyses are needed with regard to describing all the linkages from subsidy to the final quantitative environmental effects, as these can be very complex. A useful way to approach these linkages, and how to identify the harmful subsidies, may be to use the OECD guidelines described in part I.

Price support and input/output support are types of subsidies that can be expected to have relative large effects on production and thus be harmful to the environment and the economy. Furthermore, subsidies may result in a "lock-in effect", where a technology is not replaced by a new and possibly less harmful technology because support favours the old technology. Therefore, development of more efficient and perhaps more environmentally sound alternatives is not encouraged. The main economic effect of harmful subsidies is efficiency losses where GDP and growth are affected negatively.

When analysing a reform of subsidies, it seems important to differentiate between regional consequences and global consequences, especially regarding the environmental effects. The environmental effects from a regional reform of subsidies may have different consequences for the region itself than for the global environment due to the potential effects on trade. There does not seem to be a clear-cut result for the global environment when reforming subsidies, whereas the economic results are often positive.

If existing subsidies are perverse, i.e. both harmful to the economy as well as to the environment, it is very difficult to justify their existence. Even if social goals are the aim, these may be reached by using less distorting measures. Furthermore, a subsidy conditional on the levels of input use or production levels is likely to have little effectiveness in benefiting the intended recipient, i.e. the leakage effects are relatively big.

Reforming harmful subsidies is necessary, but consideration needs to be given to the losses that the receivers of the subsidies may incur. The challenge is to help or compensate the losers with minimally distorting measures. The funds for this may be taken from the saved expenses on subsidies and the economic gains in general.

In the end, negative environmental effects from activities cannot be fully removed by reforming harmful subsidies. Other measures are needed to internalise these externalities. But reforming harmful subsidies can be a step in the right direction.

When analysing the effects of subsidies, ideally all benefits and costs of subsidies should be considered to derive a calculated net benefit or cost from the subsidies in question. Expected environmental, economic and social outcomes should be considered in an integrated way. Socio-economic analysis thus seems to be a necessary tool, though data problems exist.

Work is already being carried out on defining and quantifying subsidies in the different sectors. This is the case especially in OECD, but WTO, UN, EU and many NGOs have also focused on harmful subsidies during the last decade. Multilateral subsidy reform seems to be a plausible route to advance in the area, which also will result in the biggest benefits to societies worldwide.

Even though much is being done, there is still a need for analyses; empirical as well as theoretical. Analysing and ranking the different types of subsidies according to their negative impacts, and quantifying the impacts, could be one way to make the consequences more visible and thus stimulate decisions about reducing subsidies with negative net benefits (net-costs) to society.

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Appendix A

Table A.1: Classification of principal support measures to producers by budgetary effects and points of impact.

Points of impact/support conditionally	Effects on government budgets	
	On-budget	Off-budget
Outputs	▪ Deficiency payments ▪ Sales premiums ▪ Preferential sales tax and VAT rates	▪ Market price support ▪ Border protection (tariffs, quantitative import controls) ▪ Market access restrictions ▪ Government-brokered sales contracts
Raw material and intermediate product inputs	▪ Support to material and energy input (*e.g.* energy, fertilisers, irrigation water) ▪ Provision of infrastructure below long run marginal cost	▪ Material and services in kind
Capital and labour inputs or Income or profit earnings	▪ Support to non-material and non-energy inputs (*e.g.* labour, capital equipment) ▪ Accelerated depreciation allowances (if selective) ▪ Concessional credit ▪ Debt write off ▪ Support to research and development (*e.g.,* of production techniques, safety or environmental protection)	▪ Concessional credit ▪ Royalty concessions ▪ Low rate of return requirements ▪ Exemptions from environmental standards ▪ Allowing insufficient provision for future environmental liabilities

Notes:
- There are many regulations which are not obvious support measures, and their financial effects may be indirect and difficult to assess, such as restrictions on third party access to electricity distribution infrastructure. Such a measure may have profound effects on competition (essentially ensuring a monopolistic market), but its precise pecuniary effects on corporate balance sheets is difficult to calculate. Only the more conspicuous support measures have been listed in table A.1 above. The "implicit" subsidies that result from the non-internalisation of externalities are also not listed.
- The off-budget forms of support may have second order effects on the budget. Increased efficiency of the economy as a whole, which will generally result from lower support levels, may increase revenues without increasing the tax burden as a percentage of GDP. Off-budget support measures are also often part of larger integrated support measures and so are often accompanied by other support policies, which do have direct budgetary effect.

Source: OECD (1998b)

Appendix B

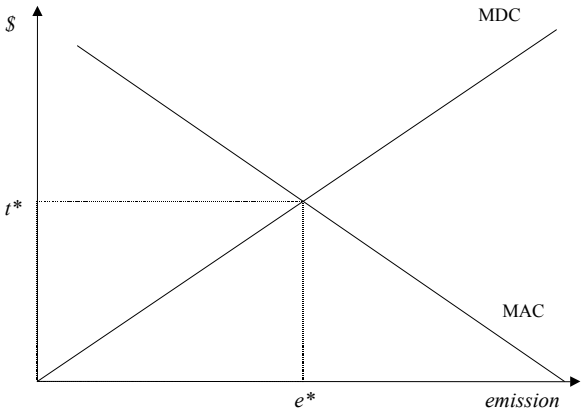
Theory of internalising negative externalities

To internalise externalities means to attribute a price and "an ownership" on the externalities. One way to do this is by imposing a tax on pollution, i.e. emissions, whereby the polluter pays a price for the right to pollute. This is the so-called "Polluter Pays Principle" (PPP). Figure B.1 shows the emissions (pollution) from a firm or industry. The marginal abatement costs for the firm (and society) related to the reduction in emissions is shown by the MAC-curve. MAC increases as emissions are reduced. The costs to society (externalities) by increased emissions are shown by the marginal damage costs (MDC), which are increasing with emissions. Note that the MDC-curve expresses the monetary value of marginal costs to society[74]. Reducing emissions will result in benefits to society, expressed by decreasing damage costs (moving down the MDC-curve). Levying an optimal tax t^* on emissions will result in the firm reducing its emissions to level e^*, where the marginal costs for the firm equal the marginal benefit to society of reducing the emissions.[75] The figure shows that even though the negative effects (damage costs) are undesirable, they should not be removed at any cost. From society's point of view there is an optimal level of emissions e^*, where marginal costs equal marginal benefit. Thus, one could argue that externalities up to e^* are not to be considered as subsidies, or that if considered as subsidies they result in a positive/neutral net benefit for society meaning that they are not perverse. Note that if the MDC-curve is not known (externalities not monetarised), it is not possible to find the optimal pollution level and thus an optimal tax. An alternative is to tax emission until a politically target level of emission is reached.

[74] Since by definition, the market does not attribute a price to externalities (damage costs), alternative methods of pricing/valuing the externalities must be used to extract the MDC-curve.

[75] Such an optimal tax is also known as a "Pigou tax", named after the economist A.C. Pigou, who examined taxes in conjunction with subsidies as means of bringing marginal private costs or benefits into alignment with marginal social costs or benefits.

Figure B.1: An optimal pollution tax.



Source: (Hanley et al. 1997)

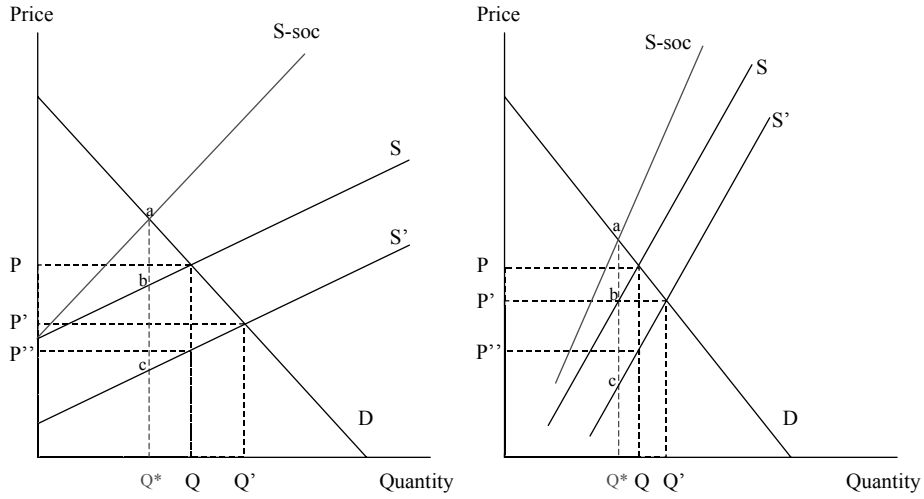
Instead of taxing emissions, subsidising emission-abatement will, in principle, have the same effect as the tax in the figure, where emission will be reduced to *e** because the producer now receives a subsidy for reducing emissions. The basic difference between a subsidy and a tax is the question of property rights, where a tax is a consequence of the polluter not having the right to pollute and thus must pay for this right. In case of a subsidy, the polluter has a right to pollute and will only reduce pollution if compensation is given.[76]

The finding of the optimal emission level requires that all the negative and positive effects have been valued (in monetary terms). As mentioned in chapter 2.1.2, this is often a difficult task. Therefore targets, for environmental protection levels are often used in practice.

[76] See for instance Hanley et al. (1997) for a further description of the differences between pollution taxes and subsidies.

Appendix C

Figure 2.4: Subsidy on producer input and the role of price elasticity.



Notes:
P is the price of the good before the subsidy; P' is the price after support; *(P - P'')* is the price change that occurs as a result of the shift in the supply curve and thus the initial value of support. *D* is the demand curve; *S* is the supply curve (marginal private costs) before support; *S'* is the supply curve (marginal private costs) including an input subsidy. *S-soc* is the marginal social cost.

Source: Adapted from Van Beers & de Moor (2001) and OECD (1998b)

Introduction of input subsidies (with the value of $P - P''$) shifts the marginal private costs curve downward to *S'* leading to lower consumer prices *P'* and higher demand *Q'*. The leakage effect can be described depending on the initial recipient of the subsidy and the price elasticity. In the figure on the left, with relatively low price elasticity, the value of the subsidy ($P - P''$) will be split between the producer and the consumer with the biggest share ($P - P'$) going to the consumer (whose demand is represented by demand curve *D*). In the figure on the right, with higher price elasticity, the producer receives the bigger share of the value of the subsidy. The figure also illustrates that the increase in production ($Q' - Q$) caused by the subsidy is further away from the optimal production level in society *Q**than before the subsidy was introduced. Thus, if the government wants to internalise the externalities by taxing output/production, the tax will have to be higher ($a - c$) than in a situation without a subsidy ($a - b$).[77]

[77] See also appendix B for a description of a tax on emissions.

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About the report

Subsidies are a widely used economical instrument which is often used for enhancing the economic and social development. A frequent topic of discussion is whether subsidies in general are bad and if they should be removed.

This report describes how certain subsidies can actually be harmful to the environment as well as to the economy. The theoretical description is supplemented by practical examples of the usage and effects of subsidies in the sectors of agriculture, energy, road-transportation, water, fisheries and forestry.

The report is intended to give an overview of the current state of knowledge on the harmful effects of using subsidies. There is an increasing awareness about the problems with harmful subsidies, but in general there is still a long way to go with regard to solving the problems, and more research is still needed.

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