Note: This is the revised version of the paper presented to the OECD Workshop on Environmentally Harmful Subsidies. It has been published in the proceedings from the Workshop (see link elsewhere on the site).

ENVIRONMENTALLY HARMFUL SUBSIDIES: BARRIERS TO SUSTAINABLE DEVELOPMENT

David PEARCE
University College and
Imperial College, London

The issue

There is now a substantial literature that addresses the key questions relating to environmentally harmful subsidies: *a priori* reasoning on why some, and probably most, subsidies damage the environment; how subsidies are to be defined; how large they are; and the sector-by-sector effects of subsidies on the environment (Kosmo, 1987; OECD, 1996, 1997; de Moor and Calamai, 1997; OECD, 1998; Myers and Kent, 1998; Sizer, 2000; van Beers and de Moor, 2001; van Beers and van den Bergh, 2001; Porter, 2002). The literature addressing the issue of what in practice can be done to reduce subsidies — what we might call the 'political economy' of subsidies — is far smaller (Pearce and Finck von Finckenstein, 1999; van Beers and de Moor, 2001). There remains, however, a need to define subsidies carefully to determine which are environmentally damaging, to detail the criteria by which their effects can be judged beneficial or detrimental to the goal of sustainable development, and to obtain a better appreciation of just how large subsidies are.

Definitions do matter. Subsidies are not always easy to identify and there are problems of baseline comparison. For example, international aviation fuel is not taxed, but it is not explicitly subsidised in the sense of cash transfers from the public purse to the oil or aviation industry. Many would argue, however, that the absence of a tax constitutes a subsidy because zero taxation is not practised on other competing modes of transport. There are clearly problems of defining the appropriate baseline.

Determining the *effects* of subsidies also matters. Even if it can be demonstrated that a given subsidy harms the environment relative to a baseline in which the subsidy does not exist, the subsidy may serve some other social purpose. For example, some OECD countries practise differential household energy sector taxation in order to protect low income and other socially vulnerable households. The absence of a tax, or the existence of lower taxes in the household sector, can be viewed as a subsidy. While there may be disagreements about the efficiency of achieving social goals through subsidies, the fact is that there may well be a trade-off between environmental damage and the achievement of socially fair taxation. Hence, while the focus of this Workshop is quite rightly on environmentally harmful subsidies, it is not sufficient to cease the analysis once environmentally harm has been determined. The social and economic effects must also be gauged so that any trade-offs can be highlighted.

Finally, *measuring the scale* of subsidies matters. It may or may not matter too much if global subsidies are USD 1 trillion or USD 1.2 trillion, but the general size matters because of what we might call the 'demonstration effect'. Media headlines are far more likely to ensue if it is observed that global subsidies are twenty times the scale of official annual foreign aid, than if they are a few hundreds of billions of dollars. Along with scale, it is vital to know how subsidies vary between rich and poor countries and in which economic sectors they are concentrated. Table 1 repeats the estimates in van Beers and de Moor (2001).[1]

However uncertain these estimates are, the general implications are clear. Subsidies probably total over USD 1 trillion per year. Around two thirds of the subsidies occur in OECD countries. Those OECD subsidies are heavily concentrated in agriculture, mining, road transport and manufacturing. Non-OECD countries mainly subsidise energy, water, fisheries and some agriculture. Relative to GDP, subsidies are twice as large in non-OECD countries. As a percentage of world GDP, global subsidies account for a staggering 4%. Perhaps most notable of all, agricultural subsidies in OECD countries account for over 30% of all subsidies.

The environmental implications of the subsidies listed in Table 1 are potentially substantial.

Table 1. Estimates of world subsidies 1994-98

(USD billion)

	OECD	Non-OECD	World	OECD as % of world
Natural resource sectors				
Agriculture	335	65	400	84
Water	15	45	60	25
Forestry	5	30	35	4
Fisheries	10	10	20	50
Mining	25	5	30	83
Energy and industry sectors				
Energy	80	160	240	33
Road transport	200	25	225	89
Manufacturing	55	negligible	55	100
Total	**725**	**340**	**1 065**	**68**
Total as% GDP	3.4	6.3	4.0	

Notes

- As the basis for Table 1 is fragmented, it involves expected differences.
- Subsidy estimates in Van Beers and de Moor (2001) for OECD countries are in general based on OECD sources. However, many of these OECD sources only cover a part of OECD. Other sources on OECD countries used obtain broader coverage; these have been checked and assessed on their validity and subsidy methodology.
- Agriculture: same source for OECD, no differences except for year.
- Transport:
  - difference in coverage. OECD (2002) covers European countries, while Van Beers and de Moor (2001) includes US and Japan. In particular, the US accounts for a large part in road transport subsidies
  - difference in definition: OECD (2002) mentions social costs, suggesting that it includes costs of congestion; Van Beers and de Moor (2001) do not.
  - difference in sector: OECD (2002) includes rail; Van Beers and de Moor (2001) do not.
- Energy:
  - difference in coverage: OECD (2002) is likely to include only coal subsidies in a few European countries. Van Beers and de Moor (2001) include all energy support in more and major OECD countries, for example US and Canada.
  - difference in definition: OECD (2002) mentions subsidies to energy production which suggests a narrower definition than Van Beers and de Moor (2001).
  - difference in year: OECD (2002) covers 1999 while Van Beers and de Moor (2001) do not.
- Manufacturing/shipbuilding/steel:
  - difference in coverage: OECD (2002) only includes EU. Van Beers and de Moor (2001) have a much wider OECD coverage (based on OECD survey, 1993 and 1998).
- Fisheries:
  - OECD (2002) seems to include financial transfers while Van Beers and de Moor (2001) also include tax expenditures and the inadequacy to cover the full economic rent from fish resources.
- Water: no adequate information to assess differences.
- Forestry: no adequate information to assess differences.
- Mining: based on a case study for the US and on macro indicators.

Source : van Beers et de Moor (2001).

First, the pervasiveness of subsidies means that economic activity in the relevant sectors will be larger than is justified. In so far as environmental damage is a linear function of the *scale* of economic activity, subsidies produce higher levels of environmental damage than can be considered 'optimal'.

Second, the *nature* of the subsidies matters. It is not appropriate in an overview paper to explore definitional classifications in any detail, but most writers make a distinction between *(a)* market price support, *(b)* cost-reducing payments, and *(c)* payments for explicit environmental purposes. Price guarantees, such that prices for output produced exceed world prices, encourage over-production and hence environmental damage. The nature of the price guarantee matters. Subsidies that vary with the scale of *production* are likely to be more environmentally harmful than subsidies that contain some element of *decoupling*, *e.g.* direct payments unrelated to output. Environmentally harmful effects in the agricultural sector, for example, arise because maximum subsidy receipts are secured by maximising production which in turn means (a) switching to intensive production techniques, and (b) extensifying production on to marginal lands and environmentally valuable areas such as woodlands, ponds, hedgerows, etc. Such direct payments may be linked to various conditions, as with the 1992 McSharry reforms under the Common Agricultural Policy in the European Union. Cost-reducing subsidies will have similar effects to price guarantees. Finally, subsidies may take the form of direct payments for environmental services. How far such payments deserve the title 'subsidy' is open to debate. Paying a producer to do something he or she would not otherwise have done is an effective subsidy, but paying for a voluntarily provided external environmental benefit might be better thought of as an example of a 'beneficiary pays' principle.

Even if it could be argued that subsidies serve some social or economic development goals, a rational look at the costs and benefits of subsidies would at least raise the right questions. Are the trade-offs that are virtually certain to arise with subsidies such that overall net benefits are being secured? If they serve some distributional goal, are those distributional benefits worth the economic and environmental costs? The underlying suspicion must be that the vast majority of these subsidies not only fail a conventional cost-benefit test, but that most of them fail to support the incomes of low income or vulnerable groups in society. In the context of water subsidies in the developing world, for example, where the 'protect the poor' argument is frequently voiced, Briscoe (1997) points to the 'hydraulic law of subsidies'. Since politicians interfere in water pricing, the effect is rarely one of protecting the poor but of actually placing them at further disadvantage. Below-cost tariffs result in losses for public water utilities that cannot then invest in proper services. The scramble for the supplies that are provided results in the better off securing supplies, and

the poor often having to resort to high cost vendors of water. The subsidies themselves actually produce the failure to protect the poor, however their objective is first formulated.

The geographical 'footprint' of the subsidies matters too. While many subsidies appear to be locally focused, the geographical extent of the effects of the subsidies listed in Table 1 is often global. The World Bank (2002) estimates that rich country industrial and agricultural protection policies impose costs of USD 100 billion annually on poor countries. What is not always recognised is that this formidable income loss — roughly twice the level of official foreign aid to developing countries — itself has environmental consequences. Poverty itself is directly linked to environmental degradation as economic agents seek to utilise the 'free' resources of nature to supplement meagre incomes. Local people will also have to switch to more marginal environmental resources if they cannot compete with subsidised exploitation of more plentiful resources by protected rich countries, a feature that is especially important in fisheries.

This brief overview suggests the following interim conclusions:

1. There is a *prima facie* case for supposing that subsidies which encourage more production will be environmentally harmful. Subsidies that try to decouple payment from output levels are less environmentally harmful, but still have the effect of keeping production in existence when the optimal solution may be for it to cease altogether.
2. Subsidies that seek to insulate domestic production from international competition are likely to have further environmentally harmful effects in the countries facing trade barriers.
3. Payments for environmental services can be seen as subsidies or as justified internalisation of external benefits, the view taken depending on the assumed allocation of property rights between producers and environmental beneficiaries.

Sustainable development

Subsidies are linked to sustainable development in a number of ways. In order to provide a framework for analysing these effects we first sketch the theory of sustainable development (for a slightly more extended treatment, see Pearce, 1999).

‘Sustainable’ simply means that the goal in question lasts through time. The choice of time horizon is problematic. Some of the sustainable development literature appears to think of time horizons as infinite. This almost certainly confuses sustainability with survivability, maximising the time period over which humans occupy the earth. That might easily be maximised if everyone opted for a subsistence standard of living. Few would vote for such a future. Hence sustainable development must refer to sustaining at least current levels of human wellbeing over some reasonable but finite time horizon. ‘Development’ is a value-word: its meaning will vary with what those defining it consider being the constituents of a ‘developed’ nation. Development occurs if at least average human wellbeing rises over time, and, ideally, the wellbeing of the poorest rises much faster than that of the richest. Precisely what the constituents of wellbeing are may not matter very much if the *conditions* for achieving a sustained development are common to all goals.

What determines the ability of a given set of humans to improve their wellbeing? The ability to create productive capacity is determined by the quantity and quality of capital assets available at the time. It is important to understand what these capital assets are, and this issue has been explored extensively in the sustainable development literature. Capital stocks can be decomposed into *man-made capital*, K_M; *natural capital* (K_N), human capital (K_h) and social capital (IC_s). Natural capital refers to traditionally defined natural resources, such as oil or gas, forests and to the stocks of assimilative capacities in the environment. Rivers, oceans and the atmosphere act as receiving media for wastes generated by economic activity and they can therefore be thought of as a capital stock yielding a flow of assimilation services. In general, what ecologists call ecological services are all economic services yielded by natural capital. Human capital refers to the stock of knowledge and skills embodied in humans. Social capital is variously defined but has something to do with the set of interpersonal relationships and institutional relationships that hold society together. A society with a greater degree of trust between individuals is a society with more social capital. A society that is corrupt and lawless has less social capital.

The productivity of all these forms of capital — their ability to generate human wellbeing — can be enhanced through *technological change*. But the ability of capital stocks to generate increases in per capita wellbeing is almost certainly decreased by population growth. As a general rule, and one that emerges from the growth economics literature of the 1970s, technological change must exceed population growth if sustainable development is to be assured. The more general rule for sustainable development is that the *technology-weighted index of per capita capital stocks must rise through time.*

This is the 'constant capital rule' for sustainable development (Atkinson *et al*., 1997).

The rule for sustainable development can now be fairly easily stated.

$$\dot{k} = \frac{d}{dt}\left(\frac{K}{N}\right) = \frac{K}{N}\left(\frac{\dot{K}}{K} - \frac{\dot{N}}{N}\right) = \frac{K}{N}\left(\frac{\dot{K}}{K} - n\right) > 0 \qquad [1]^2$$

where $\dot{k}$ is the rate of change in per capita stocks of overall capital, K is the stock of all capital assets - also known as 'wealth' (*i.e.* $K_M + K_H + K_N$, and leaving aside K_S due to measurement difficulties), N is population and $\dot{n}$ is the rate of change of population. Note that K is wealth and $\dot{K}$ is the rate of change in wealth, which is formally equivalent to *genuine savings*. Genuine savings is simply gross savings (or investment) less the depreciation on all forms of capital. Intuition tells us that savings need to exceed capital depreciation for they're to be net additions to the capital stock. Hence we can always write:

$$\dot{K} = S_g \qquad [2]$$

The requirement that changes be in per capita terms makes the 'wealth per capita rule' different to the 'genuine savings' rule for sustainability previously advocated for measuring sustainability (Pearce, 2000).

Research at the World Bank has developed sets of estimates for wealth per capita (Hamilton and Clemens, 1999; Hamilton, 2000). Take the example of the United States. The computation for the year 1997 produces the following results:

K/N = wealth per capita = USD 535 000

$S_g/N = \dot{K}/N$ = genuine savings per capita = USD 3 900

n = population growth rate = 0.008

Putting these values into equation [1] yields the change in wealth per capita as -USD 380, a *negative* change in wealth. Despite having a positive genuine savings per capita, the overall change in wealth per capita is negative. Changing the assumptions has a marked effect on this result. If genuine savings per capita is measured to be USD 4 100 instead of USD 3 900 the effect is to

secure a *positive* change in wealth per capita of +USD 612. Changes in wealth per capita also turn out to be very sensitive to the population growth rate. Hamilton (2000) suggests that genuine savings rates below 10% of GNP are consistent with negative changes in wealth per capita.[3] Perhaps more significant is the relationship between wealth per capita and population: if population growth rates exceed 1.2% p.a., there is a real risk that the change in wealth per capita will be negative. Finally, countries with positive GNP growth rates can also have declining wealth per capita, a finding that underlines the limitations of GNP as an indicator of 'true' economic progress.

While most of the literature on measuring sustainable development has focused on the *intergenerational* conditions for growing capital stocks, the most popular formulation of the goals of sustainable development made it clear that an equally, if not more, important, goal is to increase rapidly the wellbeing of those in poverty (Brundtland, 1987). The capital rule can be extended to this goal by emphasising the need for the capital stocks available to the poor to be increased at rates faster than population growth, and for their access to technology to improve. Environmental capital plays an especially important role in this strategy since the poor tend to depend more directly and extensively on natural environments for 'free' resources such as woodfuel, food, medicines and water. This emphasis on poverty alleviation has important implications for policies on subsidies since they very often have the opposite effect of protecting the vulnerable when applied in poor countries. More importantly, subsidies in rich countries can have serious detrimental effects on the wellbeing of the poor in developing economies.

Subsidies and sustainable development

The links between subsidies and sustainable development are many and complex. To facilitate analysis we focus only on the harmful effects of subsidies. Clearly, some subsidies can be beneficial. There is, for example, a powerful case for subsidising renewable energy technologies in order to secure improvements in the learning curve, accelerating the reductions in costs that are necessary if renewable energy is to compete with conventional energy (Anderson, 2001). The justification here lies in the dynamic cost reduction effects and the avoidance of the externalities associated with conventional energy production.

Harmful subsidies, *i.e.* subsidies that are likely to be inimical to sustainable development, will be harmful because they negatively affect one or more of the capital stocks identified above, or because they inhibit technological change, encourage population growth, or make poverty worse. It is possible to

present a case that subsidies contribute to all of these negative effects, thus seriously endangering sustainable development. Since the focus of this Workshop is on environmentally harmful subsidies, the linkage via the environment is stressed here.

Subsidies and sustainable development: the international poverty/environment effect

One of the ironies of subsidies is that, historically, they were often introduced to protect vulnerable groups in society. In practice, many subsidies harm vulnerable groups. We distinguish several ways in which this harmful effect comes about.

The first effect operates via subsidies in rich countries that harm the populations of poor countries. Anderson *et al.* (2000) have simulated the effects of removing rich countries' tariff and non-tariff barriers to developing country exports[4]. While it is true that developing countries face even larger barriers from protectionist policies in other *developing* countries, rich country protection costs the developing world over USD 100 billion annually. Table 2 reports the figures. The importance of the protection of the textiles sector in rich countries is evident, accounting for roughly half the losses of income to poor countries. But agricultural protection is also important.

Table 2. Effects of protectionist policies on developing countries
(USD billion)

Benefiting region	Libera-lising region	Textiles, clothing	Other manu-factures	Agriculture and food	Other primary markets	Total
Developing countries	Rich	9.0	22.3	11.6	0.1	43.0
	Developing countries	3.6	27.6	31.4	2.5	65.1
	Total	12.6	49.9	43.0	2.6	108.1

Source: Anderson *et al.* 2000.

The environmental impacts of these income losses are probably not capable of quantitative estimation, but are extensive. Poverty tends to be associated with high 'time discounting' of the future (Poulos and Whittington, 2000). In turn, high discount rates encourage the 'mining' of natural resources,

and hence environmental degradation. Poverty is also associated with high reliance on natural resources, especially where there is a *de facto* or *de jure* open access regime. Hence poverty tends to encourage greater use of these resources as a 'free' input to household income.

An example of a more complex set of subsidies in rich countries that harm poor countries' wellbeing is fisheries. Milazzo (1998) estimates global fishery subsidies to be between USD 14 and 21 billion per annum. Only about 5% of these subsidies support conservation measures; 95% directly or indirectly encourage over-exploitation. While many of the subsidies in rich countries have negative effects on fishery stocks in those countries, some of the subsidies encourage over-fishing in developing countries by rich country fleets. The European Union, for example, has agreements with a number of developing countries to fish in their coastal waters. Payments for access are below the full value of the economic resource and tend to deprive local fishermen of the resource and of the markets they could otherwise exploit. The subsidies have meaningful trade distorting and price effects that benefit the fishermen of the industrial countries and deny trade opportunities to fish exporters in the developing countries' (Milazzo, 1998).

These two examples indicate that subsidy policies in the developed world have a serious impact on poverty in the developing world, impeding the chances for sustainable development in the countries that most need to achieve it. As far as environmental impact is concerned, we can surmise that the negative environmental consequences of rich country subsidies may be most important in the countries that face rich country protectionist policies.

Van Beers and de Moor (2001) and van Beers and van den Bergh (2001) detail the ways in which subsidies distort international comparative advantage, foreign direct investment and firm location decisions. These authors stress the often 'hidden' nature of the subsidies and the difficulties of identifying subsidies and measuring their impacts. The economic sectors with the largest share of global subsidies - agriculture/fisheries, transport and energy account for 81% of world subsidies - affect 66% of world trade. If manufacturing is added, 87% of world subsidies affect 97% of world trade. Subsidies are therefore pervasive to international trade. Moreover, the economic sectors involved are those most implicated in greenhouse gas emissions, air pollution and water pollution.

Subsidies and sustainable development: the intra-national poverty/environment effect

Many subsidies have international effects even when they are intended to be fairly localised in their goals. Whether the subsidies have international repercussions or not, there is evidence to show that subsidies can seriously distort the distribution of well-being within a country and add to poverty. In the developing world, many subsidies start out as a means of protecting low-income groups against market prices which cannot be afforded. Price controls are favoured because direct subsidies to low income households are usually infeasible because of the lack of government revenues. These price controls are not discriminatory between income groups. Middle and higher income groups gain as well. The resulting 'rents' that accrue to these better-off groups provide an incentive for them to ensure that the subsidies remain. Political protests against relaxation of price controls often emanates from such groups, rather than from the poor. The result is a form of 'lock in' whereby, once introduced, incentives exist for subsidies to remain, making any reform process more and more difficult. This outcome is generic to rich and poor countries alike.

The developing world

Water pricing provides an illustration of the negative social, environmental and economic impacts of subsidies. In the developing world, water subsidies total at least USD 45 billion per annum (Table 1), again roughly equal to total official foreign aid. Urban supplies are seriously under-priced because the marginal costs of supply are rising very fast in the face of rapidly growing demand, and pricing policies tend to be based on historic cost and/or little recovery of capital costs. Hence significant subsidies exist. Agricultural provision of irrigation water in developing countries is extremely inefficient both because it is often supplied at very low supply costs, at best recovering operating and maintenance costs only, and because its has a high opportunity cost (*i.e.* the value of water in the next best use). Low prices imply low revenues for water companies and agencies, however, making investment in new supplies less likely. Substantial areas of potentially valuable agricultural land lie idle because the water infrastructure cannot be upgraded or maintained. Hence long run sustainable development is threatened. Even in a static context, subsidies worsen poverty. Irrigation subsidies, for example, tend to benefit the larger farmers and not the smaller ones who are often at the 'end of the pipe' in terms of receiving water. Drinking water subsidies similarly tend to be biased towards the better off. The poor often have no direct connection to piped water and pay substantial amounts to vendors for bottled water. Finally, these distributional impacts are combined with environmental damage. For example, low prices

encourage excess irrigation and this can result in water logging and salinisation of soils, reducing agricultural potential.

These examples could easily be multiplied for energy subsidies, the largest total subsidy of all in the developing world, and for fisheries and other natural resource sectors. Subsidies to forest clearance, for example, are often appropriated by richer classes seeking some asset investment in contexts of high inflation and political uncertainty. Yet clearance can often have its largest social impacts on the poor who previously relied on the forests for timber and non-timber products. Even where the poor may be the agents of deforestation, long run costs are borne by them as it takes longer to collect fuel wood and building materials from ever-distant wood resources. The general result is that subsidies contribute to *(a)* reduced long run potential for economic development and *(b)* worsening poverty and income distribution.

The developed world

There is far less justification in the developed world for using price controls and subsidies to protect vulnerable groups. Social insurance and tax systems are usually sufficiently sophisticated that income transfer to the poor can be made, without the rich benefiting in the way they do from price controls. Nonetheless, both targeted income transfers and subsidies often exist side by side. Winter heating allowances to senior citizens in the UK, for example, do not discriminate by income group, providing a windfall gain to richer households and also sending the wrong price signal with respect to energy conservation. Irrigation subsidies in the US probably amount to USD 2—2.5 billion (de Moor, 1997). The subsidies contribute to a situation where the 'wrong' crops are grown, *i.e.* those crops would not be grown in a competitive market. In turn, this diverts water from higher value uses, reducing economic growth potential and reinforcing the negative impacts on developing countries who might otherwise supply the market in question. Those who are protected are often not low-income groups at all. Those who gain most from agricultural subsidies, for example, tend to be the larger farmers (OECD, 1995). Moreover, subsidies have to be paid for by tax revenues, revenues that could be used for alternative purposes, including the targeted protection of vulnerable groups, investment in new technology and in general enterprise.

It is hardly surprising that subsidies in rich countries are 'captured' by higher income groups. Subsidies create rents and rents give significant returns to directly unproductive activity such as political lobbying. Higher income groups tend to be better organised and politically more influential, hence they have more scope and more power to influence legislatures. Thus, even within

developed economies, subsidies are inimical to economic development and often fail in their social goals. There are environmental consequences as well. The continuation of political pressure to preserve the rents that arise from subsidies acts as an obstacle to subsidy reform, and hence perpetuates the environmental damage from the subsidy regimes. Rent capture tends to be associated with pressure to confer at least *de facto* property rights on those who receive the subsidies. Those who gain from environmental improvement — *e.g.* the general citizenry — may then find themselves having to pay again to secure environmental benefits. Since taxpayers' money is limited, such payments may themselves be limited in size relative to the overall level of environmentally damaging subsidies. The size of agri-environmental subsidies in the EU agricultural support system is a case in point.

Subsidies and sustainable development: depleting natural capital

It is well known that many subsidies directly or indirectly contribute to the depletion of natural capital, one of the 'pillars' of sustainable development. The examples are well known: water logging and salinisation from subsidised irrigation water; excessive air pollution and greenhouse gas emissions due to transport fuel and stationary energy subsidisation (Larsen, 1994; Michaelis, 1996*a*, *b*); deforestation from subsidies to forest clearance and logging, and loss of old growth forests (Sizer, 2000; Day, 1998); over-fishing due to subsidisation of fishing fleets (Milazzo, 1998). While the general direction of the effects of subsidies appears well known, actual quantification of the environmental effects has proved far more difficult. This is not surprising given the problems of defining and measuring subsidies, and the problems of modelling subsidy impacts when so many other variables are involved in determining environmental change. Table 3 assembles some of the available estimates which, unsurprisingly, focus on greenhouse gas emissions and air pollution. However, the estimates are clear in showing that subsidy removal would result in substantial gains to air quality and the global atmosphere.

Subsidies and sustainable development: depleting human capital

Human capital comprises the major part of the world's capital assets. Table 4 shows some World Bank estimates of capital stocks, and even for a few countries, it reveals some insights. First, human capital, K_H, is the dominant capital asset, save in oil rich nations like Saudi Arabia. Human capital in India accounts for 60% of wealth and in the US it accounts for nearly 80%. Second, the average person in the US has twenty times the wealth of the average person in India. If human capital is so important, does this imply that damage to the

natural environment is relatively unimportant in hindering sustainable development? What is the link to subsidies?

Table 3. Some environmental effects of subsidies or subsidy removal

Study	Nature of scenario	Environmental impacts
Cristofaro *et al.* 1995 US	Removal of USD 8.5 billion energy subsidies. Removal of USD 15.4 billion energy subsidies.	- 10 mtC by 2010 - 37 mtC by 2035 - 64 mtC by 2010
Gurvich *et al.* 1995 Russia	Removal of energy subsidies: effects in 2010	76% reduction in TSP 39% reduction in CO2 43% reduction in NOx 66% reduction in SOx
IEA, 1999	Removal of consumer subsidies in Russia, China and six other countries	16% reduction in CO2
Larsen and Shah, 1994	Removal of world energy subsidies of USD 230 billion	21% reduction in CO2
GREEN in Michaelis 1996b	Removal of global subsidies of USD 235 billion	- 15 billion tonnes CO2 in 2050
DRI in Michaelis 1996b	Removal of coal subsidies in Europe and Japan	- 10 to -50 mtCO2

Table 4. Estimates of global capital assets

Country	K_M/N	K_H/N	K_N/N	K/N	K_H as % of K
US	76 000	308 000	17 000	401 000	77
UK	51 000	209 000	5 000	266 000	79
Germany	66 000	211 000	4 000	281 000	73
Saudi Arabia	30 000	69 000	72 000	171 000	40
Uganda	6 000	8 000	2 000	15 000	53
India	4 000	12 000	4 000	20 000	60

Source: Kunte *et al*. (1998).

It is only recently that it has proved possible to make the link between subsidies, environmental damage and loss of human capital. Subsidies deplete

natural capital, as shown in the previous section, but environmental damage has negative impacts on human capital. Here is a hitherto neglected dimension of the way in which subsidies hinder the chances of securing sustainable development.

The new evidence comes from estimates of the global burden of disease (GBD) (Murray and Lopez, 1996). Premature loss of life and morbidity are reduced to a common metric by converting the latter to fractions of years of healthy life lost through disability or illness. The resulting measure, a disability-adjusted life year (DALY), enables the burden of disease and accidents to be calculated for individual countries, regions and the world.[5] Lvovsky (2001) has decomposed the DALY data according to causal factors. Environmentally induced DALYs arise from inadequate water supply and sanitation, vector diseases such as malaria, indoor and outdoor air pollution and agro-industrial wastes and pollutants. On this basis, Table 5 presents estimates of the number of DALYs lost due to environmentally-induced causes.

Table 5. Environmentally-induced burden of disease, 2000 (DALYs)

	World: DALYS	**Non-EMEs: DALYs**	**EMEs: DALYs**
All causes 10^6 DALYs	976.8	876.4	100.4
% due to environmental factors	16.6	18.0	4.5
Total environmentally induced DALYs 10^6 DALYs	162.3	157.8	4.5
Total DALYs per 1000 people	182.5	192.6	125.5
Total environmental DALYs per 1000 people	30.3	34.6	5.6

Note: Developed economies are defined as established market economies.
EME = established market economy. Total DALYs taken from World Bank web site. Fractions due to environmental factors taken from Lvovsky (2001). EME population – 800 million. Non-EME population = 4 551 million (early 1990s). These estimates differ from those in Lvovsky(2001) since the DALY data relates to 2000 not 1990.

As might be expected, the vast proportion of environmentally induced DALYs are in the developing world. Valuing DALYs in monetary terms is controversial. Lvovsky *et al*. (2000) estimate health costs for six different developing country and East European cities and produce an implied value of a DALY of some USD 11 100. Adopting that value for developing countries alone would produce a global estimate of developing country human capital damage due to environmental causes of USD 1.75 trillion. These are based on inferred willingness to pay estimates. Using a more conventional income per capita value, the total loss of DALYs in the developing world would be just under USD 200 billion. Even the lower limit suggests a formidable cost to developing economies of environmentally induced disease. For example, USD 200 billion translates into around USD 40 per person per annum in the developing world. Treating this as a stream of damages over a 30-year time horizon[6] produces a present value of some USD 550. This can be compared to the human capital estimates for India and Uganda in Table 4. Environmentally-induced human capital damage would, on these rough calculations, amount to a 5-7% reduction in the value of human capital. These estimates need considerable refinement, and it is also the case that this loss of human capital cannot be blamed solely on subsidies. Nonetheless, the link between subsidies, environmental damage and human capital depletion has been established and this should the subject of future research.

Subsidies and sustainable development: depleting social capital

The social capital dimension of sustainable development is the least researched and the most difficult to assess given problems of definition and measurement (Isham *et al*. 2002). Social capital relates to sets of interpersonal and inter-institutional relationships in society. The better these relationships — the greater the degree of trust — the lower the transactions costs of economic exchange and therefore, potentially, the higher the chances of sustained development. Numerous indicators have been suggested for measuring social capital. Social capital may often be recognised through indicators of its decay — *e.g.* crime rates, as measures of social insecurity. Even expenditures on policing might give some measure of social insecurity (Klitgaard and Fedderke, 1995). At the political level, there are now quite widely used indicators of political freedoms, corruption and good governance. These tend to rank whole countries, and various statistical efforts have been made to determine the role that they play in securing or inhibiting rising living standards (Knack and Keefer, 1997).

How is social capital linked to subsidies? Reflection suggests that there may be many links. We select two for brief comment. First, as we have

seen, subsidies constitute rents and rents generate 'rent seeking', a process whereby interest groups seek to maximise their share of the rents rather than engaging in any economic activity that increases overall wellbeing. Rent seeking involves lobbying and, ultimately, corruption. In turn, corruption destroys trust in institutions: people no longer trust governments, regulators and government agencies, knowing them to be overly-influenced by those who can exercise political power and influence. Bribes become central to the 'working' of bureaucracies and the less privileged have less capacity to pay the bribes. Thus there is both an overall economic inefficiency — a diversion of resources into unproductive activity — and an equity issue — the poor are generally excluded from the process that allocates the resources. Subsidies are just one source of rents and there are many others, such as centralised control of permits and licences that generates rents. Nonetheless, subsidies on the scale of those listed in Table 1 clearly reveal substantial opportunities for corruption (Rose-Ackerman, 1999). Subsidies are therefore directly linked to the destruction of social capital.

A second important link is from subsidies to social capital via environmental destruction. The link between subsidies and reduced natural capital is well established (see above). But environmental assets are frequently well managed through local associations and community groups (Pretty and Ward, 2001). These social groups are frequently very vulnerable to external shocks and stresses, and most notably to governmental decisions that seek to override or replace communal management because it is believed to be inefficient. Subsidies are often involved in the process of replacing local management, perhaps because of a belief that new management regimes need financial help to raise productivity. In other cases, governments have been more enlightened and have actually sponsored local community solutions to resource management. But, while seriously under-researched in the social capital literature, there are fairly clear links between subsidies and the loss of community-oriented natural resource management.

Finally, losing social capital amounts to losing the relationships of care and concern for fellow human beings. Societies that tend to be more selfish also tend to be less caring of the natural environment. Hence the destruction of social capital has implications for arguments about 'sustainability' based on a greater social concern and less greed. Subsidies destroy both social and natural capital.

Subsidies and sustainable development: inhibiting technology

A final component of the subsidy-sustainability link is via technology. Subsidies can induce environmentally friendly technology, as with the subsidies currently in existence in many countries for renewable energy sources. Many subsidies produce 'lock in' effects to prevailing technologies, however, inhibiting the advance of new, cleaner technologies. There are two effects to consider. Subsidies to energy *per se* are environmentally harmful in so far as they induce a level of energy usage higher than would otherwise be the case. Typically, much energy use is wasted and subsidies simply reinforce the level of wastage. The second effect arises from the role that subsidies play in locking-in existing energy technologies. Subsidies are often specified by fuel source or technology, for example subsidies to the coal industry in Germany and the UK. These subsidies then inhibit the transition to renewable and low-pollution sources of energy. Nor is there any incentive to develop technologies that lower the pollution content of the fuels in question. Only higher prices will do this. The role of higher prices in inducing energy efficient technological change is reasonably well documented (Jaffe *et al*. 2000).

Subsidies and sustainable development: issues for discussion

This section has suggested that there are several potentially major links between perverse subsidies and reduced capacity to secure sustainable development. These links are best explored by looking at the ways in which subsidies affect (*a*) poverty and income inequality, and (*b*) the capital asset base of sustainable development. When viewed in this way, also revealed is a highly important finding relating to the central theme of this Workshop: the ways in which subsidies produce environmental damage are far more complex than they at first appear. In order to understand these impacts, it is necessary to examine the effects that subsidies have on poverty, especially in developing countries that are disadvantaged by protectionist policies by rich countries. It is also important to understand the links between subsidies, technological change, and human and social capital formation. Each of the changes in these forms of capital has a consequence for environmental capital. Focusing on the direct impacts on natural capital alone is not sufficient.

This conclusion probably makes the tasks facing this Workshop even more difficult. In sequence, the issues that need to be addressed are:

- Securing some form of consensus on the definition of subsidy.
- Determining criteria for defining those subsidies that are environmentally harmful from those that are not.

- Establishing the nature and possible scale of the environmental externalities arising from subsidies, noting the conclusion of this section that determining their scale and importance requires a wider sustainable development perspective than has hitherto been provided.
- Establishing what benefits (social, economic, etc.) might accrue from environmentally harmful subsidies so that the trade-offs can be clearly established.

Ideally, these issues need to be settled before detailed policy packages for subsidy reform can be developed. In practice, perhaps enough is known for subsidy reform to be advanced without such detailed information, but the scale and content of those reforms should still be informed by better analysis of the costs and benefits of subsidies. Finally, and well beyond the scope of this Workshop, the complex issue of how, in practice, to bring reform about needs to be analysed, probably most profitably via case studies of past and current exercises in reform.

ENDNOTES

1. Since the purpose of the specialist papers at this Workshop is to deal with definitions and measures of subsidy, we do not dwell on the definitional issues here.
2. To keep the exposition simple, equation [1] omits technological change, T. It is fairly straightforward to introduce technological change in the form of changes in total factor productivity. However, whether technological change affects the measurement exercise is a debated point. Essentially, if technological change is exogenous, equation [1] will understate true progress and T needs to be included. If it is endogenous then [1] captures the essence of the condition for sustainable development. See Atkinson (2000).
3. It is easy to get confused between the concepts. The rate of change of overall K is genuine savings. The rate of change in K divided by population is per capita genuine savings. The change in wealth per capita is given by d(K/N)/dt. Hence per capita genuine savings can be positive but the change in wealth per capita can be negative.
4. Tariffs are taken here to be one form of subsidy, i.e. holding domestic producer prices above the level of world prices (van Beers and de Moor, 2001).
5. Detailed estimates of DALYs are published on the World Bank web site: www.worldbank.org.hnps.
6. At a 6% discount rate.

REFERENCES

Anderson, D. (2001), "Technical Progress and Pollution Abatement: An Economic View of Selected Technologies and Practices", *Environment and Development Economics*, Vol. 6, pp. 283-311.

Anderson, K., J. Francois, T. Hertel, B. Hoekman, and W. Martin, (2000), *Potential Gains from Trade Reform in the New Millennium*, World Bank, Washington, DC.

Atkinson, G. (2000), "Technology and Sustainable Development", in OECD, *Frameworks to Measure Sustainable Development*, OECD, Paris, pp. 97-104.

Atkinson, G., R. Dubourg, K. Hamilton, M. Munasinghe, D.W. Pearce, and C. Young, (1997), *Measuring Sustainable Development: Macroeconomics and the Environment*, Edward Elgar, Cheltenham, UK.

van Beers, C. and S. de Moor (2001), *Public Subsidies and Policy Failures: How Subsidies Distort the Natural Environment, Equity and Trade and How to Reform Them*, Edward Elgar, Cheltenham.

van Beers, C. and J. van den Bergh (2001), "Perseverance of Perverse Subsidies and Their Impact on Trade and Environment", *Ecological Economics*, Vol. 36, No. 3, pp. 475-486.

Briscoe, J. (1997), "Managing Water as an Economic Good", in M. Kay, T. Franks and L. Smith (eds.), *Water: Economics, Management and Demand*, E. and F.N. Spon, London, pp. 339-61.

Cristofaro, A., B. Schillo, R. Shackleton, R and M. Shelby (1995), *The Climate Change Implications of Eliminating US Energy Subsidies*, USEPA Report to OECD, OECD, Paris.

Day, B. (1998), "Who's Collecting the Rent? Taxation and Superprofits in the Forest Sector", Environment Department, World Bank, Washington, DC, mimeo.

Gurvich, E., A. Golub, M. Uzyakov, A. Mukhin, N. Korobova, G. Hughes, K. Lvovsky, and A.Gorman (1995), *Impact of Russian Energy Subsidies on Greenhouse Gas Emissions*, Report to OECD, OECD, Paris.

Hamilton, K. (2000), "Sustaining Economic Welfare: Estimating Changes in Wealth per capita", Environment Department, World Bank, Washington, DC, mimeo.

Hamilton, K. and M. Clemens (1999), "Genuine Saving in Developing Countries", *World Bank Economic Review*, Vol. 13, No. 2, pp. 33-56.

IEA. (International Energy Agency) (1999), "Looking at Energy Subsidies: Getting Energy Prices Right", *World Energy Outlook*, OECD/IEA, Paris.

Isham, J., T. Kelly, and S. Ramaswamy (eds.) (2002), *Social Capital and Wellbeing in Developing Countries*, Edward Elgar, Cheltenham, UK.

Jaffe, A., R. Newell, and R. Stavins (2000), *Technological Change and the Environment*, Discussion Paper 00-47, Resources for the Future, Washington, DC.

Klitgaard, R. and J. Fedderke, (1995), "Social Integration and Disintegration: An Exploratory Analysis of Cross Country Data", *World Development*, Vol. 23, No. 3, pp. 357-369.

Knack. S. and P. Keefer (1997), "Does Social Capital Have an Economic Payoff? A Cross Country Investigation", *Quarterly Journal of Economics*, Vol. 112, No. 4, pp. 1251-1288.

Kosmo, M. (1987), *Money to Burn? The High Cost of Energy Subsidies*, World Resources Institute, Washington, DC.

Kunte, A., K. Hamilton, J. Dixon and M. Clemens (1998) *Estimating National Wealth: Methodology and Results*, Paper No.57, Environmental Economics Series, World Bank Washington, DC.

Larsen, B. (1994), *World Fossil Fuel Subsidies and Global Carbon Emissions in a Model with Inter-fuel Substitution*. Policy Research Working Paper No. 1256, World Bank, Washington, DC.

Larsen, B. and A. Shah (1994), "World Fossil Fuel Subsidies and Global Carbon Emissions", World Bank, Washington, DC, mimeo.

Lvovsky, K. (2001), *Health and Environment*, Environment Department, Strategy Series No. 1, World Bank, Washington, DC.

Lvovsky, K., G. Hughes, D. Maddison, B Ostro and D.W. Pearce (2000), *Environmental Costs of Fossil Fuels: a Rapid Assessment Method with Application to Six Cities*, Environment Department Paper No. 78, World Bank, Washington, DC.

Milazzo, M. (1998), *Subsidies in World Fisheries: a Re-examination*, Technical Paper No. 406, World Bank, Washington, DC.

Michaelis, L. (1996a), "The Environmental Implications of Energy and Transport Subsidies", in OECD, *Subsidies and the Environment: Exploring the Linkages*, OECD, Paris, pp. 175-192.

Michaelis, L. (1996b), *OECD Project on the Environmental Implications of Energy and Transport Subsidies: Summary Report*, OECD, Paris.

de Moor, A. and P. Calamai (1997), *Subsidising Unsustainable Development*, Institute for Research on Public Expenditure, The Hague.

Murray, C. and A. Lopez (1996), *The Global Burden of Disease*, Harvard University Press, Cambridge, Mass.

Myers, N. and J. Kent (1998), *Perverse Subsidies: Tax Dollars Undercutting Our Economies and Environments Alike*, International Institute for Sustainable Development, Winnipeg.

OECD (1995), *Adjustment in OECD Agriculture: Issues and Policy Responses*, OECD, Paris.

OECD.(1996), *Subsidies and the Environment: Exploring the Linkages*, OECD, Paris.

OECD (1997), *Reforming Energy and Transport Subsidies: Environmental and Economic Implications*, OECD, Paris.

OECD (1998), *Improving the Environment through Reducing Subsidies*, 2 volumes, OECD, Paris.

Pearce, D.W. (1999), "Measuring Sustainable Development: Implications for Agri-Environmental Indicators", in OECD, *Environmental Indicators for Agriculture: Volume 2 – Issues and Design*, OECD, Paris, pp. 29-45.

Pearce, D.W. (2000), "The Policy Relevance and Uses of Aggregate Indicators: Genuine Savings", in OECD, *Frameworks to Measure Sustainable Development*, OECD Paris, pp. 79-82.

Pearce, D.W. and D. Finck von Finckenstein (1999), *Advancing Subsidy Reforms: Towards a Viable Policy Package*, Paper prepared for UNEP Fifth Expert Group Meeting on Financial Issues of Agenda 21**,** Nairobi, December.

Porter, G. (2003), "Subsidies and the Environment: An Overview of the State of Knowledge", paper prepared for the OECD Workshop on Environmentally Harmful Subsidies, Paris, 7-8 November, published in this volume.

Poulos, C. and D. Whittington (2000), "Time Preferences for Life-Saving Programs: Evidence from Six Less Developed Countries", *Environmental Science and Technology*, Vol. 34, pp. 1445-1455.

Pretty, J. and H. Ward (2001), "Social Capital and the Environment", *World Development*, Vol. 29, No. 2, pp. 209-227.

Rose-Ackerman, S. (1999), *Corruption and Government: Causes, Consequences and Reform*, Cambridge University Press, Cambridge.

Sizer, N. (2000), *Perverse Habits: the G8 and Subsidies that Harm Forests and Economies*, World Resources Institute, Washington, DC.

World Bank (2002), *Globalization, Growth and Poverty: Building an Inclusive World Economy*, Oxford University Press, Oxford.