Article
Cees van Beers and Jeroen C. J. M. van den Bergh

Environmental Harm of Hidden Subsidies: Global Warming and Acidification

We investigate environmental impacts of off-budget or indirect subsidies, which, unlike on-budget subsidies, are not visible in government budgets. Such subsidies have received little attention in economic and environmental research, even though they may be at least as important from an environmental perspective as on-budget subsidies. We offer a typology of indirect subsidies. Next, we estimate the magnitude of these subsidies and their impact on greenhouse gas (GHG) and acidifying emissions for the agriculture, energy, and transport sectors in The Netherlands. The calculations are based on a model approach that translates a particular subsidy into price and quantity changes using empirical elasticities, followed by environmental effect estimates using pollution-intensity parameters. The various environmental pollution effects are aggregated into environmental indicators. The results show, among others, that GHG emissions caused by off-budget subsidies contribute to more than 30% of the policy targets specified by the Kyoto Protocol for CO_2 emissions reduction by The Netherlands. Reforming or removing off-budget subsidies may thus be an important strategy of effective climate policy.

INTRODUCTION

In debates on environmental policy the complementary need for removing environmentally harmful subsidies has received little attention. Such subsidies typically increase the size and pollution intensity of economic activities, often without clear, compensating social benefits. The environmental impact of direct or on-budget subsidies has been well recognized (1–5). Indirect or off-budget subsidies, not visible in government budgets, are at least as important. Research on this topic is scarce (6–9). We report findings on greenhouse gas (GHG) and acidifying emissions arising from off-budget subsidies in The Netherlands and show that subsidies in agriculture, energy, and transport in particular contribute importantly to GHG emissions. Effective climate policy therefore needs to consider removal of off-budget subsidies.

Public subsidies can be broadly defined as all government interventions that directly or indirectly cause the price for consumers to be below, or for producers above, the undistorted market price. As opposed to on-budget subsidies, off-budget subsidies are often not recognized as being subsidies. This in turn hinders the assessment of their environmental consequences. Off-budget subsidies can be categorized as follows:

i) Tax subsidies: deductions, exemptions, or special tariffs, like reduced energy taxes for specific sectors or low VAT rates for specific product categories
ii) Public provision of goods and services below their cost, like infrastructure
iii) Capital subsidies, such as loan guarantees, debt forgiveness, and government loans with "soft conditions" (e.g. below-market interest rates)
iv) Price regulation, such as minimum prices for agricultural products
v) Quantity restrictions, such as regulating a minimum use of a certain input or product
vi) Trade barriers, such as import quota and export credits

Whereas public subsidies are often introduced with a certain aim, it is not necessarily true that their implementation is preceded by a careful assessment of all costs and benefits. A complete evaluation of the impact of public subsidies ideally involves considerations of policy effectiveness, economic efficiency, and environmental and social implications (6). The presence of substantial environmental impacts of subsidies is not a sufficient condition for their removal. It is true though that a sizeable environmental impact requires a substantial counterbalancing economic or social advantage to motivate the respective subsidy. When the negative effects of a subsidy outweigh its positive effects, the subsidy is called perverse and from a social welfare perspective it would be desirable to remove it (6).

An example is price support in the agricultural sector in the European Union. This was introduced with the aim to guarantee a minimum level of income for farmers. Studies by the OECD have shown that this price support has a "transfer efficiency" ratio of 0.2, meaning that every € 5 additional subsidy leads to a € 1 increase in farm income, whereas € 4 leaks away via higher prices of land and other relevant inputs (6, 10). Moreover, the 20% of the subsidy that ends up in farmers' income mainly goes to the largest producers, who usually have relatively high incomes. Price support furthermore provokes additional production and hence extra use of fertilizer, more demand for agricultural land, and a shift to monocultures, which in turn contribute to higher environmental pressure. Hence, the agricultural price support policy can be judged as being ineffective, inefficient, and inequitable.

Policy decision makers are mostly concerned with policy effectiveness and economic efficiency but often neglect negative environmental and social effects. This partly explains why political support for removing off-budget subsidies with negative environmental impacts is difficult to mobilize. Few studies have quantified their environmental harmfulness, making it easy to neglect them. Another reason is that reducing or eliminating subsidies is guaranteed to meet strong resistance from vested interests and related lobbying groups, reinforced by feelings of historical rights (11).

The present study aims to offer a quantification of environmental damage due to support policies in the form of off-budget subsidies in the sectors of agriculture, energy, and transport. The reason is that many sizeable off-budget subsidies in OECD countries can be found in these sectors (4, 6).

SIZE OF OFF-BUDGET SUBSIDIES

In 1994–1998 more than USD 1 trillion was spent worldwide on annual subsidies that potentially harm the natural environment, mainly in resource-intensive sectors like agriculture, energy, and transport. Although quantifying off-budget subsidies is difficult, some attempts have been made. For OECD countries, off-budget subsidies to the agricultural sector amounted to USD 318 thousand million in 2002, which is 1.2% of total OECD GDP.The environmentally most harmful agricultural subsidies are market price support, output payments, and input subsidies

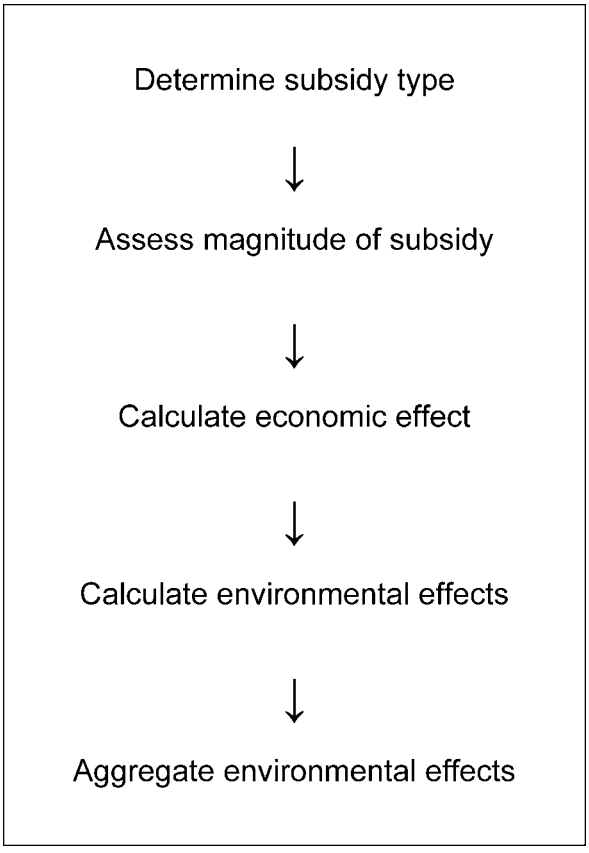

Figure. Model approach to environmental impact assessment of off-budget subsidies.

(12). The GATT and WTO trade rounds in the last 20 years led to subsidy reform but at a very slow pace (13).

A lower bound estimate of off-budget energy subsidies (excluding external costs) for the EU-15 countries is USD 27 thousand million (€ 21 thousand million), and for on-budget subsidies is USD 10 thousand million (€ 8.2 thousand million), of which some 40% is used to subsidize coal (14). The distribution of coal subsidies into on- and off-budget is about 50–50. Since 1999 a reduction in OECD coal subsidies is observed, but this is mainly caused by a reduction in coal use (12). Subsidies to oil and gas are mainly off-budget, as most on-budget subsidies are provided to investment in oil exploitation, which largely takes place outside EU borders. For the United States, federal energy subsidies were in the range of USD 40–65 thousand million in 2003 and have risen since 2006 because of the Energy Policy Act of 2005, which stipulated an increase of USD 85 thousand million over 10 years (15, 16). The rising dependence of particularly EU countries on gas deliveries from Russia has led to a renewed interest in energy security, with associated pleas for additional subsidies to stimulate a substitution to coal. Such subsidies would threaten climate policy aims given that carbon capture and storage is far from a mature technology.

In the transport sector, most off-budget subsidies relate to road transport infrastructure. For the world as a whole these are estimated to range from USD 225 to 300 thousand million. Of this, USD 100 to 150 thousand million is considered to contribute to increased damage to the environment (17).

ASSESSING THE ENVIRONMENTAL IMPACT OF OFF-BUDGET SUBSIDIES

Previous studies have assessed the height of subsidies but not their environmental impact. The relevance of the environmental impact of off-budget subsidies is illustrated by an ex post study for The Netherlands (7, 8). It used a combination of microeconomic and environmental impact assessment models to estimate the environmental effects of off-budget subsidies in agriculture, energy, and transport, focusing on GHG and acidifying emissions.

Table 1. Counts of off-budget subsidies in The Netherlands with a negative environmental *impact.*

	Sectors		
Indirect subsidy type	**Agriculture**	**Energy**	**Transport**
Tax subsidies (deductions, exemptions)	10	3	10
Public provision below cost price	4	2	3
Capital subsidies	1	1	1
Price regulation	2	1	1
Volume regulation	1	—	—
Trade measures	1	—	—
Total	19	7	15

The steps of the approach adopted are shown in the Figure. The microeconomic models that were used estimate the impact of subsidies on output (quantity) via changes in relative prices. Empirical price elasticities of demand and supply in relevant markets (agriculture, energy, and transport), taken from various empirical studies and databases like the Global Trade Analysis Project, were used for this purpose (7, 8). A range of environmental effects of the economic output changes were estimated using pollution-intensity parameters. These environmental pollution effects were subsequently aggregated into four environmental indicators, using the *EPI* method (8, 18). These indicators are greenhouse effect, acidification, photochemical ozone creation, and eutrophication (8, 18). We focus here on the first two as data for the latter two were incomplete.

Table 1 shows the distribution of the off-budget subsidies over types and sectors. In total, 46 subsidies were identified, most of which apply to agriculture and transport. These subsidies were ranked according to their estimated size in terms of equivalent, implicit monetary transfer. The largest eight, which comprise 6% of the total annual Dutch government expenditure in 2000–2002, were subjected to an environmental impact assessment.

The environmental assessment of the eight subsidies shown in Table 2 illustrates that off-budget subsidies can bring about relatively large environmental impacts. This is particularly true for the subsidies provided through the energy tax, milk price support, and designation of agricultural land. The excise tax exemption for aviation fuels has the largest environmental impact. Off-budget subsidies contribute to more than 30% of the policy targets specified by the Kyoto Protocol for the CO_2 part of GHG emissions reduction by The Netherlands during the period 2008–2012. Given the difficulty to achieve (post-) Kyoto goals, policy makers might want to pay more serious attention to the reform of environmentally harmful off-budget subsidies.

As the reported effects depend on the chosen model parameters, particularly the empirical price elasticities, we also performed sensitivity analysis on these elasticities. This showed that higher price elasticities can indeed lead to substantial increases in the values of the environmental indicators (8). Table 2 can be seen therefore as presenting conservative estimates of, or lower bounds to, both the magnitudes and environmental impacts of the subsidies.

Exemption from excise tax of aviation fuels means a considerable subsidy for the aviation sector in comparison with competing means of transport. In The Netherlands, the size of this subsidy amounts to approximately € 1.2 billion annually,

Table 2. Environmental impacts of off-budget subsidies in The Netherlands (% of total in parentheses).

Subsidies examined	Amount (in million €)	Environmental impact: Greenhouse gases (kilotonnes CO_2 equivalent)	Environmental impact: Acidification (tonnes SO_2 equivalent)
Agriculture			
1. Minimum price milk[a]	1400 (18.6)	1562 (25.4)	17 200 (27.3)
2. Low VAT rate on meat	336 (4.5)	116 (1.9)	1703 (2.7)
3. Designation of agricultural land in land use planning	800 (10.6)	1958 (31.8)	21 263 (33.7)
Energy			
4. Exemption energy tax for large users	1568 (20.8)	811 (13.2)	19 728 (31.3)
Transport			
5. Incomplete coverage of rail infrastructure costs	2000 (26.6)	358 (5.8)	550 (0.9)
6. Tax deduction for use of public transport in commuter traffic	147 (2.0)	29 (0.8)	70 (0.1)
7. Exemption from excise tax for aviation fuels	1200 (15.9)	1272 (20.6)	2433 (3.9)
8. Low profitability of government's share in Schiphol airport	80 (1.1)	55 (0.9)	106 (0.2)
Total	7531 (100)	6162 (100)	63 053 (100)

Notes: Details of the calculations are reported in (8).

which causes about 20% extra-passenger kilometers. The GHG emissions that are attributed to this subsidy equal 1.272 megatons CO_2 equivalents, more than 20% of the GHG emissions caused by all eight subsidies together. This percentage may be indicative for other industrialized countries since aviation technology and aviation tax regimes are similar. The subsidy further discourages utilization of airplanes up to their full capacity and sustainable technological innovations in aircraft engines.

CONCLUSIONS

Government policies that subsidize unsustainable activities are a widespread phenomenon, notably in agriculture, energy, and transport. Moreover, there is no clear trend of removing this government failure. While on-budget subsidies have received much attention, the role of off-budget subsidies is at least as important. They create substantial emissions of GHG and acidifying emissions, so that they in fact undermine public environmental policies. We found that off-budget subsidies contribute to more than 30% of the policy targets specified by the Kyoto Protocol for CO_2 emissions reduction by The Netherlands. This suggests that policy makers should take serious notice of the potential role of removing off-budget subsidies as a strategy of effective climate policy. It should be noted, finally, that our calculations may be conservative as they do not account for the undesirable long run effects of subsidies, namely a reinforcement of the lock-in of unsustainable technologies and a hampering of the pace and direction of sustainable technical innovations, in particular those needed for a rapid transition to renewable energy (19).

References and Notes

1. Myers, N. 1998. Lifting the veil on perverse subsidies. *Nature 392*, 327–328.
2. James, A.N., Gaston, K.J. and Balmford, A. 1999. Balancing the Earth's accounts. *Nature 401*, 323–324.
3. Perry, I. 1998. A second-best analysis of environmental subsidies. *Int. Tax Public Financ. 5*, 153.
4. Organisation for Economic Cooperation and Development (OECD). 1999. *Improving the Environment through Reducing Subsidies* (3 volumes). OECD, Paris.
5. van Beers, C. and van den Bergh, J.C.J.M. 2001. Perseverance of perverse subsidies and their impact on trade and environment. *Ecol. Econ. 36*, 475–486.
6. van Beers, C. and de Moor, A. 2001. *Public Subsidies and Policy Failures*. Edward Elgar, Cheltenham.
7. van Beers, C., van den Bergh, J.C.J.M., de Moor, A. and Oosterhuis, F.H. 2007. Determining the environmental effects of indirect subsidies: Integrated method and application to the Netherlands. *Appl. Econ. 39*, 2465–2482.
8. van Beers, C., van den Bergh, J.C.J.M., de Moor, A. and Oosterhuis, F. 2002. *Environmental Impact of Indirect Subsidies. Development and Application of a Policy Oriented Method*. Dutch Ministry of Housing, Spatial Planning and Environment, The Hague, December 2002. (http://dare.ubvu.vu.nl/bitstream/1871/10427/1/f18.pdf)
9. de Moor, A. and Calamai, P. 1997. *Perverse Subsidies*. Report for the Earth Council, Costa Rica.
10. Organization for Economic Cooperation and Development (OECD). 1995. *Adjustment in OECD Agriculture: Issues and Policy Responses*. OECD, Paris.
11. Kahneman, D., Knetsch, J.L. and Thaler, R.H. 1991. Anomalies: the endowment effect, loss aversion, and status quo bias. *J. Econ. Persp. 5*, 193–206.
12. Institute for European Environmental Policy (IEEP). 2007. *Reforming Environmentally Harmful Subsidies*. Final report to the European Commission's DG Environment, March 2007.
13. World Bank. 2007. *World Development Report 2008*. World Bank, Washington, DC, 97 pp.
14. European Environmental Agency (EEA). 2004. *Energy Subsidies in the European Union: A Brief Overview*. EEA Technical report no. 1/2004. EEA, Copenhagen.
15. Koplow, D. 2004. *Federal Subsidies to Energy in 2003—A First Look*. Policy paper prepared for the National Commission on Energy Policy, 30 July 2004.
16. Koplow, D. 2007. Subsidies in the US energy sector: magnitude, causes and options for reform. In: *Subsidies and Sustainable Development: Political Economy Aspects*. OECD, Paris.
17. EEA. 2007. *Size, Structure and Distribution of Transport Subsidies in Europe*. EEA Technical report no. 3/2007. EEA, Copenhagen.
18. VNCI. 2001. *Guideline Environmental Performance Indicators for the Chemical Industry: The EPI-method (version 1.1)*. Report of working group on environmental performance indicators, Dutch Ministry of Public Health, Planning and Environment, The Hague.
19. Arthur, B. 1989. Competing technologies, increasing returns, and lock-in by historical events. *Econ. J. 99*, 116–131.

20. First submitted 11 November 2008. Accepted for publication 10 March 2009.

Cees van Beers is professor of innovation management at Delft University of Technology. His research addresses determinants of innovation behavior of firms with a special focus on sustainable innovations. In addition, he has published on international trade and environment, and environmentally damaging subsidies. In the past, he was affiliated with Leiden University and Vrije Universiteit in Amsterdam. His address: Department of Innovation Economics and Management, Faculty of Technology, Policy and Management, Delft University of Technology Jaffalaan 5, 2628 BX Delft, The Netherlands.
E-mail: c.p.vanbeers@tudelft.nl

Jeroen C. J. M. van den Bergh is ICREA professor at Universitat Autònoma de Barcelona and professor of environmental and resource economics at Vrije Universiteit in Amsterdam. His research is on the boundary of economics, innovation studies, and environmental science. He was awarded the Royal/Shell Prize 2002 for research on "Sustainable Development, Environment and Resources," and was a member of the Energy Council of The Netherlands. From 1997 to 2007 he was professor of environmental economics at Vrije Universiteit. His address: Institute for Environmental Science and Technology, and Department of Economics and Economic History, Universitat Autònoma de Barcelona, Edifici Cn—Campus UAB, 08193 Bellaterra, Spain.
E-mail: jeroen.bergh@uab.es