Environmental Economics Based on General Equilibrium Models: The Norwegian Experience

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I. INTRODUCTION: WHY ECONOMIC MODELS?

Traditionally, planning in Norway, and in particular long term planning with a time horizon of 15 to 20 years, has been centered around macroeconomic modelling of the Norwegian economy. With the advent of the oil price shocks in the 1970's more emphasize was put on studies of energy use, and this concern was in turn reflected in the development of the modelling tools. Energy specified by type (electricity and fuel oil) was introduced as a separate input factor in the production functions and more care was taken in modelling the energy producing sectors. In the 1980's environmental issues have been put on the political agenda, for instance through the publication of the report "Our Common Future" from the World Commission on Environment and Development (1). This is now being manifested through the current work on implementing environmental variables and relations in the economic planning models.

Among environmental problems, special emphasis has been put on emissions to air of substances such as sulphur dioxide (SO_2), nitrogen oxides (NO_x) and the greenhouse gas carbon dioxide (CO_2). Recognition of the damaging effects of SO_2 and NO_x emissions resulted in international agreements on reductions of the national emission of these gases. Damages appear both locally through health damages, damages from ozone (O_3) of which NO_x is an important precursor, and through increased corrosion of materials, as well as regionally through the damages of acid rain. With the international agreements followed an increase in public attention on air pollution problems. The more recent awareness of the greenhouse problem has also brought CO_2 into the limelight of the governments.

With more or less explicit targets for future national emission levels of these compounds, the need to forecast likely development in national emissions became stronger. Furthermore, it raised the problem of what measures to adopt in order to curb emissions. Analysis of alternative control policies, their effects on emission levels, their cost to sectors of the economy and to the economy as a whole, thus arises. Finally, the question of whether the agreed or proposed targets represent rational strategies towards the environmental problems has also emerged.

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These are practical reasons for the work done in Norway on studies of interlinkages between economic development, energy use and emissions to air. The work has been carried out at the Central Bureau of Statistics, which is responsible for the development and operation of the economic planning models used by the Ministry of Finance, the Ministry of Petroleum and Energy and the Ministry of the Environment in Norway. The work has been based on various macro-economic models.

Economic models constitute a sound and necessary basis for studies of air pollution problems for several reasons.

1) Formal economic models represent a useful tool and framework for multi-sectoral policy formulation, for instance with regard to economic policy, energy policy and transportation policy. The models impose consistency requirements which are difficult to fulfil without some kind of accounting device such as a model. Use of the same model can facilitate the use of a common language and a consistent set of basic assumptions in the sectoral analysis carried out by different parts of the government.

2) Air pollution problems are many dimensional. Usually, one is concerned with a number of polluting compounds (e.g. sulphur, nitrogen oxides and carbon dioxide) being emitted from a number of sources (industrial sectors, households, transportation activities, etc.). Emissions from these sources are closely interlinked through the economic system. Without taking these links into account, abatement of emissions of one kind from one type of source can easily result in aggravated pollution problems from other sources and compounds. Thus, studies of pollution control strategies requires models of the entire economy. More partial studies of one or a few "problem" sectors are usually inadequate. Furthermore, in order to capture environmental effects of structural changes in the economy, a rather disaggregated description of the economy is mandated.

3) Economic models are also imperative in estimating the costs associated with air pollution and measures to combat excessive pollution. For instance, imposing extra costs on one sector through environmental regulation or taxation, will affect other sectors through price effects and reallocation of resources like labour and capital. Total cost to the society may be an order of magnitude different from estimates based on sectoral studies alone. Several illustrations of this will be presented below.

4) Finally, many environmental problems, and most certainly their solution, represents long term phenomena. Thus, analysis based on long term models in the form of general equilibrium models seems to be an appropriate approach. Other types of models are needed to assess the more immediate effects of environmental control policies.

In the following section a short presentation of the general equilibrium model MSG-4 will be given together with a description of how it is used for making emission projections and assessments of environmental control policies. Then follows, in section 3, a brief description of some of the projects that have been undertaken with this tool, before a conclusion with some remarks on necessary further work is attempted in section 4.

II. MODELLING STRUCTURE

Below follows a brief description of some of the main elements of the MSG-4 model. For further elaborations and details, we refer to (2-5).

Production structure

The model of producer behaviour includes substitution possibilities between five aggregate input activities; capital (K), labour (L), electricity (E), fuels (petrol and fuel oils) (F), and other materials (M). Within each aggregate, fixed proportions are assumed. The substitution responses are formally represented by Generalized Leontief (GL) cost functions (6). Electricity and fuels are assumed to be weakly separable from the other aggregate inputs, with total energy input denoted by U. The dual to the energy activity aggregate is interpreted as a price index for energy, and is denoted P_U.

For industry j the unit cost structure is represented by the following relations (omitting the rather detailed tax parameters present in the actual implementation of the model):

$$\frac{Q_j}{X_j} = h_j(t)\sum_k \sum_l \alpha_{kl}\sqrt{P_{kj}P_{lj}}\ ; \quad k,l = K,L,U,M \tag{1}$$

$$P_{Uj} = \sum_m \sum_n \beta_{mn}\sqrt{P_{mj}P_{nj}}\ ; \quad m,n = E,F \tag{2}$$

where the P's are prices of input activities, Q_j denotes total costs, $h_j(t)$ describes Hicks neutral technical change, and the α's and β's are estimated parameters.

Applying Shephards lemma, factor coefficients may be derived as:

$$Z_{kj} \equiv \frac{\partial(Q_j/X_j)}{\partial P_{kj}}; \quad k = K,L,U,M \tag{3}$$

$$Z_{Umj} \equiv \frac{\partial P_{Uj}}{\partial P_{mj}}; \quad m = E,F \tag{4}$$

$$Z_{mj} = Z_{Umj}Z_{Uj}; \quad m = E,F \tag{5}$$

where the Z_{kj}'s are input coefficients measuring aggregate input per unit of output, and the ZU_{mj}'s are energy coefficients measuring the input of electricity and fuels per unit of energy used.

The factor demand equations for industry j may then be written as:

$$\zeta_j = Z_{kj} X_j; \quad k = K,L,U,M; \quad \zeta = K,L,M,E,F \tag{6}$$

The producers are assumed to be profit maximizers, which implies that marginal costs equal output price:

$$P_{Xj} = \frac{\partial Q_j}{\partial X_j} = \sum_{\zeta} Z_{\zeta j} P_{\zeta j}; \quad \zeta = K,L,M,E,F \tag{7}$$

where P_{Lj} is an exogenous index of wage costs per unit of labour input, and P_{Kj} is the user cost of capital:

$$P_{Kj} = \sum_{i=1}^{M} \kappa_{ij} (R_j + \delta_{ij}) P_i \tag{8}$$

Rj is the rate of return to capital, the κ's are fixed industry capital structure coefficients, the δ's are fixed rate of depreciation specified by kind of capital and industry (capital stock is assumed to follow an exponential survival curve), and M is the number of capital categories (usually three).

Private investments

Optimal capital stock per unit of output in each industry is determined by the cost-minimizing procedure described above. From this, investments of type i is determined as follows:

$$J_i = \sum_{i}^{N} \kappa_{ij} [K_j - K_j(-1) + \delta_{ij} K_j] \tag{9}$$

where N is the number of industries.

Government consumption

Government consumption is exogenously determined in the model, and calculated as gross total wage, material expenditures less marketed governmental services, in accordance with national accounting practice.

External trade

Export activities are exogenously determined, while import activity levels are determined from exogenous import share coefficients for various intermediate and final demand activities.

Household consumption

Total household consumption is determined residually as what is left of total output over gross investments, government consumption, and net export. The demand for consumption activity i is written as

$$C_i = \eta_{Ci}(\Theta V)^{\xi_i} \prod_j P_{Cj}^{\gamma_{ij}} \tag{10}$$

where V is total expenditure, P_{Cj} is the price of consumption activity j, Θ is an auxiliary variable, and η_C, ξ_i and γ_{ij} are parameters. The auxiliary variable Θ is introduced to insure that the budget constraint

$$\sum_i P_{C_i} C_i = V \tag{11}$$

is fullfilled for every combination of prices and demand (horizontal adjustments of Engel curves).

Want independence is assumed between the 18 consumption activities specified, except within a group consisting of housing services, electricity and fuel oil, and a group consisting of user costs of cars, petrol and car maintenance, and public transportation services. This means that the utility function is additive in the utilities of the two groups and each of the other goods. See (3) for further details.

Emission submodel

Sectoral emissions of the following pollutants are presently modelled: sulphur dioxide (SO_2), nitrogen oxides (NO_x), carbon monoxide (CO), carbon dioxide (CO_2), (non-methane) volatile organic compounds (VOC), particulate matter, lead (Pb), methane (CH_4), and nitrous oxide (N_2O). Four types of emission sources are recognized for each industry: stationary combustion emissions, mobile combustion emissions, process emissions, and evaporation. Emissions from industries and private households due to stationary combustion are associated with the use of fuel oils, mobile combustion emissions are associated with the demand for petrol, process emissions are associated with demand for intermediate materials other than energy commodities, while evaporation is associated with both industry specific use of materials (proxy for use of solvent), total demand for gasoline (evaporation from storage and handling of gasoline) and private consumption of housing (proxy for use of paints etc.), see *table 1*. Waste generation in private households is assumed to follow total private consumption. Emissions from waste dumps (mainly methane) and incineration of waste are determined by exogenously given factors determining the relative amount of waste generated going to dumps and incinerated, respectively.

Table 1: Emission compounds, sources and indicators

	<u>*Type of sources*</u>	<u>*Indicators*</u>
1	Stationary	Fuel oil
2	Mobile	Petrol
3	Process	Raw materials, intermediate goods
4	Evaporation	Various variables
	<u>*Emission components*</u>	
1	Sulphur dioxide	SO_2
2	Nitrogen oxides	NO_x
3	Carbon monoxide	CO
4	Carbon dioxide	CO_2
5	Volatile organic components	VOC
6	Lead	Pb
7	Particulates	Prt
8	Methane	CH_4,
9	Nitrous oxide	N_2O

Emission factors are calibrated in a base year, and are projected by taking into account the effects of planned and implemented environmental control policies like emission standards for new vehicles, limits on sulphur content of heating oils, direct regulation of emissions from specified firms, etc.

III. SOME CASE STUDIES

The use of the model apparatus can, somewhat arbitrarily, be classified into four categories:

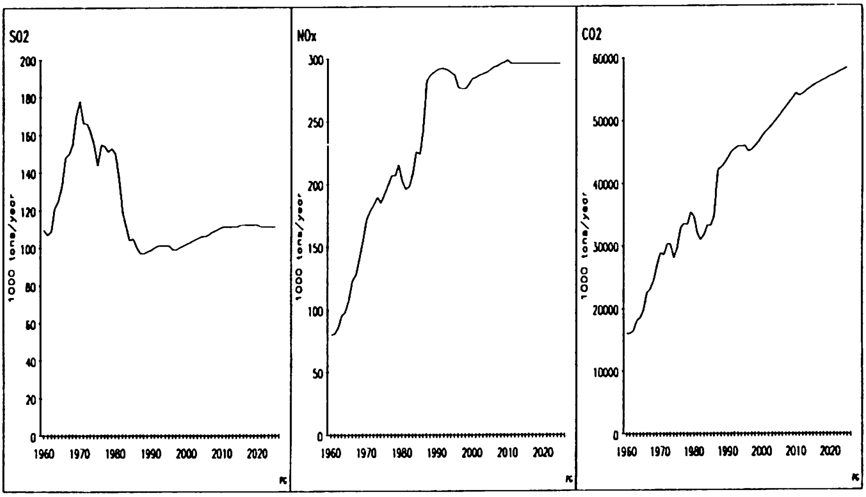
i) Developing projections of emissions to air. This is done on a regular basis in Norway in connection with the writing of the governments long term programme, energy plans, etc.

ii) Sensitivity analysis of uncertainties in key economic variables, in particular with respect to world market prices for oil, gas and other export commodities of importance to the Norwegian economy.

iii) Studies of possible control policies, their effects on the environment and their costs to the society. The control policies range from catalytic three-way cleaning of exhaust gases from automobiles, through regulation of the sulphur content of fuel oils, to taxation of emissions and polluting input factors in production activities and consumption.

iv) Dealing explicitly with costs of a deteriorated environment in the modelling of the economic system (corrosion damages, morbidity and mortality effects, etc.). Enlarged input factor costs due to excessive pollution can be incorporated in the

Figure 1: Emission projections



economic base model in order to map the impact of the damages to the long term economic growth potential.

The case studies presented below are examples of work done in Norway within these four categories.

3.1 Forecasts of emissions to air and the effects of varying energy prices

Emission projections are worked out on a regular basis in connection with governmental white papers on economic perspectives, plans for energy use and other committee reports. The projections, which usually only incorporates environmental control measures already decided on, serve as indicators of likely development in emissions to air. As such they provide early warning signals on whether targets, like international obligations to reduce emissions, are likely to be met, and if not, the order of magnitude of the gap. This is useful information for further planning of economic as well as environmental development. Figure 1 shows one such set of projections, based on an macroeconomic growth path similar to the one in the last government's Long Term Programme (7,8).

Any forecast is contingent on a number of more or less uncertain assumption. Due to its close link to emission to air, the world market price of oil is crucial in this respect.

Table 2: Emission elasticities with respect to world market price on crude oil

Component	Estimated emission elasticity (lower	upper)
Sulphur dioxide (SO_2), Volatile organic components (VOC)	-0,15	-0,25
Nitrogen oxides (NO_x)	-0,25	-0,35
Carbon monoxide (CO), Lead (Pb), and Particulates	-0,35	-0,40

Table 2 shows calculated emission elasticities for several compounds with respect to the world market oil price. In the calculation of these numbers assumption of world market as well as domestic market reactions to changes in oil price are incorporated. Emissions of compounds stemming mainly from transportation activities show the greatest sensitivity to changes in the oil price. The results are further commented on and documented in (9).

The domestic price of electricity is, among other factors, dependent on the rate of return to capital in the electricity generating sector. *Table 3* shows the percentage change in emissions of various compounds when this rate is varied from a reference level of 6 per cent. The perhaps surprising sign of the NO_x emission elasticity is due to the power intensive industry in Norway.

Table 3: Per cent change in total emission when the rate of return to capital in the electricity generating sector is varied from 6 to 5 and 7 per cent

Component	*Estimated change in emissions*	
	Rate of return	
	5,0%	7,0%
Sulphur dioxide (SO_2)	0,0	0,0
Nitrogen oxides (NO_x)	0,4	-0,6
Carbon monoxide (CO)	-1,8	2,3
Lead (Pb)	-0,1	0,1
Volatile organic components (VOC)	-0,6	0,8
Particulates	-2,4	3,1

These are but two examples of sensitivity calculations aimed at mapping the possible environmental effects of alternative development paths for variables deemed to be important in the modelling effort of future emissions to air. A general equilibrium approach is a quite appropriate tool for this type of study, since it at least in principle captures also the indirect effects of changes in important exogenous variables. These may be quite important in estimating the total effects of alternative development paths.

3.2 Emission tax on SO_2

In a study based on the MSG-4E model, the effects on emissions and on economic activity of introducing an emission tax on sulphur dioxide (SO_2) were calculated (10-14). Emissions from fuel combustion in 13 manufacturing sectors were taxed according to the sulphur content of the fuel. According to the model, which has empirically estimated relations with predominately energy-capital complementarity, taxation of SO_2 emissions reduces long term economic growth. The reduction in GDP inferred from the model calculation was considerably greater than the tax payment from sectors directly affected. Although substitution possibilities can be expected to reduce the total impact of the tax on the economic result of a sector, the capital-energy complementarity leads to less investment when the price of energy increase, thus reducing the long-term growth of that particular sector. Although taxation is a cost-effective mean to lower emissions from polluting sectors, the indirect allocation cost of the control policy should be recognized from the outset, as these costs may dominate the more easily calculable direct costs of the taxed sectors.

3.3 Reduced corrosion when emissions are lowered

Reducing SO_2 emissions leads to several benefits not considered in the previous case study. Among these benefits are reduced material damage, and probably also increased productivity of the labour force. The effects on human health are difficult to quantify. Beneficial effects in terms of reduced corrosion rates are easier to estimate, and this has been done in a separate study (15). Employing empirically determined functions of damages from SO_2 concentration on building materials, relations between national SO_2 emission and cost of maintenance were obtained. By extracting these costs in simulations using the MSG-4E model, it was possible to estimate some of the benefits accruing from clean air. The direct outlays due to SO_2 generated corrosion on materials included in the study amounted to approximately NOK 200 millions per year in 1985 and NOK 300 millions in year 2000 in fixed prices. Removing SO_2 emissions altogether would directly yield this benefit to firms and households. However, total benefits for the economy as a whole, including allocation effects caused by the reduced price of capital, was calculated to be NOK 400-500 millions per year around the turn of the century. Thus, again the repercussions in the economy of changing the operating conditions for some sectors proved to be of the same order as the more easily accessible direct effects. The lesson is that general equilibrium effects of environmental control policies must be included when the overall costs and benefits of such policies are to be assessed.

3.4 Environmental taxes or regulations?

A comprehensive study of possible developments of the Norwegian economy, energy use and emissions to air through year 2000 has recently been carried out (8). The study, which was based on a medium term macroeconomic model called MODAG (16), was motivated by the need to reconcile international agreements on reduction in SO_2 and NO_x emissions with national policies of the economy and energy use. In addition, a growing concern for global environmental problems like the greenhouse effect, has generated a demand for studies of future emission of CO_2 and scenarios attempting to reduce these emissions. Three of the scenarios developed in the study are illustrated in figures 2-4 by way of projected emissions to air.

Alternative 1 is a base scenario where no special consideration is given neither to energy use nor emissions to air. Alternative 2 is a scenario where the traditional policy of direct regulations of emissions from single firms together with stricter limits on emissions from automobiles is employed. Neither of these approaches fulfil the obligations of the present or expected future international agreements. For this reason a third alternative, alternative 3, was developed when the entire taxation scheme in Norway was restructured. Heavy taxes on use of fossil fuels were imposed, increasing the real price of all oil products

Figure 2: Emission of NO_2

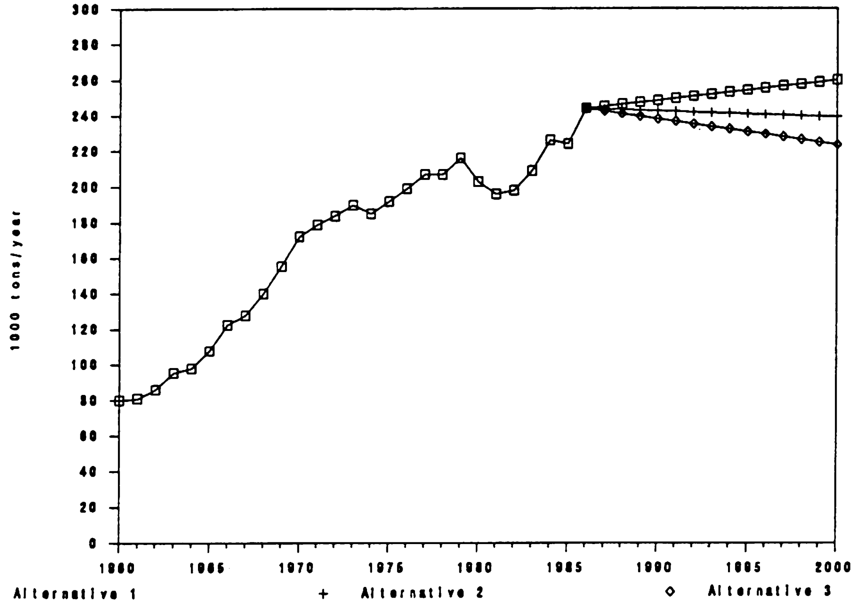
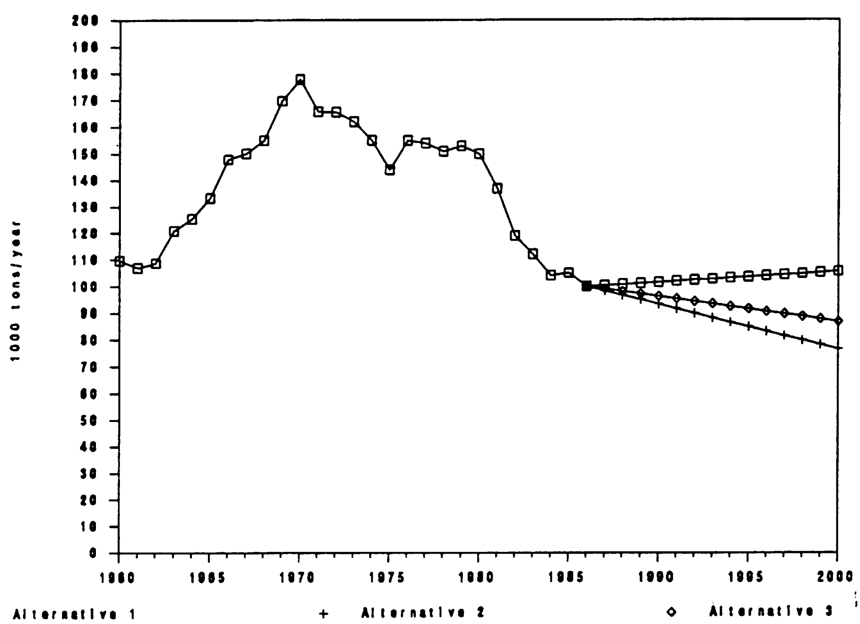
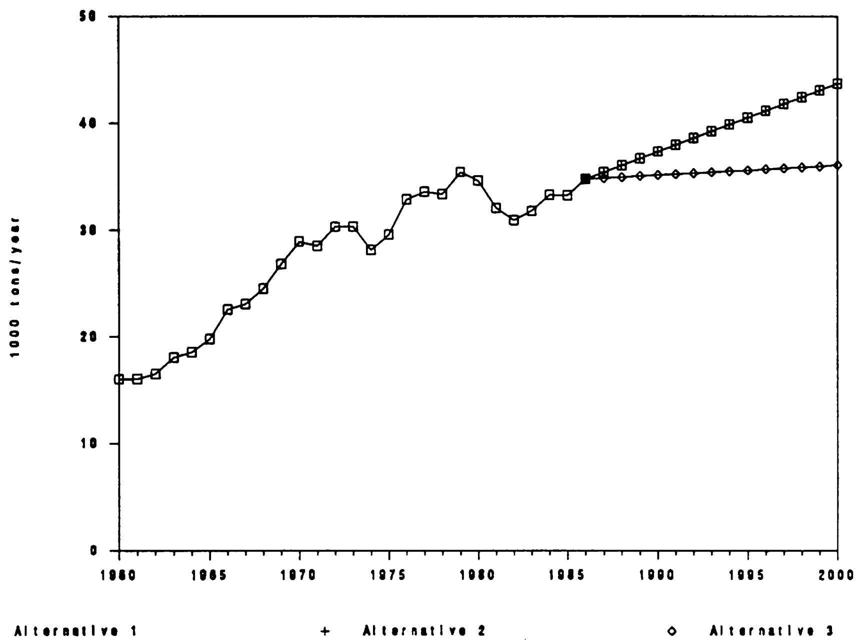


Figure 3: Emission of SO_2



by 75 per cent, and the tax revenue used to reduce income taxes. As can be seen from the figure, a combination of a new tax policy and some measures of direct regulations looks promising from an environmental viewpoint, although the political difficulties with this approach should not be underestimated.

Figure 4: Emission of CO_2



In the calculations, the total effects on main macroeconomic variables in alternative 3 were small. There are several reasons for this.

- The budget share for energy is relatively low in most sectors; on average 5 per cent of total variable costs.
- Reductions in direct income taxes were assumed to lead to reduced nominal wage increases, thus reducing the increase in production costs.
- Higher energy prices were further assumed to increase the productivity of energy.
- Finally, higher prices on fossil fuels increased the domestic demand for electricity, and thus increased investments and construction activities. This also increased the domestic activity level.

Overall, GDP and household consumption were lowered by 1-2 per cent in year 2000 compared to the reference alternative (alternative 1). Total domestic consumption of electricity was increased by 5 per cent, while demand for heating oils were reduced by 35 per cent and gasoline demand declined by almost 20 per cent.

3.5 Alternative tax scenario; marginal damage tax rate, endogenous price on oil products

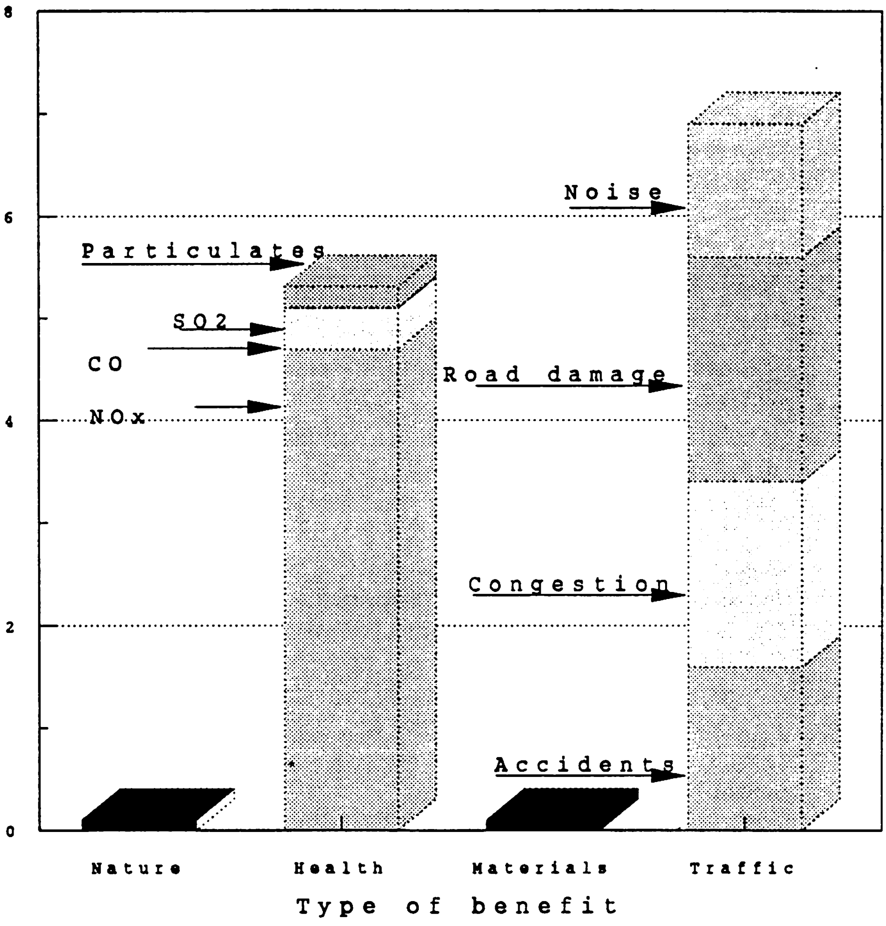
In the previous subsection, the effects of introducing a uniform tax on all oil products were described. In a closely related study (17), tax rates were instead determined from estimates of local marginal damage to health, materials and nature. The overall economic effects of this approach was not very different from the previous study. Emissions of SO_2 and NO_x were both reduced by approximately 25 per cent in year 2000 compared to the reference path, while CO and particulates were reduced by roughly 20 per cent. Information on marginal damages from emissions of SO_2, NO_x, CO and particulates also allows preliminary estimates of some of the benefits accruing from the reduction of emissions to be made. Benefits included less damage to river systems and forests, reduced health damages from NO_x, CO, SO_2 and particulates, reduced damages to materials, and also non-environmental benefits from a reduction in traffic (fewer accidents, less congestions, less deterioration of road surfaces and less noise). Estimated benefits amounted to roughly 1,5 per cent of GDP in year 2000. This is of the same order of magnitude as the reduction in GDP due to the fuel tax.

Figure 5 shows benefits from reduced emissions by type of damage. A reduction of national emissions has only small effects on damages on nature. This is due to the fact that most of these damages are caused by transboundary pollution. Also benefits from reduced corrosion turn out to be relatively small according to the calculations. Reduced health damages, however, represent quite substantial savings. In particular, benefits from reduction in NO_x emissions seem to be important. Perhaps surprisingly, economic gains from reduced road traffic are estimated to be of the same order of magnitude as the benefits from a reduction in health damages. This may provide a purely economic incentive for increasing the effective price of transportation, in addition to the environmental concerns.

The estimated benefits coming from reductions in emissions, are of course highly uncertain and almost speculative at present. They should therefore be interpreted with great care. What is more, these uncertainties come in addition to the more traditional sources of uncertainty associated with forecasting economic growth and its structure. Nevertheless, it should be recognized that only a small fraction of possible benefits from a reduction in emissions to air has been looked at in this analysis. A rough balance of marginal costs and benefits in the model calculations therefore indicates that a reduction in projected emissions levels may be warranted. Moreover, control policies to reduce emissions to air at some level may even be justified for pure economical reasons, e.g. by increasing the efficiency of the road traffic. Although several questions remain, e.g. the costs associated with a transition from income taxation to an environmentally motivated tax, the study indicates an important option within the economic, as well as the environmental policy area.

Distributional consequences of the tax increase have been analyzed, assuming fixed budget shares of the consumption goods. Increases in expenditures in the year 2000 varies

Figure 5: Yearly benefit of emissions reductions in the year 2000. Fixed 1985-NOK



between 9,3 per cent in big cities to 10,4 per cent in rural areas, for a total of 9,7 per cent increase in expenditure as measured by the Laspayres index. Similarly, families with low total expenditures are expected to experience an increase of approximately 11 per cent, while better off families are expected to meet an increase of 9,5 per cent. Hence, distributional consequences are expected to be small.

3.6 Life under a CO_2 ceiling

Limits to CO_2 emissions seem to be an important element in future strategies to combat the excessive greenhouse effect. As with many other important air pollutants, CO_2

emissions mainly stem from combustion of fossil fuels. But unlike most others, CO_2 can not be treated or removed from exhaust gases by economically viable means. Thus, only a reduction in the consumption of fossil fuels remains as a control strategies. A recent study (18) looks at the economic consequences of a rather modest approach in this direction; i.e. a stabilization of Norwegian fossil fuel related CO_2 emissions after year 2000. The price of oil products is treated as an endogenous variable in this study which primarily focuses on the period 2000-2010. Again, this is a topic which clearly requires a macroeconomic approach, and is most suitable for analysis within a general equilibrium modelling framework.

Table 4: Changes in price on and use of energy. Year 2000. Per cent

	Price on oil products	Use of Gasoline	Use of Fuel oil	Use of Electricity
Production sectors	107	-35	-30	-8
Private households	130	-36	-53	17
Total		-35	-32	-4

Table 5: Changes in emissions relative to reference scenario. Year 2010. Per cent

Sulphur dioxide (SO_2)	-25
Nitrogen oxides (NO_x)	-23
Carbon monoxide (CO)	-28
Carbon dioxide (CO_2)	-26
Particulates	-20

In addition to providing information on the required price of oil products (*table 4*, note that solid and gaseous fuels for combustion are almost absent in Norway), and the economic effects of a higher price path, the study also establishes a set of new benchmarks for further control policies against the emissions of other pollutants, most notably SO_2, NO_x and VOC, see *table 5*. Effective control of consumption of fossil fuels is also an effective policy against these emissions, thus reducing the need for ever more costly investments in cleaning technology. This illustrates the need, not only for linking studies of economic growth, energy use and for instance CO_2, but also to include other pollutants of concern to the general welfare of the society.

IV. SUMMARY AND CONCLUSIONS

In Norway, the use of slightly extended economic models has made possible the elaboration of consistent plans for the long term development of the economy, future energy use and indications of the quality of air. Thus, a common framework has been developed where representatives for the Ministry of Finance, the Ministry of Oil and Energy, and the Ministry of Environment can discuss priorities and measures. Also, building environmental models on more traditional economic planning tools facilitates the introduction of environmental issues into planning bodies, up to now seldom overly concerned with issues outside their traditional (economic) domain.

In addition, establishing a model apparatus for environmental studies creates a useful framework for the data gathering in the field of environmental statistics. It is all too easy to collect large amounts of data on the state of the environment without due attention to where and when the data are going to be used and whom it will serve. A more detailed discussion is provided in (19).

The framework described above is still partial, not yet treating other environmental problems like water pollution or generation and transportation of hazardous waste. Without a multi-pollutant framework, the danger of transferring air pollution problems to other recipients exists. The aim must be to extend the traditional concept of national capital to include important natural and environmental resources, and to provide planning tools, e.g. models, making it easier to manage the total wealth of the nation, including the environment, in a sustainable manner.

Finally, a few words on the direction of future work in Norway. This is to a large degree aimed at getting a better understanding of transportation as an economic activity within a macroeconomic and multisectoral framework. This is partly due to the rudimentary treatment this activity gets within the present models, but also a response to a trend where more of the recognizable environmental damages come from diffusive sources like automobiles. Present plans include further disaggregation of the transport sector, as well as introducing transportation as a fifth input factor in some of the more transport intensive production sectors. Costs of transportation will be linked to amount of infra-structure capital like roads, harbours, etc., and maintenance costs will be dependent on traffic volume.

The consumer block of the models are to be extended to include some 13 different consumer groups. This will facilitate studies of distributional questions raised by proposals of far reaching environmental control policies.

Further work on the estimation of the economic costs of a deteriorated environment is going to be undertaken. The aim is to identify the main components of these costs, and to include these in the modelling framework. This will make it possible to capture some of the benefits associated with environmental control policies.

The main stumbling block in the path described above is probably going to be data. Large uncertainty in, and sometimes absence of, data will make the first versions of a new model highly "experimental". By developing such models we will, however, contribute to the clarification of what data are needed for the next generation of general equilibrium models, and thus provide important input to the ongoing international work on standards for environmental statistics.

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SUMMARY

We usually are neglecting two basic and important facts in our economic accounting and in our traditional forecasting procedures; that economic activity depletes natural resources and that we use nature as a sink for wastes. This paper deals with how the model tools used for socio-economic planning in Norway has been revised and extended to cover at least one aspect of the use of the environment; air pollution. It is based on the experiences of the Central Bureau of Statistics over the last few years.