MACROECONOMIC IMPACTS OF AN EEC POLICY TO CONTROL AIR POLLUTION

Ger Klaassen and Andries Nentjes
International Institute for Applied Systems Analysis,
Laxenburg, Austria

RR–92–7
August 1992

Reprinted from *Journal of Policy Modeling* (1991) **13**(3):347–366.

INTERNATIONAL INSTITUTE FOR APPLIED SYSTEMS ANALYSIS
Laxenburg, Austria

Reprinted by permission of Elsevier Science Publishing Co., Inc.
from *Journal of Policy Modeling*, **13**(3):347–366.

Printed by Novographic, Vienna, Austria.

Foreword

It was not until the end of 1988 that the European Community reached an agreement on a Directive to regulate the emission of sulfur and nitrogen oxides from large combustion plants. A major element in the discussion was the expected cost of the Directive and the ensuing impacts on macroeconomic indicators such as employment, GDP, current balance, and consumer prices in EC countries. This report describes a study carried out on behalf of the CEC – a study unique in one respect, since, for the first time, an international model (INTERLINK from the OECD) was used to examine the macroeconomic impacts of coordinated pollution control policies in a number of countries. The study made use of the data on emissions and pollution control costs from the RAINS (Regional Acidification INformation and Simulation) model developed at IIASA, but goes one step further by also assessing the indirect impacts of pollution control measures on economic development. The study shows that not only the direct costs of pollution control are relevant, but also that the indirect impacts of a coordinated environmental policy result in a remarkable difference in macroeconomic performance among the EC countries. Although, generally, the impacts are small, some countries benefit more from a coordinated environmental policy than others.

MARKUS AMANN
Leader
Regional Air Pollution Project

Macroeconomic Impacts of an EEC Policy to Control Air Pollution

Ger Klaassen, *International Institute for Applied Systems Analysis, Laxenburg,* and Andries Nentjes, *State University, Groningen*

The OECD INTERLINK model was used to assess the macroeconomic impacts of a European Community directive to control air pollution. For this purpose the model was adapted. To meet the directive the EC would have to invest some 15 billion ECU. The annual costs would be 3.4 billion ECU in 1993. The simulation results suggest that the macroeconomic impacts are small and are positive during the investment period and more negative in the subsequent period. Differences in results among EC countries are expected. These not only are due to differences in pollution control costs but also result from indirect impacts of coordination.

1. INTRODUCTION

Acid rain is one of the major environmental problems in the European Community. The sulphur dioxide and nitrogen oxides emissions of power plants, refineries, and industries contribute to the problem to a large extent. The EC has been negotiating on strategies to control these acidifying emissions. Recent discussions have focused on a directive on large combustion plants, proposed by the Commission of the European Community. A major element in these discussions were the expected costs and ensuing economic impacts for the national economies.

The assessment of the macroeconomic impacts of pollution control policies has been the subject of numerous studies. According to an OECD overview of national studies of effects of pollution, the macroeconomic impacts are generally very small (OECD, 1984). Rose (1983), in an overview of experience in the United States with the modeling of macroeconomic impacts of air pollution abatement, felt tempted to affirm that impacts were only minor but added that no

---

Address correspondence to Ger Klaassen, International Institute for Applied Systems Analysis, A-2361, Laxenburg, Austria.

Extensive comments by JPM referees are appreciated.

Received June 1989; final draft accepted August 1990.

Journal of Policy Modeling 13(3):347–366 (1991) 347

0161-8938/91/$3.50

definite answer could be given on the expansionary or contractionary implications for the economy. Christainsen and Tietenberg (1985) stressed the uncertainty of the quantitative impacts but found evidence that permitted the conclusion that adverse employment and productivity impacts apparently have been small, although geographically and sectorally concentrated. In a 1985 survey, the OECD (1985) suggested that the initial, positive impact of environmental expenditures might outweigh the long-term, negative impacts of higher prices and eroded business profits.

The studies reviewed by Rose, the OECD, Christainsen and Tietenberg, and others have one major drawback. They describe the macroeconomic impacts only of isolated, national policies to control pollution. Although most models do examine the impacts on exports and imports, they do not include the consequences of simultaneous implementation of various national policies or the impacts of a coordinated international policy.

This contribution differs from the above studies in that it presents a study that assesses the macroeconomic impacts, for a number of countries, of an international policy to control pollution (Klaassen et al., 1988a). For the analysis an existing international model was used: the international linkage model of the OECD, INTERLINK.

In the text that follows, Section 2 describes the proposed EC directive and the associated costs. Section 3 discusses the main channels through which pollution control affects the economy and how one might capture these impacts with a macroeconomic model. Section 4 introduces the structural features of INTERLINK. The specific modifications are presented in Section 5. In Section 6 the results of the policy simulations are described and discussed.

2. THE PROPOSED EC DIRECTIVE AND ITS COSTS

2A. Introduction

The draft EC directive pertains to sulphur dioxyde (SO_2) and nitrogen oxides (NO_x) emissions from large combustion plants and stipulates that new plants larger in thermal capacity than 50 megawatts must comply with emission standards that are related to the size of the plant. In addition, EC member states are to reduce the total emissions from these large combustion plants by the end of 1993.

Table 1 shows the proposed reductions (which use 1980 as a base year) that reflect discussions as of mid-1987. These reductions were used to estimate the costs and macroeconomic impacts. They differ

Table 1: Emission Reductions and Costs

Country	SO_2 reduction (% of 1980)	SO_2 emission abated (kiloton)	Annual costs (million ECUs)[a]	Investments (million ECUs)[a]	NO_x reduction (% of 1980)	NO_x emission abated (kiloton)	Annual costs (million ECUs)	Investments (million ECUs)
Belgium	45	67	46	238	30	21	2	26
Denmark	45	201	103	436	30	78	7	65
France	45	0	0	0	30	0	0	0
F R Germany	45[b]	1,716	977	4,769	30[b]	727	667	1,620
Greece	0	25	11	31	0[c]	0	0	0
Ireland	0	64	40	168	0	20	3	22
Italy	45	753	439	2,319	30	460	189	577
Luxemburg	0	0	0	0	0	0	0	0
Netherlands	45[b]	256	129	633	30	52	7	83
Portugal	0[c]	0	0	0	0	63	29	149
Spain	10	180	93	500	10	95	4	51
United Kingdom	45	1,344	628	3,160	30	339	28	289
EEC	<45	4,606	2,455	12,253	<30	1,878	935	2,882

[a]In 1985 prices.

[b]Actual reduction higher than the required target. Costs and emission abated correspond with these higher reductions.

[c]Granted an increase.

from the ones that were agreed upon in mid-1988, after submission of the results of this study to the EC. According to the accepted directive, SO_2 emissions are to be reduced by a minimum of 40 percent, except in Denmark (34 percent), the United Kingdom (20 percent), and Italy (27 percent). Spain is allowed a standstill and Greece, Ireland, and Portugal are allowed to increase their emissions by, respectively 6, 25, and 102 percent (Haigh, 1989). Reductions in NO_x emissions are generally some 20 percent by 1993. Spain and Italy, however, are allowed a standstill and Greece, Ireland, and Portugal may increase NO_x emissions by 94, 79, and 157 percent.

Strategies to control emissions may range from technical measures, such as flue gas desulfurization, to a switch in fuel mix or additional energy conservation measures. This study examined only technical abatement measures. In order to comply with the directive's emission standards new large power plants generally will have to apply flue gas desulfurization to control SO_2 emissions and combustion modification to reduce NO_x emissions. The standard for new large industrial plants requires various abatement techniques, which vary with the size of the installation.

2B. Emissions and Costs

In estimating the costs and investments we have assumed that countries would comply with the proposed directive as follows. First, measures are taken to meet the emission standards for new plants. If this does not lead to the required percentage reduction, additional measures on existing plants or more stringent ones for new plants would be taken in the most cost-effective way. Some EC countries (Denmark, the Federal Republic of Germany, and the Netherlands), however, have already accepted national legislation to control SO_2 and NO_x emissions. If these policies are more stringent than the EC Directive, the abatement measures of the national legislation are incorporated into the analysis. If the national policy is less stringent, additional measures were assumed to meet the requirements of the directive proposal.

Whether compliance with the directive's emission standards is sufficient to meet the required overall reductions depends on the level of emissions in 1993 without abatement. The volume of unabated emissions depends on the structure of future energy supply, the level of energy demand, and the emission per unit of energy. As a result (Table 1) the volume of emissions that has to be abated varies considerably among the EC member states. Differences in costs and investments mainly depend on the volume of emission that has to be abated. To a smaller extent they result from differences in the (average) costs per ton emission-controlled. These costs per ton depend on the abatement technology and on country-specific factors such as the size of the plant, its operating hours, the fuel type, and the sulphur content of the fuel (Klaassen et al., 1988b).

Table 1 shows that Germany, Italy, and the United Kingdom would have to bear most of the costs. In Germany this is so because the country would continue with the application of its national policy, which is more stringent than the proposed directive. In Italy and the United Kingdom the large share of coal-fired power plants, in combination with the 45 percent reduction, explains the relatively large volume of SO_2 and NO_x emissions that need abatement. France would not have to take measures because of its large share of nuclear power plants. Luxemburg would not need to take steps because autonomous developments in pollution are sufficient to meet the standstill requirements. Portugal would not incur any costs to control its SO_2 emission, since it is granted an increase. The same applies for Greece regarding its NO_x emission. The average costs per ton SO_2 removed are quite similar from one country to the next. By contrast, the costs per ton NO_x emission do vary considerably. These costs would be high in Germany, Portugal, and Italy because a relatively expensive technique (selective catalytic reduction) has to be applied to attain the required emission reductions.

3. GENERAL METHODOLOGY TO ESTIMATE MACROECONOMIC IMPACTS

3A. Effects of Pollution Control

Measures to control pollution influence the economy through various channels. Three categories of impacts can be distinguished, related (1) to the expenditures on pollution control equipment, (2) to the cost of pollution control, and (3) to the reduction in environmental damage (''benefits'').

The additional investments in pollution control, or environmental investments, will cause expenditure and consumption to rise so that the gross domestic product increases. This induces additional employment and imports. Operating the pollution control equipment has similar consequences. The positive effects influence results especially in the period in which the environmental investments take place. In the same period these investments may cause either a direct or an indirect crowding out of other, traditional business investments. This has a negative influence on production capacity, level of output, and employment. Pollution control costs will affect aggregate supply performance by depressing business profits and raising market prices. The resulting deterioration in competitiveness of industries will cause a decrease in production and exports. Lower business profits may reduce the volume of investments, production capacity, and related jobs. Rising pollution control costs for consumers will reduce private consumption. The contractionary consequences of pollution control costs will become manifest mainly after the investment period.

Since pollution control aims at improving the quality of the environment, the reduction in environmental damage is also important. One might make a distinction between "cost-reducing," "output-increasing," and "utility-increasing" damage reductions or benefits (OECD, 1984). In principle the first two types of benefits might be included in a macroeconomic evaluation, since they are reflected in the level of production. All existing macroeconomic studies neglect these benefits because of an incomplete understanding of the physical relations between pollution and environmental damage (Alcamo et al., 1987) and the limited possibilities of expressing the damage in monetary terms (Klaassen, 1988a). Moreover, inclusion of utility-increasing benefits in a macroeconomic evaluation is impossible: These benefits are not expressed in market goods or services and their value is not reflected in the gross domestic product. Consequently this study had to be restricted to the impacts of costs and expenditures, excluding environmental benefits.

3B. Making Use of a Macroeconomic Model

One way to capture the range of impacts of expenditures on, and costs of, pollution control is to use an existing macroeconomic model and, where necessary, to adapt it. Such an approach has been adopted in the Netherlands (Central Planbureau, 1982). The principal usefulness is that the net overall influence exerted upon the economy and the interdependencies in an economy are taken into account. The model offers a context for the comparison of effects of environmental policy with various other types of policies. The experience and knowledge embodied in the econometric core model can be used.

The starting point of such a macroeconomic evaluation is an exogenously determined time path for the additional environmental investments and the (net) annual costs of the pollution control program. These investments and costs are disaggregated into relevant categories, such as capital costs (interest and depreciation), labor costs, and costs of raw material and energy, and they are expressed in constant prices. Also, data may be included on the mode of financing of the investments, the type of management (government, private sector), and the distribution of costs (consumers, producers, government).

The second step involves making a reference projection for the economic development without the costs and investments of pollution control. Next a projection is made including these costs and investments. The differences in impacts between the two projections can be ascribed to the environmental policy.

4. THE MULTICOUNTRY MODEL: OECD'S INTERLINK

4A. Introduction

To evaluate the macroeconomic consequences of a coordinated EC air pollution control program, simulations have to be made with an international model that includes each of the EC countries individually. For this study the January 1987 version of the OECD's INTERLINK model was used.

INTERLINK (Llewellyn and Richardson, 1985; OECD, 1988; Richardson, 1988) is a short- to medium-term multicountry model in which the economies of 23 OECD countries (the OECD area bloc) and 6 non-OECD regions are modeled separately. These country models can be linked via world trade and financial flows. The influence of one country or region on the rest of the world, including the feedback effects following from this interaction, can thus be assessed. Within the OECD, the INTERLINK model plays an important role in the context of its regular forecasting exercises (semiannual "OECD Economic Outlook"), and also policy-related simulation studies (see, e.g., EC Commission, 1988). For this study INTERLINK was used to set up baseline projections and then to simulate the effects of additional pollution control investments for the various EC countries.

4B. Structure of INTERLINK

The general structure of recent versions of the INTERLINK model is described by Richardson (1988). It consists of an OECD area bloc, a non-OECD regional bloc, and a set of world trade and financial linkages between these countries and regions. In the OECD area bloc the models for the four major EC countries (Germany, France, Italy, and the United Kingdom) are considerably more detailed than those for the smaller EC countries, although there is a high degree of structural similarity. Models for the major economies include detailed supply blocks. The production structure is used to define a concept of normal output. The actual level of output is specified with the factor utilization rate. Derived factor demand equations are specified as dynamic adjustments to desired factor inputs. Via input costs, the supply structure is linked to the determination of output prices. The cost markup is influenced by the prices of foreign competitors and the intensity of factor utilization. Endogenous labor supply, and hence unemployment, is a final element of the supply blocks.

For the smaller OECD countries there are no consistent supply blocks. Labor supply is exogenous and the demand for labor is a function of the demand-determined production level and of real wages. Business fixed investments depend on output changes and long-term real interest rates. The concept of price formation is comparable with the one for major OECD economies.

For the four largest EC countries the short-term interest rates are exogenous and they determine the short-term rates in the other OECD countries. Long-term interest rates are determined through a distributed lag of short-term interest rates.

Remaining equations are, to a large extent, comparable for all OECD country models. Government deficits are endogenous for all OECD countries. Private consumption is a function of real disposable income, prices, and real interest rates. Export and import volumes depend on world trade and on relative price competitiveness. Wage rates have been modeled primarily as a function of labor market conditions, trend productivity, and prices. For non-OECD areas, INTERLINK contains rudimentary reduced-form models. The world trade and financial linkage block provides a description of the principal mechanisms through which the OECD economies interact with each other and with non-OECD regions. A consistent set of export volume and import price estimates for each OECD country and non-OECD region are determined so that the sum of changes in countries' imports correspond to the sum of changes in countries' exports. Changes in countries' export prices have their full counterpart in partner countries' import prices. International financial linkages are based on a portfolio balance model of exchange rate determination.

5. MODIFICATIONS IN INTERLINK

5A. Introduction

The macroeconomic impacts of pollution control to be captured by INTERLINK are related to two exogenous impulses: (1) the investments in pollution control equipment; and (2) the operating costs of pollution control equipment (also called environmental exploitation expenditures).

The models in both small and large EC countries had to be adapted in such a way that they reflected the following properties of environmental expenditures:

1. Investments in pollution control raise aggregate demand but do not increase the capacity to produce marketable output.
2. Operation of pollution control equipment raises total production costs and the costs per unit output.

Because models of the large EC countries (France, Germany, Italy, and the United Kingdom) contain a detailed set of supply equations, adaptations were more elaborate and complicated than those made to the small EC country models. The modifications (Klaassen et al., 1988b) consisted, first of all, of defining new variables—the environmental investments and various types of environmental costs—and of formulating additional definition equations. Second, the new variables were inserted into the original equations of the INTERLINK model. Third, some of the existing equations had to be adapted.

5B. The Set of Environmental Equations

The first step involved the definition of a set of new variables. We distinguished the following annual pollution control costs: capital costs (interest and depreciation), costs of energy, costs of other materials, and labor costs. Their value was expressed in constant prices at factor costs for a specific year. The volume of each cost variable was transformed from constant factor costs into current market prices by making use of deflators and input/output coefficients. The above modifications were similar in both small and large EC models. For the small countries capital costs of environmental capital were determined exogenously. For large countries these costs were endogenously calculated by making use of the detailed supply blocks. The rate of depreciation of environmental capital was assumed to be equal to that of other business fixed investments.

5C. Modification of Existing Variables and Equations

The second step involved the modification of existing variables and equations. Here we present the modifications according to the blocks of equations in which they appear: the expenditure account, the supply block, the wage and domestic price block, and remaining sets of equations.

The expenditure equations had to be adjusted to ensure that the environmental investments and the operating expenses increased the appropriate expenditure categories. First, the total volume of private investment was altered; environmental investment was added to traditional business fixed investments. This modification implied the assumption that the import share of pollution control equipment equaled that for total business fixed investments. Since no data were available on the specific import coefficient for air pollution control equipment, this appeared the most plausible assumption to make. No direct crowding out of other business investments was assumed to take place. Because the majority of the environmental investments have to be undertaken by (usually semipublic) enterprises in electricity generation, we did not expect that financial constraints were to depress nonenvironmental investments. Second, the volume of annual costs for operating pollution control equipment was added to the final demand components in the volume of final domestic demand equation.

In the supply block, for large EC country models potential gross output, or production capacity, is a function of actual employment and of effective capital; however, the environmental investments do not increase production capacity. Consequently additional pollution control (environmental) capital was not included in the equations defining production capacity. On the other hand the environmental investments, as well as subsequent operating costs, do raise production costs. Hence they had to be included in the equations describing production costs. After modification the gross domestic product included net environmental investments and operating expenses. The business sector employment equation included employment due to the production of pollution control investments as well as employment in operating the equipment. The costs of pollution control required an adjustment in the definitions of average normal costs and of the growth rate of normal long-run costs: Capital as well as operating costs of pollution control were included in the definition. It should be noted that, by including environmental expenditures in aggregate output and costs and by excluding environmental investment from production capacity, the environmental expenditures increase the normal average costs of production. In addition to this cost-push impact, environmental expenditures exert a demand-pull impact on prices because a rise in actual output, given a constant nominal output, will increase the intensity of factor utilization. The changes made in the small EC models were rather more simple. The level of industrial production was increased because of environmental investment and the additional use of energy and materials in the operating of the pollution control equipment. In addition, direct employment in operating environmental capital increased dependent employment in the private sector.

In the wage and price block, for large EC models the cost-push impact of pollution control on prices was ensured by adjusting the deflator for final domestic demand; the value of operating costs was added to the numerator and the volume of these expenditures to the denominator. The small EC country models do not contain detailed cost equations. The cost-push impact of the increase in pollution control costs was modeled by adding the increase in value of the operating costs and the value of environmental capital costs to the deflator for private consumption. In addition the deflator for final domestic demand was adjusted by adding the value of operating costs to the numerator and their volume to the denominator.

Regarding the remaining blocks of equations, in the appropriation accounts only a modification in the government appropriation account was necessary. In large EC country models indirect taxes as well as subsidies were altered. It was assumed that pollution control investments were financed as traditional business fixed investments. In small EC country models the direct and indirect tax revenues from operating costs and pollution control investments were taken into account. Finally, an alteration in the energy block was made in both small and large EC country models, since the use of materials and energy in the exploitation of environmental capital leads to an increase in the demand for the imports of energy.

5D. Operating the System

The proposed directive would lead to pollution control investments in the period 1988–1993. To ensure that the impact of the pollution control costs was sufficiently reflected, the simulation period needed to be extended to include the period 1994–1997. INTERLINK is a medium-term model and its data base did not allow a projection beyond 1992. Therefore a shift in time horizon was introduced. In the model simulations investments were assumed to take place in the period 1983–1988. This permitted simulation over the full period 1983–1992, including a period (1989–1993) in which no environmental investments are made. Results obtained for the simulation period 1983–1992 are seen as a proxy for results in the period 1988–1997. It is possible from

Table 2: Investments and Costs of Pollution Control (in Million ECUs in 1985 Prices)

Country	Total investments (1988–1993)	Annual costs (1993)	Investments as % of GDP in 1985	Annual costs as % of GDP in 1985
Belgium	264	48	0.03	0.05
Denmark	501	110	0.07	0.14
France	0	0	0.00	0.00
Germany	6,389	1,644	0.08	0.20
Greece	31	11	0.01	0.03
Ireland	190	43	0.08	0.18
Italy	2,869	628	0.05	0.11
Luxemburg	0	0	0.00	0.00
Netherlands	716	136	0.04	0.08
Portugal	149	29	0.06	0.11
Spain	551	97	0.03	0.05
United Kingdom	3,449	656	0.06	0.11
EC	15,135	3,390	0.05	0.10

the simulations (covering the period 1983–1992) to draw conclusions for the period 1988–1997, provided that the courses of macroeconomic development in the two periods are not too divergent. Moreover, since the results of the simulations are expressed as annual changes in economic indicators over a baseline, or reference projection, these (relative) changes are not believed to be extremely sensitive to changes in the reference projection.

6. SIMULATION RESULTS

6A. Introduction

The relative size of the pollution control investments and costs that were used as input for the model are presented in Table 2. Investments are to be made in the period 1988–1993 and are equally distributed over the period. Annual costs increase gradually and remain constant, expressed in constant prices, after 1993.

Certain assumptions were necessary in regard to the monetary, fiscal, and exchange rate policies. As a technical assumption nominal interest rates were kept constant; that is, monetary policies were fully accommodating. In addition government consumption and investment volumes were held constant in real terms and nominal exchange rates were fixed.

6B. Results

SIMILARITIES. The main feature of the results (Table 3) is that the macroeconomic impacts of the proposed directive are very small. A comparison of Table 2 with fluctuations in macroeconomic performance over the period 1979–1985 (Eurostat, 1987; OECD, 1987a, 1987b) showed that the impacts of the directive on gross domestic product (GDP), consumer prices, private consumption, and employment are generally less than one-tenth of the fluctuations in these indicators in the past. Only for a few indicators, for example, the private consumption level in Ireland and Denmark in the period 1994–1997, are the impacts more prominent. The small extent of the impact is not surprising, since the costs and investments of the environmental program are rather small.

In addition, as to the direction of the impacts there were some common features among the EC member states. In the investment period (1988–1993) the additional domestic as well as foreign expenditure impulse has a predominantly positive influence on macroeconomic development. The impact on GDP is, to a certain extent, proportional to the size of the environmental investments. (cf. Table 2, column 2 and Table 3, row 2). Together with GDP, other variables—business investments, employment, and government financial balances—are influenced positively in most countries. Current balances are generally negatively affected because of the additional imports from non-EC countries generated by the higher EC spending. Despite the increase in nominal income the volume of consumption is hardly affected, as consumer prices rise as well. In the second period (1994–1997) the positive expenditure impact fades away, and the negative influence of pollution control costs dominate: GDP, investments, and employment fall, the current balance becomes less negative, and government financial balances are less positive. Consumer prices increase to a larger extent than nominal income; real disposable income decreases, which results in lower levels of consumption. Summarized over both periods the results are in line with the conclusions of previous national studies. These studies demonstrated that the positive macroeconomic impact on GDP and employment during the investment period slightly exceeded the loss of employment and the fall in GDP in subsequent years (OECD, 1985). Over both periods consumption is at a lower level, whereas consumer prices are at a higher level. The current balance is negatively affected.

Table 3: The Macroeconomic Impacts for Each EEC Country

	BEL	DEN	GRE	IRE	NET	POR	SPA	FRA	GER	ITA	UKM
Gross domestic product											
1988–1993	0.15	0.19	0.07	0.13	0.15	0.12	0.10	0.06	0.19	0.11	0.07
1994–1997	−0.03	−0.01	0.07	−0.24	−0.10	0.00	0.04	0.03	−0.06	0.05	−0.06
Business fixed investment[a]											
1988–1993	0.69	1.48	0.16[d]	1.30	0.90	0.49[e]	0.43	—	1.54	1.44	1.19
1994–1997	−0.19	−0.25	0.04	−0.41	−0.25	−0.02	−0.02	—	−0.28	0.21	−0.01
Private consumption											
1988–1993	0.02	0.00	0.01[d]	0.00	0.01	0.03[e]	0.04	—	−0.01	−0.03	−0.03
1994–1997	−0.09	−0.18	0.00	−0.33	−0.03	−0.02	−0.02	—	−0.07	−0.02	−0.14
Current balance[b]											
1988–1993	0.02	−0.07	0.00	−0.06	−0.02	−0.02	0.01	0.12	−0.36	−0.22	−0.22
1994–1997	0.05	−0.03	0.00	−0.09	−0.09	−0.04	0.04	−0.15	−0.27	−0.12	−0.11
Employment											
1988–1993	0.07	0.05	0.03	0.06	0.10	0.06	0.05	0.02	0.18	0.03	0.04
1994–1997	0.01	0.04	0.03	−0.05	−0.06	0.00	0.02	0.03	−0.14	0.01	−0.07
Consumer prices											
1988–1993	0.18	0.23	0.09	0.51	0.24	0.18	0.17	0.08[f]	0.49	0.42	0.48
1994–1997	0.40	0.42	0.16	0.66	0.58	0.31	0.24	0.27	0.36	0.14	0.27
Government financial Bal.[c]											
1988–1993	0.08	0.12	0.01[d]	0.01	0.10	0.02[e]	0.03	—	0.19	0.13	0.09
1994–1997	0.05	0.07	0.00	−0.18	0.01	0.00	0.01	—	0.09	0.16	0.10

Note: Figures expressed as average annual percentage changes from baseline levels. —, Not available.

[a] Inclusive of environmental investment.

[b] Billions of dollars.

[c] Percentage of baseline gross domestic product.

[d] Impact of abatement NO_x emissions not available.

[e] Impact of abatement SO_2 emissions not available.

[f] Deflator for GDP.

Table 4: The Macroeconomic Impacts for the EC

Macroeconomic impacts[a]		1988–1993	1994–1997
Gross domestic product	(in billion ECU)	3.9	−0.5
Employment	(in 1000 man-years)	84.1	−48.2
Consumption	(in billion ECU)[b]	−0.2	−0.2
Current balance	(in billion ECU)	−1.1	−1.1
Government financial balances	(in billion ECU)[b]	3.2	2.6
Consumer prices	(percentage change)[c]	0.3	0.3

Note: Characteristics of the pollution control program:
Environmental investments per year (1988–1933) (billion ECU) 3.0
Annual pollution control costs (from 1993 onwards) (billion ECU) 3.4

[a]All figures expressed as average annual changes in the specific period in current prices.

[b]Excluding France.

[c]Weighted with the consumption volumes in each EEC country.

Table 4 summarizes the aggregated impacts for the EC as a whole. From these figures the following conclusions can be drawn:

1. During the investment period (1988–1993) the multiplier for the EC as a whole is about 1.3.
2. The long-run opportunity costs of environmental protection, expressed in foregone consumption, are about five percent of the annual pollution control costs.
3. The macroeconomic costs of the EC directive are considerably less of a burden than a partial analysis of the investments and costs would suggest; over both periods employment, GDP, and government financial balances are at a higher level, although consumer prices are higher and the EC current balance is more negative.

DIFFERENCES IN COUNTRY RESULTS. Despite the similarities in the results for the various countries there are also differences. The pollution control program has a predominantly negative impact for Ireland, especially on GDP and employment. In the United Kingdom employment is negatively affected but GDP is hardly at all. Net impacts are positive for Spain, Portugal, and Greece and to a smaller extent also for Italy. The eventual consequences for the remaining countries are generally neutral to positive. The impact is somewhat less positive for Germany and the Netherlands and somewhat more for Belgium and Denmark. The effects for France, which has no pollution control costs, are positive as well.

These differences can be explained by differences in the volume of

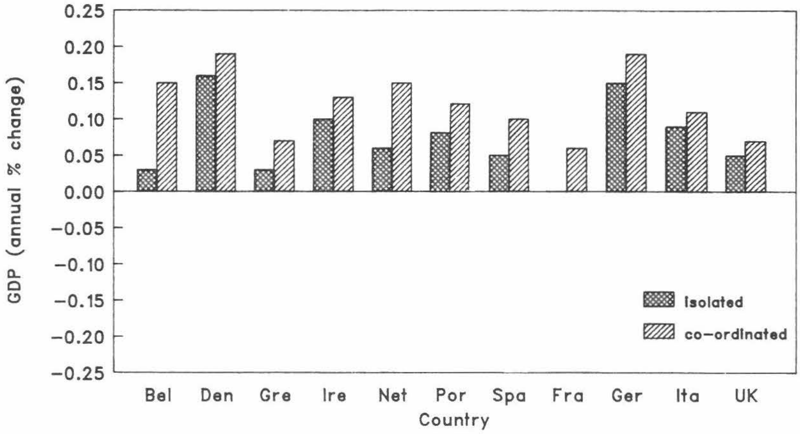

Figure 1. Impact on GDP 1988–1993.

pollution control investments and costs, the direct import share of the investments, the transmission of pollution control costs in prices, the Philips relations, and the extent of "openness" of the economy. In addition, the difference in modeling large EC countries and small EC countries is of importance.

A new element in this study, which explains a large part of the differences, is the incorporation of feedbacks from one country's pollution control policy on other countries' economic performance. The magnitude of this impact is shown in Figures 1 and 2. They present the results of the EC directive (coordinated action) on the GDP in each country, relative to the situation in which only the domestic policy would be implemented (isolated action). Other indicators show comparable influences (Klaassen et al., 1988b).

Comparison of the two figures clearly indicates that in the first period (1988–1993) all countries benefit from coordination but especially open economies such as Belgium and the Netherlands, Spain, and Greece. In addition France benefits because it has no costs at all. In the second period, however, most countries are confronted with additional losses, expressed in the form of a lower GDP. The outstanding example here is Ireland, where the fall in gross domestic product results more from foreign than from domestic environmental policies. Other countries (France, Spain, Greece), however, still benefit from coordination. For specific countries the results can be elucidated. The predominantly negative impact for Ireland results from the high import coefficient of the investments and from the large share of imports originating from

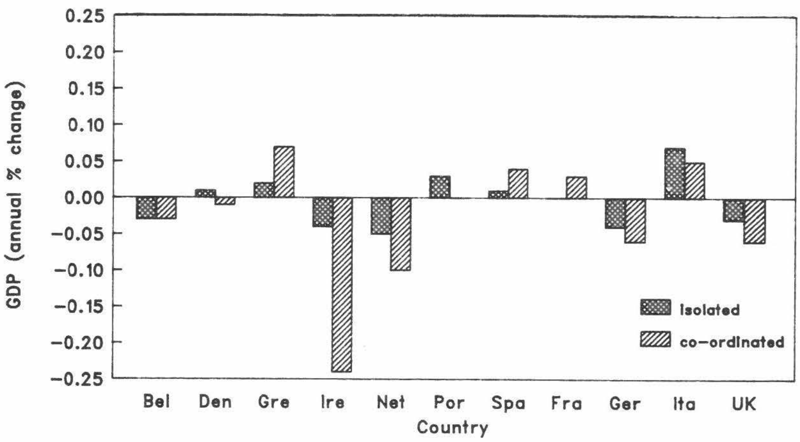

Figure 2. Impact on GDP 1994–1997.

the EC. The high import leakage dampens the positive impact of the additional expenditures. Moreover, price increases, resulting from domestic pollution control costs, are reinforced by the sharp increase in the prices of goods imported from EC countries. As a result competitiveness deteriorates and exports, GDP, and employment are negatively affected.

Net impacts remain positive for Spain, Greece, France, and to a smaller extent Italy. In Spain the direct import coefficient of the investments is relatively small, which enforces the positive impact of the spending impulse. In addition, the relative export price of manufacturers improves in the second period (1994–1997). This is also due to the fact that wage changes seem less responsive to price changes. Owing to the low level of pollution control costs the relative export price in Greece improves and Greece benefits from the EC pollution abatement program. The consequences for France are simply positive because the country does not incur any pollution control costs and hence France's competitiveness improves. The impacts for Italy are positive because of the smaller size of the pollution control program, and the small import coefficient of the investments. The smaller volume of Italian pollution control costs is the main reason why Italy's competitiveness deteriorates less and even improves in the second period, resulting in a positive impact on GDP.

The unequal distribution of positive and negative impacts is probably one of the reasons why the draft EC directive as discussed here was modified before being finally accepted. Another reason, most likely, was the asymmetric distribution of environmental benefits. Given the prevailing wind directions and sulphur deposition patterns in Europe (Alcamo et al., 1987), countries like the United Kingdom, Ireland, Portugal, and Greece hardly benefit from pollution control measures in other EC countries. This stimulates them to oppose to coordinated actions.

Summarizing, we may conclude that there are remarkable differences in results among countries. These are to a large extent a result of the impacts of one EC country's pollution control measures and costs on remaining countries' economic development. Consequently, policymakers should look not only at national pollution control costs as the yardstick for equity, but ought to incorporate indirect economic impacts of coordination as well.

6c. Elements of Uncertainty

The reliability of these results depends on a number of factors. First, the quality of the input data on cost and investments is important. Pollution control investments and costs could be higher, especially for Ireland, Spain, and the United Kingdom. Costs probably would be lower if other pollution control strategies, such as energy conservation, fuel substitution, and the use of low-sulphur fuels, had been included. In the long run this would decrease the negative impacts.

Second, the assumptions on exchange rate and on fiscal and monetary policies are important. A sensitivity analysis (Klaassen, 1988b) showed that the directive would have a more negative impact, especially for the large EC countries, if interest rates were floating instead of fixed, as was assumed. Employment, GDP, and government financial balances would be less positively influenced because of the increasing interest rates. Consumer prices, however, would be slightly lower.

Third, the specific modifications made are of importance. The assumption that pollution control investments do not directly crowd out other investments might have to be altered if a large share of the environmental investments had to be taken by industries instead of (semipublic) power plants. Furthermore, it was assumed that the direct import coefficient of environmental investments corresponded with the one for total business fixed investments. In the absence of specific data this may be a plausible assumption, but it may have led to an underestimation of positive effects for Germany. Nowadays this country is believed to have a leading role in the control of acidifying emissions in Europe. Another source of uncertainty is that no account has been taken of specific subsidies for pollution control in various member states. More important is that models for large EC countries include a detailed supply block. This implies that in such models pollution control costs influence business profitability, and thus business investments, as well as prices of final demand. In small-country models the impact of pollution control costs had to be modeled in a simpler manner. This implies that a comparison of results for small and large countries is not without risks.

Finally, the study excluded the macroeconomic impact of reductions in environmental damage. Although the extent of the damage reduction is uncertain, the positive macroeconomic impacts are probably underestimated, since damage reduction will increase productivity and reduce costs. These positive effects will compensate to an unknown extent, for the negative consequences of pollution control costs.

7. CONCLUSIONS

In spite of these elements of uncertainty the major conclusions of this study are not affected. The proposed EC directive on large combustion plants is likely to have small and positive macroeconomic impacts during the period in which the investments take place. In the subsequent period the directive is expected to have small but negative impacts on the main macroeconomic indicators of most EC countries. Remarkable differences in impacts between countries, however, are expected. Some countries benefit from coordination, whereas others have to bear additional costs as a result of the indirect impact of foreign pollution control costs on domestic economic performance.

ACKNOWLEDGMENTS

Funding for this study was provided by the Commission of the European Community and the Netherlands Ministry of the Environment.

We would like to express our gratitude to the OECD Economics and Statistics Department and its staff, which enabled us to use and adapt the INTERLINK system. We especially would like to thank Pete Richardson, Peter Kee, Wim Hafkamp, and the editor for their comments on earlier drafts of this article. The views expressed remain the sole responsibility of the authors. In no way do they reflect the opinion of the OECD or the EC on the results obtained.

REFERENCES

Alcamo, J., Amman, M., Hetteling, J.P., Holmberg, M., Hordijk, L., Kämäri, J., Kaupi, L., Kauppi, P., Kornai, G., and Mäkela A. (1987) Acidification in Europe: A simulation model for evaluating control strategies. AMBIO 16: 232–245.

Centraal Planbureau (1982) *Economische gevolgen van voorgenomen milieubeleid*. Den Haag: Centraal Planbureau.

Christainsen, G.B., and Tietenberg, T.H. (1985) Distributional and macroeconomic aspects of environmental policy. In *Handbook of Natural Resource and Energy Economics*, vol. 1 (A.V. Kneese and J.L. Sweeney, Eds.). Amsterdam: Elsevier Science Publishers.

EC Commission (1988) The Economics of 1992. *European Economy*, No. 35. Brussels: EC.

Eurostat (1987) *Review 1976–1985*. Brussels: EEC.

Haigh, N. (1989) New tools for European Air Pollution Control. *International Environmental Affairs* 1: 26–37.

Klaassen, G., Kee, P., Nentjes, A., Hafkamp, W., and Olsthoorn, A.A. (1988a) *The Macroeconomic Impacts of the EC Large Combustion Plants Directive Proposal: Economic Aspects of Controlling Acid Rain in Europe*, vol. 1. Luxemburg: Commission of the European Community.

Klaassen, G., Kee, P., Nentjes, A., Hafkamp, W., and Olsthoorn, A.A. (1988b) *The Macroeconomic Impacts of the EC Large Combustion Plants. Directive Proposal, Technical Document I: Assessment of Investments, Costs and Emission Reduction; Technical Document II: INTERLINK: Modification and Detailed Results*, vol. 2. Luxemburg: Commission of the European Community.

Llewellyn, J., and Richardson, P. (1985) Representing Recent Policy Concerns in OECD's Macroeconomic Model. *OECD Economic Studies*, No. 5.

OECD (1984) The impact of environmental measures on the rate of economic growth, the rate of inflation, productivity and international trade. In *Background Papers of the International Conference on Environment and Economics, June 18–21, 1984*, vol. 1. Paris: OECD Environment Directorate.

OECD (1985) *The Macro-economic Impact of Environmental Expenditure*. Paris: OECD.

OECD (1987a) *Economic Outlook 41*. Paris: OECD.

OECD (1987b) *Historical Statistics 1960–1985*. Paris: OECD.

OECD (1988) *OECD INTERLINK System Reference Manual*. Paris: OECD.

Richardson, P. (1988) The Structure and Simulation Properties of OECD's INTERLINK Model. *OECD Economic Studies*, No. 10.

Rose, A. (1983) Modelling the Macroeconomic Impact of Air Pollution Abatement. *Journal of Regional Science* 23: 441–459.