The effects of a carbon tax. Simulations for Italy in a multisectoral model

CENTRO DI RICERCA
ECONOMIA-AMBIENTE
UNICREA - PAVIA

DIPARTIMENTO DI ECONOMIA
PUBBLICA E TERRITORIALE
UNIVERSITA DI PAVIA

PRIMA RIUNIONE SCIENTIFICA

DEGLI

ECONOMISTI AMBIENTALI ITALIANI

The effects of a carbon tax: simulations for Italy in a multisectoral model

di

Rossella BARDAZZI e Diego PIACENTINO

Pavia, 18 marzo 1993 - Collegio Ghislieri

THE EFFECTS OF A CARBON TAX: SIMULATIONS FOR ITALY IN A MULTISECTORAL MODEL (*)

Rossella Bardazzi
University of Florence

and

Diego Piacentino
University of Urbino

Paper prepared for 'Prima Riunione Scientifica degli Economisti Ambientali Italiani', to be held in Pavia, 18 March 1993.

(*) Financial support from Murst (60% fund) and Cnr (Contrib. n.91.02029.CT10) are gratefully acknowledged. The authors are grateful to Ernesto Longobardi and Vincenzo Patrizii for the encouragement; and to Maurizio Grassini for the encouragement, advice, and generous help.

THE EFFECTS OF A CARBON TAX: SIMULATIONS FOR ITALY IN A MULTISECTORAL MODEL

Rossella Bardazzi and Diego Piacentino

Contents.- Introduction.- 2. A national carbon tax.- 3. Issues of tax design.- 4. Tax alternatives.- 5. The model.- 6. Simulations.- References.

1. Introduction

1.1. In the debate over global warming and global warming policy, reference is often made to the levy of a tax on carbon (dioxide) emissions: a tax that, by making emitting activities costlier, would discourage them and thus bring about a reduction in the resulting emissions.

This paper is concerned with the economic effects that the introduction of one such tax in Italy would bring about: effects on prices, output, and government revenues. An estimate of these effects is an essential element for the decision process on whether a global warming policy is warranted, on which scale, and with recourse to which measures. Price increases and reductions in output are the economic costs that would result from the levy of the tax, to which the environmental benefits, in terms of reduction of emissions, should be compared; on the other hand, tax revenue, while a cost to taxpayers, is also a resource that would be available to the government to fund new expenditures, reduce deficits, and/or reduce the weight of other, distortionary, taxes.

1.2. On these questions, a rich international literature has developed, involving a number of different approaches. With reference to the Italian economy, three previous studies can be recalled, due to Agostini-Botteon-Carraro [1991], Lanza-Sammarco [forthcoming] and Golinelli-Mantovani [1992]. The first and the second one use energy demand models to perform simulations of the effects of a carbon tax; the third offers estimates based on a macroeconometric model.

In the present case, a different approach is taken. To perform the simulations, a multisectoral model is used, which is called INTIMO, or Interindustry Multisectoral Model. It is a model that has been developed by Grassini [1983] and is the Italian component of the international system of intersectoral models called INFORUM (Interindustry Forecasting Project University of Maryland) [Almon, 1991].

An approach based on multisectoral modeling has the appeal of allowing detailed estimation of sectoral impacts. Also, the model used appears to be well-suited to the task, as it has been previously employed, and developed, to give estimates of the effects of fiscal manoeuvres involving indirect taxation

[Bardazzi, 1991, 1992; Bardazzi-Grassini-Longobardi, 1991, 1992). Furthermore, for the purpose of this study, the model has been strenghtened in its energy component.

1.3. The tax that is considered in the following is a tax that is supposed to be levied on a national basis, as the outcome of a unilateral decision. As this goes against much of what has been written on the subject, some explanation is in order, and is offered in Section 2. In Section 3, the problems and options are considered, that are met on the plan of tax design. In Section 4, the tax alternatives are illustrated, that are made the object of simulations. Section 5 is informs about some essential features of the model. Finally, Section 6 expounds and discusses the results of simulations.

2. A national carbon tax

2.1. Discussions of the global warming problem tend to stress, with cause, the global nature of the relationships involved. Countries that benefit from the use of the atmosphere as a sink for emissions of greenhouse gases, give rise, collectively, to a global environmental problem, in the sense that environmental damage, in the shape of growing concentration of greenhouse gases and potential climate change, is extended to the whole planet.

Furthermore, each country's emissions tend to be (relatively) small, if compared to total emissions. This means, in turn, that national efforts to reduce emissions are bound to have a minor impact on total emissions. Thus, there is a marked asymmetry with regard to the cost and benefit sides of reductions of emissions: costs, of an economic nature, are borne nationally; while benefits, of an environmental nature, are diffused, and diluted, internationally.

2.2. Consideration of this situation tends to lead to one conclusion, that incentives to national, unilateral, action are very weak or non-existent, and a solution to the global warming problem should be sought by means of international negotiation; agreements should be reached, involving a large number of countries, and committing them to a co-ordinated effort in the reduction of emission.

In this perspective, it has been asserted, a global carbon tax could play a major role. National governments could -- indeed, should -- agree on the introduction of a carbon tax, as the most efficient policy measure with the power to induce emissions reduction [Cnossen-Volleberg, 1991].

2.3. However, actual developments do not adhere to this scheme. A number of countries have committed themselves, unilaterally, to reduce their carbon emissions [Schmidt, 1991]; and some countries, again unilaterally, have introduced carbon taxes [Haugland-Lunde-Roland, 1992].

The countries that have introduced carbon taxes are the Netherlands and the Nordic countries -- Denmark, Finland, Norway

and Sweden. These taxes tend to be levied on the basis of low or very moderate tax rates, and reduced rates and exemptions directed to industrial sectors and/or energy products are generally present. The case of Sweden, however, is to be distinguished from the others, in that rates of the tax are fairly substantial; in relation to this, the introduction of the tax has occurred within a wider change in tax policy, involving lowering of personal income and company taxation.

2.4. There is perhaps a rationale that can be detected behind these developments. Given the costs of emissions abatment, and the uncertainties about environmental benefits, no general consensus has formed, at the international level, on targets for emissions reduction, nor it seems that one such consensus can emerge readily.

But governments and countries which perceive that immediate action should be undertaken, may decide to act unilaterally as a means to focus the attention of other governments and countries on the problem, to elicit co-operative attitudes at the level of international negotiation, and perhaps to induce imitative moves.

2.5. This line of reasoning can strenghtened further by consideration of the fact that systems of direct taxation are, in many countries, under severe stress and criticism, because of their disincentive effects, particularly in relation to the high level of marginal rates.

Then, a carbon tax can be seen as a practical tax device, with the capacity to raise a substantial revenue and, as a consequence, to give leeway for the reduction of other taxes.

From this point of view, a carbon tax is best seen with reference to wider reforms of the tax system -- as it has occured, incidentally, in Sweden. In this context, the substitution of a carbon tax for other taxes can be seen as entailing a welfare gain.

3. Issues of tax design

3.1. At the level of principles, a carbon tax is fairly straightforward -- it is a tax to be levied on emissions on a per unit (specific) base. There are, however, a number of aspects that must be considered, and choices that must be made, at the level of tax design, to make the tax operational.

3.2. In the first place, it can be noted that direct taxation of carbon emission is unpractical, but the possibility exists, to tax the carbon content of fuels, the combustion of which is at

the origin of the emissions. This content is stable and known, and emissions from burning correspond fairly precisely to content, as no economically viable means exist, at least for the time being, for abating or sequestering emissions after combustion. As a consequence, a carbon tax can be levied in the form of an excise tax on energy products, not much different from those which are common in many countries and in particular in Western Europe.

3.3. Secondly, the tax base must be defined. In the context of an analysis of an internationally agreed-upon carbon tax has been suggested that either consumption or production could be taxed [Whalley-Wigle, 1991]; when a national carbon tax is considered, however, it seems that consumption should be chosen, as it allows insulation of national economies, and is therefore better suited to allow national discretion in tax policy.

3.4. In the third place, there is the question of choice of the tax point, in consideration of the fact that fuels undergo, from production (or import) to final use (or export) a complex process involving transportation, transformation, and marketing.

Here it will suffice to note that there are two strong reasons that suggest to move the tax point downstream, as far as possible. In this manner, manoeuvre of tax rates and exemptions is possible (an issue that will be touched below); in addition a tax formula is used, which is usual in Italy as well as throughout Western Europe, where taxation of energy is an absolutely common practice, and is enected on the basis of the choice of taxing refined products.

3.5. In the fourth place, it can be noted that taxation of imports and exemption of exports are fully general features of the existing excise systems, and should be retained in the design of a carbn tax.

This approach is usually made operational by taking into accounts imports and exports of fuels, but not imports and exports of goods into whose production fuels have entered. This solution has been dictated, in an apparent way, by practical reasons, as international trade in fuels can be easily subjected to border controls; however, it has been suggested that taking also into account imports and exports of goods produced with use of fuels would make better economic sense, as it would offer better protection to the competitive position of domestic industry in the international trade context.

Departures from the more traditional solution, however, seem likely to meet great and perhaps forbidding difficulties. An important exception to this can nevertheless be singled out, electricity: on the one hand, primary energy content of

electricity (in case of thermal generation) is substantial, and this makes worthwile bothering; on the other hand the uniform nature of the product greatly facilitates measurement of international trade flows for taxation purposes.

3.6. In the fifth place, exemptions or reduced rates can be warranted to some energy products and/or uses, for distributional reasons, so as not to put an excessive burden on low income groups, or not to impair the competitive position of energy-intensive industrial sectors.

Obviously, the more complex the structure of differences in tax treatment, the more complicated and costly the enforcement process will be.

However, this is a problem that should not be exaggerated. The existing excise tax systems manage, without apparent stress, to differentiate rates and grant exemptions, in such a way that it is not at all uncommon that the same product is taxed differently when put to different uses (and bought by different classes of users).

3.7. Finally, if it is decided to neutralise the revenue effects of the introduction of a carbon tax, this can be made in many ways. Here, indeed, choice is wide, as several of the existing taxes could be reduced, also in combination among themselves.

4. Tax alternatives

4.1. As a consequence of the preceding, a number of options exist, as far as actual design of a carbon tax and choice of the accompanying measures are concerned.

On the present occasion, a recent proposal oroginating from the EC Commission, which has been prominent in the debate, will be taken as a departure point [EC Commission, 1991; 1992].

4.2. The tax envisaged by the EC Commission is a hybrid, involving combined taxation of carbon content and energy content of energy products. In its initial formulation, the tax should have been introduced in the current year on the basis of a reference rate of 3 dollars per barrel on crude oil, at 1990 prices and divided equally between carbon content and energy content. In the following years, the reference rate would be increased by 1 dollar a year, reaching its highest value, 10

dollars, in the year 2000.

Six industrial sectors that are characterized by higher energy intensity were chosen as possible candidates to exemption from the tax -- those of steel, chemicals, non ferrous metals, cement, glass, and cellulose and paper. This was dictated by an apprehension that the position of these sectors might suffer too great a damage from the levy of the tax.

4.3. Starting from this, five alternative scenarios have been developed. A number of assumptions were quantified and entered into the model representing the EC directives (EC Commission [1992]), to produce **case [1]** of an energy/carbon tax. A special assumption has been made about electricity: as output, it has been taxed with regard to the energy component irrespectively of the electricity type produced. As far as it concerns electricity produced from primary energy sources, its inputs have been taxed on the basis of their carbon content.

Case [2] applies the same tax rates as the previous exercise but here we have decided to exempt from the tax some energy intensive sectors which are involved in international trade and risk losing in competitiveness:

- 7 Ferrous, non ferrous ores
- 8 Non metal products (cement, glass)
- 9 Chemical products
- 10 Metal products
- 24 Paper & printing products

The possibility of a tax levied on the basis of carbon content of fuels and not also on their energy content is simulated in **case [3]**. There the applied tax rates have been calculated by doubling the CO_2 tax rate as proposed by the Commission. Therefore, electricity as output has not been taxed but full tax rates have been applied on its inputs: this is the major distinctive feature of this scenario. Finally, no intermediate sector has been exempted.

According to the Commission proposal, the introduction of a carbon tax should be accompanied by measures ensuring that the principle of tax neutrality is respected. Two different neutralization hypotheses have been simulated: a reduction in social security contributions (**case[4]**) and in value added tax (**case[5]**). We have calculated the carbon/energy tax according to the EC hypothesis with exemptions, then sectoral social security contributions have been diminished by the same amount (approximatively 2% of their total). Alternatively, VAT has been decreased by reducing the standard rate (19%) of one percentage point: this manoeuvre is rather unlikely to be undertaken but is useful for the purpose of this exercise.

Alternative tax rates scenarios are shown in the following table.

TAX RATES SCENARIOS
(lit/toe)

	EC Carbon/energy tax			Carbon tax		
	1993	1994	1995	1993	1994	1995
1 Coal	21503	28598	35694	23790	31641	39491
2 Lignite	7009	9322	11635	8235	10953	13670
3 Coke	24266	32274	40281	28548	37969	47390
4 Natural gas	23021	30618	38216	19910	26481	33051
5 Electricity	33050	43956	54863	0	0	0
6 Diesel oil	28219	37531	46843	28036	37287	46539
7 LPG	34331	45660	56989	31696	42155	52615
8 Fuel oil	28219	37531	46843	28036	37287	46539
9 Petrol	24632	32760	40889	24119	32079	40038
10 Heavy fuel oil	31494	41887	52281	32098	42691	53283
11 Aviation fuel	20862	27746	34631	25803	34318	42833
12 Petroleum coke	28109	37385	46661	31988	42545	53101

5. The model

5.1. INTIMO is an internationally linkable, dynamic, interindustry model which traces the development of the economy over time. It uses variable-coefficient input-output tables that assure accounting consistency both on the product side and on the price side. The model relies, where appropriate, on regression analysis especially for consumption, investments, exports, imports and others.

Macro totals are built up from industry detail ("bottom-up approach") with no need for an aggregate macro-model driver. Most of the carbon tax studies deal mainly with the aggregate macroeconomic effects of the tax, without paying much attention to its industrial impacts. Nevertheless the impacts of carbon taxes are expected to be different across sectors and this paper will try to show them.

The model has fully integrated real and nominal sides: this

is a key feature for dealing properly with indirect taxes: because they affect price formation, these duties should be included as endogenous variables in the nominal side of the model. However endogenous changes in outputs are extremely important to evaluate tax yields by applying structural tax rates to endogenous nominal flows.

5.2. The model has been extended to include an "energy satellite" in order to evaluate, first of all, the impact of a carbon/energy tax on the Italian economy. This is not yet an energy sub-model because there is no feedback with the main model: it's a first necessary step to adapt the approach to the requirements of a disaggregated multisectoral model.

At present, the model does not allow for any substitution towards the least carbon-intensive fuels: this feature can be devoloped together with a map of emissions by fuels within a proper energy sub-model.

5.3. The present version of the model allows a satisfactory detailed analysis of energy consumptions by users - both intermediate and final - and by energy products. The data set is based on official statistics of energy consumptions (ISTAT [1991]) evaluated in tons of oil equivalent (toe). The classification of this data base is consistent with the one adopted in the model: intermediate demand is disaggregated in 44 productive sectors, including public administration, whereas consumers' expenditure accounts for final demand of fuels.

The level of sectoral disaggregation adopted here is primarily dictated by the availability of the required energy data. However, since the question of finer disaggregation is obviously of some interest, some comments on such possibilities in terms of the input-output data are appropriate. In the 44 sectors classification, there are only 4 sectors for energy production: 2 Coal, 3 Coke, 4 Petroleum, Natural Gas, Refining, 5 Electricity, Gas, Water. Clearly such aggregation, particularly on sector 4, restricts the usefulness of the published I/O data for intersectoral modelling for the analysis of energy related issues, as separate treatment for gasoline and gas is obviously necessary for our purpose and the energy data are available on this basis.

5.4. Energy type classification is also important. We have decided to preserve the full detail available, including items with a negligible consumption level. The categories adopted for energy products are as follows:

- Coal
- Lignite
- Coke

- Natural gas (transport, heating, others)
- Electricity
- Diesel oil (transport, heating, others)
- Liquid Petroleum Gas (LPG) (transport, heating, others)
- Fuel oil
- Petrol
- Heavy fuel oil
- Aviation fuel
- Petroleum coke

This classification can be implemented by associating emissions of CO_2 and various air pollutants to different fuels. From the official data the sectoral consumption of energy products according to the input-output classification is obtained and, from this table, differences in sectoral energy needs can be seen. Also the relative dependence on specific sources of energy is given, showing the major role of heavy fuel oil, natural gas and electricity in the consumption pattern. Energy products are either absorbed by intermediate sectors (81% of the total energy consumption) or by final demand (19%).

5.5. Carbon taxes have been applied directly at the level of intermediate consumption of energy by increasing the tax component of the sectoral producers' price equations according to the carbon content of sectoral energy inputs and the level of carbon tax imposed.

The model generates consumer prices too: sectoral consumptions at constant prices are obtained from a set of fourty equations, then they are turned into current prices and the tax rates are applied to get the yield from final consumption. Thus it is assumed that the tax is fully passed on to the energy users, both intermediate and final; this assumption could be easily removed in favour of alternative hypothesis suggested by the economic theory.

Within the model, a determinant of the effectiveness of carbon taxes in reducing air pollution is the translation of the increased prices into reduced demand for energy. This effect is expected also with regard to products and sectors which are energy-intensive: steel, metal products, chemicals, cement, glass and paper.

6. Simulations

6.1. It is necessary to discuss briefely some of the assumptions that were made, together with the methodology followed for their implementation. The set of carbon taxes rates is designed to affect the 92% of the total energy consumption according to the

previous categories with disregard of some minor products. The most recent available data (1988) have been updated to 1991 along with sectoral output.

The reference scenario has been designed to represent the evolving of the current situation without any carbon tax. The rates of excises and value added tax have been fixed at their level of february 1993.

For the purposes of the exercise reported in this paper, the simulation horizon is 1995 which has been seen as the year of the medium term goals put forward by the European Commission. While, form a technical point of view, it would be easy to extend the projection horizon to any period, the confidence attached to such simulations would be limited: the lack of substitution opportunities of energy products would become, in a long-term horizon, an increasingly important weakness. Indeed, the strength of the model's design lies precisely in that it attempts to capture the short and medium-term rigidities of energy markets that originate from the very gradual changes in the energy consumption pattern and the slow introduction of technological progress.

6.2. In general, the introduction of a carbon tax has the same economic effects of an increase of excises on oil products: inflation accelerates, GDP growth rate lowers and so does energy consumption. Results presented in the following tables represent a selection of the model output.

Table 1 and 2 show aggregate results, namely tax yields (thousands of millions lira) and price indicators as percentage deviations from the reference scenario.

Tables 3 to 6 present sectoral effects of EC hypothesis on total output, producer prices, exports and imports. These results would have been available with the same detail for alternative scenarios: for the purposes of this exercise only few of them have been selected and summarized in Tables 7 (consumer expenditure), 8 (consumer prices) and 9 (production prices).

6.3. Some brief comments can be made about these results. As we can see from table 2, a carbon tax has an inflationary effect: consumer price deflator increases as well as producer price index, particularly in case [1] given the high share of intermediate sectors energy consumption.

Furthermore, an overall activity slowdown can be seen. However the impact of the tax is uneven across sectors: energy intensive activities show a marked reduction of their outputs. This effect can be explained by exports and consumers'expenditure

behaviors: because of reduced competitiveness exports of metal products, chemicals and non metal products diminish as well as private consumption of fuels.

The whole picture could be improved by exempting some sectors as in case [2]: a significant cost of this scenario is the yield contraction of about 20 per cent.

Final consumption of electricity, gas and fuels reduces because of price increase. A major role is played by electricity consumption: in fact consumer prices increase is lower in case [3] when electricity is not taxed as output. It is interesting to notice that an increased cost for operation of personal transport induces a shift of private expenditure towards purchases of public transport services.

Simulation of the alternative carbon tax scenario shows a smaller effect on producer as well as on consumer prices bringing about a negligible tax yield loss.

Finally, tax neutrality ensured by social security reduction produces favourable effects for firms with a decrease of production cost and, consequently, of producer prices, while if the carbon/energy tax is compensated by VAT important effects will regard also consumer prices and expenditures.

TABLE 1

TAX YIELDS

	1993	*1994*	*1995*
[1] EEC	**4265**	**5722**	**7258**
- Intermediate demand	3278	4404	5597
- Final demand	987	1318	1661
[2] EEC with exemptions	**3353**	**4498**	**5690**
[3] Only Carbon	**4076**	**5470**	**6939**
- Intermediate demand	3279	4406	5599
- Final demand	797	1064	1340

TABLE 2

PRICE INDICATORS

(annual growth rates differences 1992-1993)

	[1]	[2]	[3]	[4]	[5]
GNP Deflator	0.44	0.34	0.41	-0.06	0.19
Wholesale Price Index	0.30	0.20	0.24	-0.05	0.09
Consumer Price Deflator	0.44	0.39	0.35	0.17	0.04

TABLE 3

TOTAL OUTPUT - EEC IPOTHESYS
(Annual growth rates differences)

	92-93	93-94	94-95
1 Agriculture,For.,Fishery	-0.04	-0.10	-0.16
2 Coal	0.00	0.00	0.00
3 Coke	-0.14	-0.28	-0.49
4 Petroleum,Gas,refining	-0.63	-0.79	-0.94
5 Electricity,Gas,Water	-0.33	-0.45	-0.57
7 Ferrous, non ferrous ores	-0.04	-0.11	-0.22
8 Non metal min,min prod	-0.03	-0.12	-0.31
9 Chemical products	-0.04	-0.08	-0.15
10 Metal products	-0.06	-0.19	-0.40
11 Agric.& Indus.Machinery	-0.12	-0.25	-0.43
12 Office,precis,opt instr.	0.00	-0.08	-0.27
13 Electrical goods	0.00	-0.07	-0.12
14 Motor vehicles	0.04	-0.05	-0.21
15 Other transport equipment	-0.09	-0.22	-0.40
16 Meat	0.01	0.00	-0.02
17 Dairy products	0.00	-0.01	-0.02
18 Other foods	-0.02	-0.05	-0.08
19 Non alcohol,alcoh.Beverages	-0.01	-0.03	-0.07
20 Tobacco	0.08	0.12	0.15
21 Textiles & clothing	-0.02	-0.06	-0.13
22 Leather & shoe	-0.07	-0.18	-0.42
23 Wood & furniture	0.02	-0.02	-0.11
24 Paper & printing prod	-0.01	-0.05	-0.12
25 Rubber & plastic prod	-0.07	-0.14	-0.24
26 Other manufact. Prod	-0.03	-0.05	-0.09
27 Construction	0.02	0.02	-0.06
28 Recovery & repair serv.	-0.26	-0.36	-0.48
29 Trade	0.02	0.01	-0.01
30 Hotels & restaurants	0.01	0.01	-0.02
31 Inland transport	0.06	0.07	0.04
32 Sea & air transport	0.02	0.03	0.02
33 Transport services	-0.08	-0.13	-0.19
34 Communication	0.10	0.15	0.19
35 Banking & insurance	-0.03	-0.06	-0.12
36 Other private services	0.01	-0.01	-0.05
37 Real estate	0.19	0.26	0.27
38 Private education services	-0.03	-0.09	-0.12
39 Private health services	0.06	0.04	0.12
40 Recreation & culture	0.04	0.03	0.08
41 Government services	0.00	0.00	0.01
42 Public education	0.02	-0.02	-0.01
43 Public health	0.00	0.00	0.00
44 Domestic servants	0.14	0.23	0.34

TABLE 4

PRODUCTION PRICES - EEC IPOTESYS
(Annual growth rates differences)

	92-93	93-94	94-95
1 Agriculture,For.,Fishery	0.41	0.64	0.88
2 Coal	0.25	0.41	0.55
3 Coke	0.10	0.17	0.22
4 Petroleum,Gas,refining	0.30	0.50	0.64
5 Electricity,Gas,Water	0.12	0.17	0.23
7 Ferrous, non ferrous ores	0.74	1.04	1.34
8 Non metal min,min prod	0.61	0.89	1.20
9 Chemical products	0.54	0.79	1.05
10 Metal products	0.41	0.63	0.88
11 Agric.& Indus.Machinery	0.35	0.55	0.80
12 Office,precis,opt instr.	0.29	0.48	0.69
13 Electrical goods	0.30	0.49	0.70
14 Motor vehicles	0.37	0.61	0.85
15 Other transport equipment	0.37	0.62	0.89
16 Meat	0.31	0.49	0.68
17 Dairy products	0.38	0.59	0.82
18 Other foods	0.38	0.57	0.78
19 Non alcohol,alcoh.Beverages	0.37	0.57	0.80
20 Tobacco	0.00	0.00	0.00
21 Textiles & clothing	0.33	0.57	0.89
22 Leather & shoe	0.26	0.48	0.83
23 Wood & furniture	0.31	0.51	0.73
24 Paper & printing prod	0.40	0.61	0.86
25 Rubber & plastic prod	0.34	0.54	0.76
26 Other manufact. Prod	0.31	0.46	0.63
27 Construction	0.39	0.62	0.88
28 Recovery & repair serv.	0.35	0.59	0.83
29 Trade	0.36	0.62	1.01
30 Hotels & restaurants	0.39	0.63	0.92
31 Inland transport	0.08	0.15	0.22
32 Sea & air transport	0.05	0.12	0.19
33 Transport services	0.30	0.54	1.01
34 Communication	0.00	0.00	0.00
35 Banking & insurance	0.20	0.36	0.68
36 Other private services	0.14	0.25	0.57
37 Real estate	0.09	0.20	0.61
38 Private education services	0.38	0.69	1.05
39 Private health services	0.36	0.62	0.79
40 Recreation & culture	0.30	0.55	0.73

TABLE 5

EXPORTS - EEC IPOTHESYS

(Annual growth rates differences)

	92-93	93-94	94-95
8 Non metal min,min prod	-0.24	-0.58	-1.05
9 Chemical products	-0.13	-0.18	-0.29
10 Metal products	-0.12	-0.39	-0.81

TABLE 6

IMPORTS - EEC IPOTHESYS

(Annual growth rates differences)

	92-93	93-94	94-95
8 Non metal min,min prod	0.01	0.14	0.27
9 Metal products	0.05	0.08	0.12
10 Agric.& Indus.Machinery	0.51	0.74	0.94

TABLE 7

CONSUMERS' EXPENDITURE

(Annual growth rates differences 1992-93)

	[1]	[3]	[4]	[5]
17 Fuel & electric power	**-1.11**	-0.86	-1.17	-1.05
29 Operation of personal tr. Eq.	**-0.72**	-0.72	-0.69	-0.80
30 Purchased transport	**0.58**	0.54	0.40	0.32

[1] Carbon/energy tax (EEC)
[3] Carbon tax
[4] Compensated by Social Security
[5] Compensated by VAT

TABLE 8

CONSUMER PRICES

(Annual growth rates differences 1992-93)

	[1]	[3]	[4]	[5]
17 Fuel & electric power	**3.40**	**2.62**	3.37	2.90
29 Operation of personal tr. Eq.	1.17	1.13	0.96	0.57

TABLE 9

PRODUCTION PRICES

(Annual growth rates differences 1992-93)

	[3]	[4]	[5]
1 Agriculture,For.,Fishery	0.34	0.18	0.24
2 Coal	0.20	-0.16	0.02
3 Coke	0.14	0.01	0.05
4 Petroleum,Gas,refining	0.27	0.27	0.29
5 Electricity,Gas,Water	0.02	-0.06	0.04
7 Ferrous, non ferrous ores	0.62	-0.06	0.06
8 Non metal min,min prod	0.49	-0.16	0.04
9 Chemical products	0.41	-0.12	0.03
10 Metal products	0.32	-0.18	0.04
11 Agric.& Indus.Machinery	0.27	-0.18	0.05
12 Office,precis,opt instr.	0.22	-0.13	0.06
13 Electrical goods	0.23	-0.15	0.06
14 Motor vehicles	0.30	-0.09	0.15
15 Other transport equipment	0.30	-0.19	0.08
16 Meat	0.25	0.08	0.18
17 Dairy products	0.31	0.11	0.21
18 Other foods	0.29	0.10	0.23
19 Non alcohol,alcoh.Beverages	0.29	0.02	0.19
20 Tobacco	0.00	0.00	0.00
21 Textiles & clothing	0.24	-0.03	0.12
22 Leather & shoe	0.20	-0.07	0.09
23 Wood & furniture	0.24	-0.06	0.12
24 Paper & printing prod	0.28	-0.15	0.05
25 Rubber & plastic prod	0.24	-0.08	0.11
26 Other manufact. Prod	0.24	-0.01	0.11
27 Construction	0.31	-0.15	0.06
28 Recovery & repair serv.	0.29	-0.06	0.13
29 Trade	0.28	-0.09	0.15
30 Hotels & restaurants	0.30	0.07	0.22
31 Inland transport	0.07	-0.08	0.10
32 Sea & air transport	0.05	-0.06	0.08
33 Transport services	0.24	-0.11	0.11
34 Communication	0.00	0.00	0.00
35 Banking & insurance	0.15	-0.21	-0.10
36 Other private services	0.11	-0.18	0.06
37 Real estate	0.06	-0.07	-0.17
38 Private education services	0.29	-0.25	-0.02
39 Private health services	0.26	-0.06	0.04
40 Recreation & culture	0.23	-0.12	0.08

References

P. Agostini-M. Botteon-C. Carraro (1991), "Fiscal Policy to Reduce Air Pollution in Italy", Ricerche economiche, 45 (4), Oct.-Dec., 483-528.

C. Almon (1991), "The INFORUM Approach to Interindustry Modeling", Economic Systems Research, 3 (1), 1-7.

R. Bardazzi (1991), "Flussi e basi imponibili della fiscalità indiretta nella tavola dell'economia", Studi e informazioni, n. 2, 91-107.

R. Bardazzi (1992), Teoria, sistema informativo e modellizzazione delle imposte indirette, Studi e informazioni, Quaderno n.37, Firenze.

R. Bardazzi- M. Grassini- E. Longobardi (1991), "Value-Added Taxes and Other Taxes in a EEC Country Model: The Italian Case", Economic Systems Research, 3 (1), 37-47.

R. Bardazzi- M. Grassini- E. Longobardi (1992), "Imposte indirette: dal sistema informativo all'analisi teorica", in Banca d'Italia, Ricerche applicate e modelli per la politica economica, Roma, vol.2, 597-627.

Cnossen-H. Vollebergh (1992), "Towards a Global Excise on Carbon", National Tax Journal, 45 (1), March, 23-36.

M. Grassini (1983), "INTIMO: Generating National Scenarios for A Regional Model System", in IIASA -IRPET, Model Systems for Regional Planning, Pistoia, 6.1-6.17.

T. Haugland-A. T. Lunde-K. Roland (1992), "A Review and Comparison of CO2 Taxes in the Nordic Countries", in Organization for Economic Co-operation and Development, Climate Change: Designing a Practical Tax System, Paris, OECD, 25-52.

EC Commission (1991), A Community Strategy to Limit Carbon Dioxide Emissions and to Improve Energy Efficiency, Brussels.

EC Commission (1992), Proposal for a Council Directive Introducing a Tax on Carbon Dioxide Emissions and Energy, Brussels.

A. Lanza-G. Sammarco (forthcoming), "Environmental and Economic Effects of the European Carbon Tax: The Italian Case", in C. Carraro-D. Siniscalco (eds.), The European Carbon Tax: An Economic Assessment, Dordrecht, Kluwer.

K. Schmidt (1991), "How Industrial Countries are Responding to Global Climate Change", International Environmental Affairs, 3 (4), Fall 1991, 292-315.

J. Whalley - R. Wigle (1991), "The Internatinal Incidence of a Carbon Tax", in R. Dornbush - J. M. Poterba (eds.), Global Warming: Economic Policy Responses, Cambridge, Ma., 233-63.