Co-ordinated versus uncoordinated European carbon tax solutions analysed with GEM-E3[1] linking the EU-12 countries

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[1] The GEM-E^3 model was built under the auspices of European Commission (DG-XII, co-ordinator P.Valette) by a consortium involving NTUA (co-ordinator), KUL, Un. Mannheim, CORE, Un. Strathclyde and CEA.

Introduction

Policy analysis for CO2 emission reduction has accumulated a rich background, world-wide. Although controversial, the analysis concluded on the advantage of using market-oriented policy instruments, especially taxation. However, it demonstrated also the adverse implications for economic growth, employment and competitiveness.

The European Union considers carbon taxes as an important instrument to achieve its objective of stabilising CO2 emissions. Since the May 1992 initial proposal to use a 10 $/bbl carbon-energy tax, the different member states have never reached the necessary unanimity to introduce this tax. In December 1994, a new proposal (Com (92) 226 final) has been advanced that allows the different member states to install unilaterally or jointly an energy carbon tax. What is common for all the member states is a set of guidelines for use and target values if they decide to use an energy-carbon tax. The hope is to achieve a harmonised carbon tax in the medium term. In the new proposal there are two other important changes: the tax is no longer made conditional on the efforts of the rest of the OECD and each country can take special provisions for its energy intensive industry. It can grant them partial exemptions and the governments are encouraged to use the revenues of the tax for reductions of social charges weighing down the labour market as recommended in the Commission's White paper on Growth , Competitiveness and Employment.

Methodology of the paper

The aim of the paper is to examine the economic and welfare effects of the two energy-carbon tax proposals. The 1992 proposal will be called a coordinated tax, the 1994 proposal will be called an uncoordinated energy-carbon tax. In both scenarios the tax revenues will be recycled through the reduction of the social security contributions paid by employers, with a view to reducing unemployment and thereby obtaining a "double dividend" in both the economic and the environmental welfare[2].

There are several reasons why such an analysis is of interest. The 1994 proposal is new and has not yet been evaluated in economic terms. The 1992 proposal has been the object of numerous studies that have looked at different aspects of this proposal but none of them has delivered sufficient and consistent information. Almost all studies have used individual country models that had difficulties in controlling for the actions of the other member countries. Moreover most models used were traditional macro-econometric models that are not well suited to analyse the effects of important shifts in the tax system. None of these models exhibit the new modelling approach used in this paper that is 1) the linkage of the EU-12 member states and 2) the computable general equilibrium methodology.

In this paper the GEM-E3[3] model is used for the analysis. It is a dynamic multi-sectoral general equilibrium model that links the economy with the environment and the energy system. Each member state is modeled separately while the trade flows between them and the

[2]for a more detailed discussion of the "double dividend" policy issue, see "Double Dividend Analysis: First Results of a General Equilibrium Model (GEM-E3) linking the EU-12 countries", paper presented at the Workshop on Environmental taxation, revenue recycling and Unemployment, ENI E. Mattei, December 1994

[3]for a detailed description of the GEM-E3 model, see "GEM-E3 : A computable General Equilibrium Model for studying Energy-Economy-Environment Interactions in Europe", final report to the European Commission DGXII.

rest of the world are treated explicitly and in detail. Through this linkage a variety of topics can be covered. More specifically, through GEM-E3 the full effects of a Europe-wide carbon-energy tax can be consistently evaluated. Moreover as it is specially designed for the study of environment and energy problems, it contains the full arsenal of environmental policy instruments and represents the emissions and damages of associated air pollutants (NOx and SO2) as well as detailed analysis of the energy branches and energy-related consumption. Most important of all however, the GEM-E3 can assist normative analysis of policy issues, by being able to identify structural changes that occur in the economy.

The results presented in this paper reflect only intermediate model runs with GEM-E3 ver. 1.06 and will be subject to significant revision in the next future, as part of our work for the European Commission DGXII.

Model application

In this paper, we define the double dividend issue through the simultaneous imposition of a pure CO2-related tax that is exactly compensated by a reduction of the rate of social security contribution of employers, in all sectors. The reduction is performed ex-post, which means that the government surplus or deficit remains completely unaffected, thereby taking into consideration all effects, including those from changes in international trade.

The tax was carbon-oriented defined in magnitude at the order of 10$/barrel of energy equivalent. This defines a tax level proportional to CO2 emissions by fuel type. No exemptions were permitted. The tax took the form of an excise tax. This has important implications, because the implied percent changes of prices depend on the pre-existing level of excise tax. For example, fuels used in transports are mildly affected by such a tax, while the prices of fuels used in heavy industry increase significantly in percentage terms.

An important policy issue concerns also the way to implement the reduction of the rate of social security contribution of employers by sector, since both the rates and the labour costs differ by sector. We adopted a uniform reduction by sector, since this seems more realistic in many countries. Thus, we consider that the compensation of the CO2-tax is obtained globally and not by sector. To analyse the distributional effects of such a policy, we should avoid any side effect on the surplus or deficit of public budget. If we compute ex-ante the rate of social security contribution necessary to compensate CO2-tax revenues, the surplus or deficit of public budget may be different in the new equilibrium of the economy. For this reason we impose the ex-post determination of the level of the rate of social security contribution in a way to completely compensate CO2-tax revenues, that are at the new equilibrium of the economy.

As already mentioned in this paper we examine three alternatives:

- Imposition of the tax in Germany only
- Imposition of the tax in a core group of countries consisting of Denmark, Germany and the Netherlands
- Imposition of the tax in all EU-12 member states

The three scenarios are summarised in the following table.

	Reference	Carbon-energy Tax coordinated	Carbon-energy tax group uncoordinated	Carbon -energy tax individual uncoordinated
Description	No energy carbon tax	10 $ carbon tax introduced in all (12) member countries	10 $ carbon tax introduced in Denmark, Germany, Netherlands	10 $ carbon tax introduced in Germany only
Absolute CO2 objective	no	no	no	no
Exemptions for industry		no exemptions	no exemptions	no exemptions
Recycling of tax revenue		ex-post reduced ss contributions of employers	ex-post reduced ss contributions of employers	ex-post reduced ss contributions of employers
Other environmental benefits		SO2 and NOX depositions	SO2 and NOX depositions	SO2 and NOX depositions

Simulation Results

The effect of a carbon tax in the economy, depends heavily on the type of recycling of the tax revenues that will be decided upon. Therefore the positive effects that the tax appears to have in the scenarios analysed below, are largely due to their use in financing the labour costs. This leads to a "double dividend" that most countries seem to experience in the scenarios performed.

Comparing the effect of the tax when imposed in Germany alone or in the core group, or in all the EU it appears that the gains in the environment and the employment remain unaffected, while the adverse effects concerning inflation, competitiveness and labour productivity are alleviated but only mildly. The question therefore is of how big priority these gains will be considered to be, and how much importance will be attached to the relative slight deterioration of the country's position in the case of an uncoordinated implementation of the carbon tax.

Scenario I : Introduction of a CO2 tax in Germany

Introducing a CO2 tax in Germany only, seems to produce significant benefits in the environment and unemployment, coupled with only meagre adverse effects.

In the environmental frontier, the tax resulted in a decrease in total energy consumption which is reduced by more than 4.5%, leading to a reduction in emissions that range from 13% for CO2, to 20% for SO2.

The increase in the price of the fuels as intermediate inputs, leads naturally to their substitution by the other production factors, which allows the creation of 62,000 new working places and also leads to a slight revaluation of the real wage rate by some 1%. The increased income experienced by households leads to an increase in the private consumption by 0.4%, while the real interest rate remains unaffected.

From a sectoral point of view there is a shift in production and demand from the energy intensive and equipment goods industry towards the consumer goods industry and the sector of services, a change that can have important structural implications in the longer term. The burden in the German heavy industry, together with a decrease in investment (of the order of 0.8%) lead to a slight decrease of the GDP when measured in factor prices.

Another adverse effect, takes the form of some inflationary pressure (3% as measured through the consumer's price index and 0.8% through the GDP deflator). This in turn results in a small loss in competitiveness of the German industry, and a subsequent mild decrease of export market (the current account worsens by 5.7 billion DM). The labour productivity also decreases.

The other EU member states appear to gain export competitiveness from the German carbon tax, but only slightly. Most gains are to be found in the bigger trade partners of Germany (the UK, France, Italy and the rest of the world) and are the results from the decrease in imports coming from Germany.

Detailed macroeconomic and sectoral results of this scenario are presented in tables 1 to 5.

Scenario II : Introduction of a CO2 tax in a core group consisting of Denmark, Germany and the Netherlands

Most of the comments made in the previous scenario seem to hold hear as well. The adverse effects for Germany are alleviated a little bit compared to the previous scenario, while the positive ones remain the same as before.

All three countries exhibit the same basic tendencies of a considerable decrease in energy consumption (4.2% in the Netherlands and 3.4% in Denmark) and the resulting reduction in emissions in the range of 10 to 13%.

The inflationary pressures in the three countries are of about the same order of magnitude (around 3%) while employment is affected positively in all cases.

The GDP and the real interest rate remain more or less unaffected.

The other EU member states appear again to gain from the decrease in the competitiveness of the three core countries but the main winner in this respect appears to be again the rest of the world.

Detailed macroeconomic and sectoral results of this scenario are presented in tables 6 to 10.

Scenario III : Simultaneous introduction of a CO2 tax in all EU member states

The first remark concerning the imposition of the CO2 tax in all the member states is the impressive decrease in the emissions of pollutants, that add up to an impressive 15% for CO2, 11% for NOx and 18% for SO2. Energy consumption falls from a low 3% in France to more

than 7% in Portugal. The second is that in all countries (with the exception of Ireland) a double dividend occurs. Ireland is burdened more by the limited reaction possibilities of the Irish industry coupled with a possible relative lack of human resources.

Trade competitiveness deteriorates in all EU countries and total volume of trade falls as well. The EU as a whole also loses competitiveness to the rest of the world. The most affected countries in terms of loss of export share are those that depends most in heavy industry, ie. Germany and France.

Labour and factor substitution flexibility also play a very important role. Countries like the UK with importnat substitution possibilities achieve greater benefits with smaller cost, while the less adaptive ones like Greece and Ireland face the greater inflationary pressures. From a structural point of view, the shift in production and investment towards consumer goods industries and services should again be noted.

Detailed macroeconomic and sectoral results of this scenario are presented in tables 11 to 15.

For a better understanding of the results, the relative magnitude of the tax, measured as percent of the GDP, and the resulting reduction in the social security rates paid by employers are presented in the following table (as found ex-post by the model)

	Tax revenues as percent of GDP	**Reduction of social security contributions**
Belgium	**2.1%**	**4.0%**
Denmark	**2.0%**	**3.0%**
France	**1.2%**	**1.9%**
Germany	**2.0%**	**3.6%**
Greece	**1.4%**	**1.2%**
Ireland	**2.4%**	**3.0%**
Italy	**1.4%**	**1.8%**
Netherlands	**2.0%**	**3.8%**
Portugal	**2.2%**	**3.9%**
Spain	**1.9%**	**3.2%**
United Kingdom	**2.1%**	**4.7%**

Going back to the double dividend issue, the general outcome of the analysis performed with GEM-E3, confirms that some positive dividend in employment occurs, provided that the degree of labour supply flexibility is significant. This can be interpreted as the existence of unemployed labour force. If such a condition is not verified, then a positive dividend is only obtained for the environment.

Numerical Results

In the following tables the detailed results obtained from the GEM-E3 model for the three scenarios are presented.

The results are from a static (one-year) run of the model and represent percent (or absolute when so noted) changes from the reference (baseline) scenario.

- Tables 1-5 concern the first scenario -imposition of a carbon tax in Gemrany.
- Tables 6-10 give the results of the second senario -carbon tax in Denmark, Gemrany and Netherlands and
- Tables 11-15 show the results from the third scenario -carbon tax in all EU countries.

Tables 1, 6 and 11 show the macroeconomic effects of each of the three scenarios respectively, on all the EU countries.

Tables 2-4, 7-9 and 12-14 give the structural effects of each of the three scenarios respectively , on all the EU countries and

Tables 5, 10 and 15 show the changes in the trade matrix ie. the imports and exports by country of origin and country of destination.