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Achieving a 10% cut in Europe's CO_2 emissions using additional excise duties: multilateral versus unilateral action using E3ME

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Contents

Abstract

Coordinated and uncoordinated multilateral policies to reduce CO_2 emissions from 11 member states of the EU by 2010 are compared with unilateral policies to achieve a 10% cut in each member state alone. The paper presents the results from 4 projections using a large-scale, integrated, regionalised E3 model of the EU (not a general equilibrium model) estimated on time-series, cross-section data 1968-93 with international trade treated as between each member state and a European transport and distribution network. The 10% reduction is achieved by additional excise duties incremented every year 1999 to 2010 according to the carbon contents of fuels with special treatment of electricity (taxed on outputs not inputs) with revenues recycled via reductions in employers' social security contributions. Multilateral coordinated policies require a common tax rate of 156 ecu per tonne carbon (1999 prices), which rises to an average of 162 ecu/tonne with a wide range between regions when policies are uncoordinated. All the tax shift projections show double dividends of emission-reduction and employment-gain for all member states. Unilateral policies do not show much carbon leakage and they show smaller gains for output and employment. The results are compared with those from a general equilibrium model, GEM-E3, tackling the same topic.

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1. Introduction

This paper assesses the effects on employment and output of multilateral versus unilateral policies to reduce CO_2 emissions by raising excise duties on energy products in European countries according to their carbon content. It uses a large energy-environment-economy (E3) model of the EU (E3ME) estimated by econometric methods on time-series and cross-section data, which incorporates input-output tables to represent intermediate demand. In many respects it is a sequel to an earlier paper (Barker and Gardiner, 1996) which set out the key econometric properties of industrial equations for employment, wage rates and prices equations in E3ME which imply that appropriate changes in policy are expected to yield a double dividend: this paper provides the estimates of such a dividend. It is also a companion paper to one presented at an Amsterdam workshop (Barker, 1998), which uses the same base case and several of the same scenarios, but with emphasis on international trade and competitiveness, rather than the double dividend.

The literature on the modelling of CO_2 abatement is divided into applications of three types of models (see Fisher and Grubb, 1997, for a recent review): bottom-up engineering models, macroeconomic models and general equilibrium models. The study reported here uses a disaggregated macroeconomic model, but it compares very closely in terms of questions tackled, coverage of the EU, and size of the abatement with the preliminary study of Capros and others (1996) and the later study by Conrad and Schmidt (1997) using different versions of the same general equilibrium model, GEM-E3, and some of the results are compared below.

The main limitation of many of the earlier studies of carbon taxation (eg Hoel, 1992) is that they concentrated on one side of environmental fiscal reform (or EFR), viz the effects of tax increases on expenditures; the other side of EFR, the use of revenues to reduce employers' taxes and increase employment, was not treated specifically. EFR is intended to increase employment and reduce unemployment as well as improve environmental performance; it is likely that the return of revenues to the industrial sector in the form of lower labour costs will have favourable effects on competitiveness. Furthermore the use of the revenues could have a substantial effect on the distribution of the burdens of abatement between economies, given that the double dividend may be much larger in some economies than in others, depending on the operation of the labour markets as well as on the carbon-intensities of the economies and their ability to substitute away from carbon.

In the large quantitative studies of the effects of the EC's proposed carbon/energy tax (DRI, 1991 and 1992) or of a substantial package of environmental policies (DRI, 1994), the question of unilateral policy was considered at the level of the EU as a union and little or no consideration was given to the issue of burden-sharing. With the adoption of EU-wide targets for stabilisation of greenhouse gas emissions at 8% below 1990 levels as proposed for the Kyoto Treaty, the issue has become more important. The comparison of coordinated and uncoordinated carbon taxation with the recycling of revenues via reductions in employment taxes gives a further perspective on burden-sharing.

The paper is organised as follows: the next section introduces the E3ME model and describes its treatment of international trade and intermediate demand. Section 3 then describes the scenarios for taxation and their relationship to the 1997 proposed Directive on additional excise duties on energy products. Section 4 gives the estimated tax rates and effects on emissions, employment and GDP, showing the double dividend expected of such fiscal reform. Section 5 compares the results with those from the study by Conrad and Schmidt (1997) using a general equilibrium model. Section 6 concludes.

2. Modelling of the Double Dividend

The Literature

The use of market-based instruments, such as a carbon tax or excise duties on energy products, for the mitigation of GHG emissions is one of the most widely researched areas in recent years, following the European Commission's carbon/energy tax proposals of 1991, and the studies undertaken in preparation for the Kyoto Conference of December 1997. There are several reviews of the literature, emphasising different aspects of the research on costs of mitigation: Boero, Clarke and Winters (1991) survey the cost estimates and their theoretical basis; Repetto and Austin (1997) review the costs of mitigation given by US models and are able to explain 80% of differences by 7 assumptions chosen for the modelling; Barker and Johnstone (1998) review the effects of carbon taxation on international competitiveness; and Hourcade, Haites and Barker (1998) review the basis of macroeconomic cost estimates. The more specialised double dividend literature is also extensively reviewed and assessed: de Wit (1995), Majocchi (1995), Ekins (1997) with a useful analysis of the theory by Bohm (1997).

The Characteristics of E3 Modelling in the Literature

This paper addresses the double dividend issue directly using a model approach estimated on annual data 1968-93 which aims to represent the economic behaviour industry by industry in 11 member states of the EU. The econometric estimation of the model distinguishes it from the computable general equilibrium (CGE) approach which dominates the literature in this area (recent examples being Capros et al, 1996; Welsch, 1996; Conrad and Schmidt, 1997; Capros et al, 1997).

The energy-environment-economy model for Europe, E3ME, is a sectoral, regionalised, econometric model of the EU (CEC, 1995; Barker, Dieppe and Gardiner, 1996; CEC, 1998). It is not a CGE, but a disaggregated time-series, cross-section econometric model, although it has benefited from some of the techniques used in CGEs, eg calibration on recent data. The model has been constructed by a team of partner institutes across Europe with Cambridge Econometrics acting as co-ordinator of the project. The model treats member states as a distinct economic entities interacting with one another; but at the same time it is one model giving the benefits of common classifications, definitions and methodology, and with equation estimates and results capable of being aggregated to the European level. In this respect it differs from other macroeconomic models used in E3 analysis, eg the suite of DRI econometric models used to analyse possible EU E3 policies (DRI, 1991, 1992, 1994) or the HERMES model (see CEC, 1993) used to analyse the EC's proposed carbon/energy tax. In some respects, E3ME is similar to some national models used for E3 policy analysis (Cappelen, 1991; Barker and Peterson, 1987).

Many previous model applications to the greenhouse gas abatement problem have been limited in two other respects. First they have relied either on an integrated EU *macro* model (eg QUEST) so that they fail to capture important sectoral effects at the sectoral level. The use of E3ME as an integrated sectoral model addresses this problem. Second, the work on CO_2 abatement has been almost entirely divorced from that on SO_2, an approach that it is clearly inappropriate since many measures targeting one of these kinds of emissions will affect the other. Since policy needs to encompass a package of measures that will tackle both kinds of emissions, it requires a tool for analysis that models instruments and emissions consistently, including unintended side-effects.

The modelling of effects on international competitiveness requires the representation of international trade and intermediate demand: trade, because the effects on trade flows are an important aspect of competitiveness effects generally; and intermediate demand because the initial impact of the switch in taxation to carbon from labour will be transferred throughout the industrial structure according to the flows of goods and services between industries.

Econometric Modelling in E3ME

The main endogenous variables in E3ME are determined from functions estimated on historical data on European energy use and the economy. There are a relatively small number of variables (for example intra-EU export demand by commodity and by region) for which stochastic functions are estimated; around 23 in all. However these variables may well be disaggregated in two dimensions (there are 30 commodities and 11 regions operative in E3ME version 1.3 used in this study) with several different specifications.

The econometric techniques used to specify the functional form of the equations are the concepts of cointegration and error-correction methodology, particularly as promoted by Engle and Granger (1987, 1991) and Hendry et al (1984).

In brief, the process involves two stages. The first stage is a levels relationship, whereby an attempt is made to identify the existence of a cointegrating relationship between the chosen variables, selected on the basis of economic theory and a priori reasoning, eg for export demand the list of variables contains an indicator of activity in export markets, relative export prices and a measure of technological progress (see below). If a cointegrating relationship exists, then the second stage regression is known as the error-correction representation, and involves a dynamic, first-difference, regression of all the variables from the first stage, along with lags of the dependent variable, lagged differences of the exogenous variables, and the error-correction term (the lagged residual from the first stage regression). Due to limitations of data size, however, only one lag of each variable is included in the second stage.

The employment, wage rate and pricing equations for each regional industry are described and average estimates are provided in Barker and Gardiner (1996); the energy equations and the export and import volume and price equations are described by Barker (1998). Here more detail is provided on the treatment of intermediate demand and a brief summary is given of the other relationships.

Modelling Intermediate Demand in E3ME

Intermediate demand is modelled by including a set of input=output coefficients for each region in the model. These coefficients represent the total of inputs (both imported and supplied from domestic sources) per unit of output for each regional industry in the model. Eurostat have published such tables for a number of member states of the EU for 1985, but as van der Linden and Oosterhaven (1995) point out, in order to use them for intercountry modelling, the valuation basis for impost should be adjusted. Imports should be valued at producers' prices rather than at ex customs values as in the Eurostat tables. Van der Linden and Oosterhaven have provided a set of consistent tables for 9 member states for 1985 which adjust for this revaluation as well as for other inconsistencies and these tables have been included in E3ME. Input-output coefficients are calculated from the tables and intermediate demand calculated on the usual assumption that the average coefficients can be used to analyse marginal changes. There is one exception to this treatment: the coefficients for energy use are changed according to the inputs of fuels given by the energy and fuel share equations described below.

In the version of E3ME used in this study, the 1985 non-energy coefficients are mostly held constant throughout the projection. However, in the next version of the model, the coefficients will change according to logistic equations estimated by comparing the intermediate demands derived by assuming fixed coefficients with those derived as residuals between supplies and demands, excluding intermediate demands.

Modelling Energy Demand in E3ME

Demand for aggregate energy use by 17 fuel users in the 11 regions is first estimated, then the aggregate is divided by share coefficients and equations into the demand for 11 energy carriers. Energy demand is treated as derived from the demand for goods and services being produced by the industries using the energy or from the services provided by the equipment using the energy operated by final consumers. The demand for energy by a fuel user is dependent on the 'activity' for the fuel user, on relative energy prices and on deviations of temperature from the mean. A restriction is imposed to give asymmetrical price effects, so that relative price increases cause demand to fall but relative price decreases have no effect.

Modelling Intra-EU and Extra-EU Export and Import Volumes in E3ME

All trade is treated as if it takes place through a European 'pool', ie a transport and distribution network. The export and import volume equations represent each region's exports into this pool and imports from it.

Total exports and imports have been separated into two sub-components, one for intra-EU trade and one for extra-EU trade. Trade volumes are mainly determined by income and relative price variables.

Modelling Export and Import Prices in E3ME

The basic model of trade prices used in E3ME assumes that the EU regions operate in oligopolistic markets and are each small economies in relation to the total market. Certain commodities, eg crude mineral oil, have prices treated exogenously, but the majority of prices are set by producers as mark-ups on costs, ie unit costs of production.

Modelling the Labour Market in E3ME

This is a substantial topic and it is only considered in outline here (for a detailed treatment see Barker and Gardiner, 1996). The demand for employment is treated as derived from the demand for the goods and services produced by the employment, with the demand being affected by output, real labour costs, hours worked and technical progress. The wage rates of those employed are determined in a wage bargaining process, with the real wage rate in any regional industry depending on the wage rate in other industries in the same region and on the wage rate in other regions in the same industry, as well as on the unemployment rate and on the levels of benefits in relation to the average wage in the region.

3. Assumptions for the Projections and the Rate of Carbon Tax

Additional Excise Duties on Energy Products

The European Commission (Press Release, Brussels, 12 March 1997 reported in the *Financial Times*) has proposed a Directive to widen the scope of the minimum rate system to include all energy products. This proposal combines two requirements made by the Council of Ministers: the first is to present new proposals for energy taxation following the failure of the carbon/energy tax proposal to be agreed; the second is to reduce distortions in the energy market caused by different rates of excise duties on fuels in different Member States. The proposal is intended to give Member States the flexibility to differentiate rates of taxation on the basis of environmental criteria, while complying with the minimum rates; it encourages Member States to avoid increasing the tax burden and to use extra revenues to reduce taxes on labour.

The new proposal extends the present framework of harmonising duties on oil products to cover coal, gas, electricity and other energy products. New minimum rates starting on the dates 1.1.1998, 1.1.2000 and 1.1.2002 are proposed for motor fuels and heating fuels. A wide range of exemptions is proposed: fuels used by airlines, products used on navigation within Community waters; special cases. Member States may choose to exempt renewable energy sources. Special refunds are proposed for firms whose energy costs are in excess of 10% and 20% of production costs. The proposal is being considered by the Council of Ministers and governments but has yet to be adopted.

Additional Energy Duties versus a Carbon Tax

E3ME has a treatment of both a carbon/energy tax and excise duties. The main difference between them is the inclusion of tax in the basic prices of the energy industries. A carbon tax is assumed to be paid by the energy industries, eg electricity or oil refining, on the carbon content of their inputs for fossil fuels ie coal, gas and fuel oil inputs to electricity and crude oil and gas inputs to oil refining. The impact of the carbon tax is therefore initially in the prices of the energy product industries, with the higher energy prices then being passed on to other energy-using industries such as iron and steel. Excise duties on energy products are intended to be paid further down the chain of production, with the inputs into electricity and oil refining untaxed, and electricity itself subject to tax; in this case the basic prices of the energy industries are largely unaffected, except in as much as their labour costs and own use of electricity and fuel are taxed.

Additional excise duties on energy products have been treated in E3ME specifically as a new set of excise duties on purchases by industries and consumers of coal, oil products, gas and electricity, with the tax being assumed to be passed fully on to prices, the same treatment as other excise duties. The model can therefore be used to assess the implications of different structures of additional excise duties.

Assumptions for the Projections

In the projections reported in this paper, a set of escalating additional excise duties for EU Member States has been calculated for the period 1999 to 2010, but NOT adopting the exemptions and other exceptions proposed for the Directive (except the special treatment proposed for the electricity industry) and graduated according to the carbon content of the energy products being taxed (with electricity taxed on the basis of the carbon content of its generating input fuels). These rates are assumed to escalate in constant absolute amounts each year and are calculated, in the main projection, to achieve an overall reduction of 10% in CO_2 emissions below base case projections by 2010 for the total for all 11 Member States included in the current version of the model.

The revenues from these additional duties are assumed to be spent by each Member State in reducing employers' contributions to social security schemes so that the overall effect is to keep the total tax revenues from the duties and the contributions constant, ie the tax change is tax-revenue neutral in this restricted sense; however overall tax revenues and public sector borrowing may well change as other tax revenues and spending changes in response to the changed economic conditions.

This is the main assumption of the projections, but there are a large number of other assumptions which are important in affecting the results. The key assumptions are as follows.

- Tax revenues recycled via reductions in employers' taxes
- Employment can adjust freely in response to demand (ie no full employment assumption)
- The additional duties affect prices only; there is no independent response via R&D, innovation or other factor affecting competitiveness

- Prices are determined according to estimated responses from time-series equations with long-run full passing on of unit costs (ie prices are not required to clear markets, but are largely administered)
- Wage rates are determined in a wage bargaining framework such that all taxes and duties are paid by the final consumer in the long run
- The rest of the world economic activities and prices are unaffected by the introduction of the additional duties in Europe; the world oil price is unchanged between projections
- Exchange rates and interest rates are all unchanged between projections

Design of the Projections

This main projection requires a baseline projection for comparison and has been supplemented by two other projections designed to bring out the implications of policy for multilateral versus unilateral action. E3ME has been therefore solved for:

The baseline: a projection of business-as-usual growth in output, employment and CO_2 emissions, with a overall increase in CO_2 emissions of some 7% above 1990 levels by 2010 for the 11 Member States with calibration of the growth of energy demand.

Projection 1: multilateral coordinated additional excise duties on energy products in proportion to their carbon content imposed at escalating rates from 1999 sufficient to reduce national CO_2 emissions by 10% below baseline by 2010 assuming that no action is taken by other countries. These duties are tax-revenue-neutral via reductions in employers' contributions to social security.

Projection 2: as projection 1 with multilateral but uncoordinated additional excise duties sufficient to reduce national CO_2 emissions by 10% below baseline by 2010 for each of the 11 Member States included in the study. The policy is uncoordinated in the sense that each member state aims to achieve a 10% reduction by itself.

Projection 3: as projection 1 but with unilateral uncoordinated additional duties to achieve a reduction in emissions by 2010 using the duty rates of projection 1 but assuming no action is taken by any other member state.

By comparing these projections with the baseline and with each other an assessment can be made of the effects of the policies on competitiveness, as well as on CO_2 emissions, employment and GDP.

A Comparison of Rates of Carbon/Energy Taxes for a 10% CO2 reduction

An indication of the magnitude of the additional taxes is given by the *ex ante* estimates of their revenues as a proportion of GDP in current prices. These estimates are shown in Table 1 for the years 2000, 2005 and 2010. For the EU-11 they rise from 0.3% of GDP in the year 2000 to 1.5% by 2010. The increases are the outcome of the 2010 rates of tax to achieve the 10% reduction and correspond to a rate of 156 ecu per tonne carbon or $16 in 1999 prices per barrel oil-equivalent, boe, compared to the $10 1993 prices boe for 2000 proposed by the Commission for a carbon/energy tax. The estimates can be compared with those of Smith (1992) for the proposed $10 boe carbon/energy tax, which are also *ex ante* but ignore any exemptions or effects of economic growth and baseline changes in economic structure. Given these differences in treatment and the high level of tax, the percentages are very similar, with the differences in rates between countries reflecting their CO_2 emissions per unit of GDP and the exemptions of the additional excise duty proposal.

TABLE 1: EX ANTE REVENUES FROM ADDITIONAL EXCISE DUTIES AS % GDP (CURRENT PRICES)

	2000	2005	2010	1988 Pearson & Smith 10$/bl tax
Belgium	0.4	1.2	2.0	1.7
Denmark	0.5	1.5	1.9	1.0
West Germany	0.4	1.2	1.9	1.3
Spain	0.3	1.2	2.1	1.2
France	0.3	0.8	1.4	1.0
Ireland	0.7	2.3	4.0	1.8
Italy	0.4	1.4	2.5	0.9
Luxembourg	0.8	2.4	3.6	2.6
Netherlands	0.4	1.5	2.4	1.6
Portugal	0.6	2.1	4.1	1.3
United Kingdom	0.6	2.2	4.0	1.3
EU-15	0.4	1.3	2.2	

Sources: Environmental fiscal reform project and Smith (1994, p. 282) quoted in OECD (1995)

TABLE 2: COMPARISON OF ESTIMATED EFFECTS OF EU CARBON/ENERGY TAXES ON CO_2 ABATEMENT RECYCLED VIA EMPLOYMENT TAXATION

Study	Start year for tax	Finish year for tax	Tax rate (ecu/tonne 1999 prices) in final year	Finish year for CO_2 effects	Size of CO_2 effects
DRI (1991) approx	1993	2000	82 133	2005	6.2% 10%
Capro et al (1997) approx	2001	2010	336 168	2010	20% 10%
Conrad and Schmidt (1997)	1985	no data	112	no data	10%
This paper (1998)	1999	2010	156	2010	10%

Note(s) :

1 DRI (1991) take the $10 boe carbon/energy tax in 1990 prices, with preferential treatment of electricity generation. This is stated to be equivalent to a carbon tax of 35.7% (1990) ecu per tonne of carbon and an energy tax 30.5 (1990) ecu per tonne both in 2000 (p.16). The 6.2% CO_2 reduction includes effects of extra transportation taxes. In the table this carbon tax is doubled and inflated to 1999 prices assuming a price increase of 15%.

2 Capros et al (1997) find a shadow abatement cost of 240 ecu per ton carbon 1985 prices (p.6). This is converted to 1999 prices by an assumed increase of 40%.

3 Conrad and Schmidt (1997) find an overall EU tax rate of 21.82 ecu per tonne CO_2 in 1985 prices for co-ordinated policies and 23.51 ecu/tCO_2 for unco-ordinated policies. This is uprated to 1999 prices assuming a price increase of 40% and to ecu per tonne carbon by the factor 44/12 (weight of CO_2 to weight of carbon).

4 In this paper, the electricity industry is given preferential treatment.

5 Note that all the studies recycle revenues from carbon/energy taxes via reductions in employers' social security contributions; all assume fixed rest-of-the-world behaviour and fixed exchange rates. However the studies differ in their treatment of the labour market, their coverage of EU member states, their methodology, their baseline and many other assumptions. All taxes are multilateral and coordinated.

The increases can also be compared to existing rates of tax on energy and labour. In 1993 the EU-15 levied taxes on production factors (labour, capital, energy and environment) of 42% as a percentage of GDP (EEA, 1996, pp 24-25); the taxes on energy were relatively small, some 3% of GDP, while the taxes on labour were about 20% of GDP. The energy tax share may have risen slightly since 1993, but the increase of some 2.2 percentage points represented by the additional excise duties required to reduce CO_2 emissions by 10% would be a significant switch in the sources of tax revenue, raising the energy share and reducing the labour share, if employers' contributions were reduced to keep the switch tax-revenue-neutral. The increases can also be compared to those found in closely similar studies using large-scale E3 models, as shown in Table 2.

4. Effects on CO_2 Emissions, GDP and Employment

This section gives some emission and macroeconomic results for the different projections. Table 3 gives results for the multilateral coordinated policy and Table 4 those for the multilateral uncoordinated policy. Both tables show the implicit carbon tax rates and the effects on CO_2 emissions, GDP and employment of the additional duties with revenues recycled by reducing employers' contributions.

Starting with the results for the EU-11, the overall tax rate is 156.5 ecu/tonne for coordinated and 165.1 ecu/tonne for uncoordinated policies, an increase of 5.5%, indicating that there is a benefit in terms of a lower carbon tax to achieve the same reduction in emissions, but it is not very large. However the range of tax rates in the uncoordinated projection is substantial, from a rate of 42 ecu/tonne for Belgium to 252 for Denmark, 312 for Portugal and 356 for the Netherlands. For one reason or another the countries with high uncoordinated tax rates have CO_2 emission patterns which are rather unresponsive to real price increases. The CO_2 emissions are exactly 10% below base by 2010, employment 1.2% above base (1.3% in the uncoordinated case) and GDP is 1.4% above base (1.5% in the uncoordinated case), the CO_2 result being by design. The higher growth and employment in the uncoordinated projection are the result of the tax being higher, so that there are more revenues to recycle, giving a greater reduction in employment taxes and higher output and employment.

These results show a double dividend for emissions and employment in every member state covered by the study. The usual experience in most EU economies in the last 20 years has been 'jobless' growth, with employment growing much less than output. However, the projection has employment growing at a similar rate to output, through the effect of reductions in the costs of labour to employers.

GDP increases in all regions except the Netherlands (which experiences some loss of competitiveness), with the largest increases of 1.9%, ie about 0.2% pa 1999-2010, for Belgium when policies are coordinated and larger increases when policies are uncoordinated and tax rates rise much higher. The reductions in CO_2 emissions are very uneven, reflecting the different tax increases and energy structures across the EU. Similarly the increases in employment are very uneven across states, ranging from 0.6-1.3% for France, West Germany, Netherlands, Denmark and Portugal to 1.9% for Italy and a high 2.9% for Belgium; these differences change when policies are uncoordinated but remain in broadly the same range. Chart 1 shows the distribution of the CO_2 emission levels and changes across states for 2010; Chart 2 shows levels and changes for employment. In both cases the distribution of the changes is markedly different from that of the levels, but note the difference in scale on the vertical axis.

Tables 5, 6 and 7 compare these projections for CO_2 emissions, GDP and employment respectively with the results of unilateral policies in each member state. The results of the unilateral policies (labelled UNIL in the tables) are divided into those internal to the member state, those in the rest of the EU and the total EU-11 effect. Note that the column sums for the unilateral effects are deliberately not shown to

TABLE 3: CO2, GDP AND EMPLOYMENT IN MEMBER STATES, 2010

MULTILATERAL COORDINATED EU DUTY WITH REVENUE RECYCLING

difference from base

		RTCT e/tC	RCO2 mtC	RCO2 %	RGDP %	REMP th	REMP %
Belgium	(BE)	156.5	-6.1	-20.2	1.9	116.8	2.9
Denmark	(DK)	156.5	-1.1	-7.3	1.3	14.8	0.6
West Germany	(DW)	156.5	-16.8	-7.8	1.4	245.2	0.7
Spain	(ES)	156.5	-8.0	-11.4	1.2	203.9	1.4
France	(FR)	156.5	-14.7	-14.2	1.4	202.1	0.7
Ireland	(IR)	156.5	-1.3	-10.9	0.8	22.1	1.5
Italy	(IT)	156.5	-13.1	-10.6	1.7	553.7	1.9
Luxembourg	(LX)	156.5	-0.2	-10.7	1.0	2.9	1.2
Netherlands	(NL)	156.5	-2.8	-5.8	-0.8	69.7	1.2
Portugal	(PO)	156.5	-1.0	-5.6	0.6	52.6	1.3
United Kingdom	(UK)	156.5	-15.0	-9.0	1.8	426.7	1.4
EU-11		156.5	-80.1	-10.0	1.4	1910.4	1.2

Ref : E3ME13 Projection, Cambridge Econometrics C72??RAV-C72BARAV April 1998
Note : RTCT=carbon tax ecu/tonne, RCO2=CO2, RGDP=GDP, REMP=employment

TABLE 4: CO2, GDP AND EMPLOYMENT IN MEMBER STATES, 2010

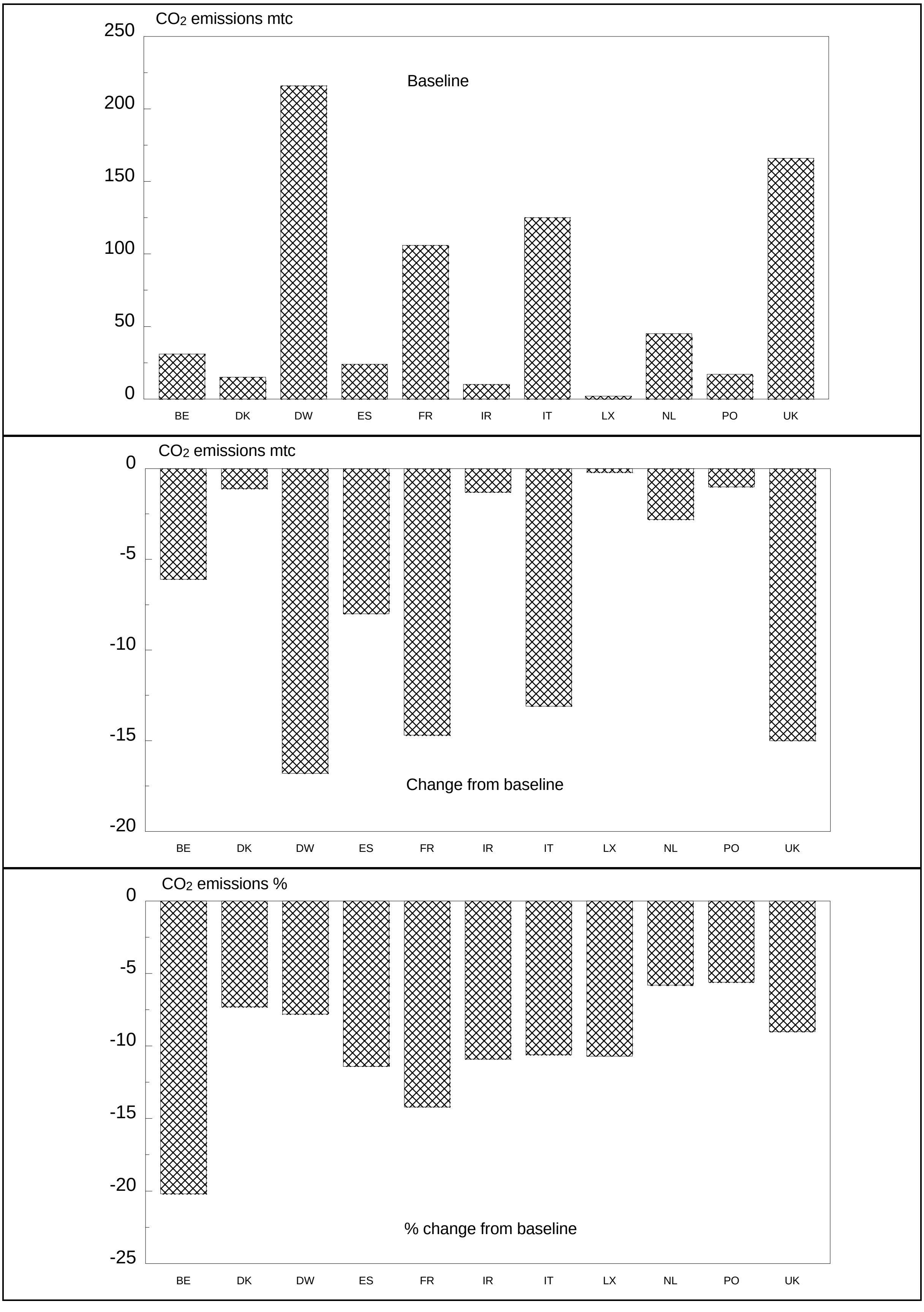
MULTILATERAL UNCOORDINATED NATIONAL DUTIES WITH REVENUE RECYCLING

difference from base

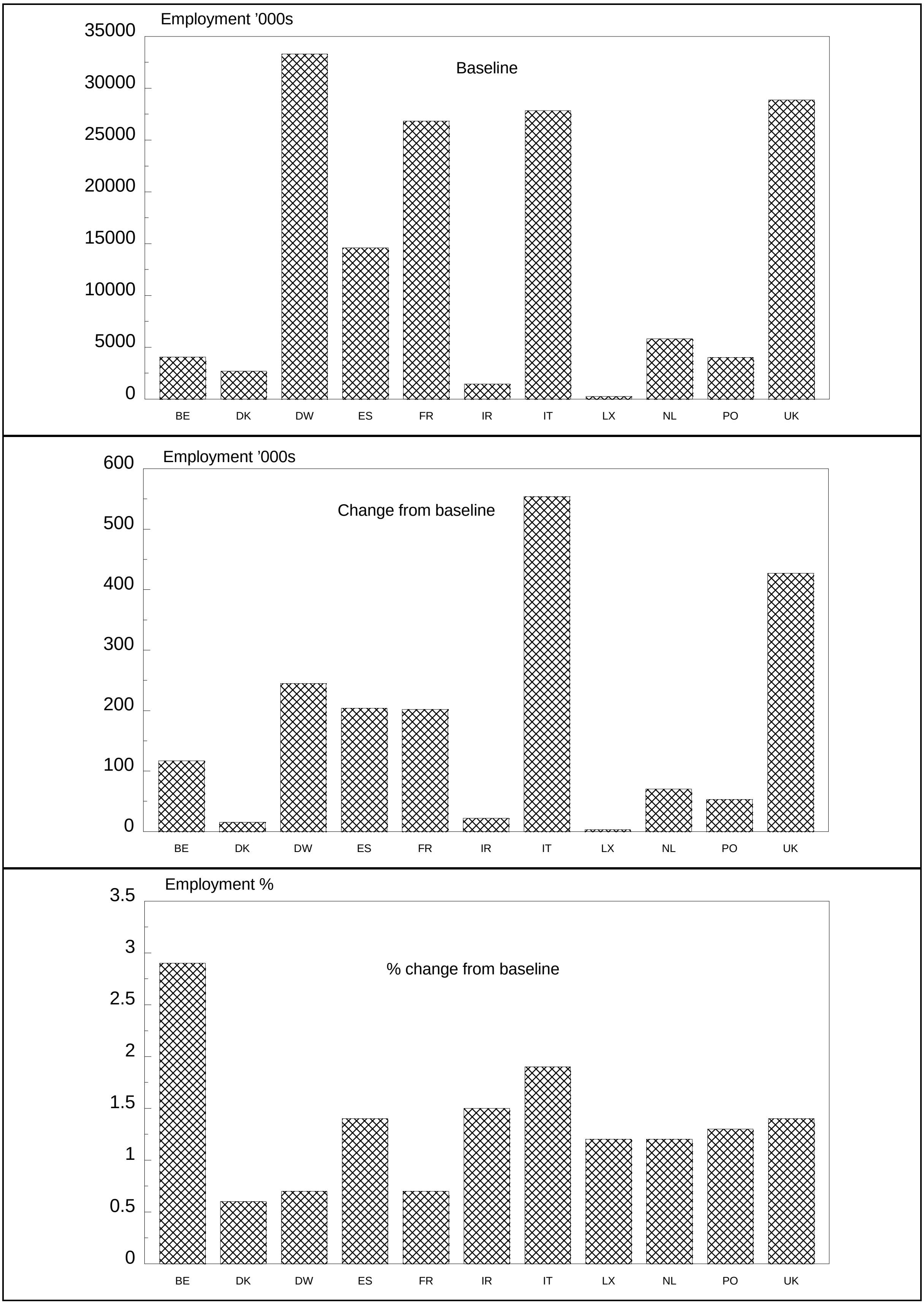
		RTCT e/tC	RCO2 mtC	RCO2 %	RGDP %	REMP th	REMP %
Belgium	(BE)	42.4	-3.0	-10.0	1.2	25.8	0.6
Denmark	(DK)	252.7	-1.5	-10.0	1.5	17.8	0.7
West Germany	(DW)	205.6	-21.4	-10.0	1.8	365.6	1.1
Spain	(ES)	106.1	-7.0	-10.0	1.0	176.2	1.2
France	(FR)	87.4	-10.3	-10.0	1.2	156.9	0.6
Ireland	(IR)	132.1	-1.2	-10.0	0.8	20.1	1.3
Italy	(IT)	119.7	-12.4	-10.0	1.6	521.4	1.8
Luxembourg	(LX)	129.1	-0.2	-10.0	1.0	2.7	1.1
Netherlands	(NL)	355.6	-4.8	-10.0	-0.9	95.8	1.6
Portugal	(PO)	312.0	-1.8	-10.0	1.7	84.8	2.1
United Kingdom	(UK)	166.9	-16.6	-10.0	2.2	500.8	1.7
EU-11		165.1	-80.2	-10.0	1.5	1967.9	1.3

Ref : E3ME13 Projection, Cambridge Econometrics C72??RAV-C72BARAV April 1998
Note : RTCT=carbon tax ecu/tonne, RCO2=CO2, RGDP=GDP, REMP=employment

CHARTS 1: CO_2 EMISSIONS BY MEMBER STATE IN 2010, CO-ORDINATED MULTILATERAL EU DUTY



CHARTS 2: EMPLOYMENT BY MEMBER STATE IN 2010, CO-ORDINATED MULTILATERAL EU DUTY



avoid any confusion; for each unilateral policy the total EU-11 effects are different as can be seen from the last column of the table. The results in the last column are those for the EU-11 together and a column sum or average is meaningless. The CO_2 results in Table 5 clearly show that there is little or no 'carbon leakage' for unilateral policies within the EU, ie unilateral action does not lead to significantly more emissions elsewhere in the EU. However, multilateral action by the EU will significantly reduce imports of oil from the rest of the world and this could in turn lead to a reduction in the world price of oil, and so encourage more world use of oil, although even in this case the extent of carbon leakage will be limited if the extra oil is used as a substitute for coal, with a higher carbon content (see Barker and Johnstone, 1998, pp. 106-108). The GDP results in Table 6 are similar across the projections. The employment results in Table 7, in contrast, show that there is significant job creation, ie unilateral policies in one member state create jobs in other labour markets via increases in imports and exports.

Tables 8, 9 and 10 provide the detail behind the summary data given in Tables 5, 6 and 7 for the simulations of unilateral policies for CO2, GDP and employment respectively. The tables show the outcome for the member state undertaking the unilateral action along the diagonal and the impacts on other member states (as covered in E3ME) along the rest of the row, with the overall EU-11 results in the final column. The interaction effects are mostly cause by the integration of the economies through international trade. The effect of unilateral action on other countries depends on the structural responses within the country taking action. If, as in the case of Spain, France and Italy, investment and exports are reduced, the effect is to reduce activity in trading partners. Table 8 shows that these negative effects of unilateral action in reducing international trade leads to other countries having lower output and lower CO_2 emissions, a feature of leakage analysis in some of the global models (Barker and Johnstone, 1998, p.94). However, most member states have small positive, but negligible, carbon leakage for unilateral action. The GDP effects on Table 9 are also positive and negative, depending on whether trade effects are dominated by reduced trade in energy products or increased trade in goods and services benefiting

TABLE 5: PROJECTIONS OF CO2 REDUCTIONS IN MEMBER STATES, 2010

difference from base in mtC

		MULT COOR	MULT UNCO	UNIL OWN	UNIL REST	UNIL SUM
Belgium	(BE)	-6.1	-3.0	-5.8	0.1	-5.8
Denmark	(DK)	-1.1	-1.5	-0.9	0.0	-0.9
West Germany	(DW)	-16.8	-21.4	-16.9	0.1	-16.7
Spain	(ES)	-8.0	-7.0	-8.0	-0.6	-8.6
France	(FR)	-14.7	-10.3	-14.7	-0.6	-15.3
Ireland	(IR)	-1.3	-1.2	-1.3	0.0	-1.3
Italy	(IT)	-13.1	-12.4	-13.1	-0.1	-13.2
Luxembourg	(LX)	-0.2	-0.2	-0.2	0.0	-0.3
Netherlands	(NL)	-2.8	-4.8	-2.5	0.1	-2.4
Portugal	(PO)	-1.0	-1.8	-1.0	0.0	-1.0
United Kingdom	(UK)	-15.0	-16.6	-14.9	0.3	-14.6
EU-11		-80.1	-80.2			

Ref : E3ME13 Projections, Cambridge Econometrics C72 April 1998
Note : MULT=Multilateral, COOR=Coordinated, UNCO=Uncoordinated, UNIL=Unilateral

TABLE 6: PROJECTIONS OF GDP EFFECTS IN MEMBER STATES, 2010

difference from base in %

		MULT COOR	MULT UNCO	UNIL OWN	UNIL REST	UNIL SUM
Belgium	(BE)	1.9	1.2	2.2	0.0	0.1
Denmark	(DK)	1.3	1.5	0.3	0.0	0.0
West Germany	(DW)	1.4	1.8	1.0	0.0	0.2
Spain	(ES)	1.2	1.0	1.0	-0.1	0.0
France	(FR)	1.4	1.2	1.2	0.0	0.3
Ireland	(IR)	0.8	0.8	0.3	0.0	0.0
Italy	(IT)	1.7	1.6	1.7	0.0	0.3
Luxembourg	(LX)	1.0	1.0	0.6	0.0	0.0
Netherlands	(NL)	-0.8	-0.9	0.4	0.0	0.1
Portugal	(PO)	0.6	1.7	0.9	0.0	0.0
United Kingdom	(UK)	1.8	2.2	1.9	0.1	0.5
EU-11		1.4	1.5			

Ref : E3ME13 Projections, Cambridge Econometrics C72 April 1998
Note : MULT=Multilateral, COOR=Coordinated, UNCO=Uncoordinated, UNIL=Unilateral

TABLE 7: PROJECTIONS OF EMPLOYMENT EFFECTS IN MEMBER STATES, 2010

difference from base in thousands

		MULT COOR	MULT UNCO	UNIL OWN	UNIL REST	UNIL SUM
Belgium	(BE)	117	26	136	-12	124
Denmark	(DK)	15	18	9	5	13
West Germany	(DW)	245	366	264	18	282
Spain	(ES)	204	176	149	-28	121
France	(FR)	202	157	170	-19	151
Ireland	(IR)	22	20	21	4	25
Italy	(IT)	554	521	552	4	556
Luxembourg	(LX)	3	3	3	-8	-5
Netherlands	(NL)	70	96	68	35	102
Portugal	(PO)	53	85	25	-2	23
United Kingdom	(UK)	427	501	440	67	508
EU-11		1910	1968			

Ref : E3ME13 Projections, Cambridge Econometrics C72 April 1998
Note : MULT=Multilateral, COOR=Coordinated, UNCO=Uncoordinated, UNIL=Unilateral

TABLE 8: CO2 EMISSIONS IN 2010, UNILATERAL EU DUTY, REVENUE RECYCLING

difference from base in mtC

		BE	DK	DW	ES	FR	IR	IT	LX	NL	PO	UK	EU11
Belgium	(BE)	-5.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	-5.8
Denmark	(DK)	0.0	-0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.9
West Germany	(DW)	-0.1	0.0	-16.9	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	-16.7
Spain	(ES)	-0.1	-0.1	0.0	-8.0	0.0	0.0	0.0	0.0	-0.3	0.0	-0.1	-8.6
France	(FR)	-0.1	-0.1	0.0	0.0	-14.7	0.0	-0.1	0.0	-0.3	0.0	0.0	-15.3
Ireland	(IR)	0.0	0.0	0.0	0.0	0.0	-1.3	0.0	0.0	0.0	0.0	0.0	-1.3
Italy	(IT)	0.0	0.0	-0.1	0.0	0.0	0.0	-13.1	0.0	0.0	0.0	0.0	-13.2
Luxembourg	(LX)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	0.0	0.0	0.0	-0.3
Netherlands	(NL)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-2.5	0.0	0.0	-2.4
Portugal	(PO)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.0	0.0	-1.0
United Kingdom	(UK)	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.0	-14.9	-14.6

Ref : E3ME13 Projection, Cambridge Econometrics C72??RAV-C72BARAV April 1998

TABLE 9: GDP IN 2010, UNILATERAL EU DUTY, REVENUE RECYCLING

% difference from base

		BE	DK	DW	ES	FR	IR	IT	LX	NL	PO	UK	EU11
Belgium	(BE)	2.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	-0.4	-0.7	0.0	0.1
Denmark	(DK)	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
West Germany	(DW)	-0.2	0.3	1.0	0.1	0.0	0.1	0.0	0.1	-0.7	0.6	0.0	0.2
Spain	(ES)	-0.1	0.0	0.0	1.0	-0.1	0.1	-0.1	0.0	0.0	0.0	0.0	0.0
France	(FR)	-0.3	0.0	0.0	0.0	1.2	0.0	0.0	0.0	-0.1	0.3	0.0	0.3
Ireland	(IR)	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
Italy	(IT)	0.0	0.1	0.0	0.1	0.0	0.2	1.7	0.1	-0.1	-0.1	0.0	0.3
Luxembourg	(LX)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0
Netherlands	(NL)	0.0	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.4	-0.1	0.0	0.1
Portugal	(PO)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0
United Kingdom	(UK)	0.1	0.4	0.3	0.0	0.1	0.2	0.1	0.2	0.0	0.0	1.9	0.5

Ref : E3ME13 Projection, Cambridge Econometrics C72??RAV-C72BARAV April 1998

TABLE 10: EMPLOYMENT IN 2010, UNILATERAL EU DUTY, REVENUE RECYCLING

difference from base in thousands

		BE	DK	DW	ES	FR	IR	IT	LX	NL	PO	UK	EU11
Belgium	(BE)	136	1	-14	3	1	0	1	0	1	0	-4	124
Denmark	(DK)	1	9	1	1	1	0	1	0	0	0	0	13
West Germany	(DW)	-4	2	264	9	6	0	3	0	0	3	-1	282
Spain	(ES)	-3	0	-5	149	-11	0	-9	0	2	2	-3	121
France	(FR)	-6	0	1	2	170	0	-8	0	1	0	-9	151
Ireland	(IR)	0	0	1	1	1	21	0	0	0	0	0	25
Italy	(IT)	-2	0	-31	18	5	0	552	0	-2	16	0	556
Luxembourg	(LX)	-1	0	-3	0	0	0	-1	3	0	0	-1	-5
Netherlands	(NL)	-2	0	10	8	11	0	4	0	68	3	1	102
Portugal	(PO)	-1	0	0	0	0	0	-1	0	0	25	0	23
United Kingdom	(UK)	2	2	15	14	17	1	11	0	1	4	440	508

Ref : E3ME13 Projection, Cambridge Econometrics C72??RAV-C72BARAV April 1998

by the reduced labour costs. The Netherlands and Belgium, both with substantial re-exports of oil, tend to have more negative secondary effects from other countries' unilateral actions. Table 10 shows that the secondary employment effects are also mixed, although positive effects tend to dominate: the Netherlands and the UK have the largest positive effect with unilateral action leading to 2 or 3 jobs created in the other EU-11 for every 10 jobs created at home.

As a summary of the overall internal and external financial effects, Table 11 shows the effects on governments' general borrowing requirements and Table 12 shows the effects on the current balance of trade for goods and services, both balances being measured as % of GDP in current prices. Government borrowing is down some 0.5% of GDP overall; although the direct tax changes are revenue-neutral, the extra activity in the economies generates more revenues for other taxes such as VAT and income tax. Only in Denmark is there a noticeable increase in borrowing. As regards the balance of trade, there is no overall EU-11 effect. There are reductions in the trade balance for some and increases in the balance for others. The large negative effect for Ireland is partly due to large trade surpluses in the base case. Italy, the Netherlands and the UK also show negative trade-balance effects with lost revenues as exports and re-exports of oil fall below base levels.

5: A Comparison of GEM-E3 and E3ME Results on the Double Dividend

The econometric E3ME model has been developed in parallel with a general equilibrium model GEM-E3 as a means for analysing E3 issues for the EU. It so happens that Conrad and Schmidt (1997) have reported on a study looking at the same issue, viz coordinated versus uncoordinated CO_2 taxes to reduce emissions by 10% in the EU, but using GEM-E3. It is therefore possible to compare in detail the results, thereby giving some insights into the different methodologies.

TABLE 11: PROJECTIONS OF GOVERNMENT BORROWING (AS %GDP) IN MEMBER STATES, 2010

difference from base in percentage points

		MULT COOR	MULT UNCO	UNIL OWN	UNIL REST	UNIL SUM
Belgium	(BE)	-0.1	0.1	-0.1	0.0	0.0
Denmark	(DK)	0.5	1.0	0.3	0.0	0.0
West Germany	(DW)	-0.1	-0.2	-0.3	0.0	-0.1
Spain	(ES)	-0.4	-0.3	-0.5	0.0	-0.1
France	(FR)	-0.2	-0.1	-0.2	0.0	0.0
Ireland	(IR)	-1.0	-0.9	-1.1	0.0	0.0
Italy	(IT)	0.1	0.1	0.0	0.0	0.0
Luxembourg	(LX)	0.1	0.1	-0.3	0.0	0.0
Netherlands	(NL)	-0.5	0.8	-0.5	0.0	0.0
Portugal	(PO)	-0.2	-0.6	-0.3	0.0	0.0
United Kingdom	(UK)	-1.8	-2.1	-1.8	0.0	-0.4
EU-11		-0.5	-0.5			

Ref : E3ME13 Projections, Cambridge Econometrics C72 April 1998
Note : MULT=Multilateral, COOR=Coordinated, UNCO=Uncoordinated, UNIL=Unilateral

TABLE 12: PROJECTIONS OF BALANCE OF TRADE (AS %GDP) IN MEMBER STATES, 2010

difference from base in percentage points

		MULT COOR	MULT UNCO	UNIL OWN	UNIL REST	UNIL SUM
Belgium	(BE)	0.6	0.7	0.7	0.0	0.0
Denmark	(DK)	0.2	0.1	-0.2	0.0	0.0
West Germany	(DW)	0.1	0.1	0.0	0.0	0.0
Spain	(ES)	0.6	0.6	0.7	0.0	0.1
France	(FR)	0.6	0.5	0.5	0.0	0.1
Ireland	(IR)	-2.9	-2.7	-2.7	0.0	0.0
Italy	(IT)	-0.2	-0.2	-0.3	0.0	-0.1
Luxembourg	(LX)	0.8	0.8	0.4	0.0	0.0
Netherlands	(NL)	-1.0	-1.5	-0.7	0.0	0.0
Portugal	(PO)	0.4	0.9	0.4	0.0	0.0
United Kingdom	(UK)	-0.4	-0.5	-0.5	0.0	-0.1
EU-11		0.0	0.0			

Ref : E3ME13 Projections, Cambridge Econometrics C72 April 1998
Note : MULT=Multilateral, COOR=Coordinated, UNCO=Uncoordinated, UNIL=Unilateral

TABLE 13: FEATURE OF GEM-E3 AND E3ME

	GEM - E3	E3ME
Coverage	11 member states: BE, DK, DW, EL, ES, FR, IR, IT, NL, PO, UK	11 member states: BE, DK, DW, ES, FR, IR, IT, LX, NL, PO, UK
Sectors	11	30
Production	CES cost functions with constant returns to scale	Factor demand equations (energy, labour) with varying returns to scale
Trade	Bilateral trade with Armington assumption	Trade into and out of an EU 'pool'
Closure of Goods and Services market	Rate of return affecting investment	Output and imports jointly determined from total demand
Product competition	Perfect competition	Varies by industry

Table 13 lists some of the differences in approach in the two models. They cover almost the same 11 countries, but the version of GEM-E3 includes Greece and excludes Luxembourg while that of E3ME excludes Greece and includes Luxembourg. GEM-E3 distinguished 11 sectors, E3ME 30 sectors. However GEM-E3 is an optimising model with equilibrium in most markets assuming perfect competition and constant returns to scale, with closure via the rate of return for investment. E3ME has estimated price and factor demand equations allowing varying degrees of competition and returns to scale, depending on estimated industrial parameters. In GEM-E3 trade is bilateral; in E3ME trade is into and out of a common EU transport and distribution network. GEM-E3 is calibrated on a set of input-output tables for 1985; E3ME is estimated on annual data 1968-1993 also using input-output tables for 1985. The different treatment of time in the two studies is illustrated by the fact that in GEM-E3 the 10% reduction in CO2 is imposed for 1985, the base year, but in E3ME the 10% reduction is achieved gradually over the period 1999-2010 by increasing excise duties each year. One difference between the studies which is important for results for different member states is that in GEM-E3 the electricity industry is taxed on its inputs, but in E3ME it is taxed on its outputs, so that the industry does not respond by substituting away from fuels with a high carbon content. The E3ME treatment follows that proposed by the European Commission for the carbon/energy tax and the additional excise duties on energy products. The higher substitutability in GEM-E3 leads to the expectation that the carbon tax will be lower to achieve a 10% reduction in CO2 than that in the E3ME study, an expectation borne out by the results.

Table 14 shows the main macroeconomic results from the two studies. The studies are agreed on two major findings. First, there is a double dividend for the EU-11 with an increase in employment of 0.4% in GEM-E3 and of 1.4% in E3ME. The double dividend is apparent in the results for all member states covered by both studies whether tax rates are coordinated or not or whether action is multilateral or unilateral. From the earlier studies of the double dividend (Carrero and Siniscalco, 1996), it is the modelling of the labour market which is crucial for the finding. In the version of GEM-E3 behind these results, wage determination is modelled by assuming that the real wage follows the rate of labour productivity. In E3ME the wage equation is also estimated such that, in the long run, real wage rates are determined by productivity changes.

The second major agreement between the studies is that the effects of a coordinated policy are surprisingly small. In the GEM-E3 results, the overall tax rate rises by 7.7%, in E3ME by 5.5%, when

TABLE 14: MACROECONOMIC EFFECTS OF MULTILATERAL POLICIES TO CUT CO_2 EMISSIONS: GEM-E3 AND E3ME RESULTS COMPARED FOR EU11

Model	GEM-E3		E3ME	
Source	Conrad and Schmidt		This paper	
	COOR	UNCO	COOR	UNCO
CO_2 tax in ecu/tonne C	118.8	120.5	156.5	165.1
		% difference from base		
CO_2 reduction	10	10	10	10
GDP	0.15	0.17	1.40	1.46
Employment	0.40	0.44	1.23	1.29
Gross output	-0.35	-0.36	0.39	0.47
Consumption	0.27	0.28	1.61	1.72
Investment	-0.57	-0.58	-0.16	0.05
Exports	-0.45	-0.46	0.19	0.38
Imports	-0.67	-0.74	-0.73	-0.40

Note(s) : The coverage of the EU11 is slightly different in the models and the definitions of the macrovariables may differ.

tax rates are not coordinated. The range of the uncoordinated tax rates is narrower for the GEM-E3 results (76 ecu/tC 1999 prices for Belgium to 319 ecu/tC for Denmark) compared with that for the E3ME results (42 ecu/tC for Belgium to 356 for the Netherlands) perhaps reflecting the assumptions of similar behaviour between member states in the general equilibrium approach. The closeness of the two sets of results (coordinated and uncoordinated, marked COOR and UNCO in Table 14) shows that both models agree that international competitiveness effects are likely to be small if not negligible.

Table 14 also shows some important differences between the studies. The first is the much lower overall tax rate in GEM-E3: the rate in E3ME is 32% higher to achieve the same result. This is partly because GEM-E3 study imposes the carbon tax on electricity inputs, but this does not seem enough to explain the difference. There must also be generally higher substitution possibilities in GEM-E3, a feature of general equilibrium versus econometric models described by Repetto and Austin in their comparative study (1997). The second major difference is that the GEM-E3 GDP, output and consumption results are all much smaller than those in the E3ME study. In the GEM-E3 study, exports are some 0.5% lower than base; in the E3ME study exports are some 0.2 to 0.4% higher. There are weaker feedbacks between output, consumption and investment in GEM-E3, so that the increase in GDP is not amplified as much as in E3ME.

These points are illustrated by Charts 3 and 4 which plot the results for changes in CO_2 emissions and employment for the 10 member states which are common to both studies: Chart 3 shows the results from GEM-E3 and Chart 4 from E3ME on the same scale and with the tax rates converted to ecu per tonne carbon in 1999 prices (ecu/tC). The charts show the effects of coordinated and uncoordinated multilateral tax rates: the coordinated results are shown as '*'s along the horizontal line given by the common tax rate; and the uncoordinated results are shown as 'O's along the vertical line given by the -10% reduction in CO_2 emissions. The results for the outlier states are joined with an arrow to show the direction of more coordination.

CHART 3: CO_2 AND EMPLOYMENT IN GEM-E3: EFFECTS OF MULTILATERAL CARBON TAXES

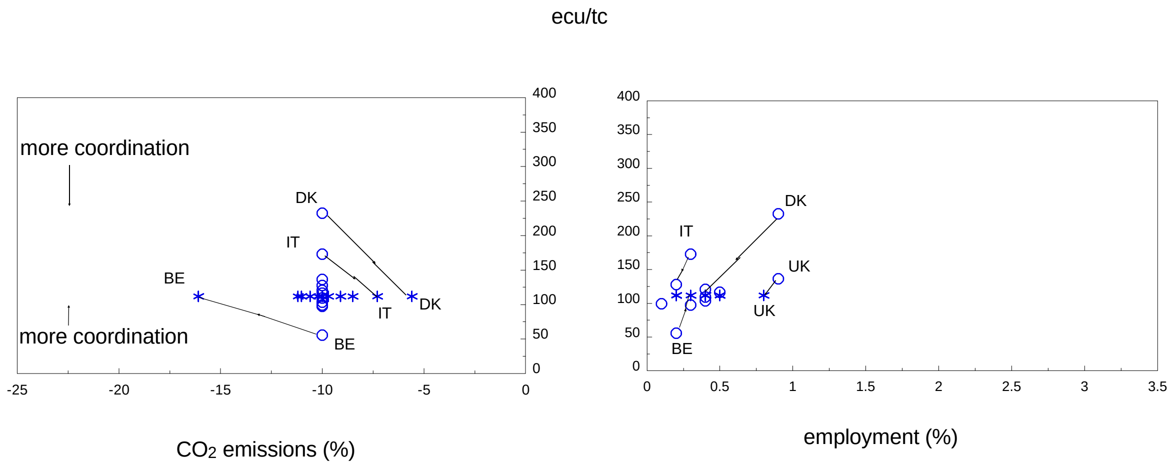
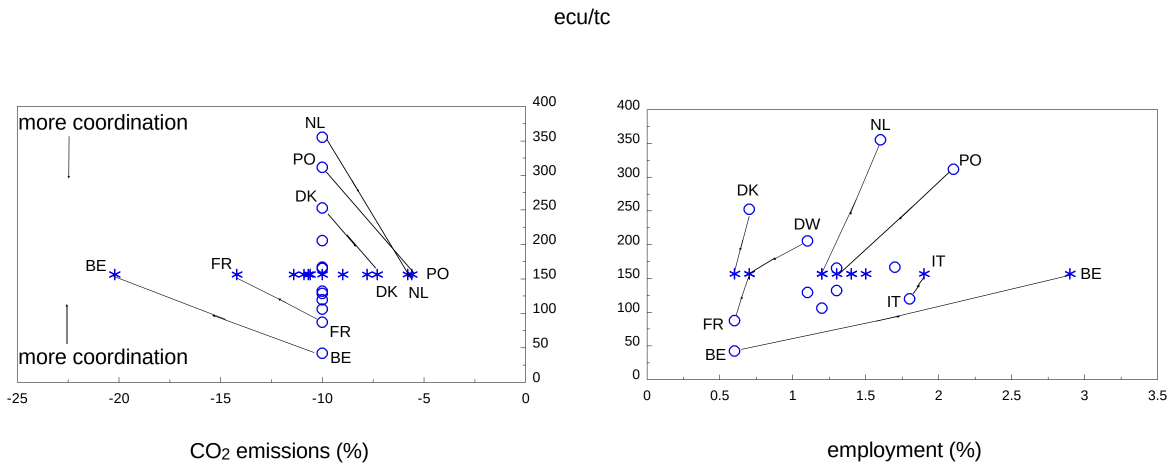


CHART 4: CO_2 AND EMPLOYMENT IN E3ME: EFFECTS OF MULTILATERAL EXCISE DUTIES



Some results are common to both studies. The finding of the double dividend in each member state is shown by the emission changes always being negative and the employment changes always positive in the charts. The effects of more coordination is for those states with tax rates higher than the common rate moving to have a smaller emission reduction, and vice versa for those states with lower rates. When the tax rates fall, there is less revenue to recycle, so the employment gains are also lower and vice versa as shown in the right-hand panels of the charts. Other results in the charts show the differences between the modelling approaches. First, the results from GEM-E3 are clearly clustered closer together than those from E3ME, illustrating the greater range of estimated coefficients in E3ME as an econometric model. Second there is the higher tax rates in E3ME. And third the employment effects are much larger in E3ME, associated with the higher output and GDP effects.

6. Conclusions

The main findings of the study are

1) All member states benefit from a double dividend in the results, with the scale of the dividend depending on the operation of the labour market and the inflexibilities in the energy structures. Those with the most inflexible structures raise the most revenues and reduce labour taxes the most. From this perspective, the 'burden sharing' problem is one of sharing the political costs on changing the tax system, rather than any significant real costs for the economies, given a long time period for adjustment and relatively low rates of tax (156 ecu per tonne by 2010 or $16 per barrel oil equivalent). The scale of the employment increase is modest, some 1.2% above base, and some of the increase comes from increases in participation in the labour market, rather than reductions in unemployment. However the results confirm the findings of other empirical work (DRI, 1991, 1994; Capros et a 1997; Conrad and Schmidt, 1997) that significant reductions in GHG emissions via a shift in taxes from labour to pollution are not likely to reduce EU GDP and incomes let alone employment.

2) The differences between multilateral coordinated and uncoordinated tax policies are relatively small. There is an increase of some 5% in efficiency when tax rates are coordinated (ie the overall tax rate is 5% less) but this means that, ironically, the revenue recycling is less and therefore the double dividend is lower.

3) Unilateral policies can have significant but mixed effects on other member state's labour markets, eg a unilateral UK tax is estimated to increase employment by 440,000 in the UK and 67,000 in other EU countries by 2010.

4) Any carbon leakage from unilateral policies is negligible in these projections.

Qualifications

These findings are subject to many qualifications and the paper concludes with three of the most important. First, exchange rates and the world oil price are assumed fixed at baseline values in the different projections. The exchange rate assumption seems reasonable in that most member states are expecting to enter a single currency and the overall effects of the EU balance of trade with the rest of the world are very small. There is however, a downward pressure on world oil prices in the projections as the imports of oil to Europe would decline: the implicit assumption is that OPEC would act as a swing producer and bear the burden of reduced world oil supply to maintain the oil price.

A second qualification is the acceptability of the assumed switch in the tax structure, so that in the short run consumers will pay more carbon-based taxes and industry would pay less employment-based taxes.

The labour market is assumed to behave as it did on average over the data period in that some of the decrease in employment taxes are taken as increases in wage rates, but that the overall costs of labour fall and the fall is passed on as a fall in prices (compared to the base). Such tax shifts must take place in an atmosphere of cooperation in the labour market if they are not to lead to competition between unions and employers and more wage inflation.

The third qualification is more basic. The model used for the projections uses relationships estimated on past data; but technologies become obsolete and institutions change. The model outcomes largely rely on the future continuing along the same path as the past.

7. References and Reading

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