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Economic, Environmental and International Trade Effects of the EU Directive on Energy Tax Harmonization[1]

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Table of Contents

Abstract

In October 2003, the European Union introduced a Directive which widens the scope of the EU's minimum taxation system from mineral oils to all energy products including coal, natural gas and electricity. It aims at reducing distortions that currently exist between Member States as well as between energy products. In addition, it increases previous minimum tax rates and thus the incentive to use energy more efficiently. The Directive will lead to changes in the energy tax schemes in a number of countries, in particular some southern Member Countries (Greece, Spain, Portugal) and most of the Eastern European EU candidate countries.

In this paper, we analyze the effects of the EU energy tax harmonization with GTAP-E, a computable general equilibrium model. Particular focus is placed on the Eastern European countries which became new members of the EU in May 2004. We investigate the effects of the tax harmonization on overall economic growth and sectoral development. Special attention is paid to international trade in order to analyze if competitiveness concerns which have been forwarded in the context of energy taxation are valid. Furthermore, the effect on energy consumption and emissions and thus the contribution to the EU's climate change targets is analyzed.

JEL classification: C680, F180, H230, O520, Q480

1 Introduction

In October 2003, the European Union introduced a Directive restructuring the Community framework for the taxation of energy products and electricity (2003/96/EC). It widens the scope of the EU's previous minimum tax rate system from mineral oils to all energy products (including coal, natural gas and electricity) and increases the rates of previously existing minimum tax taxes. It thus aims at reducing distortions that currently exist between Member States and between mineral oils and the other energy products which up to now have not been subject to EU tax legislation. The Directive is considered an essential requirement for both the proper functioning of the internal market and the coherence of energy, transport and environment policies in Europe.

The Directive is the result of a series of attempts to establish a comprehensive and more stringent system of energy taxation in Europe. In 1992, a Community system for taxing mineral oils was established by two Directives. One dealt with the harmonization of the structure of excise duties on mineral oils (92/81/EEC) while the other focussed on the approximation of the rates of excise duties on mineral oils (92/82/EEC). This system, however, was far from a full harmonization of oil taxation. Authorized by the Council, Member States introduced numerous exemptions or reductions for specific policy considerations, adding up to more than one hundred special provisions in the 15 Member States.

The attempt to introduce a European CO_2/energy tax which was launched in 1992 (COM/92/226 FINAL) met strong resistance from several Member States. Since tax issues have to be decided unanimously in the EU, the attempt was first revised (COM/95/172 FINAL) and finally given up. Subsequently, the European Commission presented a proposal for a taxation framework of energy products (including coal and gas) and electricity in 1997. After a long process of discussion and modification of this proposal the Council of the European Union finally adopted the Directive 2003/96/EC of 27 October 2003 restructuring the Community framework for the taxation of energy products and electricity. The Directive is substantially less stringent than the 1997 proposal. It gives minimum tax rates to comply with by January 2004 for various fuel types and electricity depending on whether it is used as a fuel, for industrial or commercial purposes or for heating. For a number of energy products and for electricity, minimum rates will be increased again by January 2010. The Directive includes various general and Member specific exemptions and transitional periods. In addition, an amendment was adopted as of April 2004 by the EU's Council of Ministers that allows the EU accession countries temporarily to apply country specific exemptions or lower rates of excise duty.[2] The exemptions may last no longer than 2012.

Following the Commission's presentation of the new tax proposal in 1997, a number of studies were conducted to analyze its economic and environmental effects (e.g. Barker, 1998; Kouvaritakis 2003; Klok 2002; Heady 2000). Jansen and Klaassen (2000) use three EU-wide top-down simulation models to study the macroeconomic and sectoral impacts of the 1997 proposal. They focus on the double dividend debate[3] and analyze the effects of different ways

[2] The EU accession countries, in the following also referred to as new EU Member States, EU+10 or new Eastern European EU Member Countries, include: Czech Republic, Cyprus, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia. EU15 relates to the 15 (old) European Union Member Countries: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain, Sweden, UK. EU25 corresponds to the sum of both, i.e. to all EU Member Countries as of May 1st 2004.

[3] The double dividend hypothesis stipulates that by using the additional revenue from environmental taxes to reduce existing distortions of the tax system welfare gains or other benefits could be reaped in addition to the reduction of environmental externalities. Cf. Goulder (1995).

of allocating tax revenues in order to understand whether (and if so how) a double dividend can be obtained. All models in the analysis confirm that the proposal will have positive macroeconomic impacts if the tax revenues are recycled by reducing social security contributions paid by employers. GDP and employment are expected to be higher and CO_2 emissions lower in almost all Member States. Sectoral impacts are modest, the energy sector is expected to suffer the most. The models show significant differences in their results which are mainly due to the model types, country coverage, and the way tax exemptions are handled.

The study by Heady et al. (2000) uses a bottom-up engineering approach for calculating the effects of the proposed tax. CO_2 abatement cost curves (or CO_2 savings supply curves in their terminology) are estimated to analyze the impact of energy taxes on energy and CO_2 savings. The model further calculates the cost-effective investments necessary to achieve the CO_2 savings and the effects on employment. The results of this model reveal the same direction of the effects as the top-down models and support the double–dividend hypothesis. The results range in the upper end of the scale compared to the top down model results.

None of those studies, however, investigate the effects of the final directive. In this paper, we go beyond those studies in analyzing the effects of the EU Directive on tax harmonization as actually put into force in January 2004. We compare the effects with those that would have resulted from the more stringent 1997 proposal. We pay special attention to environmental and trade effects in those countries where substantial changes in the tax schemes are required, in particular the new Eastern European EU member countries but also some southern member countries (Greece, Spain, Portugal). We make use of the most recent GTAP data set which includes detailed sectoral data on Eastern European countries. Using a 13 sector, 12 region aggregation of the GTAP-E model, we simulate three policy scenarios to investigate the comparative static effects of the tax harmonization on economic growth, energy consumption and emissions, as well as on international trade

The paper is organized as follows. We first provide a brief overview of the main features of the new EU Directive on energy tax harmonization. This following, we introduce the modeling framework and discuss the underlying data. In the consecutive section, we present the model scenarios and a discussion of the results. The last section summarizes the analysis and concludes the paper.

2 The EU Directive on Energy Taxation

This section summarizes the Directive 2003/96/EC for the taxation of energy products and electricity. Table 1 outlines the minimum levels of taxation according to the Directive. The main characteristics of the Directive are described in the following.

- Energy products are taxed if they are used as fuel or for heating, but not if used for other purposes (raw materials, chemical reductions or in electrolytic or metallurgical processes, dual use).
- Crude oil is not subject to taxation.
- Electricity input is taxed, not so however energy carriers as input to electricity generation.
- Energy inputs to district heating are not taxed, while energy inputs for heat generation are taxed.
- Energy use for certain industrial or commercial purposes is subject to reduced minimum tax rates, in particular in stationary engines and for agricultural purposes, compared to the taxation levels applicable to fuel used in motor cars.
- Specific provisions apply to the taxation of commercial diesel in order to mitigate the effects on competitiveness for road hauliers. Moreover, the Directive allows to apply higher tax rates for the non-commercial use of diesel and thus to reduce the existing gap between diesel and gasoline tax rates in this user category.
- Lower tax rates on business than on non-business use are possible.
- Many other exemptions and tax reductions are permitted as long as they are not detrimental to the proper functioning of the Internal Market and will not result in distortions of competition.
- Energy products used for air navigation or maritime transport within Community waters are exempt. However, domestic flights and flights between Member States which entered into a pertinent bilateral agreement may be taxed.
- Renewable energy sources, energy used for combined heat and power generation (CHP) and CHP-electricity, as well as energy used for the carriage of goods and passengers by train, metro, tram or trolleybus may be exempt from the tax.

- The tax burden on energy intensive firms (with energy costs of at least 3 % of the production value or energy tax amounting to at least 0,5 % of the added value) may be limited .
- Taxes may be reduced for firms that have entered into commitments to reduce CO_2 emissions or where tradable permit schemes are implemented (down to zero in the case of energy-intensive businesses and down to 50% in the case of other businesses).
- Furthermore, the Directive includes a series of general and Member specific transitional periods (article 18, Annex II, and Amendment as of April 2004). Member States with difficulties in implementing the new minimum levels of taxation will be allowed a transitional period until 1 January 2007, particularly in order to avoid jeopardizing price stability, provided that this does not significantly distort competition.

Table 1
Minimum levels of taxation according to Directive 2003/96/EC

Energy Carriers	Units	Motor fuels			Heating fuels and electricity	
	in Euros per...	1.Jan. 2004	1. Jan. 2010	special industrial, commercial purposes	non-business use	business use
Leaded petrol	1000 l	421	421	-	-	-
Unleaded petrol	1000 l	359	359	-	-	-
Gas oil	1000 l	302	330	21	21	21
Kerosene	1000 l	302	330	21	0	0
Heavy fuel oil	1000 kg	-	-	-	15	15
LPG	1000 kg	125	125	41	0	0
Natural gas	GJ gcv	2,6	2,6	0,3	0,3	0,15
Coal, coke	GJ gcv	-	-	-	0,3	0,15
Electricity	MWh	-	-	-	1	0,5

gcv – gross calorific value
Source: Directive 2003/96/EC, European Commission.

A comparison of the new minimum and the actual taxation (Table 2) reveals that in the 15 old Member States in many cases no or only small changes will be necessary to fulfill the Directive. Even if one disregards possible exemptions and reduced rates in the transition period, the necessary tax changes in most cases are not very significant except for Greece. In fact, tax rates in some countries are already substantially higher than the new minimum taxes.

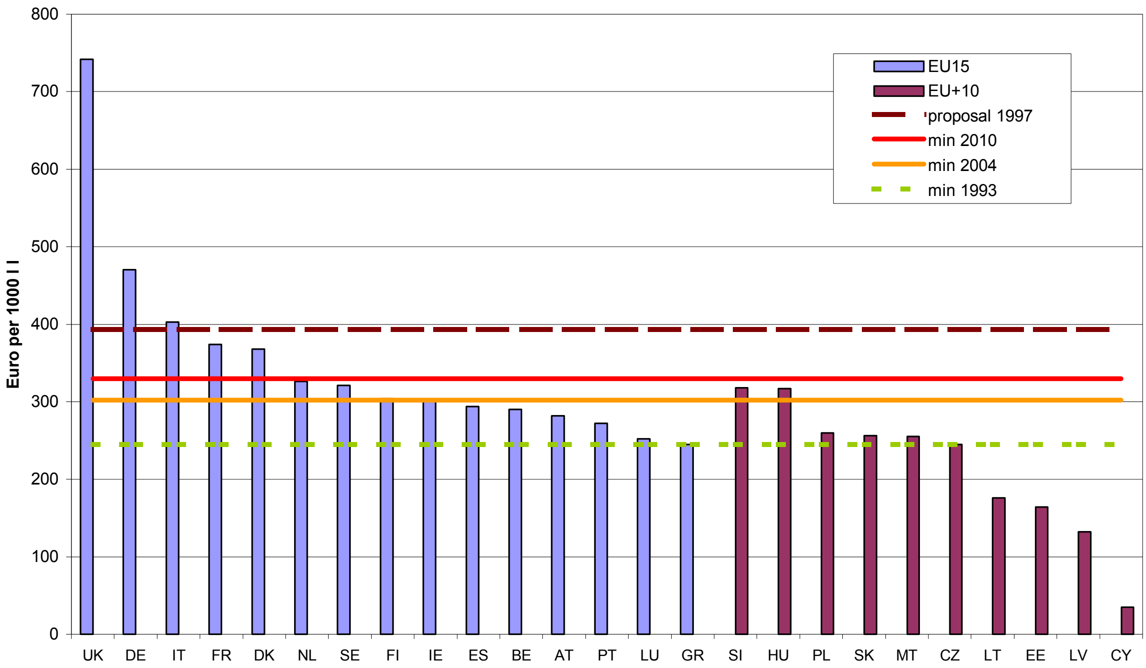
Table 2
Comparison of minimum and actual taxation

		Minimum taxation		Actual taxation in member states (2002)																		
Energy Carriers	in euro per ...	1997 Proposal	Directive 2004/10	AT	BE	DK	FI	FR	DE	GR	IE	IT	LU	NL	PT	ES	SE	UK	CZ	HU	PL	SI
Unleaded Petrol	1000 l	500	359	414	507	548	559	581	624	296	401	542	372	628	470	396	504	729	351	409	381	276
Diesel (Transp.)	1000 l	393	302/330	290	304	370	304	383	440	245	304	403	253	344	269	294	341	729	264	336	255	276
LFO	1000 l	39	21	76	13	279	68	49	61	166	47	403	5	198	33	85	279	50	0	0	42	0
Heavy fuel oil	1000 kg	34	15	36	6	52	57	19	18	19	14	31	6	32	27	14	..	44	0	0	0	0
Nat. Gas	GJ gcv	0,7	0,3 a)	1,0	0,3	7,2	0,5	0	1,0	0	0	4,3	0	2,5	0	0	4,5	0	0	0	0	0
Coal, coke	GJ gcv	0,7	0,3 a)	0	0	7,3	2,1	0	0	0	0	0	0	0,6	0	0	10	0	0	0	0	0
Electricity	MWh	3	1 b)	20	1,4	89	7,0	7,3	17,9	0	0	40	2,4	45	0	5,1	22	0	0	0	0	0,3

a) 0,15 euro for business use; b) 0,5 euro for business use; all taxes without sulphur tax and VAT; .. - data not available
White fields indicate that actual taxes are less than minimum taxes.
Sources: IEA 2003, BMU Umwelt 2003, EC 2003

However, in the new Member States actual tax rates are often lower than the new minimum taxation. For example taxation of gas oil (diesel) is below the 2004 level in 8 of the 10 and below the 2010 level in all new Member States (Figure 1). In some cases, there is even a huge gap between actual taxation levels and the former minimum levels (in force since 1993).

Figure 1 Minimum and actual taxes on gas oil (2002, Germany 2003)



Data: EU, BMU

3 CGE Modeling Framework and Data Issues

3.1 Modeling Framework

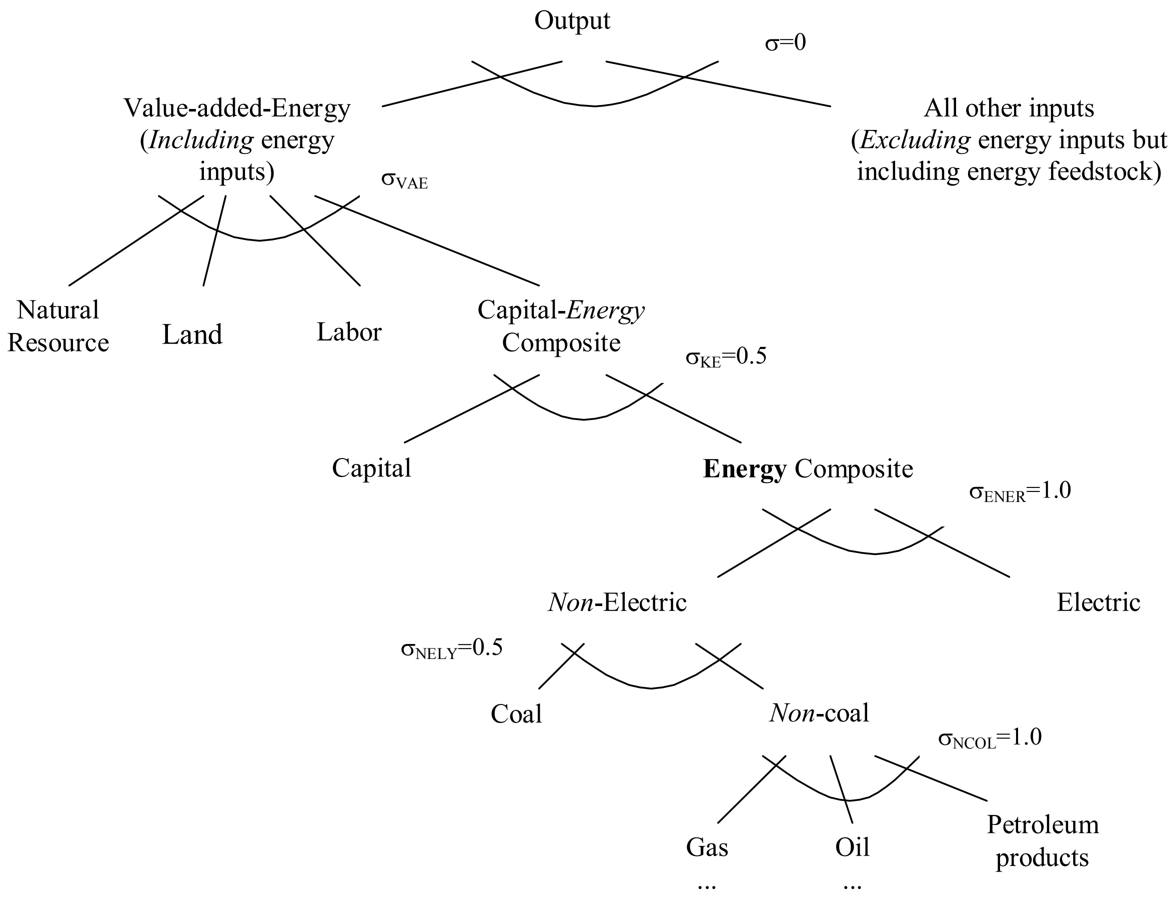
The simulation of the economic and environmental impacts of the Directive is undertaken with the computable general equilibrium (CGE) model GTAP-E as described in Burniaux and Truong (2002). GTAP-E is a modified version of the static global trade model GTAP (Hertel 1997). In its standard form, the GTAP model assumes perfect competition and constant returns to scale in production. Production is modeled with the help of a nested production tree, allowing for CES-substitutability in most nests, but assuming fixed coefficients for value added and intermediate inputs. Labor is mobile within every region, but immobile between regions. The capital stock in each country is fixed, the allocation to the sectors of production flexible. All factors of production are fully employed.

GTAP-E has been designed to analyze issues of energy and climate change policy. It differs from the standard GTAP model mainly with respect to the representation of the production structure and by accounting for absolute quantities of energy use and CO_2 emissions. The production nesting is changed in order to allow for substitution between energy and other factors of production (see Figure 2). The top level of the production tree specifies a fixed-coefficient combination of labor, non-energy intermediate inputs and a “value added-Energy” aggregate. The latter is broken down in the subsequent nest into natural resources, land, labor and a capital-energy composite. The capital-energy composite is made up by capital and an energy composite. The energy aggregate consists of electric and non-electric energy. In the bottom level nest, non-electric energy is modeled as a combination of oil, gas and petroleum products. All nests except the top level are specified as CES functions.

Public and private consumption as well as private savings are modeled as the outcome of the optimizing behavior of a “regional household” combining private households and the government. Regional household income consists of returns to primary factors and net taxes. Total regional income is allocated to government spending, private consumption and private savings by a Cobb-Douglas function, i.e. all three components obtain a (roughly) fixed share of regional income.[4] Government expenditure is allocated to specific commodities in subsequent CES nests. Private spending is broken down into an energy and non-energy composite by a CDE (Constant Difference of Elasticity) function, and are further decomposed in their components in subsequent CES nests. The choice between domestic and imported goods in consumption as well as production and the subsequent bilateral trade flows are modeled using the Armington assumption, specifying that domestic and imported commodities are imperfect substitutes. Household savings can finance either domestic or foreign investment.

[4] The shares are not exactly constant, because the use of non-homothetic CDE (Constant Difference of Elasticity) functions on the lower level can entail minor changes (McDougall 2003).

Figure 2
GTAP-E Production and Capital-Energy Composite Structure



3.2 Data Issues

The analysis makes use of the most recent GTAP data set (version 5.4) which for the first time includes detailed sectoral data for Eastern European countries. We aggregate the data in a way that allows us to investigate those countries/regions and sectors for which we expect the effects to be the largest while at the same time keeping the number of sectors and countries at a manageable level. The 13 sector aggregation as shown in Table 3 puts emphasis on energy intensive as well as energy producing industries which will be immediately affected by the new Directive. Moreover, the level of aggregation allows to investigate secondary growth and trade effects by separating non-energy intensive manufacturing into a group of labor intensive and a group of capital intensive products. The 12 regions individually cover the four largest EU15 member countries (DEU, FRA, GBR, ITA), three main EU accession countries (POL, CZE, HUN), a group of southern EU15 countries (EUS) and aggregates for i) the rest of Eastern European accession countries (XAC), ii) the rest of the EU15 Member States (XEU), the rest of OECD countries (XOECD), and the rest of the world (ROW).

Table 3
Sectoral Aggregation

Sectors		
1	AGR	agriculture, forestry, fishing, food, beverages, tobacco
2	COL	coal
3	OIL	crude oil
4	GAS	natural gas, gas manufacture, distribution
5	p_c	petroleum products, coal products
6	ely	electricity
7	TCL	textiles, clothing, etc. (labor intensive, non energy intens. manuf.)
8	M_E	machinery and equipment (capital intensive, non energy intens. manuf.)
9	MIN	non metallic minerals and products (energy intensive manufacturing)
10	MET	primary metals and metal products (energy intensive manufacturing)
11	OEIM	other energy intensive manufacturing (pulp and paper products, water)
12	T_T	trade and transport services
13	SER	other services

The EU Directive gives minimum taxes as specific taxes, i.e. in the form of Euro per physical quantity of energy. As excise taxes in GTAP-E are modeled as ad valorem taxes, tax rates need to be converted in order to serve as an input to the model. We use information on current energy prices and excise taxes (IEA 2003) to calculate the (ex ante) gross price increase (% ad valorem) needed to comply with the Directives minimum tax.[5]

According to the EU Directive, different tax rates apply to i) gas oil used as motor fuels and used for heating purposes, and to ii) natural gas, coal and coke, and electricity used for commercial and non-commercial purposes. Since gas oil, gasoline, heavy and light fuel oil etc. are all aggregated into the GTAP category p_c (petroleum products) we carry out several adjustments to account for the differing tax rates within this category. Firstly, we compose tax tables for industrial (commercial users) and for private consumption (non-commercial energy users). Secondly, we use energy consumption data for mineral oil products (EUROSTAT 2003) to calculate the share of each fuel type within the petroleum product category, separated

[5] Specifically, the gross price increase (in %) is calculated as the difference of the EU directive's minimum tax and the current excise tax in relation to the current gross price (net price plus excise tax) for each energy product.

by industry and household. We allocate the use of transport-related petroleum products to industry and household, based on the assumption that about 95% of gasoline (leaded and unleaded petrol) and 25% of road-transport related diesel is consumed for transportation purposes in the household sector.[6] The remaining part, i.e. 5% of gasoline and 75% of road transport related diesel is used within the industrial sector. The shares for each fuel type within the petroleum products category are then used to arrive at a weighted average tax increase for aggregated petroleum products for each country needed to comply with the Directive. This approach moves ahead from those applied in other studies, such as Kouvaritakis et al. (2003), Jansen/Klaassen (2000) or the original GTAP data base approach which simply allocates 50% of transport related energy consumption to households (Dimaranan and McDougall, 2002).

It is impossible to account for all industry and country specific exemptions due to the degree of aggregation in the CGE model and data problems. Nevertheless, we account for two important exemptions. Firstly, own energy use in energy producing sectors is not taxed. Secondly, energy inputs to electricity production are not taxed.[7]

3.3 Implementation of Policy Scenarios

Since the Directive sets minimum tax rates at a level below current tax rates in many Member States, there are ambiguities as to the effect of the Directive. This gives rise to two stylized policy scenarios:

a. Scenario MTH (minimum tax harmonization): In the first scenario we assume that Member States fulfill the minimum tax rates as set by the Directive. Countries whose tax rates are higher than the minimum tax hold their tax rates at the higher level. This will lead to partial harmonization of the tax rates, only.

b. Scenario FTH (full harmonization on the level of minimum taxes): The second scenario is based on the assumption that Member States with higher tax rates lower their taxes to the

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(Min. EU tax – current excise tax)/gross price with gross price = net price + excise tax. Thus, a negative sign means the actual tax is higher than the minimum tax.

[6] This assumption is supported by a German household survey conducted in 2004 which revealed similar shares (Fh-ISI Karlsruhe et al. 2004).

[7] Moreover, in calculating ad valorem taxes based on the average energy price for industry, we indirectly account for exemptions for energy intensive industries. Highly energy intensive industries usually pay lower unit prices of energy than other industries. A quantity tax as given in the Directive would thus imply a higher ad valorem tax rate for energy intensive industries. The average industry ad valorem tax increase we calculate tends to underestimate those rates and thus come closer to the reduced rates energy intensive industries need to comply with.

minimum level. While it may be unlikely that countries actually reduce their taxes based on the new Directive, it shows how far beyond the minimum tax some of the energy products in some countries or regions are currently taxed. Analyzing this scenario provides an insight as to what level of minimum taxes would be necessary if the EU strived for a full harmonization of taxes, or if all EU Member States applied just the minimum tax rates in order to avoid competitive disadvantages. Furthermore, it shows what efficiency gains can be obtained by reducing distortions from different tax rates within the EU.

Additionally, we consider a third scenario which reflects the earlier, more demanding proposal for a Directive in order to analyze if the watered-down current Directive is justified on economic grounds:

c. Scenario MTH97 (minimum tax harmonization on levels proposed in 1997): In this scenario, Member States fulfill minimum taxation according to the Commission's tax proposal in 1997 and hold their tax rates constant if they are higher (partial harmonization).

The degree of harmonization can be measured by the standard deviation related to the mean (coefficient of variance). In the case of gas oil (diesel), this indicator before minimum taxation amounts to 0.343 for EU15, 0.389 for EU+10 and 0.424 for EU25. In scenario (a) it is remarkably reduced to 0.236 for EU25, in scenario (c) to 0.169 for EU25 and in scenario (b) to zero, indicating full harmonization.

The gross price changes which would be induced by implementing the Directive's minimum (unit) taxes are given in the following tables. These serve as an input to modeling the three policy scenarios. The ad valorem tax changes are separated into average industry and household gross price changes. Table 4 shows the full tax harmonization scenario (FTH) taking into account the minimum tax rates for 2004; Member States with current tax rates lower than the Directive's minimum tax need to increase their taxes (positive numbers) while Member States with current tax rates higher than the required minimum tax choose to reduce their taxes to the minimum level (negative numbers).

Replacing negative numbers in Table 4 by zeros leads to our scenario of partial harmonization: the minimum tax harmonization scenario (MTH). Member States increase their taxes to fulfill the minimum taxation set by the Directive and hold their tax rates constant at current levels in case they are currently higher than the minimum tax.

Table 5 provides the required gross price changes to comply with the 1997 proposal. Since the 1997 proposal involved stricter rates for all energy products (compare Table 2), all gross energy price changes are higher than those required for the actual Directive. We only model the partial harmonization for the 1997 proposal. Thus, all Member States with taxes lower than the proposal increase their taxes while all other states keep their tax rates constant (MTH97). The MTH97 scenario can be derived from the FTH97 scenario in Table 5 by replacing all negative numbers with zeros.

Table 4
Gross price changes in scenario FTH (full tax harmonization) induced by implementing the minimum rates for 2004*

FTH		FRA	DEU	GBR	ITA	CZE	HUN	POL	XAC	EUS	XEU
1 col	Industry	4.2	2.9	-3.4	9.7	13.6	5.5	9.1	15.6	13.3	-16.9
	Households	5.3	3.4	4.2	3.8	17.5	8.7	9.3	30.6	-11.2	-11.2
3 gas	Industry	3.4	-9.3	-3.0	-5.7	3.4	3.0	3.4	4.5	2.9	-1.1
	Households	3.3	-8.0	3.9	-33.6	5.3	6.0	4.3	10.4	2.9	-10.6
4 p_c	Industry	-11.8	-17.3	-31.8	-19.5	6.7	-5.5	3.4	8.8	-4.9	-3.6
	Households	-17.1	-21.9	-35.0	-28.1	2.7	-3.2	-1.9	12.7	-7.2	-12.7
5 ely	Industry	1.3	-5.0	-6.3	-24.6	1.0	0.7	1.0	0.5	-0.7	-3.7
	Households	-6.6	-12.3	0.9	-26.0	1.5	1.2	1.4	1.2	-0.6	-16.8

*Scenario MTH can be derived by replacing all negative numbers with zeros.

Table 5
Gross price changes in scenario FTH97

		FRA	DEU	GBR	ITA	CZE	HUN	POL	XAC	EUS	XEU
1 col	Industry	19.6	13.7	24.1	45.4	63.3	25.6	42.6	72.7	61.9	10.4
	Households	12.5	7.9	9.8	8.8	40.9	20.4	21.6	71.3	-6.9	-6.9
3 gas	Industry	16.1	2.0	12.3	9.3	15.9	14.0	16.0	20.8	13.7	13.7
	Households	7.6	-3.2	9.1	-30.2	12.3	13.9	10.0	24.2	6.7	-5.4
4 p_c	Industry	0	-6.1	-24.5	-8.9	20.7	7.5	15.5	23.1	6.3	8.2
	Households	-4.8	-10.4	-22.4	-15.9	22.4	14.5	15.9	35.3	8.0	0.9
5 ely	Industry	7.7	-0.2	-1.8	-22.5	5.7	4.4	5.8	5.5	4.0	1.4
	Households	-4.5	-10.9	2.8	-24.7	4.5	3.7	4.1	4.3	1.4	-14.9

*Scenario MTH97 can be derived by replacing all negative numbers with zeros.

3.4 Recycling of Tax Revenues

The way in which the additional tax revenue is used is important for the effects of energy taxes. In the discussion about energy taxation, the "double dividend" issue has played a prominent role.[8] This issue, however, is not the focus of the current paper, mainly for two reasons. Firstly, the Directive does not contain any prescriptions about the tax recycling. The earlier 1997 proposal much more specifically instructed countries to follow the twofold goal of greater protection of the environment and increased employment, and thus to use the additional tax revenue to reduce labor costs. In regard of the different economic, fiscal and labor market situations within the EU Member States, all assumptions about tax recycling in light of the current Directive would have to be rather arbitrary. Secondly, the double dividend debate in Europe has been dominated by the issue of a reduction of labor costs and its effects on unemployment. However, since the GTAP data base lacks information on labor and capital income tax this aspect cannot be dealt with properly in this framework. For these reasons, the standard closure of GTAP-E was used which allocates the additional tax revenue to government spending, private consumption and private savings in the same proportions as total spending in the initial situation.

4 Analysis of the Energy Tax Policy Scenarios

The results of the simulations will be discussed in three blocks: the effects on energy and CO_2 emissions, the macroeconomic impacts and the influence on structural change and international trade.

Energy Prices, Energy Demand and CO_2 Emissions

The primary impulse of the Directive is on energy prices and demand. Energy price changes do not necessarily reflect the exact tax modification, because the induced adjustment of energy demand influences the market prices for energy (including the import prices of energy).

In general, energy demand follows changes in energy gross prices due to in- or decreased taxes (compare Table 6). In the MTH scenario, energy demand does not change much in the old Member States. In most cases, the change in demand is well below 1%, except for gas demand in France, Great Britain and the Southern European Countries, where due to an increase in gas taxes demand decreases between 2 and 3%. In the new Member States, the picture is somewhat different although the changes in energy demand are still rather limited. All new Member States apart from Hungary have to increase their energy taxes, in particular

[8] Cf. footnote 3.

those for natural gas and petroleum products (compare Table 4). In the Czech Republic, for example, compliance with the Directive leads to a price increase of 3 to 5%. In the rest of the new Member states, gas demand decreases by about 2% and demand for petroleum products by up to almost 6%. In spite of a small increase of electricity taxes in the new Member States, electricity demand increases slightly. This can be explained by the substantially higher tax increase for fossil fuels which leads to a substitution towards electricity.

In the FTH scenario, the four largest of the old Member States reduce most of their energy taxes (see Table 5). Therefore, in particular in Italy, the demand for gas, petroleum products and electricity rises between 17 and 21%. In Great Britain, the demand for petroleum products even rises by about 33%, in France and Germany by 13 and 18% respectively. As energy taxes in the Southern European Countries are more or less at the level of the Directive, the FTH scenario reveals minor effects for theses countries. The changes in energy demand range from -2 to +3%. For the new Member States the changes in energy demand are quite similar to the MTH scenario. However, the decrease in demand for petroleum products is slightly stronger despite the same changes in energy taxes as in the MTH scenario. This can be explained inter alia by higher world market prices for petroleum products due to increased demand in the other European Member States.

Table 6
Change of total demand of energy goods in volume (%)

	FRA	DEU	GBR	ITA	CZE	HUN	POL	XAC	EUS	XEU	XOECD	ROW
FTH												
col	0.39	1.97	0.05	12.48	-0.39	-0.83	-1.59	-2.03	-0.48	6.43	-0.13	-0.22
gas	-3.76	5.51	-3.02	14.61	-1.89	-2.11	-2.28	-1.91	-2.25	3.35	0.24	0.24
p_c	12.88	17.78	32.85	20.27	-4.99	1.84	-2.31	-6.93	2.61	4.38	-1.40	-1.20
ely	0.65	4.05	-0.94	19.80	0.66	-0.83	0.06	0.44	0.10	6.35	0.09	-0.09
MTH												
col	-0.98	-0.15	-0.28	-1.22	-1.62	-0.45	-1.25	-2.10	-0.53	0.14	0.04	0.05
gas	-2.64	0	-1.23	-0.01	-2.27	-1.95	-2.24	-2.10	-1.91	0.03	0	0.02
p_c	0.08	0.02	0.02	0.02	-3.45	0.04	-1.36	-5.63	0.01	0.02	0.02	0.01
ely	-0.43	0.03	-0.24	0.03	0.22	-0.38	0.19	0.39	0.05	0.02	0	0.01
MTH97												
col	-4.56	-0.54	-1.66	-5.14	-6.54	-2.32	-5.04	-8.41	-3.63	-0.76	0.19	0.25
gas	-9.01	-0.53	-5.79	-3.12	-8.94	-6.59	-8.08	-8.91	-7.30	-4.20	0.01	0.09
p_c	0.53	0.25	0.23	0.27	-11.89	-5.23	-8.40	-13.36	-4.37	-3.57	0.19	0.15
ely	-2.63	0.15	-0.34	0.51	-0.36	-1.59	-0.11	-0.85	-1.32	0.51	0	0.08

In the MTH97 scenario, all Member States have to increase their energy taxes. The only exceptions are taxes for petroleum products in France, Germany, Great Britain and Italy and electricity taxes in Germany and Italy which are currently above the thresholds. In general, the changes in energy demand in the old and the new Member States are more balanced than in the other two scenarios. Gas consumption reduces by 3 to 9%. Only in Germany, gas demand would hardly change. Demand for petroleum products decreases between 5 and 13% in the new Member States and between 3 and 4% in the southern and the remaining Member States (EUS & XEU). The effect on electricity demand is rather limited at less than 1% in all Member States, except for France, Hungary and the Southern European Member States, where the electricity demand will decrease by 1 to 3%.

Energy demand in the rest of the world (XOECD & ROW) is hardly affected in all three scenarios. The changes in the demand for the individual products are substantially below 1%. Only in the FTH scenario, the substantial increase of demand for petroleum products in the old Member States leads to decreasing demand for theses products in the rest of the world (-1 to –1,5%).

The effect on CO_2 emissions is quite remarkable for some countries (see Table 7). In the FTH scenario, CO_2 emissions increase in the old Member States and decrease in the new Member States. CO_2 emissions in the Great Britain and Italy, for example, increase by more than 15%. In contrast, the other two scenarios (MTH, MTH97) result in decreasing CO_2 emissions for all Member States. Obviously, the contribution to climate protection is much stronger in the MTH97 scenario than in the MTH scenario. In the new and Southern Member States, the latter scenario decreases CO_2 emissions by 5 to 11%. In the other Member States, the effect would be somewhat smaller but in most countries still important.

Table 7
Change of emissions by region (%)

	FRA	DEU	GBR	ITA	CZE	HUN	POL	XAC	EUS	XEU	XOECD	ROW
FTH	4.87	9.43	16.66	15.65	-2.87	-0.41	-1.69	-3.11	1.04	4.31	-0.70	-0.46
MTH	-1.11	-0.04	-0.14	-0.11	-3.23	-0.81	-1.38	-2.99	-0.72	0.04	0.02	0
MTH97	-4.12	-0.32	-0.72	-1.53	-11.17	-4.42	-5.30	-8.78	-6.12	-3.26	0.15	0.04

Emissions leakage from the EU to the rest of the world (ROW) can be observed for emissions from all energy products except for gas in the MTH scenario. CO_2 emissions in the EU25 as a whole decrease while they slightly increase in the rest of OECD (XOECD) and ROW. The latter includes the group of oil exporting countries. The leakage is highest for crude oil and petroleum product related emissions. In the FTH scenario, the opposite effect – a negative leakage - can be observed. CO_2 emissions increase for the EU25 as a whole while they decrease for the ROW, again with the exception of gas.

4.1 Macroeconomic Effects

Table 8 reports the effect on real GDP. Within the general equilibrium framework of GTAP-E all factors of production are assumed to be fully employed. Furthermore, in the current simulations, there are no changes of factor endowment or technological parameters. Therefore, an increase of GDP must be due to either a reduction of distortions (e.g. from the tax system) in the economy or an improvement of terms of trade.

Table 8
Change of real GDP and of Terms of Trade (%)

	1.1.1.1.1.1 Change of real GDP			*1.1.1.1.1.3 Change of Terms of Trade*		
	FTH	**MTH**	**MTH97**	**FTH**	**MTH**	**MTH97**
FRA	0.56	0.00	0.00	-0.10	0.00	-0.03
DEU	0.57	0.00	0.01	-0.10	0.00	0.02
GBR	0.87	0.00	0.00	0.17	0.00	-0.03
ITA	0.87	0.00	0.01	-0.10	0.00	0.02
CZE	-0.19	-0.13	-0.58	-0.14	-0.10	-0.35
HUN	0.12	-0.01	-0.44	-0.03	0.00	-0.02
POL	-0.11	-0.06	-0.40	-0.17	-0.06	-0.24
XAC	-0.22	-0.18	-0.57	0.07	0.03	0.00
EUS	0.13	0.00	-0.24	-0.15	0.00	-0.04
XEU	0.23	0.00	-0.18	-0.03	0.00	0.03
XOECD	-0.02	0.00	0.00	-0.16	0.00	0.04
ROW	-0.01	0.00	0.00	0.26	-0.01	-0.04

In the MTH scenario, which involves tax increases in some countries but no tax reductions, the effects on GDP are very small. They are slightly negative for those countries which need to substantially increase their energy taxes, namely the accession countries. The increase in energy taxes induces a reduction of energy use and thus a reduction of the productivity of the other factors of production. The scenario MTH97 displays a similar pattern, but in general the values are larger due to the fact that the required tax increases are higher in MTH97.

In the scenario of full tax harmonization (FTH) some countries substantially reduce their energy tax rates (especially Germany, Italy, Great Britain and the rest of the EU), whereas the tax increases are the same as in the scenario MTH. This produces an increase in GDP between 0,5% and almost 1% for the countries with tax reductions. It is interesting to note that two countries, France and Hungary, which only reduce the tax rates on petroleum products, also experience an increase in GDP. In the case of France, the increase is almost as large as for Germany which reduces taxes for almost all energy products. For the other countries, the negative effect on GDP is higher compared to MTH. This can be explained by the increase in energy demand in the countries with tax reductions and of the European Union as a whole which leads to increasing world energy prices. Therefore, a deterioration of the terms-of-trade can be observed for all EU countries with exception of Great Britain which is an oil exporter itself.

The energy price increase also affects the rest of the OECD and the rest of the world which now display slightly negative effects on GDP. This effect is less pronounced for the rest of the world than for the OECD, since the former group comprises the oil-exporting countries which now profit from a positive terms-of-trade effect.

Table 9
Effect on the balance of trade (% of GDP)

	FTH	**MTH**	**MTH97**
FRA	-0.08%	0.02%	0.07%
DEU	-0.37%	0.00%	-0.04%
GBR	-0.81%	0.00%	0.00%
ITA	-0.52%	0.00%	-0.01%
CZE	0.82%	0.55%	1.92%
HUN	0.00%	0.05%	0.64%
POL	0.38%	0.17%	0.76%
XAC	0.66%	0.44%	1.55%
EUS	0.02%	0.00%	0.24%
XEU	-0.08%	0.00%	0.26%
XOECD	0.11%	0.00%	-0.04%
ROW	0.13%	0.00%	-0.04%

The effect on the trade balance (Table 9) must be interpreted taking account of the macroeconomic identity *trade balance (i.e. export – imports) = savings – investment*

and the closure of GTAP-E used for these simulations. Whereas savings are an (almost) constant share of regional income, investment depends on the (current) rate of return on capital in the applied closure.[9] With an increase of energy prices the rate of return on capital, a complementary factor of production, and thus investment drops. This leads to a surplus of the trade balance if savings do not over-compensate this change. Therefore, an improvement of the trade balance can be observed for those countries which substantially increase energy prices. In the scenario FTH, the trade balance deteriorates in those EU countries which reduce energy taxes.

4.2 Structural Effects

The analysis of structural production effects supports the results on changes in energy prices, energy demand and real GDP. Sectoral output behaves in accordance with the changes in energy price and energy demand. Consequently, the largest effects can be observed for energy producing and energy intensive sectors in those countries where tax changes are most pronounced. To illustrate the effect on sectoral output, it seems interesting to build three country clusters: 1) A group of countries with large effects: Czech Republic and the rest of accession countries (XAC), 2) a group of countries with middle range effects: France and Hungary, and 3) a group of countries with small effects: Germany and Italy. The countries in group 1 need to increase taxes for all energy products. This leads to substantial decreases in sectoral output for gas and petroleum products as well as energy intensive industries. Being at comparative advantage in terms of relative input prices, non-energy intensive industries raise their production, as does the electricity industry. The latter effect is due to significantly lower tax increases for electricity than for the other energy products. The effects are the same for all three scenarios, though they are much more pronounced in the MTH and in particular in the MTH97 scenario.

[9] In this closure an increase of the (current) rate of return in one country attracts a higher share of global investment to this region. This effect is mitigated by the assumption that higher investment brings down the *expected* rate of return.

Group 2 (France, Hungary) needs to raise taxes for all energy inputs except for petroleum products. This leads to a rather different effect on sectoral output than for group 1. In the FTH scenario both countries show a shift towards petroleum products as taxes in this sector decrease. This induces a rise in crude oil production. The remaining sectors by and large stay about the same, even though gas and electricity taxes need to be raised. The overall effect on real GDP is positive. The driving effect of the petroleum product sector is eliminated in the MTH scenario. For this reason, both countries show negligible effects on sectoral output with the exception of gas and electricity output where a more pronounced tax adjustment is required and thus output decreases.

Group 3 includes those countries where no tax increase other than for coal input is required: Germany and Italy. The effects on sectoral output are small in the MTH scenario. For the FTH scenario, an increase in output of all tax-decrease energy producing sectors other than coal – which suffers a higher tax - can be observed. Energy intensive industries report a higher output. For the MTH97 scenario, taxes will need to be increased for gas input to industry in addition to coal. Consequently, a decrease in gas production can be observed.

4.3 International Trade Effects

Whereas the level of the balance of trade is determined by the macroeconomic links the structure of imports and exports is mainly determined by the relative prices of the commodities.[10] The change of the patterns of exports and imports can be described by the indicator of revealed comparative advantage (RCA). This is calculated by dividing the export-import ratio at the sectoral level by the overall export-import ratio. Transformed into logarithms a value above zero identifies an industry which has an export-import ratio above average indicating a comparative advantage, a value below zero indicating a comparative disadvantage.

Analogously, the changes of the export-import ratio at the sectoral level compared with the changes of the total export-import ratio can be used to describe the changes in the pattern of comparative advantage (see Table 10). A positive value indicates an improvement of the comparative advantage position of the industry, a negative value indicates a deterioration.

[10] Additionally, income changes in countries with different patterns of demand can contribute to changes.

In scenario MTH and (even more pronounced) in MTH97, in accession countries the relative position of energy sectors in foreign trade is improved due to lower imports (exception is gas in CZE), in manufacturing the comparative advantage shifts from the energy-intensive sectors (MIN, MET and OEIM) to the non energy-intensive sectors (M_E and TCL), and transportation is losing while services is gaining comparative advantage. The changes in EUS show a similar picture. The opposite changes in general occur in the traditional EU countries which tend to gain comparative advantage in energy-intensive sectors and to lose in non energy-intensive sectors.

As may be expected, this pattern is more pronounced in scenario FTH. As a paradoxical result we find here an increase in comparative advantage in labor-intensive, non energy-intensive TCL for the traditional EU countries, which is due to an interaction of changes in relative factor prices and demand.

The pattern of comparative advantage in non EU countries shifts from energy commodities to manufacturing industries in the energy-saving scenarios MTH and MTH97, while the changes are in the opposite direction in the more energy-consuming scenario FTH.

Table 10
Change in RCA (revealed comparative advantage)

MTH	AGR	COL	Oil	Gas	p_c	ely	TCL	M_E	MIN	MET	OEIM	T_T	SERV	CGDS
FRA	0.0	4.1	-0.2	3.3	-0.2	0.6	-0.1	0.0	-0.1	-0.2	-0.2	0.1	0.1	-0.1
DEU	0.0	-0.1	0.0	-0.4	-0.1	-0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
GBR	0.0	0.7	0.0	0.3	-0.1	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
ITA	0.0	1.2	-0.1	-0.3	-0.1	-0.4	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
CZE	0.6	3.3	4.3	-21.7	2.8	1.6	0.2	0.1	-2.0	-1.0	0.5	-0.4	1.5	-1.0
HUN	-0.1	1.9	0.4	1.9	-0.9	0.7	0.0	0.0	-0.3	-0.5	-0.8	0.1	0.1	-0.1
POL	-0.5	6.6	2.5	2.4	1.0	2.0	0.1	0.3	-1.4	-1.4	0.0	-0.1	0.7	-0.5
XAC	-0.4	5.4	3.1	2.9	4.2	0.9	0.1	0.8	-3.9	-1.1	-0.3	-0.4	1.1	-0.5
EUS	0.0	1.9	-0.1	3.4	0.0	-0.1	0.0	0.0	-0.1	-0.2	0.0	0.0	0.0	0.0
XEU	0.0	-0.6	0.1	-0.3	-0.1	-0.2	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
XOECD	0.0	-0.3	0.0	-0.4	0.0	-0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ROW	0.0	-0.5	0.0	-0.5	0.0	-0.2	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0

FTH	AGR	COL	Oil	Gas	p_c	ely	TCL	M_E	MIN	MET	OEIM	T_T	SERV	CGDS
FRA	0.8	2.6	-8.5	6.6	-10.9	8.4	0.1	-0.1	1.1	-0.5	-0.4	1.4	-0.5	0.2
DEU	-0.1	-14.1	-11.4	-6.6	-13.8	-3.0	0.7	-0.2	3.8	1.1	0.9	1.6	-1.1	1.3
GBR	0.0	3.5	-37.5	-2.3	-20.7	-0.5	5.1	-2.0	8.4	0.5	-0.9	4.9	-3.2	3.2
ITA	1.8	-11.4	-19.9	-14.1	-14.5	-24.2	1.2	0.0	6.4	4.3	3.6	-0.1	-2.9	2.1

CZE	0.9	0.2	10.6	-22.1	8.2	12.1	0.3	0.3	-4.4	-1.4	0.6	-1.1	2.7	-1.5
HUN	0.2	4.1	5.8	5.0	0.6	4.1	-0.5	0.0	0.1	-0.7	-1.0	0.0	-0.1	0.0
POL	-0.8	9.0	10.6	5.6	6.7	2.6	0.1	1.3	-3.9	-1.9	-0.2	-0.8	1.7	-1.3
XAC	-0.5	6.5	2.9	5.4	10.4	3.5	-0.1	1.3	-6.4	-1.6	-0.6	-1.1	2.0	-0.8
EUS	0.2	4.9	0.1	9.9	-0.6	2.7	-0.2	0.6	-0.7	-0.3	0.0	0.0	0.4	-0.2
XEU	0.4	-14.7	-4.0	-1.3	4.6	-1.4	0.3	0.2	-0.6	0.7	0.7	-0.2	0.3	0.1
XOECD	-0.3	0.3	6.3	1.0	2.2	3.8	-0.3	0.2	-2.1	-0.4	-0.5	-0.7	1.0	-0.9
ROW	-0.3	1.3	3.4	0.6	1.9	0.5	-0.6	-0.1	-1.8	-0.7	-0.4	-0.7	0.5	-0.2

MTH97	AGR	COL	Oil	Gas	p_c	ely	TCL	M_E	MIN	MET	OEIM	T_T	SERV	CGDS
FRA	-0.1	17.7	-1.4	11.3	-1.3	3.6	-0.5	-0.1	0.1	-1.0	-0.9	0.5	0.1	-0.3
DEU	0.0	-1.0	0.0	-2.4	-1.3	-1.1	-0.2	-0.2	0.8	0.3	-0.1	0.2	-0.3	0.2
GBR	0.0	5.9	0.4	-2.0	-2.4	-0.5	-0.1	-0.1	0.5	0.0	-0.1	0.3	-0.2	0.0
ITA	0.0	4.3	-1.1	1.7	-1.1	-1.8	-0.1	-0.3	0.5	-0.1	-0.2	0.3	-0.2	0.1
CZE	2.1	11.0	13.5	-95.4	6.7	6.4	0.1	0.2	-5.7	-4.3	1.2	-0.3	5.0	-3.6
HUN	-1.3	7.8	8.6	5.9	1.4	2.8	0.7	0.7	-5.2	-2.4	-3.8	-0.2	1.9	-1.1
POL	-2.2	24.6	14.1	7.9	5.8	8.2	0.3	1.1	-5.8	-6.2	0.0	-0.3	2.8	-2.4
XAC	-1.0	21.2	7.9	10.4	7.2	5.4	0.3	2.6	-11.4	-5.2	-1.5	-0.2	3.7	-2.1
EUS	0.0	13.0	5.0	3.1	2.7	2.6	0.3	0.3	-3.0	-2.0	-0.9	-0.3	1.0	-0.9
XEU	-0.4	0.0	1.9	7.1	2.4	0.6	-0.1	0.6	-1.7	-0.2	0.0	-1.1	1.1	-0.5
XOECD	0.1	-1.3	-0.5	-2.3	-0.4	-1.6	0.0	0.0	0.6	0.3	0.1	0.1	-0.4	0.3
ROW	0.1	-2.2	-0.3	-2.6	-0.4	-1.2	0.1	0.1	0.6	0.5	0.1	0.1	-0.3	0.1

5 Summary and Conclusions

With the new Directive on Energy Taxation, the European Union intends to reduce existing distortions of competition between Member States and energy products as a result of divergent rates of tax on energy products. Moreover, it wants to increase incentives to use energy more efficiently and to cut carbon dioxide emissions. The Directive (as well as previous proposals for a CO_2/energy tax) has been subject to controversial debates, because most member states were afraid that higher energy taxation may have adverse effects on their economy. As a result, the Directive is far less stringent than previous proposals and includes a number of general and Member specific exemptions and transitional periods.

This paper analyzed the effects of the Directive and of a previous proposal for such a Directive (1997 proposal) on the economy, on energy use and related CO_2 emissions. In order to account for the ambiguity that results from minimum tax rates, which are substantially lower than existing tax rates in many Member States, alternative scenarios were developed, assuming full tax harmonization at the minimum level on the one hand and partial harmonization (without reduction of currently higher tax rates) on the other hand. The results can be summarized as follows:

In the case of *partial tax harmonization*, the Directive induces reductions of energy demand and CO_2 emissions. These go along with some GDP losses, especially in the accession countries, while in the other countries the effects are negligible. The scenario of *full tax harmonization* shows that the current directive would not contribute to overall energy savings and CO_2 reductions if the traditional Member States were not willing to accept tax differentials in the future. In the case of full tax harmonization, those countries could increase their GDP at the expense of the new Members. This implies that energy taxes would have to be harmonized on a higher level if the double objective of a reduction of distortions and a reduction of energy use and related emissions are to be pursued in the future.

A partial tax harmonization following the minimum tax level suggested by the 1997 proposal would have brought about much larger reductions in energy demand and subsequent CO_2 emissions than the current proposal. Consequently, the energy efficiency and environmental goals of the Directive would have come closer to be met. At the same time, the economic effects of the proposal for the old EU Member States would have been small to even positive for some States. For the accession countries, however, the economic effects would have been more pronounced. Larger negative effects on GDP may have resulted.

By and large, a EU Tax Harmonization is likely to entail some costs for the new Member States. This will, however, not necessarily mean a welfare loss to the new members. On the one hand, they may profit from welfare gains from the EU membership, on the other hand from an improved environment. Moreover, accession countries receive support from the European Union to adjust to community framework and to catch up with the old Member States.

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