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Double Dividend of Climate Protection and the Role of International Policy Coordination in the EU - An Applied General Equilibrium Analysis with the GEM-E3 Model

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Non-technical summary

National economic concerns still hinder the implementation of effective policy measures that would enable a significant reduction of greenhouse gas emissions. Considering other economic problems like unemployment, the enforcement of Maastricht criterions and highly tensed social security systems, the global warming issue seems to be of less priority on the political agenda of EU governments. Nevertheless, the international political pressure forces policy-makers to do something and show at least political willingness. One frequently mentioned instrument that might enable governments to escape the dilemma is the idea of an environmental tax reform. The hope that advocats have in mind is to obtain two positive effects at the same time (double dividend): a decrease in greenhouse gas emissions and an increase in employment and/or consumer welfare.

Our analysis shows that, from an empirical point of view, obtaining an economic dividend in terms of welfare by undertaking an 'intelligent' environmental tax reform remains at least possible, but relying on it seems rather optimistic as there are numerous uncertain influences that might alter the sign of the welfare effect. Obtaining an economic dividend in terms of employment seems to be more robust. But, the hope that an environmental tax reform might contribute substantially to solve the problem of unemployment melts away.

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Abstract

While there is some hope that the ongoing climate change negotiations will soon come up with concrete, time scheduled and binding emission reduction commitments, the question of how to achieve these targets is still unsolved.

The objective of this paper is to analyse alternative settings of an environmental tax reform and its economic and environmental impacts on the EU. The methodological framework used is based on a multi-country and multi-sectoral computable general equilibrium model for eleven EU-member states. The emphasis of the analysis lies on the institutional setting of a carbon dioxide reduction policy and on the specification of the labour market. The institutional settings analysed are related to the degree of environmental policy coordination. As standard neo-classics neglegt the problem of unvoluntary unemployment, we relax this restriction in the second part of the analysis in order to test alternative (more rigid) labour market specifications. The major findings of the paper can be summarized as follows: 1) There is some potential for a double dividend in the EU. 2) Coordination beats not always unilateral actions. 3) Labour market rigidities play a crucial role to both, the double dividend and the coordination issue.

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1 Introduction

While there is some hope that the ongoing climate change negotiations come up soon with concrete, time scheduled and binding emission reduction commitments, the question of how to achieve these targets is still unsolved. This irresolution holds for both, the type and/or mix of instruments and the degree of international cooperation with respect to joint or unilateral implementation. In the pre-Kyoto period the European Commission claimed for all industrialized countries a 15% reduction of greenhouse gases by 2010 based on the emissions of 1990 not knowing exactly how such a promise could be achieved.

Even those emission projections that take into account some political action (conventional wisdom scenarios) estimate an EU-wide increase of greenhouse gas emissions up to 8% by 2010. Based on these growth estimates the actual reduction accounts for 23% - a rather ambitious goal that will be hardly reached if efficient instruments are not launched within the next few years. Unfortunately many EU member states are currently sharing the same economic problems: high unemployment, high taxes that are hard to reduce because of the public deficit criterions given by the Maastricht Treaty and the Monetary Union and increasing social security rates because of increasing unemplyoment and the aging of societies.

Obviously, the implementation of environmental policy instruments should not hinder other economic or political goals like GDP growth, international competitiveness or employment. The discussion whether there exists a 'no regrets' policy, that improves environmental quality without negative impacts on the economy, has been raised a long time ago but has not been solved yet. While the inital discussion has addressed mainly the longer term which ranks around the Porter-Hypothesis, the recent debate revolves more around the short term and is linked to optimal taxation. The hope that advocates have in mind is to obtain a so called double dividend (one for the environment and one for employment and/or economic welfare) by generating a revenue neutral tax reform that is more efficient than a given pre-existing one. Considering both, the climate change issue and the problem of unemployment, it seems straightforward to tax emissions or energy and reduce labour costs by recycling the tax receipts to employers' social security contribution in a revenue neutral way. If one could prove the existence of a double dividend that is linked to such an environmental tax reform, its acceptance could be improved considerably.

The objective of this paper is to analyse such a tax reform and its impact on the EU economy. For this purpose we first present an analytical framework that enables the analysis of alternative policy instruments on the national and the EU-wide level. This part of the paper deals with the description of a computable general equilibrium model GEM-E3 for eleven EU member states. A brief outline of the model will explain the general scope, the assumptions made, the agents considered and their underlying behaviour.

Subsequently we apply this framework to identify and assess the economic and environmental impacts of alternative tax reforms. The emphasis of the analysis lies on the institutional setting of a carbon dioxide reduction policy and on the behaviour of agents in the labour market. Both aspects seem to be rather crucial for the economic impact of environmental tax proposals. The institutional settings analysed are related to the degree of environmental policy coordination. In the first setting Germany decides to be a forerunner in combating climate change by reducing the emissions by 10% within ten years. In the second setting the EU member states decide to combat climate change in a coordinated way. The target (10% emission reduction) is set at the EU level and all countries try to reach this goal jointly. As the policies differ considerably with respect to the environmental improvement obtained, comparing the two implicitly assumes that the (German) policy maker is indifferent to the actual environmental benefit achieved by the policy. One could think about such a behaviour if one finds that the policy maker reacts mainly to international political pressure than to eventually occuring national environmental damages (that might be very low). A reduction of 10% could offset the international pressure on whatever level (national or EU-wide) this reduction will be. Hence, what the policy maker minds is the national economic impact of the policy implemented and not the overall environmental benefit achieved. In this respect, the comparison undertaken is more a concern of political opportunity than of economic efficiency.

A standard criticism to the neo-classical framework of CGE-modelling is that it neglects the problem of unemployment. To grasp this criticism the assumption of a market clearing wage rate is relaxed during the course of the analysis. Imposing the same policy (environmental tax reform) under alternative wage rules enables a comparison of impacts with respect to alternative labour market regimes.

A reconsideration of our findings with respect to the results of similar analyses that can be found in the literature closes the paper.

2 The specification of the model

2.1 The state of the art

The global nature of economic activity and environmental consequences and the increasing understanding of the interdependence of these human-related systems have led to the development of a model generation that tries to address this linkage to improve the knowledge about the current and future potential effects of human behaviour. These integrated assessment models usually incorporated the know-how of several disciplines and vary in the presentation of complexity according to the question they intend to address.

Models with economic origin often use the computable general equilibrium (CGE) approach. These models have been used quite extensively to study energy-economy-environment interactions, but they cover usually only a part of the policy relevant problems. Most effort has been done with respect to global warming, some models being also used within the IPCC[1] activity. Examples of global or multi-regional models in this field are the Nordhaus-models DICE (Nordhaus (1994)) and RICE (Nordhaus/Yang (1996)), the MERGE model of Manne et al. (1995), the OECD model GREEN of Burniaux et al. (1991), the model G-CUBED of McKibbin/Wilcoxen (1992), the model of Perroni/Wigle (1994) and the EU-model WARM of Carraro/Galeotti (1996). Welsch (1996) uses an aggregated CGE model for the European Community to study the effect of joint versus unilateral carbon taxation in a two-region framework.

Furthermore there are a couple of one-country applications like the models of Boyd et al. (1995), Glomsrød et al. (1992) and Proost/Van Regemorter (1995) which try an integrated assessment of alternative policy options. The acidification problem was addressed mainly by one-country approaches like the model of Bergman et al. (1995), Glomsrød et al. (1992), Boyd et al. (1995) and Conrad/Schröder (1991a). There is a wide range of model developments that do not handle the environmental consequences explicitly but deal with the topic in purely economic terms. Examples of this group of applications are the models of Jorgenson/Wilcoxen (1993), Hazilla/Kopp (1990) or Stephan (1989).

2.2 Cost function and input coefficients and the price system

We characterize the technology of a cost minimizing industry by nested CES cost functions. $C(X,PK,PLEM,g)$ 0is the cost function at the first stage for producing output X given the input prices for the capital, PK, and the labour/energy/material ag-

[1] Intergovernmental Panel on Climate Change

gregate, $PLEM$ respectively. The price diminishing technical progress g is specified by exponential rates of diminuition. This is the dual approach of incorporating input using or input saving technical change. This type of technical change considers autonomous (costless) energy efficiency improvements.

Profit maximization under constant returns to scale implies marginal revenues equal to marginal costs which explains the output price PX of domestic production in terms of a CES unit cost function:

(1) $PX = PX(PK,PLEM,g)$0

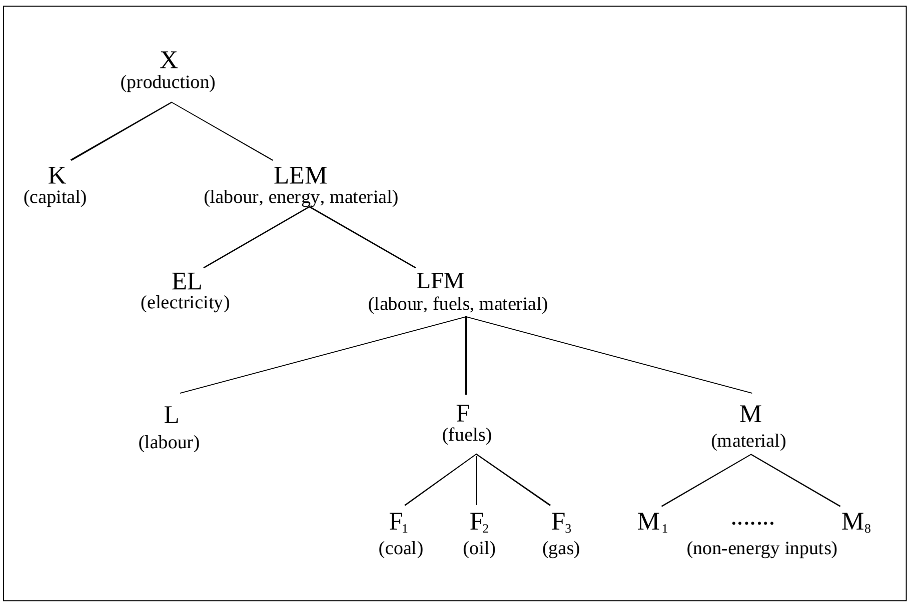
From Shephard's Lemma we derive the factor demand functions as variable (price dependent) input coefficients:

(2) $\frac{K}{X} = a_K$, with $a_K = a_K\left(\frac{PX}{PK}, g\right)$;0

(3) $\frac{LEM}{X} = a_{LEM}$, with $a_{LEM} = a_{LEM}\left(\frac{PX}{PLEM}, g\right)$0.

In principle, one could include all the input prices of the model in one CES unit cost function. This, however, would imply the assumption, that the elasticity of substitution between all inputs is the same. Nesting of inputs into several aggregates allows for different elasticities of substitution. Hence, the production structure presented in Figure 1 follows conceptually the assessment of substitutability of inputs.

Figure 1: The nested production and factor price scheme



Capital input as derived from (2) is the desired capital stock, say K_{des}. In the GEM-E3 model we treat, however, capital as a quasi-fixed stock over the current year at a level from the end of the previous year, say K_{-1}. We therefore use (2) to determine an endogenous ex-post price of capital based on a rate of return which the industry has earned ex-post. For that purpose we solve (2) for PK_{post}:

(4) $$PK_{post} = PX \cdot f\left(\frac{X}{K_{-1}}, g\right)$$

PK_{post} is the endogenous shadow price of capital which clears the market for fixed K_{-1}. It will be used to calculate capital income $PK_{post} \cdot K_{-1}$ in period t.[2]

If we determine an exogenous ex ante price of capital PK_{ante}, then (2) can be employed to determine the desired stock of capital K_{des}. Let this ex ante price be the standard user cost of capital formula $PK_{ante} = PI \cdot (r + \delta)$0 where PI is the price of investment goods, r is the rate of return on risk-free government bonds (exogenously given or determined by the closure rule) and δ is the rate of replacement. Then the desired capital stock is

(5) $$K_{des} = X \cdot a_K, \qquad \text{with } a_K = a_K\left(\frac{PX}{PK_{ante}}, g\right)0.$$

Net investment I_{net} with 'adjustment' is given by

(6) $$I_{net} = m(K_{des} - K_{-1})0$$

Finally, the capital stock for the next period is

(7) $$K = I_{br} + (1-\delta)K_{-1}, 0$$

where $I_{br} = I_{net} + \delta \cdot K_{-1}$ (gross investment).

We next specify a CES price function for the aggregate *LEM*

(8) $$PLEM = PLEM(PEL, PLFM, g), 0$$

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[2] It is easy to check that our calculation of PK_{post} is equivalent to calculating it from the zero profit condition.

where PEL is the price of electricity (EL) and $PLFM$ an aggregation of the prices of labour (L), other fuels (F) and material (M).

One level further down of the nesting the unit cost function for the *LFM* aggregate has to be specified:

(9) $PLFM = PLFM(PL,PF,PM,g)$ **0**

Again, we derive the *LFM* and *EL* aggregates as well as the price-dependent composition of the *LFM* aggregate from Shephard's Lemma.[3] This yields the input coefficients for labour, the material aggregate and the fuels aggregate.

The final level is given by a CES-composition of these aggegates. The fuels aggregate consists of three fuel inputs (1,2,3: coal, gas, oil) whereas the material aggregate considers seven non-energy inputs (5-11: agriculture/forestry/fishery products, energy intensive products, equipment goods, consumer goods, transport, services and non-market services). Sector 4 is the electricity sector specified already by equation (8).

(10) $PF = PF(P\tilde{Y}_1, P\tilde{Y}_2, P\tilde{Y}_3, t)$ 0

(11) $PM = PM(P\tilde{Y}_5, \ldots, P\tilde{Y}_{11}, t)$,0

where $P\tilde{Y}_i$ denotes the price of domestic supply PY_i plus indirect taxes.[4]

Applying again Shephard's Lemma yields the derivation of the input coefficients. If we multiply the input coefficient of the aggregates by the coefficients of their sub-inputs we obtain the overall input coefficients a_i with respect to the domestically produced supply:

For fuel inputs

(12) $$a_{i,X} = \frac{F_i}{X} = \frac{F_i}{F}(\cdot)\cdot\frac{F}{LFM}(\cdot)\cdot\frac{LFM}{LEM}(\cdot)\cdot\frac{LEM}{X}(\cdot) \qquad i = 1,\ldots,3$$ 0

for material inputs

(13) $$a_{i,X} = \frac{M_i}{X} = \frac{M_i}{M}(\cdot)\cdot\frac{M}{LFM}(\cdot)\cdot\frac{LFM}{LEM}(\cdot)\cdot\frac{LEM}{X}(\cdot) \qquad i = 5,\ldots,n$$ 0

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[3] i.e., similar to equations (2) and (3).

[4] see also equation (16).

for electricity

(14) $$a_{EL,X} = \frac{EL}{LEM}(\cdot) \cdot \frac{LEM}{X}(\cdot) 0$$

and for labour

(15) $$a_{L,X} = \frac{L}{X} = \frac{L}{LFM}(\cdot) \cdot \frac{LFM}{LEM}(\cdot) \cdot \frac{LEM}{X}(\cdot)\ 0$$

The dot in the parantheses indicates that the coefficients depend on relative prices.

The parameterization is based on calibration using country specific social accounting matrices which link input-output tables with common national accounting. This procedure permits to calculate most parameters from observed input coefficients, given a range of other parameters like the elasticities of substitution.

2.3 The foreign trade specification

For modeling intra-industry foreign trade between the EU member countries, the Armington approach is widely accepted: domestically produced goods and imports from different countries are imperfect substitutes. Thus dual to a CES production function $Y_c=f(XD_c,IM_c)$, giving domestic supply Y_c in country c as an aggregate of domestic production (for domestically demanded goods) XD_c and imports IM_c, is a CES unit cost function.[5]

(16) $$PY_c = \left(c_x \cdot PXD_c^{1-\sigma_x} + (1-c_x) \cdot PIM_c^{1-\sigma_x}\right)^{\frac{1}{1-\sigma_x}},$$

where $\sigma_x > 0$ is the elasticity of substitution, c_x a distribution parameter and PY_c, PXD_c, and PIM_c are the corresponding prices of Y_c, XD_c, and IM_c (price of aggregated imports is in national currency of country c). From this cost function we derive both the share of domestic production (for domestically demanded goods) and the share of imports in total supply:

(17) $$\frac{XD_c}{Y_c} = c_x \cdot \left(\frac{PY_c}{PXD_c}\right)^{\sigma_x}$$

(18) $$\frac{IM_c}{Y_c} = (1-c_x) \cdot \left(\frac{PY_c}{PIM_c}\right)^{\sigma_x}.$$

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[5] Note that XD_c is the production for the domestic market only.

If the model determines total domestic supply, then we have to allocate aggregate import demand, derived from (18), to the 11 EU member state countries and to the rest of the world (*row*) who contribute to this aggregate import demand. Thus, considering a specific good, the imports of country *c* consist of the exports of the other 11 countries in that good. Therefore, the demands for the 11 goods are also distinguished by place of production. There will be French import demand of consumer goods produced in the United Kingdom and produced in Spain. To obtain such a trade matrix with 11 x 12 import demand functions by good and place of production we specify a CES import unit cost or price function (12 = *row*):

(19) $$PIM_c = \left(\sum_{k=1}^{12} c_{m,k} \cdot PIMP_{c,k}{}^{1-\sigma_m} \right)^{\frac{1}{1-\sigma_m}} \qquad c = 1, \ldots, 11,$$

where $PIMP_{c,k}$ is the price of imports coming from country *k* in currency of country *c*. As there are import taxes and duties (t_{dut}), it is $PIMP_{c,k} = \left(1 + t_{c,k,dut}\right) \cdot PEX_{k,c} \cdot e_c / e_k$, where all exchanges rates are in national currency per ECU and $PEX_{k,c}$ is derived from equations (25) and (26).[6] Given the price index PIM_{row} and the exchange rates $e_{row,c}$, the eleven prices PIM_c can be calculated.

Again, a cost minimizing composition of the import aggregate is the objective of the importing country. Shephard's Lemma, applied to the cost function PIM_c in (19) yields:

(20) $$\frac{IMP_{c,k}}{IM_c} = c_{m,k} \cdot \left(\frac{PIM_c}{PIMP_{c,k}} \right)^{\sigma_m}, \qquad k = 1, \ldots, 11, row$$

where $IMP_{c,k}$ is the import by country *c* from country *k* in currency of country *c*.[7] Multiplying equation (20) by IM_c, derived from equation (18), yields a trade matrix for each of the 11 commodities.

The country specific imports $IMP_{c,k}$ have to match the export demand by definition, i.e.

(21) $$EXP_{k,c} = \frac{IMP_{c,k} \cdot e_k}{e_c}.$$

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[6] Since we distinguish 11 goods, we would have to write $PIMP_{i,c,k} = \left(1 + t_{i,c,k,dut}\right) \cdot PEX_{k,c} \cdot e_c / e_k$

[7] Because of $\sum_k c_{m,k} = 1$, the adding up condition $\sum_k PIMP_{c,k} \cdot IMP_{c,k} = PIM_c \cdot IM_c$ is automatically satisfied.

In contrast to many other model specifications the version of the GEM-E3 model used here differentiates export supply by place of destination: Domestic production X_c is supplied on the domestic market XD_c, on the EU market $EX_{c,eu}$ and on the rest of the world market $EX_{c,row}$. Firms maximize revenue, given the production level X_c determined by the input-output solution:

$$\max_{XD,EX,EX_{row}} R = PXD_c \cdot XD_c + PEX_{c,eu} \cdot EX_c + PEX_{c,row} \cdot EX_{c,row}$$

$$\text{s.t. } X_c = X_c(XD_c, EX_c, EX_{c,row}),$$

where $X_c(\cdot)$ is a transformation function with a constant elasticity of transformation (CET). We choose again the dual approach in terms of a revenue function $R(X, PXD, PEX_{eu}, PEX_{row})$, dual to the CET transformation function. Since the latter is assumed to be homogeneous of degree one, the revenue function can be written as:

(22) $$R(X,..) = X \cdot \left(\gamma_c \cdot PXD^{1-\sigma_T} + \gamma_{eu} \cdot PEX_{c,eu}^{1-\sigma_T} + \gamma_{row}\ PEX_{c,row}^{1-\sigma_T}\right)^{\frac{1}{1-\sigma_T}}$$

where $\sigma_T < 0$ is the elasticity of transformation. The supply functions are derived by using Hotellings Lemma, i.e. by differentiating the revenue function with respect to the product prices.

Since the sales identity $PX \cdot X = R(X,...)$ has to hold, the product prices have to satisfy the price equation:

(23) $$PX_c = \left(\gamma_c \cdot PXD_c^{1-\sigma_T} + \gamma_{eu} \cdot PEX_{c,eu}^{1-\sigma_T} + \gamma_{row} \cdot PEX_{c,row}^{1-\sigma_T}\right)^{\frac{1}{1-\sigma_T}}$$

Therefore, the export supply is given by the following equations:

domestic market

(24) $$XD_c = X_c \cdot \gamma_c \cdot \left(\frac{PX_c}{PXD_c}\right)^{\sigma_T}$$

EU-market

(25) $$EX_{c,eu} = X_c \cdot \gamma_{eu} \cdot \left(\frac{PX_c}{PEX_{c,eu}}\right)^{\sigma_T}$$

world market

(26) $$EX_{c,row} = X_c \cdot \gamma_{row} \cdot \left(\frac{PX_c}{PEX_{c,row}} \right)^{\sigma_T}$$

As export demand is determined by (21), equation (25) can be used to find the equilibrium price $PEX_{c,eu}$ which matches demand and supply of exports. Since the price PX_c is the unit cost, determined in (1), (23) can be solved for PXD_c. Then XD_c in (24) can be calculated. Finally, given the import demand of the rest of the world ($IMP_{c,row}$, see (27) below), the price $PEX_{c,row}$ is derived from the export supply function (26).

To determine the import demand of the rest of the world (*row*) we proceed as in equations (16) to (19) by choosing the index *row* instead of *c*. Dividing (18) by (17) yields the import demand function:

(27) $$IM_{row} = X_{row} \cdot f\left(\frac{PX_{row}}{PIM_{row}} \right)$$

The world market prices PX_{row} and the output of the rest of the world X_{row} are exogenous for all eleven commodities. One of these prices serves as the numeraire. Finally, there is a price function for PIM_{row} similar to (19) and import demand functions $IMP_{row,k}$ analogous to (20).

This yields a trade surplus or deficit (TS):

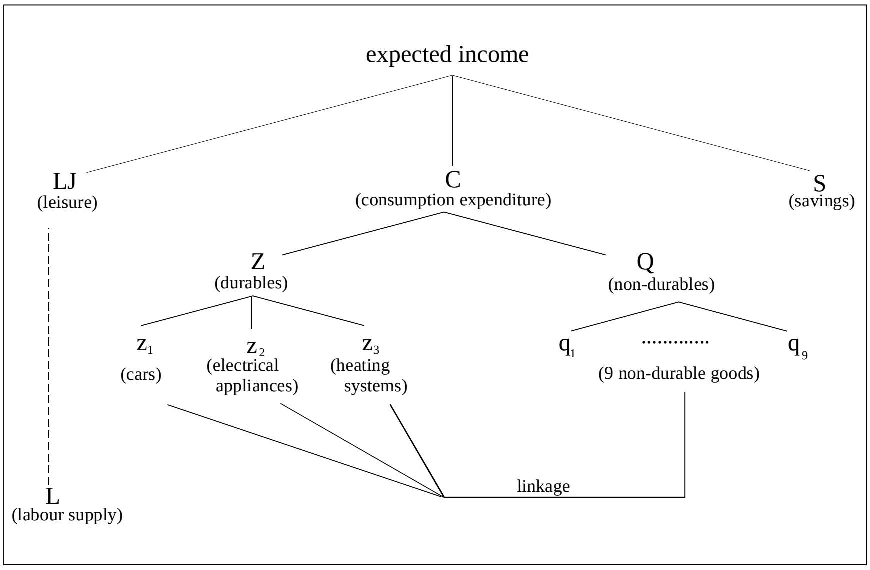
(28) $$TS = PEX_{c,eu} \cdot EX_{c,eu} + PEX_{c,row} \cdot EX_{c,row} - PIM_c \cdot IM_c \,.$$

As the nominal exchange rates are assumed to be exogenous, the current account is not balanced. Depending on the scenario to be simulated, the current account might increase or decrease and even change the sign.

2.4 Consumer demand and labour supply

The behaviour of consumers is assumed to perform a two-stage budgeting procedure: an intertemporal allocation of lifetime wealth endowment between present and future consumption of goods and leisure, and an intratemporal allocation of total consumption of goods into durable and non-durable goods. The durables are distinguished by three (cars, heating systems, electrical appliances), the non-durables by nine categories of consumption. Demand for non-durables like gasoline or electricity is linked to the use of durables. Hence, demand for linked non-durbales and the demand for services from durables has to be reconciled with investment demand for modifying the stocks of durables towards their optimal levels. We therefore employ a restricted expenditure function with stocks of durables as quasi-fixed goods. The expenditure function is derived from the Stone-Geary utility function which underlies the linear expenditure system. Figure 2 shows the household's allocation problem.

Figure 2: The household allocation scheme



At the first stage a representative household determines an allocation of his resources between present and future consumption by maximizing an intertemporal utility function subject to an intertemporal budget constraint:[8]

(29) $$\max_{C_t, LJ_t} \sum_t (1 + s)^{-t} (\beta_c \ln(C_t - C_0) + \beta_{LJ} \ln(LJ_t - LJ_0))$$

$$\text{s.t. } WT = \sum_t (1+r)^{-t} (PC_t \cdot C_t + PLJ_t \cdot LJ_t)$$

where WT is present value of wealth. C_t is private consumption in volume, C_0 its subsistence level, LJ_t is leisure (in volume) and LJ_0 its subsistence level, s is the subjective discount rate and r is the nominal interest rate. An initial commitment for leisure could be $LJ_0 = 12$ hrs/day multiplied by the average working days per year. The price of leisure is $PLJ = (1 - t_{hss} - t_{fss}) \cdot (1 - t_{hdir}) \cdot w^{nom}$ where t_{hdir} is the marginal direct tax rate for labour income and t_{hss} and t_{fss} are the contributions of employers and employees to social security. Under myopic expectations and the assumption of constant and equal growth rates for inflation and the nominal wage rate, the Fisher relation can be used to reduce the demand functions for consumption and leisure to the following formulas:[9]

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[8] β_C and β_{LJ} are normalized so as to sum up to one.

[9] see Schmidt (1997) for a complete representation of the derivation.

(30) $$C = C_0 + \frac{s}{r_r}\left(\beta_c \frac{1}{PC}\right)(Y_{disp} + PLJ \cdot LJ - PC \cdot C_0 - PLJ \cdot LJ_0)$$

(31) $$LJ = LJ_0 + \frac{s}{r_r}\left(\beta_{LJ} \frac{1}{PLJ}\right)(Y_{disp} + PLJ \cdot LJ - PC \cdot C_0 - PLJ \cdot LJ_0),$$

where r_r is the real long term interest rate which is assumed to be constant in the standard version of the model.[10]

The last equation is implicit in *LJ* and has to be solved for *LJ*. Labour supply is given by the remaining time resources, i.e. total time resources minus leisure demand. In the standard neo-classical version of the model, the wage rate serves to match labour demand of firms and leisure demand of households.

The savings of households can then be determined by $S=Y_{disp} - PC \cdot C$.

Two types of consumption expenditure are distinguished: the expenditure for non-linked non-durable goods (e) which is allocated on the second stage of the consumer decision problem and the expenditure for the use of durables (this covers capital costs and demand for linked non-durables associated with the use of durables).

The expenditure function for the variable non-durables with three quasi-fixed durable goods (Z_1, Z_2, Z_3 for cars, electric appliances, and heating, respectively) is

(32) $$e(p_1, ..., p_m; u; Z_1, Z_2, Z_3) = \sum_{i=1}^{m} p_i \cdot Q_{o,i} + u \cdot \prod_{j=1}^{3}(Z_j - Z_{o,j})^{-\gamma_j} \cdot \prod_{i=1}^{n}\left(\frac{p_i}{\beta_i}\right)^{\beta_i}$$

where we denote the prices of consumption categrories p_i by small letters to indicate that they do not match directly to prices of products $P\tilde{Y}_l$. The variable *u* is the utility level, $Q_{0,i}$ is the minimum required quantity of good *i*, $Z_{0,j}$ is the minimum required quantity of a durable good *j*, and $\sum p_i \cdot Q_{0,i}$ is 'subsistence expenditure'. The expenditure minimizing demand for non-durable goods, given utility *u* and the stocks of the three durables, can be derived by partial differentiation of the expenditure function with respect to the prices:

(33) $$Q_i = Q_{0,i} + \frac{\beta_i}{p_i}\left(e - \sum_{i=1}^{m} p_i \cdot Q_{0,i}\right), \quad i = 1,...,m$$

[10] The long term interest rate is endogenized if the constraint of a balanced current account is imposed (other version of the model).

The desired stocks of durables and the ex-post service prices of durables can be derived in an analogous way as used for the restricted cost function approach. With an exogenous ex-ante user cost of durables p_{Z_j}, the desired stock follows from

$$\frac{\partial e(\cdot\ ,\tilde{Z}_j)}{\partial Z_j} = -\,p_{Z_j}, \qquad i.e.$$

(34) $$\tilde{Z}_j = Z_{0,j} + \frac{\gamma_j}{p_{Z_j}}\left(e - \sum_{i=1}^{m} p_i \cdot Q_{0,i}\right)$$

Purchases of new durables under partial adjustment restrictions ($0<\tilde{m}_j \leq 1$) are:

(35) $$I_{Z_j}^{net} = \tilde{m}_j \cdot (\tilde{Z}_j - Z_{-1,j}) \qquad j = 1, 2, 3.$$

We finally obtain the total consumer expenditures $PCE \cdot CE$ including both, non-durables and the services from durables.

(36) $$PCE \cdot CE = \sum_{i=1}^{m} p_i \cdot Q_i + \sum_{j=1}^{3} p_{Z_j} \cdot (Z_{-1,j} + I_{Z_j}^{net})$$

We should finally say some words about the specification of the user cost of a durable, p_{Z_j}. In principle, we could set p_Z equal to $p_Z = PI \cdot (r+\delta)$, where PI is the price of the durable, δ is the rate of replacement and r is the interest rate. However, as some non-durable goods as gasoline, electricity, and heating are linked to the stock of durables, we used a composition of these goods into a linked part and into a disposable part. The idea behind such a composition is that demand for gasoline (Q_G) is linked to the use of the stock of automobiles (Z). Or, in algebraic terms, $Q_G = \alpha_{G,Z} \cdot Z + \tilde{Q}_G$, where $\alpha_{G,Z}$ is yearly gasoline consumption per unit of purchase price of the car and $\tilde{Q}_G$ is gasoline consumption from fast driving or bad maintenance of the car.[11] The latter is considered to be a part of the non-linked non-durables and is therefore not further specified. The user concept for durables implies a cost price p_Z of the services of e.g. an automobile which includes the user cost of capital plus the cost of gasoline, i.e. $\tilde{p}_Z = PI(r+\delta) + \alpha_{G,Z} \cdot p_G$. The introduction of a tax on CO_2 or NO_x will increase the price of gasoline. Hence, the user cost of an already purchased car will increase while the demand for new cars will decline. Under a carbon dioxide tax, for instance, the cost price of a car is $p_Z = PI\,(r+\delta) + \alpha_{G,Z} \cdot (p_G + t_{CO_2} \cdot e_{CO_2})$, where t_{CO_2} is the tax rate and e_{CO_2} is the emissi-

[11] For more details see Conrad/Schröder (1991b).

on coefficient for gasoline. If we incorporate furthermore a property tax or motor vehicle tax rate τ, then the user cost of a car is

(37) $$p_Z = PI \cdot (r \cdot (1+\tau) + \delta + \tau) + \alpha_{G,Z} \cdot p_G$$

For guess-estimation of the parameters $Q_{0,i}$, β_i and γ_j we make use of the properties of a linear expenditure system, i.e. from guess-estimates of *n* income elasticities one obtains the *n* parameters β_i and from guess-estimates of *n* direct price elasticities one obtains the *n* parameters $Q_{0,i}$, given the β_i's (and similarly for the parameters of the durables).

2.5 Demand, supply and model closure

The standard system of input-output accounting is given by

(38) $$Y_i = \sum_{j=1}^{n} a_{i,j} \cdot X_j + F_i$$

where F_i is final demand with $F_i = C_i + CG_i + I_i + IG_i + EX_i$. C_i is private consumption of good *i*, CG_i and IG_i are government consumption or investment, respectively (exogenous), I_i is gross investment by origin and EX_i are exports.

Since our demand system determines consumption goods by categories and our system of investment functions investment demand by destination, transition matrices are required transforming demand into deliveries from the industries. Therefore, the C_i's in final demand have to be seen as the result of the transition matrix of the type (branches x categories) multiplied by the consumption categories. Similar to the matching of consumption categories to products, an investment matrix with fixed technical coefficients serves to compute investment demand by origin (products) from investment demand by destination (branches) as evaluated from investment behaviour in (5) and (6), together with investment for replacement and decay, i.e. $\delta \cdot K_{-1}$. The system (38) can be written as a system in the unknown variables Y_i if we rewrite it as

(39) $$Y_i = \sum_{j=1}^{n} a_{ij} \cdot \left(\frac{X_j}{Y_j} \right) \cdot Y_j + F_i$$

with X_J / Y_J determined by (17).

In value terms, demand has to be equal to supply:

(40) $$PZ_i \cdot Y_i = \sum_{j=1}^{n} P\tilde{Y}_j \cdot X_{ij} + (1+t_i) \cdot P\tilde{Y}_i \cdot (C_i + CG_i) + P\tilde{Y}_i \cdot (I_i + IG_i) + PEX_i \cdot EX_i$$

where PZ_i is the market price including indirect taxes, $P\tilde{Y}_i$ is the price of domestic supply including indirect taxes on production and t_i indicates the value added tax rate on consumption. $X_{i,j}$ represents the intermediate demand of good i. The accounting identity from the input side is:

(41) $$PY_j \cdot Y_j = \sum_{i=1}^{n} P\tilde{Y}_i X_{ij} + PL_j \cdot L_j + PK_j \cdot K_{-1,j} + PIM_j \cdot IM_j$$

If we sum (40) over *i* and (41) over *j* and then subtract (41) from (40) we obtain the national accounting identity saying that the private gross domestic production from both the flow of cost approach and from the flow of product approach should be equal, i.e.

(42) $$\sum_j (PL_j \cdot L_j + PK_j \cdot K_{-1,j}) = \sum PY_i \cdot F_i - \sum_j PIM_j \cdot IM_j$$

This identity is satisfied if and only if total saving, involving income distribution and fiscal policy relationships, equals total investment. Following Walras' Law, this market ($n+1$) is in equilibrium if an equilibrium price vector has been found for the other n markets (supposed that the demand, supply and price functions are specified according to the needs of an Arrow-Debreu economy). Therefore, the saving-investment identity ($I=S$) and the corresponding global shadow price of capital (mobility of (new) capital between sectors but not across countries is assumed) is automatically given.

2.6 The environmental module in GEM-E3

The scope of the environmental issue is limited to three pollutants: nitrooxides (NO_X), sulfur dioxide (SO_2) and carbon dioxide (CO_2). For SO_2 and NO_X we specify abatement costs which will increase the cost price of using pollution intensive inputs. To derive such a cost price, we start with the primal production function approach where material input M consists of material input M_1 for production and of material input, M_2 required for complying with environmental regulation, i.e. $M=M_1+M_2$. Let us assume that the environmentally related input M_2 is proportional to the flow of pollutants, which in turn depends on the input of fossil fuel F, i.e. $M_2 = \alpha \cdot e \cdot F$, where e is an emission or waste coefficient in terms of tons of an air pollutant per unit of the energy input. Combining the two equations yields: $M = M_1 + \alpha \cdot e \cdot F$. Using this composition we will rewrite the standard cost minimization approach given by:

$$C(X, PK, PL, PEL, PF, PM) = \min_{K,L,EL,M,F} \left(PK \cdot K + PL \cdot L + PEL \cdot EL + PM \cdot M + PF \cdot F \right)$$
$$s.t.\ X = f(K, L, EL, F, M),$$

replacing M by $M_1 + \alpha \cdot e \cdot F$ one obtains

$$C(X, PK, PL, PEL, PF, PM) = \min_{K,L,F,M} \left(PK \cdot K + PL \cdot L + PEL \cdot EL + PM \cdot M_1 + \widetilde{PF} \cdot F \right)$$
$$s.t.\ X = f(K\ L, EL, F, M_1 + \alpha \cdot F),$$

where $\widetilde{PF} = PF + PM \cdot \alpha \cdot e$ is the cost price of energy. It consists of the energy price and the additional costs due to environmental regulation when using one unit of energy input. As the cost of regulation increases with the enforcement intensity, α should depend on the degree of abatement. We therefore specify α as a function in the degree of abatement a, which represents the enforcement in pollution control:

$$\alpha = c(a) \cdot a$$

The degree of abatement is defined as the ratio of abated emission over potential emissions ($0 \leq a \leq 1$) and $c(a)$ are the costs of abatement measures per unit of emission or waste, measured in base year prices. They depend on the degree of abatement with $c'(a) > 0$ and $c''(a) > 0$. Finally, e is an emission or waste coefficient in terms of tons of an air pollutant per unit of energy input. With this interpretation of α we obtain the following cost price for energy

(43) $$\widetilde{PF} = PF + PM \cdot \alpha \cdot e = PF + PM \cdot c(a) \cdot a \cdot e.$$

This cost price of energy increases over-proportional by an enforcement in environmental regulation. On the production side this implies an increasing share of complementary material inputs. The change of the cost price of energy will also cause the firm to alter its input choices. A stricter environmental policy will have a substitution effect which will result in a reduced demand for energy and its price complements and in an increased use of its substitutes. This integration of abatement costs in a cost-price concept will be used for modeling the impact of regulation on household and firm behaviour; for the latter each sector will be treated separately.

The cost price approach can be extended for the case of several pollutants. Then $\widetilde{PF}$ is

(44) $$\widetilde{PF} = PF + PM(c_{SO_2}(a_{SO2}) \cdot a_{SO_2} \cdot e_{SO_2} + c_{NO_x}(a_{NO_x}) \cdot a_{NO_x} \cdot e_{NO_x})$$

with abatement costs for SO_2 and for NO_X. If there is a tax on a pollutant, then there is also a cost price component for the actual emissions, i.e.

(45) $\widetilde{PF} = PF + PM \cdot c\,(a) \cdot a \cdot e + t \cdot (1 - a) \cdot e\,.$

Finally, if there is an energy tax (t_F) and/or an emission tax on carbon dioxide, t_{CO_2}, where no convenient end-of-pipe measures exist, then a turns out to be zero in the equation above.

The cost price approach can be embedded in the CES price function by replacing in equation (10) the price of the energy components $P\tilde{Y}_i$ by $\widetilde{PF}_i$. This also increases the overall price index of energy, $\widetilde{PF}$. Environmental regulation will then have an impact on the composition of the energy aggregate F. It will also increase the price of the product according to equation (1), and it will reduce the demand for energy derived from equation (10).

2.7 Welfare measure

The welfare change used for the evaluation of policy scenarios is represented by Hick's measure of equivalent income variation (*EV*). The EV is based on the intertemporal utility maximization problem and has to be derived from equations (29) - (31). In a single period t we have

(46) $EV_t = FE(PC_t^0, PLJ_t^0, U_t^1) - FE\,(PC_t^0, PLJ_t^0, U_t^0\,),$

where *FE* is the expenditure function corresponding to (29) - (31). *EV* gives the change in expenditure at base case prices PC^0 and PLJ^0 that would be equivalent to the policy-implied change in utility. In order to derive the expenditure function from the utility function, we insert the demand functions (30) and (31) into the utility function (29), and solve for the level of utility, say U_t:

(47) $U_t = \frac{s}{r_r} \cdot \left(\frac{\beta_c}{PC_t}\right)^{\beta_c} \cdot \left(\frac{\beta_{LJ}}{PLJ_t}\right)^{\beta_{LJ}} \cdot (FE_t - PC_t \cdot C_0 - PLJ_t \cdot LJ_0)$

where FE_t is total expenditure:

$$FE_t = Y_{disp,t} + PLJ_t \cdot LJ_t$$

(47) solved for FE_t gives the expenditure function used in (46) to determine *EV*:

$$FE_t(\,PC_t, PLJ_t, U_t\,) = U_t \cdot \left(\frac{\beta_c}{PC_t}\right)^{-\beta_c} \cdot \left(\frac{\beta_{LJ}}{PLJ_t}\right)^{-\beta_{LJ}} \cdot \left(\frac{s}{r_r}\right)^{-1} + PC_t \cdot C_0 + PLJ_t \cdot LJ_0$$

The utility level U_t *is* calculated from the t^{th} element of the sum of utilities in (29).

If *EV*<0, welfare after the policy measure is lower than in the base case. The consumer would be willing to pay the maximum amount *EV* at the fixed budget level $FE^0=FE(PC^0,PLJ^0,U^0)$ to avoid the decline of utility from U^0 to U^1. Similarly, if *EV*>0, the consumer would be willing to pay the maximum amount *EV* to see the change in environmental policy implemented.

The standard model version considers full competitive equilibrium in all markets, including the labour market. At this stage it covers eleven countries (Belgium, Germany, Denmark, France, Greece, Ireland, Italy, The Netherlands, Portugal, Spain and United Kingdom) and eleven products or sectors (agriculture, coal, crude oil and refined oil products, gas, electric power, energy intensive industries, equipment goods industries, consumer goods industries, transport, services, non-market services).

3 Empirical analysis of the double dividend issue

3.1 Policy options and scenario definition

As an application of the GEM-E3 model we have estimated the welfare gain of alternative CO_2-reduction policies. Each policy is linked to a reduction target that is achieved by a CO_2 tax with a rate just high enough to achieve the given reduction goal. The revenue from this tax is used to reduce the employers' contribution to social security. This is the so-called "double dividend" analysis. The carbon tax should affect the substitution of energy for other inputs and reduce global warming (first dividend). This substitution effect could have already a positive impact on the demand for labour. However, the recycling of the tax money to social security as a partial compensation for employers' contribution should increase the demand for labour. The hope, the advocates of the double dividend have in mind is that the substitution effect towards more labour outweighs the output effect in terms of lower growth. Some authors describe this positive effect on the labour market as the second dividend, others define the second dividend in terms of economic welfare. Our analysis deals with both definitions as we are in general not convinced that the double dividend criterion is sufficient to be 'the one and only' measure that should be used to accept or neglect a policy. From a policy maker's view one might accept a loss in economic welfare if the policy measure supports more employment significantly.

In our empirical analysis we focus on the double dividend issue under two institutional settings. The settings are related to the degree of environmental policy coordination. In the first setting Germany decides to be a forerunner in combating climate change by reducing the emissions (of the base year) by 10% within ten years. The other EU countries do not apply particular measures for reduction. In the second setting the EU member states decide to combat climate change in a coordinated way. The target of 10% emission reduction is set at the EU level and all countries try to reach this goal together. Hence, in this setting, the marginal costs are equalized not only across sectors but across countries as well.

One could think about other schemes of coordination, e.g. every country reduces 10% of its base year emissions or a 'full' coordination policy where the winners compensate the losers via side payments. These schemes are not discussed here. We rather view the climate topic from a German policy maker's perspective. Hence, the issue of concern is: 'What can Germany gain from an EU-wide coordinated environmental tax reform?'.

It is evident that the overall EU-wide emission reductions of the two scenarios specified above are different. Hence, we do not analyse solely an efficiency gain due to a better allocation from coordination.[12] The policies differ considerably with respect to the environmental improvement obtained and the economic burden on the economy. Comparing the two policies implicitly assumes that the German policy maker is indifferent to the actual environmental benefit achieved by the policy. One could think about such a behaviour if one finds that the policy maker reacts mainly to international requests given for example by the ongoing negotiations of the Climate Convention than to eventually occuring national environmental damages (that might be very low). Advertising a reduction of 10% could offset the international pressure on whatever level (national or EU-wide) this reduction will be. Hence, what the policy maker minds is then the national economic impact of the policy implemented and not the environmental benefit achieved. To this concern, the comparison undertaken is more a question of political opportunity than of economic efficiency.

For both policy options the emission reductions are obtained by an (endogenously computed) tax on CO_2 emissions. This tax is levied on producers and consumers. The tax reform is supposed to take place in a revenue neutral way, i.e. the receipts are kept in the country that imposes the tax and are used to reduce the employers' contribution to social security. The revenue neutrality is achieved by keeping the share of public deficit on GDP constant. As the tax and the recyling is endogenous, the problem of tax erosion induced by the decrease in emissions is implicitly solved. Hence, the reduction of wage costs through recycling of tax receipts is limited by the public deficit constraint.

The time horizon of target realization is set to ten years. The reduction within these ten years is assumed to take place linearly, i.e. in each year the level of emissions (in terms of the base year) is reduced by 1%.

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[12] This was done e.g. by Conrad/Schmidt (1996a or 1996b).

As the 10% target is expressed in terms of emissions of the base year, economic growth will increase the actual reduction effort. To take this aspect into account, we consider the expected emission growth in the eleven countries. The rates assumed for this study are based on an estimate of the European Commission. It is considered to be a 'conventional wisdom' scenario[13] and covers both economic growth and growth in energy efficiency. The country specific emission growth rates are depicted in the last column of table 1.

One way to consider the growth aspect in the simulations could be to calibrate energy efficiency, emission coefficients and economic growth in such a way that the model generates ('ex-post') the expected economic and environmental development. This procedure turned out to be very difficult in the complex world of our multi-country and multi-sector model.

Another way is to consider the growth aspect in the reduction plan of the policy. Then, the targets imposed include the 10% reduction of the base year emissions plus the expected emission growth.[14] Former sensitivity analyses have shown, that it is sufficient to limit the growth consideration to the policy targets if the structural changes due to the expected growth are reasonable and if one looks at the results in relative terms only. In the tables below, the policy impacts of the counterfactual equilibrium (policy simulation) are presented as percentage change of the reference equilibrium (reference simulation). What is shown then is the pure policy effect; assumptions that are kept unchanged in both scenarios are ruled out.

Furthermore, we limit the presentation of results to the impacts that are obtained at the end of the implementation horizon. In the tables below yearly values of the tenth year are depicted by a '10' in the period line while figures that concern the entire time horizon are marked by a '1-10' in the period line.[15]

3.2 Simulation Results

3.2.1 Unilateral action versus coordination

We start with the unilateral case where Germany decides to reduce its emissions solely. The last column of table 1 shows the underlying CO_2 emission growth rates as-

[13] i.e. it is not very optimistic but also not very pessimistic and includes some measures that will probably take place in the countries without imposing a 'major' policy instrument (like an emission tax).

[14] As we had no better data, we assumed, that all sectors grow at the same rate.

[15] Further details on the periodical values can be obtained from the authors on request.

sumed. The column eleven depicts an actual (net) emission reduction of -7%.[16] Together with a negative expected growth rate for Germany of -3%, the 10% goal is reached. The increase of emissions in the other countries indicates the EU internal carbon leakage. The emission growth in the EU is lowered (almost 2%) but the absolute increase remains positive.

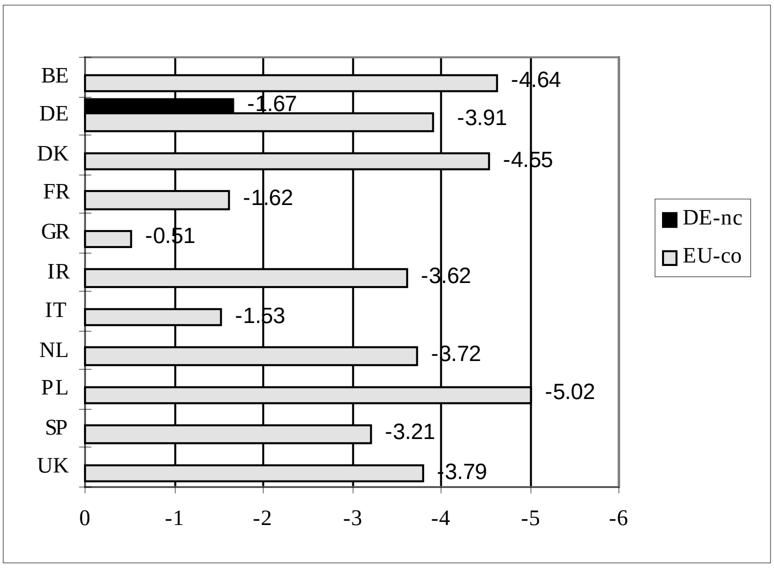
As table 1 shows, the unilateral 10% reduction of Germany requires an emission tax of 8.24 ECU per tonne of CO_2 at the end of the reduction plan. The welfare effect measured in equivalent variation and expressed in percent of GDP is positive (0.02%). As both environment and welfare are improved, the so called double dividend is obtained. The welfare gain is achieved due to the increase in consumption (0.13%) which outweighs the ’negative’ effect linked to the increase in employment (0.26%) (more employment means less leisure as population and therefore total time endowment is fixed). As employment and the real wage rate (0.47%) go up, there is more (labour) income for consumption. Other incomes (i.e. non-labour income)[17] decrease which reinforces the effect on employment (increase in labour supply). Since gross domestic production falls by -0.20%, labour productivity declines. The investment of firms falls by -0.18%. Therefore, the positive effect in GDP is linked solely to the increase in consumption and the changes in the current account. Imports decrease (-0.24%) more than exports (-0.13%) which leads to an ’improvement’ of the current account. The other countries gain or lose slighty according to the trade relations. The interested reader is refered to the figures in table 1.

The effect on employers’ rate to social security is depicted in figure 3. Recycling the receipts of the emission tax in a revenue neutral way leads to a reduction of this rate by 1.67 percent points (see the bar for DE-nc). As Germany acts unilaterally there is no reduction in the other countries.

Figure 3: Employers’ Contribution to Social Security (change in %-points)

[16] Throughout the discussion of results the sign of the numbers in the tables are kept whatever formulation is used. For example we will not change the sign in the following expressions: ’the emission growth rate is -3%’ and ’the emissions fall by -3%’.

[17] The changes in other income are not depicted in the tables.



The simulation results of the coordinated policy are presented in table 2 and figure 3. The country specific reductions of employer's social security contribution due to the CO_2-tax receipts are depicted in figure 3 (see bars of EU-co). The cuts are between 0.51 (Greece) and 5.02 (Portugal) percent points. Most countries (Belgium, Germany, Denmark, Ireland, Netherlands, Spain, United Kingdom) find a reduction between 3.5 and 4.5 percent points.

Real wage rates and employment increase in all countries with the exception of Greece. Greece faces a very high actual CO_2 reduction of -24.06%.

The EU-wide actual emission reduction (including the growth effect) is -13.74% while the contribution of countries to the common target differs according to their ability to adjust towards lower emissions (see table 2a and b). The target requires a uniform tax rate of 22.01 ECU per tonne of CO_2.

The positive effect of wage cost reduction is outweighed by the decline in production (-0.78%). Hence, there is a decrease in employment (-0.06%) in Greece. Private consumption rises between 0.06% (Great Britain) and 1.47% (Belgium). Exceptions are Greece (-0.92%, due to the decrease in real income) and Italy (-0.04%, due to a drop in other incomes that compensates the positive effect in labour income). Gross domestic production falls in all countries as the relief of labour taxes (i.e. rate of social security) is not fully compensating the increase in domestic production costs due to emission taxation. Again with the exception of Greece, GDP rises everywhere in the EU. The welfare measure EV in percent of GDP is negative for Greece (-1.71%), Great Britain (-0.38%), Germany (-0.22%), and Italy (-0.21%). For the other countries the EV shows up as a a (positive) welfare gain.

What are the conclusions that can be drawn at this stage of the analysis:

1. Based on the parameter set used for the above two simulations, and the assumption of a perfect competitive world, we always (with the exception of Greece) find a dividend for the labour market, i.e. employment increases. This is the case irrespective of the policy imposed, i.e. coordinated/non coordinated or high/low emission reduction effort (for Germany: -7.25% in the unilateral case and -15.47% in the coordinated case).

2. Obtaining a second dividend in terms of economic welfare is crucially linked to the design of the policy. This is shown by the German example: while the unilateral 'low' emission tax gives a positive effect on EV, the coordinated but higher emission tax gives an overall negative effect, i.e. the EV of Germany is negative. Amongst others there are particularly two effects of importance: First, the increasing distortion of a higher emission tax outweighs the positive effect that is linked to the decrease in labour tax and its distortionary effect. Secondly, a coordinated policy leads to a drop in exports as the demand in other EU-countries is now affected by own policy measures.

3. Within our model framework and its parameterization, the strong double dividend hypothesis with respect to economic welfare has to be rejected because of its lack of stability. The second dividend is linked not only to the tax level but to country specific characteristics as well. In the coordinated case, Denmark and Italy face approximately the same actual reduction effort under the unique tax rate, while they differ in the sign of the welfare gain: The EV is positive for Denmark whereas it is negative for Italy.

3.2.2 Labour Market Regimes

It is intuitively clear, that the imposed flexibility on the labour market plays an important role for the dividend of employment as well as for a welfare dividend.

To get an idea how sensitive impacts are due to the assumption of a perfect competitive labour market, alternative labour market regimes are tested. Imposing labour market rigidities implicitly assumes another utility function of households. For the purpose of our sensitivity analysis we assume that unemployment is completely compulsary, i.e. leisure due to unemployment is not utility increasing. For reasons of simplicity leisure demand of households is kept fixed (this is equivalent to a fixed labour supply). As an explicitly specified wage rule describes the potential development of the real wage rate, unemployment becomes a residual, i.e. supply of labour minus demand of labour.

Two imperfect labour market regimes are examined: In one variation the real wage rate is kept constant. Unions are supposed to have some bargaining power as the decrease in labour productivity linked to an environmental tax reform has no impact on the real wage rate. The nominal wage rate covers inflationary effects, i.e. it changes according to the consumer price index.

In a second analysis we assume that unions are not able to keep the level of the real wage rate but have to accept an adjustment according to the (lagged) changes in labour productivity.

Table 3 shows the findings of this sensitivity analysis with respect to equivalent variation (EV) as percentage of GDP, consumption and employment. Note that the EV is an ordinal measure which can be used to evaluate policy simulations within one model variation only. As the rigid labour market regimes implicitly assume a different utility evaluation, the EV can show which policy is prefered under a particular labour market regime but it is not appropriate to assess policies under different labour market regimes:[18] While there is no unemployment in a classical labour market, leisure of the unemployed is supposed to be involuntary in the rigid labour market regimes. As in the latter more employment is matched by former unemployed, there is no loss in utility because of a decrease in leisure. Hence, to compare the results across model variations one has to take the two components of utility, i.e. consumption and employment (respectively leisure) into account.

In the classical labour market regime, Germany would prefer the national policy. There is a welfare gain for the households of 0.02% of GDP, whereas the coordinated policy yields a welfare loss of -0.22% of GDP. If real wages are assumed to be inflexible (fixed real wage rate) German households are indifferent to the institutional setting of the policy but they would like to see one of the two implemented: the EV of both is equal and positive. For a wage rule with labour productivity adjustment, Germany is better off to choose the national policy, but German consumers would like to see none of the two policy options to be implemented.

To enable a comparison across model variations changes in consumption and employment have to be taken into account. We will exemplary discuss the impact of different labour market specifications for the unilateral policy[19]: If real wage rates are fixed, demand for labour is higher than in the flexible labour market as there is no price mechanism that adjusts demand and supply (which would lead to higher wage costs). The additional labour demand is met by the formerly unemployed. Production costs and the fall in total output are lower. At the same time private consumption rises less than in the flexible labour market case as the increase in real in-

[18] The main reason for this inconvenience is the fact that we have to compute a separate reference run for each labour market regime. As the computations of EVs refer to different bases they are not comparable.

[19] For reasons of clarity we suppress a more detailed presentation of the figures of these simulations.

come is lower. Hence, households have to work more for an additional unit of consumption than in the classical labour market case. However, the distortionary effect of the pre-existing labour tax (rate of social security contributions) is higher in the case of unemployment,[20] which is another source of the positive effect in employment. In the third labour market specification the decrease in labour productivity lowers real wage rate. The effect on employment is even a bit higher than in the case with fixed real wage rate. But private consumption is almost unchanged as the level of real income is not affected considerably; the employment effect is outweighed by the decrease in the real wage rate.

How do the results of the coordinated policy differ with respect to the different assumptions for the labour market? In principle the findings are similar to those for the unilateral policy: there is more employment under a rigid labour market but real income and therefore consumption increases less. The marginal rate of consumption to employment is highest for the flexible labour market, decreases in a market with fixed wage rate and is lowest for a labour market where the real wage is adjusted according to labour productivity. Hence, in terms of households' efficiency the rigid labour market regimes lowers the positive effect of the policy.

If the goal of the policy is to increase employment without lowering the level of consumption, the coordinated policy is appropriate for most countries. Under the labour market regimes 'perfect competition' and 'fixed real wage rate' only Greece and Italy are affected negatively, whereas in the third regime Germany, Greece, Italy and United Kingdom are worse off. Under all three market regimes, there is an EU-wide positive effect for labour without lowering the total level of consumption.

What are the conclusions of the labour market sensitivity analysis?

Labour market rigidities alter the results found in a perfect competitive world. But again everything depends: Labour market rigidities will worsen the impact of the policy on employment in those model applications, which find no dividend for employment in a competitive world, as less flexibility in the labour market will increase adjustment costs. Whereas a rigid labour market improves the (positive) effect on labour in applications that find a dividend for employment in the perfect world already. This is obvious as a positive effect on employment in a competitive world is linked to the increase in the after tax real wage rate. A wage rule that keeps the real wage rate fixed enables firms to demand the formerly unemployed labour force at unchanged unit costs. Hence, production costs are lower than in the competitive case.

[20] This is in line with the findings of Bovenberg/de Mooij (1994b) and Bovenberg/van der Ploeg (1994)

It is beyond the scope of this paper to discuss the appropriateness of the labour market regimes imposed and to judge about the most realistic one. Nevertheless in undertaking a medium term analysis one might expect some inflexibility in real wages. A decrease in real wages or the assumption of a clearing labour market seems at least in the short term less plausible. If one believes in the inflexibility of wages in the short and medium term, a coordinated policy that taxes emissions and reduces wage costs would be favourable for all countries with the exception of Greece. The other labour market regimes traces more losers, i.e. there are more countries who refuse the mitigation policy because an economic dividend is not obtained. Another aspect is the question of compensating the losers. As the figures in the tables show, there is an EU-wide benefit of coordination under the flexible labour market and under the regime with fixed real wage rate. If one would find a compensation mechanism that makes the losers better off (at least indifferent to the policy), one might find a strategy where all countries are willing to cooperate. This aspect is a topic of future research.

3.3 Exploring the deviancy

Why are our empirical results not fully compatible with some other theoretical and empirical findings of e.g. Bovenberg/de Mooij (1994a, 1994b), Pethig (1996) or Goulder (1995b), who reject the double dividend hypothesis more or less systematically? In summary the differences are linked to the following issues:

- full general equilibrium effects versus comparative static analysis,
- agents considered,
- endogeneity of factors and number of inputs considered,
- optimality of the pre-existing tax system,
- assumed factor mobility,
- foreign trade specification and its parameterization.

Analytical studies done e.g. by Bovenberg/de Mooij (1994a, 1994b), Bovenberg/van der Ploeg (1994) or Pethig (1996) are based on more simple static general equilibrium models. Their work focus on an analytical comparative static evaluation of these models. As Pethig stresses, *comparative static analysis* becomes "... very messy even in simple models..." if one releases the very restrictive assumptions on preferences and technologies that enable a full characterisation of conditions under which a double dividend might be obtained. Applied general equilibrium analysis allows for more complex specifications which cannot be solved analytically any more. Hence, it is a priori not clear, why the results obtained by comparative static analysis in simplified models should hold in a much more complex world that uses real world data and traces *full general equilibrium effects*.

Another explanation is the *consideration of agents*. In contrast to the theoretical analysis of Bovenberg and others, where only three agents are distinguished (households and firms are not separated), the model used here takes four agents into account (household, firms, government and foreign). Therefore firms keep a part of capital income for investment. Hence, a policy-induced decrease in capital income affects both, firms and households, which in turn lowers the (negative) impact on private consumption.

Furthermore, the theoretical result in Bovenberg/de Mooij (1994a), that pollution taxes reduce the incentive to supply labour, is not in contradiction to our model results because their proof is based on the *assumption of a single input* (labour) and on a constant labour productivity. In Bovenberg/Van der Ploeg (1994) three inputs are used (labour, energy, and capital), however the prices of capital and energy are determined on global competitive markets, i.e. they are exogenous. In their factor price frontier $\frac{(w+t_L)}{p}=\phi\left(\frac{\overline{PK}}{P},\frac{\overline{PF}+t_F}{P}\right)$, a given tax on fossil fuel (t_F) uniquely determines the producer wage $\frac{(w+t_L)}{P}$. Hence, the energy tax is fully born by the immobile factor labour and thus amounts to an implicit labour tax. The factor price frontier in our model, derived from the unit cost function, is (in a shorter version):

$$1 = \phi\left(\frac{PL}{P}, \frac{PK}{P}, \frac{(PF+t_F)}{P}, \frac{PM}{P}\right),$$

where prices of capital and of energy are endogenous. The carbon tax is therefore not an implicit labour tax, i.e. the effect of a lower tax on wages is not fully offset by the carbon tax. This explains why in Bovenberg/Van der Ploeg an increase in the energy tax harms employment as the higher energy tax is shifted onto the immobile factor (i.e. labour) only. Hence, the higher cost of energy depresses the market wage $\frac{w}{P}$. In the GEM-E3 model it depresses both factor prices, i.e. labour and capital, as the user cost of capital is endogenous. In an open economy framework the endogenous PF absorbs also some of the tax impact (depending on the 'openness' assumed).

The GEM-E3 model includes a range of *pre-existing taxes* and transfers, e.g. direct taxation of households and firms, employers and employees contribution to social security, import duties, subsidies, value added tax and social benefits. In contrast to the assumptions of e.g. Bovenberg/de Mooij, the pre-existing tax systems in the countries considered are not optimal. Hence, one could argue that a tax reform could enable efficiency gains which are not linked solely to a new environmental tax but to a general change in (effective) factor tax rates.[21] But this is still not in line with the findings of Bovenberg/Goulder (1996), who show that both, the analytical and the empirical analysis coincidence even if one considers pre-existing taxes: While they find analytically that the prospects of a double dividend are enhanced if "... a revenue neutral tax reform shifts the burden of taxation to the less efficient (undertaxed) factor...", there is no empirical evidence obtaining such a situation: no double dividend is obtained in their numerical analysis for a wide range of parameters.

Again these findings are crucially linked to the *factor mobility assumptions* they make. In both, the analytical and the numerical analysis capital is fully mobile. While in a comparative static analysis capital mobility is usually assumed to cover the long term effects of a policy, the meaning is different if it is imposed for an intertemporal (periodically computed) numerical model. There the assumption of full capital mobility holds for both, the short (which seems to be rather unrealistic) and the long run. It is worthwhile to stress this aspect as the mobility issue has important impacts on the excess burden of taxes. Böhringer et al. (1996) find for their CGE-

[21] Goulder (1995b)

model for Germany a marginal excess burden (*meb*) of 36.5 for labour taxes and a *meb* of 82.8 for capital taxes under the assumption of full capital mobility. This situation changes significantly if existing capital is assumed to be sector specific, i.e. sectorally and internationally immobile. The *meb* for labour taxes is then 14.2 while the *meb* for capital taxes drops to -12.5. Hence, the marginal excess burden of the overall tax system decreases sharply if the assumption of full capital mobility is removed. As Bovenberg/Goulder (1996) concede, a highly suboptimal pre-exisiting tax system (i.e. a tax system where the *meb* of different taxes vary quite a lot) enhaces the chance of obtaining a double dividend, if the burden of the new environmental tax falls mainly on the undertaxed factor (which is capital in our case) and relieves the burden of the overtaxed factor (labour).

The putty-clay approach used in our recursively dynamic model assumes sectoral fixed capital stocks within a single period. In such a situation the burden of the environmental tax falls partly on capital as stocks can adjust only gradually over time by depreciation and gross investment. This specification is in line with the empirical evidence that can be found at least in the short and medium term and which denies that firms can easily grab their facilities and go somewhere else if production conditions become a bit worse than they were before.[22]

Another explanation for the mismatch of our results to those of others can be drawn from the *foreign trade specification and its parameterization*. There are three interrelated subjects of importance:

First, in countries with little or without own primary energy resources, an energy or emission tax affects mainly imported goods. Hence, the (direct) burden due to substitution falls to those sectors that produce the taxed good, i.e. it is shifted abroad. Second, as exports are produced with taxed energy, the demanding country (the rest of the world in particular) contributes to the reduction of domestic wage costs. And third, the impact of an environmental tax reform is also crucially linked to the trade specification and trade closure that is imposed.

While most single country model applications often use closed economy and/or small country assumptions, our model specifies open economies and relieves the small country assumption partly. In particular, there is no constraint on the trade balance in the standard version of the model, i.e. the current account is not balanced through an endogenous exchange rate. Furthermore, adopting the Arminton assumption in the foreign trade specification is - at least in its operation - equivalent to a specification that gives countries some monopsony power to influence the prices on the world market.[23] In a multi-country trade framework, the imports of country *a*

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[22] see e.g. Dean (1992), Jaffe et al. (1995)

[23] This is independent of the use of an (CET) export supply function.

delivered by country *b* have to match the exports of country *b* to country *a*. If imports and domestically produced goods are imperfect subsitutes an increase in export prices of country *a* will not cut imports in country *b* coming from country *a* to zero. Hence, a part of the burden of the environmental tax reform undertaken in the exporting country *a* falls on the importing country *b*. Country *b* pays the tax through the export price of *a* without gaining anything from revenue recycling.

This aspect seems to be crucial for the results: A higher elasticity of substitution in the Armington function will decrease the chance of obtaining a second dividend. Many studies imply elasticities which do not correspond to the empirical evidence. The GREEN-model of Burniaux et al. or Böhringer et al. use elasticities of substitution around four for both levels, the domestic supply (nest of domestically produced goods and the import aggregate) and the import aggregate (nest of imports by origin, i.e. exporting country). Even if the literature on the empirical estimation of foreign trade elasticities is very limited, assuming two times a substitution elasticity around four seems rather unrealistic. Reconsidering the findings of these studies most estimations of own price elasticities are between 0.5 and 2. Jorgenson/Wilcoxen e.g. have estimated import demand price elasticities for the U.S. economy within a range of 1.5 to 2.0.[24]

Deriving the relation between the price elasticity of demand ($el_{i,i}$) and the elasticity of substitution (σ) for our model specification under ceteris paribus assumptions gives the following expression:

$$el_{i,i} = \sigma \cdot \left(1 - \frac{PIM_i \cdot IMP_i}{PY \cdot Y}\right).$$

It indicates that the elasticity of substitution σ should be close to the own price elasticity, as long as the import shares of domestic demand are small. A similar relationship can be found for the cross price elasticities.

Of course there are other differences in model specifications that might play a role for the results obtained. Even if the differences are of minor importance in a comparative static analysis they might not be negligible in a full equilibrium analysis based on real data. Alternative specification and differences in the underlying data are the major reason why the findings of empirical work are less unique than those of the analytical work. While the models of Goulder (1995a) and Bovenberg/Goulder (1996) trace no double dividend for the US economy, the models of Jorgenson/Wilcoxen (1994) and Ballard/Medema (1993) confirm the double dividend hypothesis for the same economy.

[24] see also Stern et al. (1976), Reinert et al. (1992).

Finally, one should reconsider that the analysis traces economic benefits or losses only. The welfare measure chosen abstracts from any (individual) environmental benefit. As the simulation results indicate, a tax on CO_2 reduces also emissions of other (energy related) pollutants like SO_2 or NO_x. The sum of benefits from slowing environmental degradation might outweigh occuring costs easily. Integrating economic costs and environmental benefits within one assessment framework is also a topic of our future research.

4 Conclusion

National economic concerns still hinder the implementation of effective policy measures that would enable a significant reduction of greenhouse gas emissions. Considering other economic problems like unemployment, the enforcement of Maastricht criterions and highly tensed social security systems, the global warming problem seems to be of less priority for national policy makers. Nevertheless, the international political pressure forces governments to do something and show at least political will. To escape the dilemma countries choose their strategy with respect to least cost criteria; the potential environmental benefit is of less importance as long as the reductions achieved relieve the political requests of the international society.

The purpose of this study was to point out clearly the assumptions underlying the model specification and their potential impact on the empirical outcomes of the analysis. There is a wide range of factors that play an important role for the double dividend issue. Apart from the labour market specification this concerns in particular the ’openness’ of the economy assumed, the number of agents considered and the factor mobility imposed. While alternative assumptions with respect to these issues might explain some of the divergence of results that can be found in the literature, a major disadvantage remains: there is (at least at the current state of economic modelling) no complete reliability either to reject or to confirm the existence of a double dividend - everything is linked to the reliability of the model specification and its parameterization.

Our simulations with a multi-country multi-sector CGE-model for the European Union indicate that a revenue neutral environmental tax reform, where CO_2 emissions are taxed and the tax receipts are used to release the employers’ contribution to social security, might yield a double dividend. But the positive effect obtained on the economic side is rather small (for Germany e.g. the positive welfare could be 0.02 percent of GDP) and it depends crucially on the institutional setting of the policy chosen (unilateral versus EU-wide coordination) as well as on the labour market regime imposed (flexible versus rigid labour market).

In a classical labour market specification Germany obtains a double dividend if a unilateral policy is imposed. The coordinated policy makes Germany worse off as a small welfare loss is obtained. There are two reasons for explanation: First, the two policies (unilateral: 10% CO_2 reduction in Germany, coordinated: 10% CO_2 reduction EU-wide) are not neutral with respect to the environmental goal obtained and second, the burden sharing between countries in the coordinated policy is not considering the 'polluter pays principle.' The allocation of a country's contribution is obtained by the (coordinated) minimum cost solution on the EU level. Taking into account the differences in potential[25] emission growth rates (which is below average for Germany) yields a reduction for Germany that is much higher in the coordinated case compared to the one by unilateral action.

Nevertheless there is an overall benefit of coordination. Therefore, more sophisticated coordination schemes that include side payments could enable the acceptance of such a coordinated policy by all parties (countries).

The outcomes are different if one specifies the labour market alternatively. Assuming fixed real wage rates makes Germany indifferent to the two policies; there is a small welfare gain in both policies. If real wage rates are adjusted according to the decrease in labour productivity - the latter is linked to every policy that reduces labour cost - no double dividend is obtained. Hence, justification or rejection of the double dividend hypothesis depends crucially on the labour market assumptions made.

From an empirical point of view, obtaining an economic dividend in terms of welfare by undertaking an 'intelligent' environmental tax reform remains at least possible, but relying on it seems rather optimistic as there are numerous uncertain influences that might alter the sign of the welfare effect. Obtaining a second dividend in terms of employment seems to be more robust. At any rate, even if there might be no 'no regrets' policy, the economic impact of such a reform seems - from the perspective of consumer welfare - within acceptable limits.

[25] If no policy action would have been undertaken.

Table 1: The impact of an unilateral environmental tax reform in Germany (DE-nc) (percent changes from baseline)

a)

	EV in % of GDP	GDP (%)	Production (%)	Priv. Consumption (%)	Investment (%)	Exports (%)	Imports (%)
Period	**1-10**	**10**	**10**	**10**	**10**	**10**	**10**
Belgium	-0.01	0.00	-0.01	-0.01	-0.01	-0.02	-0.01
Germany	0.02	0.09	-0.20	0.13	-0.18	-0.13	-0.24
Denmark	0.01	0.00	0.00	0.01	0.00	0.00	0.01
France	-0.01	0.00	0.00	-0.01	0.00	-0.02	-0.02
Greece	-0.01	0.00	0.00	0.00	0.00	0.00	-0.01
Ireland	0.00	0.00	0.00	0.00	0.00	-0.01	0.00
Italy	-0.01	0.00	0.00	-0.01	0.00	-0.01	-0.02
Netherlands	-0.04	0.00	-0.01	-0.02	0.00	-0.02	-0.03
Portugal	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01
Spain	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01
Great Britain	-0.01	0.00	0.00	-0.01	-0.01	-0.01	-0.02
EU-11	0.00	0.02	-0.05	0.03	-0.07	-0.03	-0.02

b)

	Employment (%)	After tax real wage rate (%)	Non-labour income (%)	CO_2-tax (ECU/ton CO_2)	CO_2 reduction[1] (in % of base)	CO_2-emissions[1] (in % of base)	CO_2-projection[2] (%)
Period	**10**	**10**	**10**	**10**	**1-10**	**1-10**	**1-10**
Belgium	0.00	-0.01	-0.01	0.00	0.3	2.3	2.0
Germany	0.26	0.47	-0.31	8.24	-7.0	-10.0	-3.0
Denmark	0.00	0.01	0.00	0.00	0.4	17.4	17.0
France	0.00	-0.01	0.00	0.00	0.3	7.3	7.0
Greece	0.00	0.00	0.00	0.00	0.1	13.1	13.0
Ireland	0.00	0.00	0.00	0.00	0.1	13.1	13.0
Italy	0.00	-0.01	0.00	0.00	0.1	9.1	9.0
Netherlands	0.00	-0.02	-0.02	0.00	0.1	3.1	3.0
Portugal	0.00	0.00	0.00	0.00	0.1	28.1	28.0
Spain	0.00	0.00	0.00	0.00	0.0	5.0	5.0
Great Britain	0.00	-0.01	-0.01	0.00	0.1	4.1	4.0
EU-11	0.05	-	-	-	-2.0	1.7	3.7

[1] considering underlying growth (see [2])
[2] projection of business-as-usual: conventional wisdom and no emission reduction policy (i.e. rates include economic growth and efficiency improvements)

Table 2: The impact of a coordinated environmental tax reform in the EU (EU-co) (percent changes from baseline)

a)

	EV in % of GDP	GDP (%)	Production (%)	Priv. Consumption (%)	Investment (%)	Exports (%)	Imports (%)
Period	**1-10**	**10**	**10**	**10**	**10**	**10**	**10**
Belgium	1.87	0.54	-0.11	1.47	0.62	-0.69	-0.24
Germany	-0.22	0.13	-0.55	0.13	-0.55	-0.37	-0.80
Denmark	0.56	0.35	-0.03	0.72	0.23	-0.44	-0.42
France	0.34	0.12	-0.27	0.34	-0.11	-0.33	-0.38
Greece	-1.71	-0.28	-0.78	-0.92	-1.32	0.21	-2.05
Ireland	1.47	0.09	-0.20	1.07	-0.08	-0.57	-0.13
Italy	-0.21	0.09	-0.30	-0.04	-0.38	-0.29	-1.01
Netherlands	0.32	0.47	-0.09	0.51	-0.01	-0.29	-0.58
Portugal	0.24	0.52	-0.29	0.67	0.05	-0.65	-0.76
Spain	0.57	0.31	-0.25	0.81	0.21	-0.41	-0.09
Great Britain	-0.38	0.30	-0.44	0.06	-0.36	0.01	-0.81
EU-11	0.01	0.19	-0.37	0.23	-0.31	-0.22	-0.59

b)

	Employment (%)	After tax real wage rate (%)	Non-labour income (%)	CO_2-tax (ECU/ton CO_2)	CO_2 reduction[1] (in % of base)	CO_2-emissions[1] (in % of base)	CO_2-projection[2] (%)
Period	**10**	**10**	**10**	**10**	**1-10**	**1-10**	**1-10**
Belgium	1.03	3.08	-0.12	22.01	-17.5	-15.5	2.0
Germany	0.58	0.85	-0.83	22.01	-15.0	-18.0	-3.0
Denmark	0.65	1.48	-0.28	22.01	-13.4	3.6	17.0
France	0.30	0.68	-0.32	22.01	-14.3	-7.3	7.0
Greece	-0.06	-1.18	-0.73	22.01	-24.1	-11.1	13.0
Ireland	0.39	1.60	0.05	22.01	-12.2	0.8	13.0
Italy	0.26	0.20	-0.58	22.01	-12.0	-3.0	9.0
Netherlands	0.97	2.02	-0.71	22.01	-14.9	-11.9	3.0
Portugal	1.17	1.97	-0.63	22.01	-13.7	14.3	28.0
Spain	0.94	1.51	-0.26	22.01	-15.3	-10.3	5.0
Great Britain	0.63	0.48	-1.20	22.01	-10.3	-6.3	4.0
EU-11	0.54	-	-	-	-13.7	-10.0	3.7

[1] considering underlying growth (see [2])
[2] projection of business-as-usual: conventional wisdom and no emission reduction policy (i.e. rates include economic growth and efficiency improvements)

Table 3: The impact of alternative labour market regimes (percent changes from baselines)

Labour market regime	**Classical labour market**						**Real wage rate fix**						**Real wage rate according to labour productivity**					
Institutional setting	Germany alone			EU (coor)			Germany alone			EU (coor)			Germany alone			EU (coor)		
Variable	EV (% of GDP)	Consumption	Employment	EV (% of GDP)	Consumption	Employment	EV (% of GDP)	Consumption	Employment	EV (% of GDP)	Consumption	Employment	EV (% of GDP)	Consumption	Employment	EV (% of GDP)	Consumption	Employment
Belgium	-0.01	-0.01	0.00	1.87	1.47	1.03	0.00	0.00	0.00	0.58	0.31	1.77	0.00	0.00	0.00	0.24	0.20	1.78
Germany	0.02	0.13	0.26	-0.22	0.13	0.58	0.08	0.04	0.51	0.08	0.05	1.11	-0.02	0.01	0.54	-0.12	-0.02	1.17
Denmark	0.01	0.01	0.00	0.56	0.72	0.65	0.02	0.01	0.02	0.53	0.34	1.44	0.03	0.02	0.02	0.38	0.28	1.50
France	-0.01	-0.01	0.00	0.34	0.34	0.30	0.00	0.00	0.00	0.20	0.10	0.63	0.00	0.00	0.00	0.06	0.05	0.65
Greece	-0.01	0.00	0.00	-1.71	-0.92	-0.06	0.01	0.00	0.01	-0.17	-0.11	0.25	0.01	0.01	0.01	-0.32	-0.15	0.24
Ireland	0.00	0.00	0.00	1.47	1.07	0.39	0.00	0.00	0.01	0.26	0.14	0.96	0.00	0.00	0.01	0.01	0.06	1.00
Italy	-0.01	-0.01	0.00	-0.21	-0.04	0.26	-0.01	-0.01	-0.01	0.00	-0.04	0.39	-0.01	-0.01	-0.01	-0.13	-0.08	0.40
Netherlands	-0.04	-0.02	0.00	0.32	0.51	0.97	-0.02	-0.01	-0.01	0.30	0.13	1.75	-0.03	-0.01	-0.01	0.05	0.05	1.76
Portugal	0.00	0.00	0.00	0.24	0.67	1.17	0.00	0.00	0.00	0.80	0.39	2.15	0.00	0.00	0.00	0.43	0.29	2.24
Spain	0.00	0.00	0.00	0.57	0.81	0.94	0.00	0.00	0.00	0.32	0.21	1.66	0.00	0.00	0.00	-0.04	0.07	1.72
Great Britain	-0.01	-0.01	0.00	-0.38	0.06	0.63	0.00	0.00	0.00	0.07	0.04	0.95	0.00	0.00	0.00	-0.14	-0.05	0.99
EU-11	0.00	0.03	0.05	0.01	0.23	0.54	0.02	0.01	0.10	0.14	0.07	0.97	-0.01	0.00	0.11	-0.05	0.00	1.00

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