# RECYCLING ENERGY TAXES.

# IMPACTS ON A DISAGGREGATED LABOUR MARKET

by

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## 1. Introduction

The phenomenon of high and persistent unvoluntary unemployment is still one of the major concerns for European governments. At the same time increasing attention has been devoted in Europe to environmental protection and sustainable development. The need of modern administrations to cope with these two issues has heated the debate on the “double dividend hypothesis”. This hypothesis suggests that shifting the tax system away from labour towards polluting sources would encourage employers to substitute labour for capital and other inputs, thereby making production more labour intensive and less polluting at the aggregate level.

Even if differing positions exist in the economic literature about the “employment double dividend” issue, nonetheless they seem to agree that very restrictive conditions must be met for the recycling of environmental taxation to produce an increase in aggregate employment (Cf. Bovenberg, 1997). Moreover, even when these conditions are met, the effects on employment of a fiscal reform which reduces distortionary taxation in the labour market and increases environmental taxation are likely to be small (Bovenberg and Goulder, 1993). The possibility of an “employment double dividend” has been identified, but only in the short run, in Carraro, Galeotti and Gallo (1996). Surveys of the literature can be found in Bovenberg (1997), Carraro (1998) and Bosello, Carraro and Galeotti (1999) .

In this paper we would like to explore another dimension of the “employment double dividend” issue, namely the possibility that the double dividend arises because the environmental fiscal reform uses the revenue of higher emission charges to reduce gross wages of unskilled workers, whose employment therefore increases. Hence, the goal is to increase total employment by stimulating labour demand for unskilled workers. This was indeed the original idea in Drèze *et al.* (1992), and subsequently in Delors’ White Book. However, the available economic literature does not yet seem to have assessed the actual Delors’ proposal. The likely reason is that existing models are not designed to capture the main feature of the European labour market, which is highly centralised (Calmfors and Driffil, 1993), often segmented (Freeman and Gibbons, 1993, Katz 1993), and in which wages are the outcome of a bargaining process between unions and firms (Moene, 1988; Snower, 1993; Sneessens, 1995). In particular, existing models do not distinguish between demand and supply for skilled and unskilled workers, and are thus unable to answer the main question addressed in this paper: can employment increase when the environmental fiscal reform aims at lowering unskilled workers’ labour cost?

In a previous paper (Carraro, Galeotti and Gallo, 1996), we have already analysed whether an environmental tax reform, where energy taxation is increased and the resulting revenue is recycled into lower payroll taxes, can actually reduce pollution and unemployment. The analysis was carried out using the WARM model, where technical progress was endogenised and wage negotiations were carefully modelled, but labour was assumed to be a homogenous good (Brunello, 1996; Carraro and Galeotti, 1996).

In this paper, we generalise previous results by introducing three main extensions. First, the WARM model is developed to include the three new countries (Austria, Finland and Sweden) which have adhered to the European Union in the mean time. Second, we modify the WARM model by segmenting the labour market into two interrelated markets: one for skilled and one for unskilled workers. In this way, we compare the effects of environmental tax reforms in which the fiscal revenue is recycled either through a reduction of wages of the entire labour force or through a reduction of gross wages of unskilled workers only (as originally proposed in Delors' White Book). Third, the policy scheme is modified with respect to Carraro, Galeotti and Gallo's (1996) paper. Instead of assuming a uniform emission tax across EU countries and looking at the effects of revenue recycling on employment, we determine whether there is a country specific optimal tax which enables EU governments to achieve a given employment target. The main policy goal therefore moves from environment to employment. Finally, the simulation period has been extended up to 2030.

The structure of the paper is as follows. First, we briefly review the main characteristics of the WARM model, focusing mainly on the changes that were necessary in order to integrate a newly estimated imperfectly competitive and segmented labour market into the previous structure. Section 2 shows the structure of the model and the related econometric estimates. Then, Section 3 describes the main features and hypotheses that characterise the baseline scenario. The results of our simulation experiments are shown in Section 4 (detailed Tables are presented in the Appendix) which is divided into two subsections. The first subsection considers the non co-operative case in which each country sets its own employment target and the optimal tax to achieve it. The second one considers the co-operative case in which the employment target is set at the EU level, the tax is harmonised, and a system of fiscal transfers across EU countries is used to achieve the optimal solution. Two policy options are considered in each of the above cases. In the first one, the revenue of the environmental tax is used to reduce social security contributions paid on unskilled workers' gross wages. In the second one, the tax determined in the first policy experiment is taken as given, but its fiscal revenue is recycled to the entire labour force, i.e. to achieve a reduction of social security contributions paid by employers on all employed workers. The goal is to verify whether or not it is more efficient to pursue a general reduction of all gross wages rather than of the wages of a segment (the unskilled one) of the labour market. The final section is devoted to summarising the main conclusions of the papers and further possible developments.

## 2. An Econometric Model of a Segmented Labour Market

The main features of the WARM model are carefully described in Carraro and Galeotti (1996) and in Carraro, Galeotti and Gallo (1996). Here we would like to present a new version of the labour market module that has been used to replace the old one in the WARM model in order to carry out the simulation experiments described in the Introduction.

In the new version of the WARM model, we distinguish between a primary sector, which includes all workers except those in the agriculture sector, and a residual secondary sector. In the primary sector, wages and employment are the outcomes of a bargaining process between unions and firms' managers. The secondary sector is perfectly competitive.

In the primary sector, unions play a crucial role. They are modelled as a representative agent who aggregates the preferences of those who participate in the labour market and who uses his bargaining power to obtain a wage above the competitive level. Bargaining is a sequential process: in the first stage, unions and firms in the industrial sector agree upon the wage rate; subsequently, firms in the other sectors and the government set their wages on the basis of differentials which depend upon the union bargaining power as well as upon general and sector-specific economic conditions. Then, employment is determined by labour demand.

The primary labour market is further segmented into a market for skilled and a market for unskilled workers. Hence, the above sequential bargaining process takes place twice because there are two independent unions. We expect the bargaining power of skilled workers' union to be higher than that of the unskilled workers' union. This difference in the bargaining power should capture not only the effective *institutional* influence of unions (here proxied by the number of union members), but also the *insider* effect due to the degree of specialisation of the different kinds of workers (a skilled worker may be difficult to replace and is therefore expected to have a higher influence on firms' decisions than an unskilled, easy to substitute, worker). The estimates of the bargaining powers will be shown below.

As is now standard in the economic literature (Cf. McDonald and Solow, 1981), the outcome of the bargaining process is obtained as the interior solution of the maximisation of the Nash objective function subject to the labour demand function. To compute this solution, a union's utility function has to be specified. The assumption is that the union maximises the total rent given by the product of the level of overall employment times the individual earnings of employees in the unionised sector. Then, the solution of the maximisation problem yields an equation in which $s = \frac{\theta WN}{\Pi}$, the ratio between gross wage and profits per capita, is determined as follows:

(1) $$s = \frac{\beta}{(1-\rho)\cdot u} + \beta\phi\varepsilon_{n\theta w}$$

where $q = 1/(1 - o - t)$ is the fiscal wedge, in which o represents social contributions and $t$ is the ratio between income taxes and gross wages. The share *s* increases as union bargaining power (b*)* increases and decreases as unemployment rate (*u*), employment elasticity to wages ($e_{nqw}$) and the weight attributed by the union to employment in its utility function (f) increase; r is the replacement rate measured as the ratio of unemployment benefits to average earnings (see Brunello, 1996 for a detailed presentation of the theoretical model and of its solution).

As previously mentioned, in our new theoretical setting there are two unions: one for the skilled workers (S) and one for unskilled ones (U). These two unions, each endowed with its own specific utility function, bargain separately with firms to maximise the utility of their members. These two bargaining processes yield two separate share equations with different value of b and f. for each group of workers.

Equation (1) defines the long-run value of the relative share *s*. However, in the short run, *s* can differ from the value derived from equation (1). The short-run dynamic is represented by the following adjustment mechanism (Brunello, 1996):

$$\log \bar{s}_i = \log(b_i \cdot (1 + r_{fi} e_i f_i)) + l_{3i} \cdot (\log wedge_i - \log wedge_{i-1}) + \quad (2)$$
$$+ l_{4i} \cdot (\log \bar{s}_{-1}) + \sum_{j=1}^{12} Dummy_{ji}$$

with $i = S, U,$ and where $l_{3i}$ and $l_{4i}$ are the short-term adjustment parameters. The first accounts for variations of the fiscal wedge in differences, the second for the one-period-lagged "corrected" share $\bar{s}_i$ : note that, when taking logs of (2), we set $\bar{s}_i = s_i \cdot (1 - r_i) \cdot u_i$ and $r_{fi} = (1 - r_i) \cdot u_i$. Moreover, a set of country specific dummies is designed to capture the country specific effects directly on the share.

In order to estimate the parameters b and f. of eq. (2), we used a multi-step iterative procedure. Assume:

$$f_i = f_{0i} + f_{1i} \cdot \frac{1}{Er_i} \qquad i = S, U \quad (3)$$

i.e. that the weight placed by unions on employment is inversely related to the employment rate (*Er*). Then, the initial values of $f_i$ are derived from (3) for arbitrary initial values of the coefficients parametrising (3) (we assumed one). This initial time series is used to estimate b in (2) under the following functional forms:

$$b_i = l_{1i} + l_{2i} \cdot UNION \qquad i = S, U. \quad (4)$$

The estimates of equation (4) are expected to show a positive relationship between *UNION*, the unionisation rate, and b, the unions' bargaining power.

Given the estimated $b$, from (2) and (3) we obtain new values for $f_i$ which are then used in the next step of the iterative procedure for a new estimate of $b$. This iterative estimation procedures proved to converge and to provide satisfactory results. The estimation results are shown in Table 1 and 2 below, for the 12 original EU countries and for Austria, Finland and Sweden respectively (two different data sets were used).

Table 1: Share equation for skilled (S) and unskilled (U) workers. Parameters estimated on the EU12 data set.

| **Variable** | **Parameter** | **S** | | | **U** | | |
|---|---|---|---|---|---|---|---|
| | **Name** | **Value** | **Error** | **t-statistic** | **Value** | **Error** | **t-statistic** |
| **Constant** | **λ1** | -0,4703 | 0,1136 | -4,1394 | -0,6203 | 0,0911 | -6,8086 |
| **Union. rate** | **λ2** | 7,30E-02 | 2,82E-02 | 2,5921 | 6,75E-02 | 2,18E-02 | 3,1022 |
| **Wedge dif.** | **λ3** | -2,9783 | 1,2491 | -2,3843 | -2,2311 | 1,5086 | -1,4788 |
| **Lag. share** | **λ4** | 0,9584 | 0,0427 | 20 | 0,8276 | 0,044 | 18,806 |

Table 2: Share equation for skilled (S) and unskilled (U) workers. Parameters estimated on the Austria, Finland and Sweden data set.

| **Variable** | **Parameter** | **S** | | | **U** | | |
|---|---|---|---|---|---|---|---|
| | **name** | **Value** | **Error** | **t-statistic** | **Value** | **Error** | **t-statistic** |
| **Constant** | **λ1** | -0,6012 | 0,4439 | -2,2857 | -0,6372 | 0,623 | -1,003 |
| **Union. rate** | **λ2** | 5,23E-02 | 6,42E-02 | 1,2401 | 5,15E-02 | 9,30E-03 | 1,4213 |
| **Wedge dif.** | **λ3** | -0,4006 | 0,5676 | -0,7872 | -0,4567 | 2,6 | -1,175 |
| **Lag. share** | **λ4** | 0,891 | 0,1456 | 6,1315 | 0,9143 | 0,1468 | 5,7552 |

As expected, for each group of workers, the unionisation rate *UNION* appears directly related to the unions' bargaining power $b$. The sign of the parameter $l_2$ is indeed positive for both skilled and unskilled workers. As a consequence, higher unionisation rates imply higher wage pressure and higher labour cost. The parameter $l_3$ also has the expected sign. As said, it captures the effect of the variation of the fiscal wedge on the labour cost. Its negative sign confirms (for all workers and for all data sets) that an increase of labour taxation actually increases wages and reduces labour demand.

Table 3. Union bargaining powers (b) and marginal substitution rates wage/employment (f (1-r )$u$) for skilled and unskilled workers.

| | Betau | Betas | MSRu | MSRs |
|---|---|---|---|---|
| **Austria** | 0.6234 | 0.6635 | 0.0787 | 0.2154 |
| **Belgium** | 0.9050 | 1.0983 | 0.5342 | 1.0762 |
| **Denmark** | 0.9818 | 1.1815 | 0.3272 | 0.6592 |
| **Finland** | 0.7285 | 0.7695 | 0.1091 | 0.6152 |
| **France** | 0.5052 | 0.6656 | 0.4641 | 0.9349 |
| **Germany** | 0.6657 | 0.8394 | 0.2905 | 0.5852 |
| **Greece** | 0.6019 | 0.7703 | 0.5351 | 1.0779 |
| **Ireland** | 0.7904 | 0.9746 | 0.8352 | 1.6825 |
| **Italy** | 0.7895 | 0.9733 | 0.6333 | 1.275 |
| **Lux.** | 0.7230 | 0.9013 | 0.0632 | 0.1274 |
| **Holland** | 0.6163 | 0.7859 | 0.3123 | 0.6291 |
| **Portugal** | 0.7082 | 0.8853 | 0.3907 | 0.7871 |
| **Spain** | 0.4980 | 0.6579 | 0.7462 | 1.5033 |
| **Sweden** | 0.7812 | 0.8236 | 0.0853 | 0.2452 |
| **U.K.** | 0.7252 | 0.9038 | 0.6650 | 1.3396 |
| **EU15** | 0.7095 | 0.8595 | 0.4340 | 0.9094 |

Table 3, which summarises the results for the fifteen European Countries, shows that the two types of workers have different bargaining powers and different preferences for employment. In particular, skilled workers can influence firms' choices more than unskilled workers. It also emerges that firms slightly prevail over unions in the determination of wages. The European average values of b (0.7095 and 0.8595 for U and S respectively) show a bargaining power which is about 58% or 54% for firms against the 42% or 46% for U or S unions respectively.

Skilled and unskilled workers' unions both have a strong preference for wages over employment, but the value for unskilled workers is lower than the one for skilled workers. The European values of the marginal rate of substitution between wage and employment (0.4340 and 0.9094 for U and S respectively) show that U unions are willing to give up 1% of the net wage in exchange for a 2.5% increase in employment whereas S unions value these two components almost equally. The explanation for this last result could be found in the fact that skilled workers usually have higher and more reliable wages than unskilled ones.

In order to complete the specification of the segmented labour market, we need to estimate the two equations which endogenise social security contributions demanded by the government. Indeed, a noticeable feature of WARM is the endogenisation of government behaviour. The fundamental assumption here is that its strategies can be endogenised as functions of the economic policy goals, i.e.

through a set of reaction functions. In the new version of WARM, social security contributions at current prices (*OSv*) are segmented according to the disaggregation introduced for the labour market.

(5)

$$OSv_i = ZLv_i \cdot \left[ g_{0i} + g_{1i} \cdot u + g_{2i} \cdot OSv_{i-1} / ZLv_{i-1} + g_{3i} \cdot TRGpv / P65\_ + \right.$$
$$\left. + g_{4i} \cdot Whlm_i + \sum_j Dummy_{ji} \right]$$

i = U, S

Social security contributions are endogenised as a share of total labour costs (*ZLv*) and they depend on *u*, the unemployment rate, $OSv(-1) / ZLv(-1)$, the ratio between total social contributions and total wages lagged one period, the ratio between transfers and the retired population (that is *TRGpv/P65_,*) and the net hourly wage (that is *Whlm*). A set of dummy variables accounts for country specific effects, where *j* is the index for each EU member country. Tables 4 and 5 show our estimation results.

Table 4. Social security contribution equations for skilled (S) and unskilled (U) workers. Parameters estimated on the EU 12 data set.

| Variable | Parameter | S | | | U | | |
|---|---|---|---|---|---|---|---|
| | Name | Value | Error | t-statistic | Value | Error | t-statistic |
| Unempl. | γ1 | 0,0813 | 0,026 | 3,1184 | 0,0811 | 0,0265 | 3,0526 |
| Lagged ssc/TLcost | γ2 | 0,7985 | 0,0424 | 18,822 | 0,791 | 0,0521 | 15,174 |
| Tr./retired | γ3 | | | | 2,39E-06 | 2,91E-06 | 0,8229 |
| Net h.wage | γ4 | -0,0958 | 0,0279 | -3,4321 | -0,014 | 0,431 | -3,2513 |
| Constant | γ0 | 0,08 | 0,0134 | 5,9634 | 0,0973 | 0,0193 | 5,0346 |

Table 5. Social security contribution equations for skilled (S) and unskilled (U) workers. Parameters estimated on the Austria, Sweden and Finland data set.

| Variable | Parameter | S | | | U | | |
|---|---|---|---|---|---|---|---|
| | Name | Value | Error | t-statistic | Value | Error | t-statistic |
| Unempl. | γ1 | | | | | | |
| Lagged ssc/TLcost | γ2 | 0,7447 | 0,0668 | 11,4457 | 0,0709 | 0,0657 | 10,16 |
| Tr/retired | γ3 | | | | | | |
| Net h.wage in diff. | γ4 | -11,6966 | 3,1090 | -3,762 | -15,185 | 5,2699 | -2,855 |
| Constant | γ0 | 0,0603 | 0,0161 | 3,7452 | 0,076 | 0,0156 | 4,863 |

These results confirm that social security contributions are used as a counter-cyclical fiscal instrument. Indeed, the unemployment rate appears to be positively related to the level of social security contributions (positive sign of the parameter $g_1$), whereas the hourly net wage appears with a negative sign (parameter $g_4$). Broadly speaking, increasing unemployment rates boost social security contributions. This can be explained by two major factors: first, a worsening in working conditions (i.e. in job stability as usually associated with high unemployment rates) tends to be compensated by the government with higher non-job benefits; secondly, higher social security contributions, that at least in part pay for retirement benefits, are a way to promote the exit of old incumbent workers and thus to create new jobs (see e.g.: Reid and Robertson 1965; Hart 1984).

## 3. Baseline Scenario

Given the very limited number of exogenous variables in WARM, what we need in order to define the baseline scenario are mainly the level of world demand, the prices of energy inputs and of raw materials, the dynamics of population growth and of public spending, the unionisation index and the replacement rate.

The paths of the exogenous variables of the model have been chosen taking into account both the world scenarios provided by the World Bank and some Europe-specific features such as the Maastricht criteria on public debt, inflation and long-term interest rate. In our baseline, the world import volume is expected to grow in the four decades 90-00, 00-10, 10-20, 20-30 at rates equal to 4.5, 3.3, 3.0 and 2.7 per cent respectively. We assumed a yearly 2% growth rate of world import prices. The population growth rate varies from the lowest values of Denmark and Ireland (0.06% on average, along the projected periods), to the highest of Austria and Luxembourg (0.7% on average, along the projected periods: these high values are due to the higher than proportional increasing share of eldest people). Public spending has been assumed to grow at an annual average of about 1.5%. This rate enabled us to set the ratio of public debt over GDP according to the Maastricht target wich sets the above ratio at 0.6. As far as the labour market exogenous variables are concerned, we chose a constant or decreasing unionisation index and a constant or slightly increasing replacement rate index for the majority of countries.

A very detailed analysis has been carried out to design the evolution of the sectoral import-export flows structure. More precisely, for each of the products considered in the model (durables, non durables, services, agricultural goods, coal, oil, gas, and electricity), we checked the sustainability of fixing a 2% growth rate of export prices in order to obtain reasonable import flows from the European countries as a whole and from the Rest of the World as well.

The consequences of these assumptions on the main endogenous variables of the model can be described as follows. The long-run GDP growth rates range between 1.2% and 2.5%. Southern Europe (namely Greece, Spain and Portugal) and Ireland keep growing more steadily than the other countries; among the countries belonging to Western Europe, the Netherlands shows the best performance. A characteristic of the baseline is that consumption growth is faster than GDP growth. In all countries the baseline employment growth rate is positive or slightly negative. Hence, given that the investment share is declining, we can say that the production sector will use more intermediate and import inputs than fixed and/or quasi-fixed inputs. Finally, long-term nominal interest rates tend to converge towards stable values around 4-5% whereas inflation will decline, mainly in Finland, Austria and the United Kingdom, while higher values are shown for Ireland, Spain, Portugal.

## 4. Employment Double Dividend with a Segmented Labour Market

Given the baseline scenario just briefly described, simulation experiments designed to assess the effects of an environmental tax reform were performed. This reform is designed to achieve the so-called "employment double dividend". Therefore, a CO2 emission tax is introduced and its revenue is recycled to reduce social security contributions paid by employers. The first part of the reform, the emission tax, aims at internalising the emission externality, thus reducing pollution. The second part of the reform, by reducing gross wages, aims at increasing employment. If both objectives are achieved, the tax reform yields a "double dividend".

In previous works (Cf. Carraro, Galeotti and Gallo, 1996; see also Bovenberg's 1997 and Bosello, Carraro and Galeottti, 1999's surveys), a given tax rate was selected (usually the 19 Euros per ton of carbon proposed by the European Commission) and the whole revenue was used to reduce social security contributions paid on all employed workers' wages (with the constraint that the reform should not modify the baseline budget deficit - or surplus). In this work, three major changes are introduced.

First, given the segmented structure of the labour market in WARM, we can analyse the effectiveness of a fiscal reform in which the tax revenue is used to reduce social security contributions (i.e. gross wages) for unskilled workers only, as originally proposed in Drèze *et al.* (1992). The effects of this reform are then compared with those obtained when the tax revenue is recycled to reduced all workers' (skilled and unskilled) gross wages. We will show that the fiscal reform is more effective, in terms of employment gains, when the fiscal revenue is used to reduce gross wages of all employed workers.

Second, given the importance of the employment target, which is likely to be far more important for EU governments than the environmental one, we explicitly design the tax reform to achieve employment growth, at least in the short run. Therefore, we assume that all governments aim at achieving an average increase in employment of about 1% in the first five years after the introduction of the tax reform. We then determine what is the optimal, emission tax rate which enables governments to actually achieve the target, if one exists.

Third, when designing the environmental tax reform we consider two different institutional scenarios. In the first one, the main goal is employment. Hence, we do not assume a uniform tax rate applied in all EU Countries. Rather we assume that all countries agree on the general principles of the proposed tax reform (i.e. a tax on CO2 emissions recycled into lower social security contributions), but are free to set their own country specific tax and social security contributions rates with the aim of achieving the domestic employment target. This fiscal reform is therefore optimal from the employment viewpoint, not from the environmental one.

The second scenario is the one in which a harmonised environmental policy is introduced in the EU, and in which the costs of the environmental policy are reduced through revenue recycling. Hence, we assume that the tax rate is uniform across European countries in order to equalise marginal abatement costs. Then we assume that the revenue is re-distributed among European countries in order to achieve the same employment increase in all countries. In other words, all countries gain equally, if there is an employment gain, from the introduction of the environmental fiscal reform. We will show that in the case in which the fiscal revenue is recycled only to unskilled workers, the reform can guarantee a short-term increase of employment of 1% in all countries, whereas the employment increase becomes 2% when the fiscal revenue is recycled to all employed workers. Notice that to achieve this result in the presence of a uniform tax rate, a “co-operative” re-distribution of the fiscal revenue among European countries becomes necessary.

### 4.1 Non Co-operative Employment Targets

Let us focus on the first scenario. In both simulation runs (revenue recycling into unskilled workers’ gross wages, revenue recycling into all workers’ gross wages), the emission tax is applied on the consumption of all fossil fuel consumers, but not in the electricity sector, by raising excise taxes and VATs. This tax is evaluated at 1980 prices and partially indexed to the consumers’ price index (the degree of indexation is assumed to be 50%). Therefore, in real values the tax is declining over time.

In both simulation experiments, the fiscal reform is introduced in 1997 and simulations are carried out up to 2030. The simulation experiments determine the optimal tax rate that enables the government in each country to achieve the employment goal (an average 1% increase in employment in the first five years). In all simulations the fiscal revenue is recycled so as to maintain the budget surplus or deficit unchanged.

Let us first consider the case in which the fiscal manoeuvre focuses on the reduction of unskilled workers’ social security contributions. Results are shown in Tables A1.2 and A1.3. In the first five years, the impact of the tax reform on labour costs is negative (from -0.2% in Italy to -4.7% in Greece) whereas it is positive on total employment (1%, as targeted). Therefore the tax reform can achieve its first dividend, at least in the short run. However, the total impact of the reform is the sum of two different effects: a reduction of gross wages for unskilled workers, with a subsequent employment increase, and a related positive impact on the skilled workers' gross wage, which induces a reduction of their employment. This substitution effect, albeit mild, is the outcome of the substitutability of skilled and unskilled workers in the production process. The available data led indeed to estimate a small degree of substitution, rather than complementarity, between the two types of workers.

In the long run, the aggregate labour cost tends to revert back to the baseline level and then to increase. Therefore, employment slowly reverts to its baseline value with a small negative effect at the end of the simulation period. This result is consistent with theoretical predictions which suggest that, in a bargaining framework like the one assumed to model the labour market in WARM, all changes in the gross wage are translated into changes of the net wage in the long run (Brunello, 1996). Hence, long-run employment cannot be modified by changes of the fiscal wedge. The dynamic bargaining process embodied in the WARM model perfectly captures this theoretical feature, even if in the long run there is a mild over-heating effect that leads net wages to increase more than the gross wage reduction.

What about the environmental dividend? Table A1.4 shows that the fiscal reform can also reduce emissions (from -0.2% in Sweden to -2.1% in Italy) in the short run. Hence, the double dividend can be achieved, even if the environmental one is not very large. However, in the long-run results are less positive. The tax reform induces a stimulus to economic growth and consumption in particular (see Tables A1.5-A1.6). Hence, in the majority of countries, the positive effect on emission reduction disappears because GDP, mainly through its consumption component, increases. This effect is explained by the increased net wages and employment levels, which boost consumption of all goods, including energy consumption, and by the small amount of technical progress that takes place for transport and heating (the major sources of energy consumption for households). As a consequence, the long-run effects of the environmental tax reform are slightly negative for both environment and employment.

What are the tax levels that lead EU governments to achieve the short-run double dividend just described? Are they feasible? What is the shock on energy prices that need to be absorbed by the production system?

The values of the optimal tax that we determined for each EU country are very different. The initial values set by governments range from 2.53 Euros per ton of carbon in Luxembourg, to 32.84 Euros in Sweden. However, most countries choose tax rates between 10 and 19 Euros per ton of carbon (table A1.1).

Notice that, for a given employment target, a higher energy tax has to be imposed when:

- the elasticity of substitution between skilled and unskilled workers is large, because an increase of employment for unskilled workers leads to a large reduction of employment for skilled workers;

- the share of unskilled workers is low, because there are decreasing returns in the effectiveness of the fiscal reform;

- unions' bargaining power is high, because in this case unions can quickly translate a reduction of social security contributions into net wage increases (this was also shown in Carraro, Galeotti and Gallo, 1996).

Let us consider some examples which clarify how the above mechanisms work. In the United Kingdom, the low level of substitution between skilled and unskilled workers, and the large number of unskilled workers, enable the UK government to set a rather low value of the tax, despite the rather high value of unions' bargaining power (which has a strong influence mainly in the long run); in Ireland too, the large share of unskilled workers allows the government to impose a rather low level of taxation, despite the high substitution level. By contrast, in Sweden the small number of unskilled workers implies the introduction of a heavier tax rate to achieve the employment objective, whereas in Germany powerful unions force the government to impose a tax rate higher than the Italian and French ones. A mix of all three factors determines the resulting level of taxation in the other countries.

Let us now consider the second simulation experiment. Here we assume that the tax rate takes the same values determined in the first simulation experiment to achieve the short run employment objective. Given the tax rates, the goal is to analyse whether recycling of the resulting tax revenue into lower social security contributions of all workers yields higher employment and environmental benefit (at least in the short run) than recycling to unskilled workers only.

In the short run, the fiscal reform seems to be more effective overall (tables A2.1-A2.5). As far as labour is concerned, in the majority of the countries the aggregate labour cost reduction, and the corresponding employment increase, are larger than in the first simulation experiment (the weighted average of the difference of the employment change for all EU15 countries is 0.6%). Hence the effect on employment of this second fiscal reform is considerably more significant. As far as emissions are concerned, the results largely depend on the effects of the fiscal reform on the growth dynamics of the economic systems. Emissions decrease at more or less the same rates as in the first simulation experiments (for the whole EU the difference is -0.18%) and GDP slightly rises (for the EU the difference is +0.4%).

Even in the long term, for example the last five years from 2026 to 2030, the second fiscal reform provides better results on employment than the first one. The EU15 aggregate difference for employment is +0.55%, whereas it is +2.4% for emissions and +1.6% for GDP. The high difference registered for emissions in the weighted average is mainly due to the high weights of France, Germany, Italy and Spain, whose GDP is boosted by the fiscal reform with obvious effects on energy consumption and emissions. As a consequence, the second fiscal reform emphasises the trade-off between employment and environment in the long run (higher employment levels are achieved at the price of higher emission levels), but it still yields a double dividend in the short run.

### 4.2 EU Coordinated Environmental Fiscal Reforms

The second set of simulation experiments is devoted to equalising the costs and benefits of the environmental fiscal reform across European countries by introducing a co-operative re-distribution mechanism for the fiscal revenue. As said, the tax rate is assumed to be the same in all countries in order to equalise marginal abatement costs. Moreover, the same employment gain must be achieved in all European countries in order to provide all of them with the same benefit from the fiscal reform (again we assume that employment is the real target of the fiscal reform and therefore we measure benefits in terms of employment gains, i.e. per cent increases of employment).

As in the non co-operative scenario previously examined, we consider two possible ways of recycling the fiscal revenue. In the first one, the tax revenue is used to reduce payroll taxes, and hence gross wages, of unskilled workers only. In the second one, the fiscal revenue is used to reduce gross wages of all employed workers. The uniform tax rate is set at 10 Euros per ton of carbon in 1997 (remember that the tax is evaluated at 1980 prices and partially indexed to the consumers' price index -- the degree of indexation is again assumed to be 50%). In both simulation experiments, the fiscal reform is introduced in 1997 and simulations are carried out up to 2030.

The results concerning the first case -- revenue recycling to unskilled workers -- are shown in Table A3.1. The feasible uniform increase of employment that can be achieved by a zero-sum re-distribution of the fiscal revenue is 1% by the year 2000 (each second column). In other words, the resources raised by the 10 Euros carbon tax in Europe, if appropriately redistributed, enable all European countries to achieve a 1% increase in employment by the year 2000. This type of co-operation also yields a reduction of carbon emissions in almost all European countries, despite the increased energy consumption related to the increased employment.

What are the long-run effects of the co-operative fiscal reform? As expected, the bargaining process in the labour market reduces the beneficial effects on employment of the gross wage reduction. Again, net wages increase, thus further reducing employment. Nonetheless, some gains remain even in the long-run in all countries except Belgium, Luxembourg and the U.K.; these gains range between +0.3 and +0.9. By contrast, the environmental benefit is much lower in the long run, because the increased net wage stimulates energy consumption (at the same time the tax in real terms becomes lower and lower).

Which countries will receive transfers in order to harmonise the benefits of the reform? The simulation was designed to keep the aggregate budget surplus or deficit unchanged by the year 2000, thus assuming that the governments' policy horizon is quite short. At the same time, we look at the sustainability of the reform in the long run (table A4.2). Belgium, France, Greece, Portugal and the U.K. experience a relative budget surplus (i.e. the co-operative reform increases the surplus or reduces the deficit) and therefore benefit from the fiscal re-distribution. However, in the long run only the U.K. preserves a significant relative budget surplus.

The results are even more encouraging when the fiscal revenue is used to reduce the gross wage of all workers (table A4.1). As in the non co-operative scenario previously analysed, this type of fiscal reform seems to be more effective. Indeed, the resources collected through the tax and re-distributed across European countries enable the governments to achieve a 2% increase in employment in all countries by the year 2000 (the only exception is Ireland, where the increase is 1.2%). This increase tends to be lower in the long-run, but it remains significant – above 1% -- in several countries.

Of course, this larger impact on employment penalises the environment. The emission reduction achieved by the reform is much lower in this case than in the case in which the fiscal revenue was recycled only to unskilled workers. In some countries (Finland, Ireland, Germany, Spain and Sweden) emissions increase by the year 2000. This negative effect on the environment is even larger in the long-run. Hence, the usual trade-off between environment and employment is again supported by our simulation experiments.

**5. Conclusions**

A few conclusions can be derived from the simulation experiments described in the previous section:

- the proposed fiscal reform seems to have a larger impact on employment when the fiscal revenue is used to reduce the gross wage of all workers; our simulations in fact reveal the existence of a mild substitution between skilled and unskilled workers. The direct consequence is that a targeted recycling to unskilled workers has a negative impact on the employment of skilled ones. This negative impact reduces the employment dividend;
- there exists the possibility to equalise both the costs and the benefits of the reform across EU countries through the introduction of a “co-operative” re-distribution mechanism. We showed that a harmonised energy taxation coupled with a EU co-ordinated employment policy can provide a larger increase of employment in the EU.

As in previous studies (Cf. Brunello, 1996, Carraro-Galeotti-Gallo, 1996) the short-run beneficial impact of the reform on both employment and the environment tends to disappear in the long run, even if the employment increase does not vanish completely, because of the growth effects when the fiscal reforms reduces the gross wage of all workers. The employment dividend tends to be reduced in the long run, because gross wages cannot be permanently lowered via lower social contributions. Unions are indeed able to transfer to workers the initial benefits that the fiscal reform provides to firms.

However, our results do confirm the existence of a short-run employment double dividend. But, as said above, they do not support Delors’ proposal. Indeed, the largest benefits for employment are achieved when the fiscal revenue is recycled to all workers, even if these benefits have to be traded-off with the related environmental losses.

A deeper analysis of this trade-off, as well as a welfare maximising determination of the optimal fiscal reforms, can be achieved through the specification of a welfare function for each country. This makes the use of a complex model like WARM much more difficult, but will be the objective of further research on the double dividend issue. Additional efforts have also to be devoted to improving the specification of the model in terms of sectoral disaggregation.

# APPENDIX: Simulation Results

## A.1 Non co-operative scenario: targeted recycling to unskilled workers.

### Table A1.1 $CO_2$ emission tax (at 1980 prices)

| | FIN | BEL | DEN | IRE | FRA | GER | GRE | ITA | LUX | NET | AUS | POR | SPA | UK | SWE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *97-00* | 17,41 | 3,32 | 12,11 | 8,57 | 12,11 | 17,20 | 7,08 | 8,04 | 2,53 | 9,03 | 18,91 | 10,14 | 19,27 | 4,51 | 32,84 |
| *01-05* | 12,02 | 3,33 | 12,01 | 8,61 | 12,13 | 17,25 | 6,27 | 8,07 | 2,53 | 9,04 | 16,75 | 9,55 | 18,79 | 4,52 | 29,28 |
| *06-10* | 6,33 | 3,33 | 9,90 | 8,63 | 12,13 | 17,27 | 5,11 | 8,13 | 2,53 | 9,04 | 13,68 | 8,63 | 17,89 | 4,52 | 24,07 |
| *11-15* | 3,34 | 3,33 | 7,65 | 8,64 | 12,14 | 17,26 | 4,20 | 9,10 | 2,52 | 9,04 | 11,17 | 7,79 | 17,01 | 4,52 | 19,73 |
| *16-20* | 1,76 | 3,32 | 5,97 | 8,66 | 12,15 | 17,25 | 3,99 | 10,51 | 2,53 | 9,04 | 9,12 | 7,07 | 16,16 | 4,52 | 16,14 |
| *21-25* | 0,93 | 3,32 | 5,61 | 8,68 | 12,17 | 17,24 | 3,99 | 12,16 | 2,53 | 9,05 | 7,44 | 6,90 | 15,34 | 4,52 | 13,18 |
| *26-30* | 0,49 | 3,32 | 5,61 | 8,70 | 12,19 | 17,22 | 3,99 | 14,09 | 2,53 | 9,04 | 6,07 | 6,89 | 14,61 | 4,53 | 10,73 |

### Table A1.2 Differences wrt baseline of labour costs (in percent.)

**Unskilled**

| | FIN | BEL | DEN | IRE | FRA | GER | GRE | ITA | LUX | NET | AUS | POR | SPA | UK | SWE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *97-00* | -10,3 | -11,5 | -10,0 | -3,7 | -17,9 | -20,9 | -28,1 | -24,8 | -8,4 | -11,6 | -12,3 | -25,9 | -21,7 | -6,4 | -9,5 |
| *01-05* | -8,1 | -11,4 | -12,7 | -2,8 | -20,9 | -23,6 | -26,9 | -26,2 | -9,1 | -3,7 | -10,9 | -24,4 | -23,6 | -7,6 | -11,0 |
| *06-10* | -1,9 | -8,1 | -9,1 | -1,4 | -18,2 | -18,2 | -18,5 | -17,9 | -6,3 | -1,7 | -5,6 | -14,2 | -15,0 | -5,6 | -7,3 |
| *11-15* | 1,9 | -5,1 | -4,5 | -0,1 | -15,9 | -13,5 | -10,3 | -11,5 | -3,9 | -1,1 | -1,3 | -6,2 | -4,9 | -3,9 | -3,4 |
| *16-20* | 3,3 | -2,3 | -1,4 | 1,1 | -14,4 | -10,5 | -5,6 | -7,5 | -2,6 | -1,0 | 1,4 | -1,1 | 0,6 | -2,6 | -0,3 |
| *21-25* | 3,5 | -0,7 | -0,5 | 1,9 | -13,6 | -8,9 | -3,5 | -5,0 | -2,0 | -1,0 | 3,0 | 1,1 | 3,1 | -1,8 | 1,8 |
| *26-30* | 3,1 | -0,2 | -1,0 | 1,7 | -13,5 | -8,3 | -2,0 | -3,6 | -2,8 | -1,0 | 3,8 | 2,0 | 3,5 | -0,9 | 3,0 |

**Skilled**

| | FIN | BEL | DEN | IRE | FRA | GER | GRE | ITA | LUX | NET | AUS | POR | SPA | UK | SWE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *97-00* | 2,2 | 1,5 | 3,6 | -0,1 | 3,0 | 5,2 | 8,7 | 7,8 | 2,4 | 2,2 | 2,4 | 14,7 | 6,1 | 0,0 | 1,5 |
| *01-05* | 2,4 | 1,2 | 4,5 | -0,1 | 3,4 | 5,8 | 10,0 | 7,6 | 2,3 | 2,0 | 2,6 | 13,0 | 8,2 | 0,0 | 2,2 |
| *06-10* | 1,1 | 1,4 | 3,3 | 0,0 | 4,0 | 6,4 | 8,4 | 7,0 | 2,0 | 1,6 | 1,5 | 10,3 | 10,0 | 0,0 | 1,7 |
| *11-15* | -0,1 | 1,8 | 1,9 | 0,0 | 4,7 | 7,0 | 6,4 | 6,7 | 1,9 | 1,4 | 0,5 | 8,5 | 11,0 | 0,0 | 0,9 |
| *16-20* | -0,7 | 1,8 | 1,0 | 0,2 | 5,2 | 7,2 | 4,8 | 6,0 | 1,8 | 1,3 | -0,2 | 6,9 | 11,0 | 0,0 | 0,2 |
| *21-25* | -0,9 | 1,7 | 0,8 | 0,2 | 5,5 | 7,0 | 3,5 | 5,2 | 1,8 | 1,3 | -0,6 | 5,7 | 10,5 | 0,0 | -0,3 |
| *26-30* | -1,0 | 1,6 | 1,1 | 0,2 | 5,6 | 6,8 | 2,1 | 4,3 | 1,9 | 1,3 | -0,9 | 4,8 | 9,1 | 0,0 | -0,6 |

**Total**

| | FIN | BEL | DEN | IRE | FRA | GER | GRE | ITA | LUX | NET | AUS | POR | SPA | UK | SWE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *97-00* | -1,2 | -2,0 | -1,3 | -1,6 | -2,3 | -3,0 | -4,7 | -0,2 | -1,0 | -0,9 | -1,5 | -3,9 | -3,6 | -3,0 | -1,3 |
| *01-05* | -0,4 | -2,0 | -1,6 | -1,4 | -2,7 | -1,9 | -3,5 | -0,7 | -1,3 | 0,5 | -1,0 | -3,9 | -2,4 | -3,2 | -1,1 |
| *06-10* | 0,3 | -0,8 | -0,9 | -0,8 | -1,4 | 0,3 | -1,0 | 1,1 | -0,6 | 0,5 | -0,3 | -0,2 | 1,5 | -2,4 | -0,5 |
| *11-15* | 0,4 | 0,3 | -0,2 | 0,0 | -0,1 | 1,8 | 0,7 | 2,5 | 0,1 | 0,5 | 0,0 | 2,4 | 4,5 | -1,7 | -0,1 |
| *16-20* | 0,3 | 1,0 | 0,3 | 0,7 | 0,7 | 2,5 | 1,3 | 2,8 | 0,5 | 0,4 | 0,2 | 3,7 | 5,4 | -1,2 | 0,1 |
| *21-25* | 0,2 | 1,3 | 0,4 | 1,3 | 1,3 | 3,0 | 1,2 | 2,6 | 0,6 | 0,3 | 0,3 | 3,9 | 5,3 | -0,9 | 0,2 |
| *26-30* | 0,0 | 1,2 | 0,5 | 1,3 | 1,6 | 3,3 | 0,7 | 2,2 | 0,6 | 0,3 | 0,3 | 3,7 | 4,0 | -0,6 | 0,2 |

## Table A1.3 Differences wrt baseline of employment levels (in percent.)

**Unskilled**

| | FIN | BEL | DEN | IRE | FRA | GER | GRE | ITA | LUX | NET | AUS | POR | SPA | UK | SWE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *97-00* | 4,7 | 7,8 | 4,9 | 3,8 | 9,5 | 9,5 | 18,2 | 16,4 | 6,1 | 15,5 | 5,6 | 12,4 | 8,9 | 1,9 | 4,4 |
| *01-05* | 3,8 | 8,0 | 6,1 | 2,5 | 11,8 | 12,1 | 17,9 | 18,3 | 6,7 | 5,6 | 5,1 | 11,5 | 9,9 | 2,1 | 5,0 |
| *06-10* | 1,1 | 6,3 | 4,2 | 1,1 | 10,4 | 9,8 | 12,1 | 12,8 | 4,8 | 3,0 | 2,5 | 6,8 | 6,2 | 1,3 | 3,3 |
| *11-15* | -0,6 | 4,8 | 2,2 | 0,0 | 9,4 | 7,8 | 7,0 | 8,7 | 3,3 | 2,1 | 0,5 | 3,8 | 2,3 | 0,7 | 1,6 |
| *16-20* | -1,3 | 3,0 | 0,8 | -0,8 | 9,0 | 6,8 | 4,0 | 6,0 | 2,4 | 1,9 | -0,7 | 2,0 | 0,0 | 0,4 | 0,3 |
| *21-25* | -1,5 | 1,6 | 0,6 | -1,2 | 9,0 | 6,8 | 2,4 | 4,3 | 2,2 | 1,8 | -1,4 | 1,1 | -1,2 | 0,2 | -0,7 |
| *26-30* | -1,4 | 1,2 | 1,2 | -1,1 | 9,5 | 7,9 | 1,1 | 3,2 | 3,2 | 1,9 | -1,9 | 0,7 | -2,0 | -0,1 | -1,3 |

**Skilled**

| | FIN | BEL | DEN | IRE | FRA | GER | GRE | ITA | LUX | NET | AUS | POR | SPA | UK | SWE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *97-00* | -1,0 | -2,2 | -1,4 | -1,5 | -2,6 | -3,1 | -8,0 | -8,5 | -4,2 | -3,1 | -1,3 | -8,2 | -4,1 | 0,3 | -0,4 |
| *01-05* | -1,1 | -2,3 | -2,3 | -1,6 | -2,9 | -5,1 | -8,2 | -9,2 | -4,6 | -1,9 | -1,3 | -7,7 | -5,9 | -0,5 | -0,9 |
| *06-10* | -0,4 | -2,0 | -1,9 | -1,1 | -3,0 | -4,4 | -6,2 | -7,4 | -3,4 | -1,3 | -0,8 | -5,6 | -4,5 | -0,6 | -0,7 |
| *11-15* | 0,2 | -1,6 | -1,1 | -0,2 | -3,0 | -3,4 | -3,9 | -6,2 | -2,6 | -1,1 | -0,3 | -3,8 | -2,2 | -0,5 | -0,3 |
| *16-20* | 0,5 | -1,1 | -0,4 | 0,9 | -3,1 | -2,6 | -2,7 | -5,4 | -2,0 | -1,1 | 0,0 | -2,4 | -0,6 | -0,3 | 0,0 |
| *21-25* | 0,6 | -0,8 | -0,2 | 2,1 | -3,1 | -2,2 | -2,1 | -4,8 | -1,7 | -1,2 | 0,2 | -1,6 | 0,2 | -0,1 | 0,2 |
| *26-30* | 0,6 | -0,7 | -0,3 | 2,3 | -3,1 | -2,1 | -1,6 | -4,4 | -2,0 | -1,4 | 0,3 | -1,1 | 0,7 | 0,0 | 0,4 |

**Total**

| | FIN | BEL | DEN | IRE | FRA | GER | GRE | ITA | LUX | NET | AUS | POR | SPA | UK | SWE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *97-00* | 1,0 | 1,1 | 1,1 | 1,1 | 1,0 | 1,0 | 1,0 | 1,0 | 1,1 | 1,1 | 1,0 | 1,0 | 1,0 | 1,1 | 1,0 |
| *01-05* | 0,6 | 0,8 | 1,0 | 0,8 | 1,4 | 0,3 | 1,3 | 1,7 | 1,3 | 0,2 | 0,9 | 0,8 | 0,3 | 0,8 | 0,8 |
| *06-10* | 0,2 | 0,3 | 0,5 | 0,3 | 0,8 | -0,2 | 0,9 | 0,9 | 0,9 | 0,2 | 0,4 | -0,1 | -0,4 | 0,3 | 0,4 |
| *11-15* | -0,1 | 0,0 | 0,1 | -0,1 | 0,3 | -0,4 | 0,5 | 0,1 | 0,5 | 0,1 | 0,0 | -0,5 | -0,5 | 0,1 | 0,2 |
| *16-20* | -0,1 | -0,2 | 0,0 | -0,3 | 0,0 | -0,4 | 0,2 | -0,2 | 0,2 | 0,1 | -0,2 | -0,5 | -0,4 | 0,0 | 0,1 |
| *21-25* | -0,1 | -0,3 | 0,1 | -0,4 | -0,2 | -0,3 | 0,0 | -0,4 | 0,1 | 0,1 | -0,4 | -0,5 | -0,3 | 0,0 | 0,0 |
| *26-30* | -0,1 | -0,2 | 0,2 | -0,4 | -0,3 | -0,3 | -0,3 | -0,4 | 0,2 | 0,1 | -0,5 | -0,4 | -0,2 | 0,0 | 0,0 |

## Table A1.4 Differences wrt baseline of CO2 emissions (in percent.)

| | FIN | BEL | DEN | IRE | FRA | GER | GRE | ITA | LUX | NET | AUS | POR | SPA | UK | SWE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *97-00* | -0,9 | -1,4 | -0,8 | -0,1 | -1,6 | -2,0 | -0,9 | -2,1 | -0,9 | -1,3 | -0,8 | -1,8 | -1,5 | -0,9 | -0,2 |
| *01-05* | -2,5 | -0,3 | -0,9 | 0,0 | 0,5 | -0,2 | -0,1 | -2,8 | -0,9 | -0,2 | -0,9 | -0,6 | -0,6 | -0,7 | 0,2 |
| *06-10* | -3,0 | 0,4 | -0,1 | 0,0 | 1,7 | 0,6 | 0,0 | -2,1 | -0,6 | -0,2 | -0,9 | 0,8 | 0,0 | -0,6 | 0,2 |
| *11-15* | -2,9 | 0,8 | 0,6 | 0,2 | 2,3 | 0,9 | -0,3 | -2,0 | -0,6 | -0,2 | -0,9 | 1,7 | -0,2 | -0,5 | 0,3 |
| *16-20* | -2,6 | 1,1 | 1,1 | 0,5 | 2,6 | 1,0 | -0,8 | -2,3 | -0,6 | -0,1 | -1,0 | 2,3 | -0,9 | -0,5 | 0,5 |
| *21-25* | -2,4 | 1,9 | 1,5 | 0,9 | 2,7 | 1,1 | -1,2 | -2,5 | -0,7 | 0,0 | -1,2 | 2,6 | -1,3 | -0,4 | 1,1 |
| *26-30* | -2,2 | 1,8 | 1,9 | 0,7 | 2,7 | 1,2 | -1,6 | -2,5 | -0,8 | 0,1 | -1,6 | 3,3 | -2,3 | -0,4 | 1,5 |

## Table A1.5 Differences wrt baseline of GDP values (in percent.)

| | FIN | BEL | DEN | IRE | FRA | GER | GRE | ITA | LUX | NET | AUS | POR | SPA | UK | SWE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *97-00* | 0,2 | -0,2 | 0,1 | -0,2 | 0,0 | -0,2 | 1,3 | -0,5 | 0,0 | 0,2 | 0,1 | -0,6 | 0,1 | -0,1 | 0,5 |
| *01-05* | 0,1 | 0,1 | -0,1 | -0,3 | 0,9 | 0,8 | 1,0 | -1,0 | 0,0 | -0,2 | 0,0 | -0,5 | 0,3 | 0,0 | 0,3 |
| *06-10* | 0,2 | 0,3 | -0,1 | -0,1 | 0,9 | 0,8 | 0,3 | -1,1 | 0,0 | -0,2 | 0,0 | -0,6 | -0,2 | -0,1 | 0,2 |
| *11-15* | 0,3 | 0,4 | 0,0 | 0,1 | 0,8 | 0,4 | 0,0 | -1,5 | -0,1 | -0,2 | 0,0 | -0,4 | -1,1 | -0,2 | 0,1 |
| *16-20* | 0,4 | 0,3 | 0,2 | 0,5 | 0,6 | 0,0 | -0,2 | -1,7 | -0,2 | -0,1 | 0,0 | -0,2 | -1,9 | -0,2 | 0,1 |
| *21-25* | 0,3 | 0,2 | 0,3 | 0,8 | 0,4 | -0,2 | -0,4 | -1,8 | -0,2 | -0,1 | 0,0 | -0,1 | -2,5 | -0,2 | 0,0 |
| *26-30* | 0,3 | 0,0 | 0,4 | 0,6 | 0,3 | -0,3 | -0,6 | -1,8 | -0,2 | -0,1 | 0,0 | 0,0 | -2,9 | -0,2 | -0,1 |

### Table A1.6 Differences wrt baseline of consumption levels (in percent.)

| | FIN | BEL | DEN | IRE | FRA | GER | GRE | ITA | LUX | NET | AUS | POR | SPA | UK | SWE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *97-00* | 1,2 | -0,4 | 0,1 | -0,2 | -0,3 | -0,5 | 0,2 | 0,1 | -0,1 | 0,3 | 0,2 | -1,2 | -0,6 | -0,8 | 0,8 |
| *01-05* | 0,9 | 0,5 | -0,1 | 0,0 | 1,2 | 1,4 | 1,3 | -0,6 | -0,1 | -0,1 | 0,3 | -0,1 | 0,4 | -0,5 | 0,5 |
| *06-10* | 0,9 | 1,0 | 0,2 | 0,2 | 1,7 | 1,9 | 1,2 | -0,6 | 0,0 | -0,2 | 0,2 | 0,8 | 0,7 | -0,4 | 0,3 |
| *11-15* | 0,8 | 1,0 | 0,4 | 0,5 | 1,8 | 1,7 | 0,7 | -1,0 | -0,2 | -0,2 | 0,2 | 1,0 | 0,0 | -0,3 | 0,1 |
| *16-20* | 0,7 | 0,8 | 0,6 | 0,9 | 1,6 | 1,2 | 0,1 | -1,5 | -0,3 | -0,1 | 0,2 | 0,9 | -1,2 | -0,3 | 0,0 |
| *21-25* | 0,5 | 0,5 | 0,7 | 1,0 | 1,3 | 0,8 | -0,4 | -1,9 | -0,4 | 0,0 | 0,2 | 0,6 | -2,3 | -0,3 | -0,1 |
| *26-30* | 0,4 | 0,2 | 0,8 | 0,6 | 1,1 | 0,5 | -0,7 | -2,0 | -0,4 | 0,0 | 0,1 | 0,8 | -3,2 | -0,2 | -0,2 |

## A.2 Non co-operative scenario: recycling to both skilled and unskilled workers

### Table A2.1. Differences wrt baseline of labour costs (in percent.)

**Unskilled**

| | FIN | BEL | DEN | IRE | FRA | GER | GRE | ITA | LUX | NET | AUS | POR | SPA | UK | SWE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *97-00* | -1,7 | -2,7 | -2,6 | -1,5 | -4,9 | -5,6 | -11,2 | -7,2 | -0,8 | -1,9 | -2,4 | -3,7 | -4,6 | -2,8 | -5,1 |
| *01-05* | -0,9 | -3,2 | -4,0 | -1,4 | -6,4 | -7,2 | -10,3 | -6,8 | -0,9 | -0,8 | -1,9 | -1,9 | -6,6 | -2,6 | -6,0 |
| *06-10* | 0,0 | -2,0 | -2,6 | -0,9 | -5,1 | -4,7 | -5,9 | -2,3 | 0,1 | -0,8 | -0,7 | 3,5 | -3,3 | -1,6 | -3,3 |
| *11-15* | 0,3 | -0,6 | -0,6 | -0,3 | -3,7 | -2,3 | -2,0 | 0,8 | 0,9 | -1,0 | 0,0 | 7,0 | 0,9 | -0,7 | -0,6 |
| *16-20* | 0,3 | 0,4 | 0,6 | 0,6 | -2,7 | -1,0 | -0,1 | 2,2 | 1,3 | -1,2 | 0,3 | 8,2 | 4,2 | -0,2 | 1,1 |
| *21-25* | 0,2 | 0,8 | 0,7 | 1,3 | -2,3 | -0,7 | 0,5 | 2,5 | 1,3 | -1,4 | 0,4 | 8,0 | 6,3 | 0,2 | 2,1 |
| *26-30* | 0,1 | 0,7 | 0,2 | 1,3 | -2,4 | -0,9 | 0,7 | 2,1 | 0,7 | -1,6 | 0,5 | 6,9 | 7,4 | 0,4 | 2,5 |

**Skilled**

| | FIN | BEL | DEN | IRE | FRA | GER | GRE | ITA | LUX | NET | AUS | POR | SPA | UK | SWE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *97-00* | -2,4 | -3,7 | -2,9 | -0,1 | -3,0 | -4,6 | -0,4 | -2,3 | -1,9 | -1,8 | -2,4 | -13,9 | -18,8 | 0,0 | -1,4 |
| *01-05* | -1,8 | -4,1 | -4,4 | -0,1 | -4,9 | -6,9 | 0,1 | -5,1 | -2,6 | -3,1 | -2,3 | -16,4 | -26,7 | 0,0 | -1,5 |
| *06-10* | -0,1 | -2,8 | -2,1 | 0,0 | -4,0 | -4,4 | 1,0 | -5,0 | -2,0 | -3,6 | -1,1 | -10,5 | -24,2 | 0,0 | -1,6 |
| *11-15* | 0,7 | -1,5 | 1,2 | 0,0 | -2,6 | -1,2 | 1,6 | -3,8 | -1,3 | -4,1 | -0,1 | -4,6 | -18,7 | 0,0 | -1,3 |
| *16-20* | 0,9 | -0,5 | 3,1 | 0,1 | -1,3 | 1,2 | 1,4 | -3,3 | -0,7 | -4,5 | 0,5 | -0,1 | -13,1 | 0,0 | -1,1 |
| *21-25* | 0,7 | 0,0 | 3,2 | 0,2 | -0,2 | 2,7 | 0,8 | -3,3 | -0,1 | -4,7 | 0,7 | 2,6 | -8,4 | 0,0 | -0,8 |
| *26-30* | 0,5 | 0,0 | 2,5 | 0,2 | 0,7 | 3,6 | 0,1 | -3,6 | 0,6 | -4,9 | 0,7 | 4,1 | -4,7 | 0,0 | -0,8 |

**Total**

| | FIN | BEL | DEN | IRE | FRA | GER | GRE | ITA | LUX | NET | AUS | POR | SPA | UK | SWE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *97-00* | -2,1 | -3,4 | -2,8 | -0,7 | -3,5 | -5,4 | -3,9 | -3,4 | -1,6 | -1,8 | -2,4 | -9,8 | -11,9 | -1,7 | -2,3 |
| *01-05* | -1,5 | -3,9 | -4,3 | -0,7 | -5,2 | -5,1 | -3,3 | -5,5 | -2,1 | -2,6 | -2,2 | -10,8 | -15,5 | -1,4 | -2,6 |
| *06-10* | -0,1 | -2,6 | -2,3 | -0,5 | -4,2 | -2,2 | -1,2 | -4,5 | -1,4 | -2,8 | -0,9 | -5,1 | -11,5 | -0,9 | -2,0 |
| *11-15* | 0,6 | -1,3 | 0,6 | -0,1 | -2,8 | 0,2 | 0,4 | -2,9 | -0,6 | -3,1 | -0,1 | -0,2 | -6,0 | -0,5 | -1,1 |
| *16-20* | 0,7 | -0,4 | 2,3 | 0,4 | -1,6 | 1,6 | 0,9 | -2,1 | -0,1 | -3,4 | 0,4 | 3,0 | -1,4 | -0,3 | -0,6 |
| *21-25* | 0,6 | 0,1 | 2,4 | 1,0 | -0,6 | 2,4 | 0,7 | -2,0 | 0,3 | -3,6 | 0,6 | 4,6 | 1,6 | -0,2 | -0,2 |
| *26-30* | 0,4 | 0,1 | 1,9 | 0,9 | 0,1 | 2,8 | 0,3 | -2,2 | 0,6 | -3,7 | 0,6 | 5,1 | 3,0 | -0,1 | -0,1 |

## Table A2.2 Differences wrt baseline of employment levels (in percent.)

**Unskilled**

| | FIN | BEL | DEN | IRE | FRA | GER | GRE | ITA | LUX | NET | AUS | POR | SPA | UK | SWE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *97-00* | 1,1 | 1,3 | 2,0 | 1,4 | 2,4 | 1,8 | 5,3 | 4,1 | 0,1 | 2,2 | 0,8 | -1,6 | 3,1 | 0,5 | 2,9 |
| *01-05* | 0,8 | 1,0 | 2,1 | 1,1 | 3,5 | 3,5 | 5,2 | 3,6 | -0,2 | 0,2 | 0,8 | -2,3 | 3,6 | 0,4 | 2,8 |
| *06-10* | 0,4 | 0,4 | 0,7 | 0,6 | 2,9 | 2,8 | 3,2 | 0,8 | -0,7 | -0,4 | 0,3 | -3,1 | 2,6 | 0,1 | 1,6 |
| *11-15* | 0,1 | 0,0 | 0,0 | 0,1 | 2,4 | 2,0 | 1,5 | -0,9 | -1,0 | -0,6 | 0,0 | -2,4 | 2,4 | -0,1 | 0,4 |
| *16-20* | 0,0 | -0,4 | 0,1 | -0,3 | 2,3 | 1,6 | 0,5 | -1,7 | -1,1 | -0,5 | -0,2 | -1,2 | 2,1 | -0,2 | -0,4 |
| *21-25* | 0,0 | -0,6 | 0,5 | -0,7 | 2,4 | 1,6 | -0,1 | -1,9 | -0,9 | -0,4 | -0,3 | -0,3 | 1,7 | -0,3 | -0,8 |
| *26-30* | 0,0 | -0,6 | 0,9 | -0,6 | 2,7 | 2,3 | -0,5 | -1,9 | -0,3 | -0,3 | -0,4 | 0,5 | 0,7 | -0,3 | -1,1 |

**Skilled**

| | FIN | BEL | DEN | IRE | FRA | GER | GRE | ITA | LUX | NET | AUS | POR | SPA | UK | SWE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *97-00* | 1,7 | 1,7 | 2,1 | -0,7 | 1,1 | 1,9 | -1,8 | 0,3 | 0,9 | 1,6 | 1,1 | 5,0 | 4,8 | 0,6 | 1,5 |
| *01-05* | 1,4 | 1,3 | 2,2 | -0,9 | 2,2 | 0,0 | -1,7 | 1,6 | 1,3 | 2,6 | 1,3 | 6,9 | 2,8 | 0,2 | 1,1 |
| *06-10* | 0,5 | 0,7 | 0,4 | -0,8 | 1,9 | -1,0 | -1,3 | 2,2 | 1,2 | 2,7 | 0,6 | 4,7 | 0,1 | 0,0 | 1,1 |
| *11-15* | -0,2 | 0,6 | -0,9 | -0,3 | 1,5 | -1,1 | -0,7 | 2,3 | 1,0 | 3,0 | 0,0 | 3,5 | -1,1 | 0,1 | 0,9 |
| *16-20* | -0,4 | 0,4 | -1,1 | 0,5 | 1,2 | -0,9 | -0,4 | 2,7 | 0,7 | 3,4 | -0,4 | 2,8 | -1,2 | 0,2 | 0,7 |
| *21-25* | -0,4 | 0,4 | -0,8 | 1,6 | 0,9 | -0,8 | -0,2 | 3,1 | 0,4 | 3,6 | -0,5 | 2,2 | -0,9 | 0,2 | 0,6 |
| *26-30* | -0,3 | 0,3 | -0,5 | 1,8 | 0,7 | -0,8 | -0,1 | 3,5 | -0,1 | 3,8 | -0,6 | 1,6 | -0,3 | 0,2 | 0,5 |

**Total**

| | FIN | BEL | DEN | IRE | FRA | GER | GRE | ITA | LUX | NET | AUS | POR | SPA | UK | SWE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *97-00* | 1,5 | 1,5 | 2,1 | 0,4 | 1,5 | 1,9 | 0,6 | 1,7 | 0,5 | 1,7 | 1,0 | 2,1 | 4,1 | 0,6 | 1,9 |
| *01-05* | 1,2 | 1,2 | 2,2 | 0,3 | 2,6 | 1,1 | 0,8 | 2,4 | 0,5 | 1,9 | 1,1 | 2,8 | 3,1 | 0,3 | 1,6 |
| *06-10* | 0,5 | 0,6 | 0,5 | 0,1 | 2,2 | 0,1 | 0,5 | 1,6 | 0,2 | 1,6 | 0,5 | 1,2 | 1,1 | 0,1 | 1,3 |
| *11-15* | -0,1 | 0,4 | -0,5 | 0,0 | 1,7 | -0,3 | 0,2 | 0,9 | -0,1 | 1,7 | 0,0 | 0,9 | 0,2 | 0,0 | 0,8 |
| *16-20* | -0,2 | 0,2 | -0,6 | -0,1 | 1,5 | -0,3 | 0,0 | 0,7 | -0,2 | 1,8 | -0,3 | 1,1 | 0,0 | 0,0 | 0,4 |
| *21-25* | -0,2 | 0,1 | -0,3 | -0,1 | 1,3 | -0,3 | -0,2 | 0,7 | -0,2 | 1,8 | -0,5 | 1,2 | 0,0 | 0,0 | 0,2 |
| *26-30* | -0,2 | 0,1 | -0,1 | -0,1 | 1,1 | -0,3 | -0,3 | 0,7 | -0,2 | 1,9 | -0,5 | 1,2 | 0,0 | 0,0 | 0,1 |

## Table A2.3 Differences wrt baseline of CO2 emissions (in percent.)

| | FIN | BEL | DEN | IRE | FRA | GER | GRE | ITA | LUX | NET | AUS | POR | SPA | UK | SWE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *97-00* | -0,6 | -1,7 | -0,4 | -0,1 | -1,7 | -2,0 | -1,3 | -1,1 | -0,6 | -1,7 | -0,8 | -1,5 | -1,0 | -0,8 | 0,2 |
| *01-05* | -2,1 | -0,1 | -0,2 | 0,0 | 1,5 | 0,6 | -0,3 | 0,0 | -0,1 | -0,1 | -0,8 | 2,7 | 2,0 | -0,6 | 0,2 |
| *06-10* | -2,7 | 1,1 | 1,1 | 0,0 | 3,6 | 2,0 | 0,0 | 1,4 | 0,5 | 0,3 | -1,0 | 5,0 | 4,9 | -0,5 | 0,3 |
| *11-15* | -2,9 | 1,9 | 1,9 | 0,1 | 4,9 | 2,4 | -0,1 | 2,2 | 0,7 | 0,6 | -1,3 | 6,6 | 7,0 | -0,4 | 0,4 |
| *16-20* | -2,8 | 2,6 | 1,9 | 0,5 | 5,5 | 2,4 | -0,4 | 2,7 | 1,0 | 0,9 | -1,5 | 7,9 | 7,7 | -0,4 | 0,6 |
| *21-25* | -2,6 | 3,6 | 1,7 | 0,9 | 5,7 | 2,3 | -0,8 | 3,0 | 1,1 | 1,1 | -1,8 | 9,3 | 7,8 | -0,3 | 1,4 |
| *26-30* | -2,4 | 3,6 | 1,7 | 1,0 | 5,7 | 2,3 | -1,0 | 3,2 | 1,1 | 1,3 | -2,3 | 10,4 | 6,8 | -0,3 | 1,8 |

## Table A2.4 Differences wrt baseline of GDP values (in percent.)

| | FIN | BEL | DEN | IRE | FRA | GER | GRE | ITA | LUX | NET | AUS | POR | SPA | UK | SWE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *97-00* | 1,1 | -0,3 | 0,7 | -0,2 | 0,1 | 0,1 | 0,8 | 0,3 | 0,0 | 0,2 | 0,5 | 1,1 | 2,6 | -0,3 | 1,3 |
| *01-05* | 1,1 | 0,2 | 0,9 | -0,3 | 1,7 | 2,1 | 0,9 | 1,1 | 0,2 | 0,4 | 0,8 | 2,9 | 5,9 | -0,2 | 0,7 |
| *06-10* | 0,6 | 0,7 | 0,6 | -0,1 | 2,1 | 2,5 | 0,3 | 1,5 | 0,2 | 0,5 | 0,4 | 2,0 | 7,0 | -0,2 | 0,6 |
| *11-15* | 0,3 | 0,9 | 0,3 | 0,1 | 2,2 | 2,0 | 0,1 | 1,5 | 0,1 | 0,6 | 0,1 | 2,1 | 7,4 | -0,2 | 0,4 |
| *16-20* | 0,1 | 0,8 | 0,2 | 0,4 | 2,1 | 1,4 | 0,0 | 1,6 | 0,0 | 0,7 | -0,1 | 2,4 | 7,0 | -0,2 | 0,2 |
| *21-25* | 0,1 | 0,7 | 0,3 | 0,7 | 2,0 | 0,9 | -0,1 | 1,6 | 0,0 | 0,8 | -0,1 | 2,5 | 6,2 | -0,2 | 0,0 |
| *26-30* | 0,1 | 0,5 | 0,3 | 0,6 | 1,8 | 0,6 | -0,2 | 1,7 | -0,1 | 0,9 | -0,2 | 2,5 | 4,9 | -0,2 | -0,1 |

## Table A2.5 Differences wrt baseline of consumption levels (in percent.)

| | FIN | BEL | DEN | IRE | FRA | GER | GRE | ITA | LUX | NET | AUS | POR | SPA | UK | SWE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *97-00* | 1,9 | -0,8 | 0,3 | -0,1 | -0,4 | -0,8 | -0,2 | -0,3 | -0,7 | -0,3 | 0,1 | -1,4 | -0,7 | -0,6 | 1,8 |
| *01-05* | 1,9 | 0,6 | 0,4 | -0,1 | 1,8 | 2,4 | 1,0 | 0,5 | 0,2 | 0,0 | 0,8 | 3,3 | 3,3 | -0,4 | 0,8 |
| *06-10* | 1,6 | 1,6 | 1,3 | 0,1 | 3,1 | 3,9 | 1,1 | 1,6 | 0,8 | 0,3 | 0,8 | 5,3 | 7,1 | -0,3 | 0,7 |
| *11-15* | 1,0 | 1,9 | 1,5 | 0,4 | 3,7 | 3,9 | 0,8 | 2,0 | 0,7 | 0,6 | 0,5 | 5,6 | 9,3 | -0,2 | 0,4 |
| *16-20* | 0,5 | 1,7 | 1,2 | 0,8 | 3,8 | 3,3 | 0,3 | 2,2 | 0,7 | 0,7 | 0,3 | 5,5 | 9,8 | -0,2 | 0,2 |
| *21-25* | 0,3 | 1,4 | 0,7 | 1,0 | 3,6 | 2,6 | 0,0 | 2,2 | 0,5 | 0,9 | 0,2 | 5,4 | 9,0 | -0,2 | -0,1 |
| *26-30* | 0,2 | 1,1 | 0,5 | 0,8 | 3,4 | 2,1 | -0,2 | 2,2 | 0,4 | 1,0 | 0,1 | 4,9 | 7,6 | -0,1 | -0,2 |

## A.3 Harmonised tax and employment policy: targeted recycling to unskilled workers.

**Table A3.1. Difference wrt baseline of cumulate GDP, labour and emissions (in percentage)**

| | FIN | | BEL | | DEN | | IRE | | FRA | | GER | | GRE | | ITA | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *2000* | * | ** | | | | | | | | | | | | | | |
| GDP | 0,2 | 0,5 | -0,4 | -0,8 | 0,1 | 0,4 | -0,1 | 0,2 | 0,0 | 0,3 | -0,1 | 0,9 | 1,0 | 1,1 | -0,4 | -0,3 |
| Labour | 0,6 | 1,0 | 2,0 | 1,0 | 0,6 | 1,0 | 0,8 | 1,0 | 0,6 | 1,1 | 0,4 | 1,1 | 0,8 | 1,0 | 0,9 | 1,1 |
| Emissions | 0,2 | 0,4 | -2,5 | -2,9 | -0,5 | 0,1 | -0,1 | 0,0 | -0,9 | -0,5 | -0,8 | -0,2 | -1,3 | -1,2 | -1,7 | -1,6 |
| *2030* | | | | | | | | | | | | | | | | |
| GDP | -0,1 | 0,0 | 0,4 | -0,3 | 0,2 | 0,6 | 0,4 | 0,6 | 0,5 | 0,8 | 0,1 | 1,3 | -0,2 | -0,1 | -1,4 | -1,3 |
| Labour | 0,2 | 0,3 | 0,4 | -0,6 | 0,5 | 0,9 | 0,0 | 0,0 | 0,3 | 0,7 | 0,0 | 0,4 | 0,4 | 0,5 | 0,1 | 0,3 |
| Emissions | -0,7 | -0,8 | 1,3 | 0,6 | 0,6 | 1,1 | 0,4 | 0,5 | 1,6 | 2,1 | 0,3 | 1,4 | -1,4 | -1,4 | -2,3 | -2,1 |

| | LUX | | NET | | AUS | | POR | | SPA | | UK | | SWE | | EU15 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *2000* | * | ** | | | | | | | | | | | | | | |
| GDP | -0,1 | -1,3 | 0,2 | 0,3 | -0,1 | 0,4 | -0,4 | -0,2 | 0,1 | 1,0 | -0,1 | -0,7 | 0,1 | 0,7 | -0,1 | 0,2 |
| Labour | 3,3 | 1,0 | 0,8 | 1,1 | 0,3 | 1,0 | 0,7 | 1,1 | 0,4 | 1,1 | 1,7 | 1,1 | 0,2 | 1,0 | 0,8 | 1,1 |
| Emissions | -2,7 | -3,6 | -0,9 | -0,8 | -0,4 | -0,3 | -1,3 | -1,1 | -0,5 | 0,3 | -1,4 | -1,8 | -0,1 | 0,4 | -1,1 | -0,8 |
| *2030* | | | | | | | | | | | | | | | | |
| GDP | -0,3 | -0,8 | -0,1 | 0,0 | 0,0 | 0,1 | -0,3 | 0,0 | -0,7 | -0,2 | -0,6 | -1,1 | 0,0 | 0,2 | -0,2 | 0,1 |
| Labour | 0,6 | -0,5 | 0,2 | 0,4 | 0,1 | 0,6 | -0,1 | 0,3 | -0,1 | 0,3 | 0,3 | -0,1 | 0,1 | 0,6 | 0,2 | 0,3 |
| Emissions | -1,7 | -0,5 | -0,1 | 0,0 | -0,6 | -0,7 | 2,0 | 2,2 | -0,5 | 0,1 | -1,2 | -1,7 | 0,2 | 0,5 | -0,2 | 0,1 |

**Note:**

*: simulation with 10 ECU carbon tax. Recycling to blue-collars only.

**: simulation with 10 ECU carbon tax and fiscal resources re-distribution in order to have a "coordinated" increase of labour up to 2000. Recycling to blue-collars only.

## A.4 Harmonised tax and employment policy: recycling to both skilled and unskilled workers.

**Table A4.1. Difference wrt baseline of cumulate GDP, labour and emissions (in percentage)**

| | FIN | | BEL | | DEN | | IRE | | FRA | | GER | | GRE | | ITA | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *2000* | * | ** | | | | | | | | | | | | | | |
| GDP | 0,5 | 1,6 | -0,7 | -1,1 | 0,4 | 1,0 | -0,2 | 2,7 | 0,1 | 0,8 | 0,0 | 1,9 | 0,7 | 1,9 | 0,3 | 0,6 |
| Labour | 0,7 | 2,1 | 3,0 | 2,1 | 1,1 | 1,9 | 0,3 | 1,2 | 0,8 | 2,1 | 0,7 | 1,9 | 0,6 | 2,0 | 1,4 | 2,0 |
| Emissions | 0,3 | 1,1 | -3,2 | -3,6 | -0,3 | 1,0 | -0,1 | 0,5 | -1,0 | 0,0 | -0,8 | 0,3 | -1,6 | -0,5 | -0,8 | -0,4 |
| *2030* | | | | | | | | | | | | | | | | |
| GDP | 0,2 | 0,4 | 1,5 | 0,8 | 0,6 | 1,4 | 0,4 | 2,0 | 1,5 | 2,2 | 0,8 | 3,0 | 0,2 | 0,8 | 1,4 | 1,6 |
| Labour | 0,2 | 0,7 | 1,4 | 0,4 | 0,6 | 1,5 | 0,0 | 0,1 | 1,3 | 2,3 | 0,1 | 0,9 | 0,2 | 1,0 | 1,1 | 1,4 |
| Emissions | -0,7 | -1,1 | 4,0 | 3,5 | 1,5 | 2,4 | 0,5 | 0,7 | 3,4 | 4,5 | 0,9 | 2,9 | -0,8 | -0,3 | 2,0 | 2,3 |

| | LUX | | NET | | AUS | | POR | | SPA | | UK | | SWE | | EU15 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *2000* | * | ** | | | | | | | | | | | | | | |
| GDP | 0,0 | 0,1 | 0,3 | 0,4 | 0,0 | 1,2 | 0,8 | 1,2 | 0,9 | 1,8 | -0,5 | 0,6 | 0,2 | 1,4 | 0,1 | 1,0 |
| Labour | 1,9 | 2,1 | 1,6 | 1,9 | 0,1 | 1,9 | 1,4 | 2,1 | 1,4 | 2,0 | 0,8 | 2,0 | 0,2 | 2,1 | 1,0 | 2,0 |
| Emissions | -1,9 | -1,8 | -1,4 | -1,4 | -0,6 | 0,0 | -1,0 | -0,7 | -0,4 | 0,4 | -1,2 | -0,4 | -0,1 | 1,0 | -0,9 | -0,1 |
| *2030* | | | | | | | | | | | | | | | | |
| GDP | 0,3 | 0,3 | 0,7 | 0,8 | 0,1 | 0,5 | 2,8 | 3,3 | 3,2 | 3,6 | -0,5 | 0,9 | 0,1 | 0,5 | 0,9 | 1,9 |
| Labour | 0,0 | 0,1 | 1,9 | 2,0 | 0,1 | 1,1 | 1,7 | 2,3 | 0,5 | 0,8 | 0,2 | 1,1 | 0,2 | 1,2 | 0,7 | 1,3 |
| Emissions | 3,2 | 3,1 | 0,8 | 0,9 | -0,7 | -1,0 | 8,3 | 8,9 | 2,9 | 3,6 | -0,9 | 0,3 | 0,2 | 0,8 | 1,4 | 2,4 |

**Note:**

*: simulation with 10 ECU carbon tax. Recycling to blue- and white-collars.

**: simulation with 10 ECU carbon tax and fiscal resources re-distribution in order to have a "coordinated" increase of labour up to 2000. Recycling to blue- and white-collars.

**Table A4.2 Revenue transfers (cumulated differences with respect to the baseline in million EUROs).**

| | Budget surplus in differences wrt baseline | | |
|---|---|---|---|
| | | U recycling | U+S recycling |
| **FIN** | 2000 | -38,868 | -57,29 |
| | 2030 | 2,137 | 3,32 |
| **BEL** | 2000 | 3782,428 | 8464,68 |
| | 2030 | -420,484 | -2253,93 |
| **DEN** | 2000 | -242,682 | -659,857 |
| | 2030 | -2146,873 | -4450,682 |
| **IRE** | 2000 | -144,22 | -2008,25 |
| | 2030 | -908,891 | -3504,219 |
| **FRA** | 2000 | 344,164 | -491,039 |
| | 2030 | -14045,5 | -28282,813 |
| **GER** | 2000 | -2899,344 | -5125,492 |
| | 2030 | -13126,281 | -22136,5 |
| **GRE** | 2000 | 81,266 | -1570,027 |
| | 2030 | -3486,375 | -14268,656 |
| **ITA** | 2000 | -8681,891 | 5803,641 |
| | 2030 | -4617,125 | -11430,063 |
| **LUX** | 2000 | -9,688 | -16,676 |
| | 2030 | -7,646 | 95,68 |
| **NET** | 2000 | -1660,734 | 443,309 |
| | 2030 | -2119,031 | 310,25 |
| **AUS** | 2000 | -462,234 | -460,719 |
| | 2030 | -121,664 | -331,105 |
| **POR** | 2000 | 266,628 | 454,516 |
| | 2030 | -550,32 | -842,125 |
| **SPA** | 2000 | -2373,113 | 843,902 |
| | 2030 | -22363,344 | -15865,344 |
| **UK** | 2000 | 12352,855 | -4986,254 |
| | 2030 | 17477,063 | -49232,969 |
| **SWE** | 2000 | -305,566 | -633,692 |
| | 2030 | 1,977 | 3,129 |
| **EU 15 (aggr.)** | 2000 | 9,001 | 0,752 |
| | 2030 | -46432,357 | -152186,027 |

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## SUMMARY

This paper analyses the costs and benefits of a fiscal reform designed to simultaneously increase environmental quality and employment. The investigation is carried out using an econometric general equilibrium model in which the labour market is unionised and segmented, i.e. in which demand, supply and the wages formation process for skilled and unskilled workers are explicitly modelled. This allow us to simulate the implementation in European countries of an harmonised carbon tax whose fiscal revenue in each country is re-cycled to reduce the gross wages of unskilled workers only rather than those of the whole labour force. This paper describes first the theoretical features of the segmented labour market which have been developed and then shows the estimates of the labour market equations. The effects of the double-dividend policy reform previously described are analysed and then compared with those of the traditional and simpler environmental fiscal reform in which the fiscal revenue is used to reduce the gross wages of all workers. We will show that (i) the "green" fiscal reform is more effective, in terms of employment gains, when the fiscal revenue is used to reduce gross wages of all employed workers as a mild substitutability relationship among skilled and unskilled workers is identified, (ii) the employment dividend increases when the tax reform is carried out in a co-operative way i.e. equalising through international co-operation its marginal benefits and costs among countries, (iii) if an "employment double dividend" is feasible in the short-run, a trade-off employment/environment remains in the longer term.



**Keywords:** Double dividend, Environmental fiscal reform, Environmental modelling.

**JEL:** H0, H2, H3.



## NON TECHNICAL SUMMARY

This paper analyses the impacts of energy taxes whose revenue is recycled to reduce gross wages and increase employment. The main novel feature of this paper is the attempt to assess the effectiveness of this fiscal reform by using a labour market model in which both skilled and unskilled workers are used in the production process. This segmentation enables us to compares a policy which aims at reducing unskilled workers' wages, as in the original Delors' White book, with a policy in which the environmental fiscal revenue is used to reduce the gross wage of all workers. Moreover, two policy scenarios will be considered. A non co-operative one in which each country determines the optimal domestic energy tax to achieve a given employment target, and a co-operative one, in which the energy taxes are harmonised to equalise marginal abatement costs in the EU, and in which the employment target is set for the EU. Our results show that: (i) an employment double dividend can be achieved in the short run only, even if a trade-off between environment and employment always exists; (ii) the effect on employment is larger when the fiscal revenue is recycled into all workers' gross wages rather than into unskilled workers only; (iii) a co-operative policy leads to even larger benefits in terms of employment provided that an adequate redistribution of fiscal revenues is adopted by EU countries.