An Applied General Equilibrium Analysis of a Double Dividend Policy for the Spanish Economy

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Abstract

In this paper we study whether an adequately designed tax policy may foster the attainment of a double dividend. By a double dividend we mean a situation where policies give rise to a reduction in inefficiencies (more welfare or more employment) and promote a better environmental quality (less CO2 emissions). We follow the tax reform literature and consider a policy scenario where the size of the public sector is kept fixed in terms of tax collections and spending but the composition of the tax instruments can be modified by the government. Of particular interest is to consider the partial substitution of the labour tax by a new, hypothetical ecotax on CO2 polluting goods. This requires the modelling of the labour market to incorporate its response to tax policies since taxes will alter optimal demand schedules by firms and employment opportunities may change. The modelling facility we use is an applied general equilibrium model of the Spanish economy calibrated to two Social Accounting matrices for 1990 and 1995 and to some exogenous elasticities. We find that there seems to be room for a double dividend outcome provided the economy satisfies some flexibility conditions related to the technology and the labour market.

Keywords: double dividend, tax reform, ecotaxes.

JEL code: H21, H22, C68

I. Introduction

There is growing empirical evidence and increasing scientific consensus that CO2 emissions play a significant role in the spreading of the greenhouse effect. Authorities have tried to respond to this concern proposing different control mechanisms and policies with the Kyoto protocol taking top honours in the political agenda. In the European Union (EU) as a whole, for instance, the stated target is an 8 percent reduction in emissions in 2012 in relation to 1990 levels. The preferred policy tool in the EU has been the creation of a market for emission permits that can be traded among polluting firms. Another tool that has been under consideration is the enactment of *green* tax reforms by way of levying an ecotax on CO2 polluting goods. There is, however, a considerable tax load in the EU and any new tax category should satisfy some neutrality requirement regarding total government tax income. In addition, any new tax intended to reduce emissions would at the same time affect production levels downwards and production costs upwards. All things considered a new ecotax should, if enacted, be finely tuned with the rest of tax instruments and overall tax and spending policies.

The reduction of CO2 emissions via a new neutral tax instrument raises the question of whether or not there would also be an efficiency gain if a current tax is substituted for an ecotax. This is the idea behind the tax reform literature (Feldstein, 1974, Atkinson and Stiglitz, 1980, Ahmad and Stern, 1984) that aims at identifying what changes in the tax rates of an existing tax system would promote partial efficiency improvements. Consider, for instance, that after enacting an ecotax we consider a reduction of the tax on labour use by firms. There will be, on the one hand, an increase in the production costs due to the new indirect tax and a corresponding push-up effect in prices. On the other hand, a reduction of the labour tax will lower the wage bill in total production costs, generating a decreasing effect on prices. The final effect on prices is not at all clear and will depend on the interaction effect of costs and the behavioural response of the economic agents involved. Collateral to how prices adjust we will also have quantity adjustments both in final output and inputs utilisation. As a possibility, if demand for labour falls relative to labour supply and the labour market is subject to frictions or rigidities then unemployment may increase.

A careful general equilibrium accounting of cost increases and cost reductions is obviously needed if we want to weigh up the final effects. Since the net effects are unclear, the realisation of a double dividend turns out to be an empirical question.

In this paper we study the double dividend question within the context of the Spanish economy and under the applied general equilibrium framework. We have built a computable model that allows us to evaluate resource allocation, prices and quantities, in response to changes in tax policies. The model is calibrated to two different databases for 1990 and 1995. This double calibration has the advantage of giving us a measure of the overall robustness of the simulation results to the numerical specification. The model simulates alternate fiscal scenarios and sums up results in terms of CO2 emissions, employment levels and a money metric measure of private welfare. A first important result that is worth advancing here is that a double dividend policy is feasible, but not under all scenarios. A second relevant result links the presence of a double dividend to the degree of flexibility in the economy. By flexibility we mean technological adaptability in terms of higher substitution possibilities as well as some adaptability in the labour market in terms of unemployment responsiveness to the real wage rate. Summing up, more flexibility increases the likelihood of observing a double dividend result. The type of applied general equilibrium model we use in this study is well known in the literature and has become a widespread tool for policy analysis. The popularity of this family of models can be traced to the seminal contributions of Scarf (1973) and Shoven and Whalley (1984).

The paper is organised as follows. In Section II we describe, very briefly, the state of the double dividend literature. In Section III we outline the structure of the simulation model. Section IV presents the main empirical results and Section V concludes the paper.

II. The Double Dividend

Public economics consider environmental quality as a public good and pollution as a negative externality. In terms of optimal taxation, therefore, a Pigouvian tax on the polluting agent equal to the marginal environmental damage (*MED*) is all that is needed to internalize the externality. The Pigouvian tax allows the competitive equilibrium to be again efficient. In reality, however, there are taxes distorting economic decisions and, in addition, some markets may not behave competitively. A line of research has explored how to design an optimal environmental tax under competitive conditions but in the presence of existing distorting taxes. This is the "second best" approach in the sense that the environmental tax should not reduce initial welfare (Sandmo, 1975, Bovenberg and Van der Ploeg, 1994, Bovenberg and Goulder, 1996, Parry, 1995). The theoretical answer states that the optimal tax *t*, in the second best sense, should satisfy *t=MED/MCPF* where *MCPF* is the marginal cost of public funds. From a theoretical perspective, it is shown that a new tax interacts with the existing taxes creating additional distortions that affect private welfare. The question is if these interactions are welfare reducing or not. The Double Dividend (DD) hypothesis states that the neutral substitution of a given existing tax by a new environmental tax may indeed give rise to a Double Dividend, namely a reduction in emissions and an improvement in efficiency. In fact this hypothesis is nothing but a restatement of the tax reform literature mentioned before concerning partial welfare improvements plus an obvious reduction effect in emissions if the new tax is directed towards emission producing goods. In other words, we are considering what we may call a "third best" scenario whereby a (non-optimal) tax substitution within an existing tax system may be welfare promoting if conveniently calculated. The DD issue is therefore one that should be studied and perhaps settled empirically.

There are several versions of the DD hypothesis going from "weak" to "strong" possibilities regarding efficiency gains once an environmental tax is enacted (Goulder, 1995). The "weak" DD hypothesis states that there might be an improvement in efficiency under a lump-sum devolution of the collections of the environmental tax. The "strong" DD hypothesis concerns tax recycling and states that the efficiency gain may be the result of tax recycling (Pearce, 1991, Bovenberg and de Mooij, 1994a). Finally the "strongest" or "employment" DD assumption takes the view that tax recycling between the environmental tax and the existing tax on labour use may foster employment levels (Drèze and Malinvaud, 1993). Recent surveys that collect and discuss the different versions of the DD can be found in Bovenverg (1999), Bosello et al. (2001) and Schob (2005).

There is contradicting empirical evidence of the possibility of implementing a DD although most contributions conclude that no DD can be observed. Goulder (1992, 1995), Parry (1995) Bovenberg and Goulder (1996), Parry et al (1998) are good examples of negative empirical evidence. On the other hand, Jorgenson and Wilcoxen (1993) and Denis and Koopman (1995) provide positive evidence in favour of a DD under certain assumptions. Most of the models used to explore the DD hypothesis are models of perfect competition with no frictions. The frictionless assumption is particularly difficult to justify for the labour market when facing the considerable unemployment levels of the European economies. Some models have aimed to address the employment (or unemployment) question and these models have found quite more evidence in favour of the DD. The critical issue seems to be whether any new environmental tax can be shifted to agents that do not receive labour income (Bovenberg and de Mooij, 1994, Bovenverg and van der Ploeg, 1994b, 1998). When the tax can be shifted forward to other agents, the tax load over labour is reduced and an employment DD may arise. It is not surprising them that partial equilibrium models or general equilibrium models with one good and one agent are not especially conducive to observe a DD. The room for shifting forward any tax is limited or simply non existent.

Full-fledged general equilibrium models, on the other hand, should provide enough flexibility for interactions to take place and adjustments to be realised, particularly labour market adjustments. A characteristic of labour markets in Europe is the presence of involuntary unemployment. Workers may be inelastically offering their labour endowment at a given wage rate but if demand is not enough to absorb it, then involuntary unemployment will arise. The wage may have been negotiated by unions over the full employment wage, for instance. Unions, however, may react to the unemployment rate with some adjustment flexibility in wages. This labour market friction introduces a feedback mechanism between the real wage and the unemployment rate that will make both the wage rate and the unemployment levels endogenous variables. Thus a specific labour market unemployment equilibrium structure can then be embedded into an otherwise standard general equilibrium model that picks up frictions and extends the notion of equilibrium to encompass that of the labour market.

III The modelling facility

We build a disaggregated general equilibrium model of the Spanish economy and implement it using two different Social Accounting matrices for 1990 and 1995. Thanks to the use of two independently constructed databases we can compare and validate the robustness of the simulation results. In our analysis we simulate the introduction of a new environmental tax (ecotax, for short) modelled as an *ad-valorem* tax on energy goods while we reduce labour taxes across all production sectors under a constant tax collections assumption. Due to data restrictions the model contemplates a single representative consumer and this precludes us to consider any distributional effects of the enacted policies and focus exclusively on efficiency issues. All our tax simulations depict two main scenarios and for two periods (´90 and ´95). The first scenario takes into account a so-called "rigid" version of the economy where there is no technological adjustment to changing prices and unemployment is kept fixed at the baseline level. The second scenario depicts a "flexible" version of the economy and we allow for choice of technique in primary factors and for labour market adjustments in response to changing prices and market conditions. The comparison of results in both limiting scenarios allows us to infer to what extent technological and behavioural flexibilities matter in attaining a double dividend.

The model we use follows the tradition of applied general equilibrium modelling as developed by Shoven and Whalley (1984) and Ballard et al. (1985) both of whom emphasise, unlike the World Bank trade oriented models, the role of the government as an spending and a tax collecting agent. These models offer a comprehensive representation of the circular flow of income with agents such as producers, consumers, the government and the foreign sectors explicitly following a set of behavioural rules for the attainment of their specific goals. The level of disaggregation in the model is consistent with the detail in the SAM database on number of production sectors, consumer types, etc.

The production side of the economy includes 35 constant-returns to scale sectors with a subset of 6 of them being energy suppliers sectors. The total supply of a sector is an aggregation of domestic and imported goods. Domestic output is the result of combining an aggregate primary factor (value added) with intermediate goods. In turn value added is an aggregation of labour and capital. The productive technology adopts the nested structure familiar in computable general equilibrium models. Profit maximisation and a competitive environment guide the behaviour of producers.

There is a single representative consumer who maximises utility over present and future consumption (savings) under a budget constraint. Gross income is the result of selling the endowments of labour and capital owned by the consumer in the factors markets plus transfers that the consumer receives from the government and the foreign sectors. Disposable income is gross income once the income tax has been deducted.

The government plays a singular role in the model and a more detailed description of its activities follows. On the income side we distinguish 5 different tax categories. There is an income tax with collections denoted by *INC*, an indirect production tax *IND*, a value-added tax *VAT* a payroll tax *PRT* and tariffs *TAR* on imports. In addition we consider a hypothetical ecotax *ECO* in the counterfactual scenarios (*ECO*=0 in the baseline). We add up tax income from all sources and denote it by *TI*. Besides total tax income *TI* the government also obtains capital income *KG* from its properties and assets. With its income the government buys public consumption *GPC*, public investment *GPI* and provides social transfers *GST*. The difference between income and expenditures is the government deficit (or surplus) *GDF*:

$$GDF = (TI + KG) - (GPC + GPI + GST)$$

We can rearrange this expression to obtain:

$$GPC + GPI + GST = TI + KG - GDF$$

Under this budget constraint representation we see that having a negative deficit can be interpreted as initial endowment of bonds (i.e., a borrowing from the private sector) in the hands of the government that permits to execute an expenditure level higher that total income. Notice that under this representation the activity level of the government discretionary spending (public consumption and public investment) can be made exogenous or endogenous. In the first case, the activity level is fixed and the deficit is endogenously determined in equilibrium. In the second case, the government modifies its expenditure levels in accordance to its income so as to maintain a target level of deficit.

The labour market also has a special role in the model and some technical details are now provided. We want to model unemployment and we do so by assuming involuntary unemployment in a simple way. The representative consumer is endowed with labour that is elastically offered at the current real wage rate up to the point of full labour utilization. At his point the labour supply is depleted and becomes fully inelastic. Demand for labour is the result of profit maximization by firms. Under competitive conditions and constant-returns to scale, firms formulate their conditional demand for labour. If aggregate conditional demand for labour intersects the labour supply function in the elastic zone, unemployment arises since not all of the labour endowment is being used. In addition we include a feedback reaction between the real wage and the unemployment rate *u* that aims at picking up wage flexibility in the labour market:

$$\frac{w}{cpi} = \left(\frac{1-u}{1-\bar{u}}\right)^{1/\beta}$$

Here w is the nominal wage rate, cpi is a consumption price index, $\bar{u}$ is the baseline unemployment rate and β is an elasticity that measure the sensitivity of the real wage rate *w/cpi* to the unemployment rate *u*. For instance when $\beta = \infty$ the real wage is fully rigid and unemployment is fully flexible; when $\beta = 0$ unemployment is fully rigid (fixed) and the real wage is fully flexible. In between these polar cases, $0 < \beta < \infty$, we have that as β increases the sensitivity of the real wage to unemployment decreases.

As is standard in general equilibrium analysis the description of an equilibrium state includes a vector of prices and an allocation such that all markets for goods, services and factors clear --with the possible exception of the labour market, all private agents maximise their objective functions under their restrictions, the government fulfils its expenditure plan under its income constraint and all macro accounting identities are satisfied (particularly the “savings = investment” identity). From the price and allocation equilibrium values all aggregate National Income and Product Accounts can be calculated (GDP, tax revenues, etc.) if necessary. Also from the equilibrium values we can measure the level of CO2 emissions using emission coefficients adapted from EuroStat. We distinguish emissions that originate from production activities and from final demand. Their levels depend upon the respective emissions “technology” and the levels of output and final demand. Since output and demands are equilibrium magnitudes within the model and the observed equilibrium is dependent on the tax rate structure, we find here the link between the tax instruments and the level of CO2 emissions. As the government explores new tax policies (even if only counterfactually) each possible new equilibrium comes with a level of (counterfactual) emissions. Each new possible equilibrium can also be assessed in terms of the welfare effects on consumers or the unemployment rate. We measure private welfare using a money metric equivalent variation quantity. Thus for each equilibrium we have two measures that relate to the Double dividend issue we are exploring, one measuring environmental quality, the other one measuring possible efficiency gains (in terms of welfare or employment levels)[1].

IV Policies and Simulation Results

The model is calibrated to two SAM databases (1990 and 1995) of the Spanish economy. Calibration entails the specification of all technological, behavioural and tax parameters in such a way that once the model is endowed with these parameter values and an equilibrium is computed, the empirical data reported in both SAMs turns out to satisfy all of the equilibrium conditions. We refer to this equilibrium as the baseline or benchmark equilibrium and we use it as a yardstick to appraise the effects of any change in the tax instruments, particularly in our case, the introduction of the ecotax. The model has an exogenous elasticity, namely β. Its reference value of $\beta = 1.25$ is taken from the empirical econometrics literature (Andres et al, 1990).

All tax rates used in the model are effective, *ad-valorem* tax rates. When these rates are applied to the database tax base, all observed tax collections are recuperated. In the simulated equilibrium the tax bases are endogenous and price and quantity dependent. This affects the income side of the government budget constraint. Expenditures in public consumption and investment are price dependent too, therefore endogenous. Social transfers from the government are also price dependent since in actual practice transfers are indexed to the evolution of a consumption price index to keep its purchasing power constant in real terms.

We consider two versions of the model that represent two polar cases. The first version is referred to as the *rigid* model and no technological substitution is allowed, nor is any change in the level of unemployment. In the second version of the model, on the contrary, firms can adjust their demands for primary factors over a smooth isoquant and there may be adjustments in the labour market that make employment levels, or alternatively the unemployment rate, endogenously determined. We call this version the *flexible* model. In addition each model version contemplates two main tax policy scenarios. The first one consists in the introduction of a new set of ecotaxes on top of the existing tax system. The second scenario compensates the increased tax pressure with a reduction

[1] A more detailed technical description of the model and the overall equilibrum conditions can be found in

in the labour tax so as to maintain total tax collections constant in real terms. The reduction in the labour tax amounts to a homogenous lowering of the Social Security contributions paid by employers across all productive sectors. We choose this tax as the compensating tax because of its likely boosting effects on the labour market.

The tax policy scenarios that we examine include the adoption of a new 10 percent ecotax on the use of energy products and a 15 percent increase in the effective tax rate on petrol products. We consider these policies by themselves and then jointly. A summary of the simulation results appear in tables I to V. A first impression is that numerical results for 1990 and 1995 follow very similar patterns—an indication that despite using two different and independently built databases there is enough built-in robustness in the results to transcend them. We will use the 1995 numerical results for clarity of exposition and to lead the discussion.

Table I displays the simulated effects of the new energy tax policies under the rigid version of the model and with no compensation of the new tax revenues. Total CO2 emissions would fall about 4 percent from the baseline. Of these 21 percent are related to the change in final demand and less than 2 percent to adjustments in production. Total utility and money metric utility—as measured by the equivalent variation index— both fall. Since the levels of employment and capital are kept at the initial levels, the observed change should be explained by a small contraction in aggregate activity levels but with a considerable allocation shift conducive to a substantial reduction in emissions. Consumers, for instance, cannot shift forward the new taxes and the reduction in their real income explains the fall in demand and utility. The reduction in CO2 emissions is not accompanied by an efficiency gain and no double dividend is observed.

Table II is like Table I but now a revenue neutral reduction is the labour tax is enacted. Total emissions fall again but less than before. Emissions linked to production fall a bit more and emissions linked to final demand fall a bit less than before. Price adjustments are spread over all sectors and the fall in real income is substantially lower. The equivalent variation loss is about a fourth of the previous one. The results of the simulations in this scenario give us a hint on the efficiency cost of the ecotax policies. Emissions can be reduced and the efficiency cost in terms of equivalent variation can be interpreted as a shadow cost. When a tax compensation scheme is contemplated, the efficiency cost associated to emission reductions is quite smaller. Table II, however, does not show the existence of a double dividend.

Moving on to Tables III and IV we analyse the same simulations as in Tables I and II but under the flexible model version. Here unemployment is endogenous and the choice of technique takes place over smooth Cobb-Douglas isoquants defined on labour and capital. Table III examines the same unrestricted tax policies of Table I above whereas in Table IV we add the compensated reduction in the labour tax. In Table III CO2 emissions fall a bit more that in the rigid version with the main reduction taking place in emissions related to production activities. This is an indication that the ecotax policy does induce a change towards labour-capital combinations with a lesser indirect energy content. The welfare indicators fall and do so more than in the rigid version. A possible explanation is that labour use falls now that unemployment is endogenous. About a percent point increase in the unemployment rate is observed. This reduces labour income and has a negative effect on welfare. In sharp contrast to this we find in Table IV that unemployment decreases under all tax policies and that welfare improves under the 10 percent ecotax policy. The total level of CO2 emissions is smaller that in the equivalent policy scenario in the rigid model (Table II). There is therefore a double dividend in terms of *welfare gain*, *unemployment reductions* and *diminished level* of CO2 *emissions*. In fact there is an employment double dividend under all three tax policies and a strong double dividend under the selective 10 percent ecotax policy.

The revenue neutral tax policies of Table IV do indeed provide a positive drive in terms of efficiency gains. The reduction in the labour tax across all productive sectors proves to be stimulative enough to bring about a substitution of capital for labour and alleviate unemployment levels. In fact the results carry over to both empirical databases for 1990 and 1995 and this is good empirical evidence in favour of the overall effectiveness of the studied tax policies. The policy conclusion is that there is enough room for an adequate redesigning of the actual tax system in such a way that efficiency gains are indeed possible at no cost in terms of tax collections to the government. With the revenue neutral assumption driving the redesigned tax policy all government expenditure policies (public consumption, public investment, and social transfers) can continue unabated. The economy, however, would reach a different equilibrium with a double gain in terms of environmental quality and efficiency improvements. Flexibility, therefore, seems to be the leading reason explaining these double gain. In Table V we check this assertion by way of measuring the economic and environmental impact under different labour market flexibility scenarios. We simplify by showing results only for the most recent database—1995—and for the 10 percent across the board ecotax.

A first consideration is that an increasing labour market flexibility gives rise to better efficiency indicators (both in terms of less unemployment an more real income) but at a cost in terms of decreasing emissions. Examining the effects of a value of $\beta = \infty$ in relation to the reference elasticity of $\beta = 1.5$ we can see that there is almost a gain of 2 percent points in the level of employed labour but then total emissions of CO2 decrease by just about half the total level for the reference elasticity (from 2.78 percent fall to 1.49 percent fall). In fact, the composition of emissions shows that production emissions might even rise (from a 1.01 percent fall to a 0.34 percent increase). The ecotax would initially induce a substitution effect that reduces emissions but we also see that more labour market flexibility would bring about a volume or output effect working in the opposite direction to offset the substitution effect. Thus more flexibility does not give way to dominant double dividend situations. The parametric trade-off between real income and emissions could then be traced to a higher degree of labour market flexibility.

V Concluding remarks

We have used a computable general equilibrium model of the Spanish economy implemented with two Social Accounting Matrices to examine the likelihood of a double dividend as a result of the enactment of an environmental tax reform. This methodology is well-known for its modelling versatility and its ability to capture the detail of decision making at the level of basic agents—producers, consumers, and the government. The modelling of the labour market is especially important since we wanted to capture some empirical characteristics of the Spanish labour market. A first key aspect is the possibility of involuntary unemployment. A second one is the linking of the real wage rate to the unemployment rate using a labour market elasticity that can be interpreted as a measure of market rigidity.

Two main conclusions should perhaps be commented. The first one is that an employment double dividend with lower CO2 emissions and lower unemployment levels is an empirical possibility under a rather standard set of model characteristics and policy options. The second conclusion has to do with the fact that, up to a point, a more flexible labour market will respond better to tax policies directed to contain emissions and improve labour utilization. To achieve this double goal, however, revenue neutral tax policies are necessary but not always sufficient.

Simulation results showing a double dividend situation illustrate what is empirically and theoretically possible but not necessarily what will actually happen. Results depend always on the structure of the model, the behavioural rules of private agents, whether or not new tax policies will go accompanied by different expenditure policies of the government, and many other implicit and explicit assumptions that are needed to make a model operational. For instance, we assume no substitution among intermediate energy inputs in both the rigid and flexible versions of the model. A justification for this assumption is that we look at the equilibrium in the short run. Notice though that this restrictive modelling assumption can be seen as a least favourable scenario for lowering CO2 emissions. Then even under this restriction a double dividend could in principle be observed in our model. What appears to be a restrictive assumption turns out to be a good supporting argument for the occurrence of a double dividend.

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Table I : **Ecotax effects**

i) Rigid model

ii) No labour tax compensation

Indicators	**base situation**	**(a) 10% ecotax**	**(b) 15% Δ petrol tax**	**(a) + (b)**
Unemployment in %	16,250 (22,900)	16,250 (22,900)	16,250 (22,900)	16,250 (22,900)
% Δ utility	-	-0,013 (-0,015)	-0,002 (-0,003)	-0,016 (-0,018)
Equivalent variation[a]	-	-3,385 (-5,775)	-0,607 (-1,099)	-4,047 (-7,009)
% Δ production emissions	-	-1,028 (-1,408)	-0,055 (-0,160)	-1,083 (-1,562)
% Δ demand emissions	-	-15,195 (-15,518)	-4,329 (-6,506)	-18,921 (-21,148)
% Δ total emissions	-	-3,382 (-3,251)	-0,765 (-0,989)	-4,046 (-4,121)

[a]: in billions of 1990 (1995) Euros.

<u>Table II</u> : **<u>Ecotax effects</u>**

i) Rigid model

ii) With labour tax compensation

Indicators	**base situation**	**(a) 10% ecotax**	**(b) 15% Δ petrol tax**	**(a) + (b)**
% Δ in labor tax	-	-11,416 (-12,280)	-1,728 (-2,258)	-13,044 (-16,641)
Unemployment in %	16,250 (22,900)	16,250 (22,900)	16,250 (22,900)	16,250 (22,900)
% Δ utility	-	-0,003 (-0,003)	-0,001 (-0,001)	-0,004 (-0,005)
Equivalent variation[a]	-	-0,673 (-1,244)	-0,222 (-0,389)	-0,943 (-1,726)
% Δ production emissions	-	-1,091 (-1,601)	-0,064 (-0,191)	-1,155 (-1,788)
% Δ demand emissions	-	-13,878 (-14,715)	-4,125 (-6,373)	-17,469 (-20,273)
% Δ total emissions	-	-3,214 (-3,315)	-0,739 (-0,999)	-3,865 (-4,203)

[a]: in billions of 1990 (1995) Euros.

<u>Table III</u> : **<u>Ecotax effects</u>**

i) Flexible model ($\beta = 1.25$)

ii) No labour tax compensation

Indicators	**base situation**	**(a) 10% ecotax**	**(b) 15% Δ petrol tax**	**(a) + (b)**
Unemployment in %	16,250 (22,900)	17,070 (23,777)	16,400 (23,104)	17,260 (24,027)
% Δ utility	-	-0,162 (-1,897)	-0,298 (-0,374)	-1,954 (-2,326)
Equivalent variation[a]	-	-4,076 (-7,348)	-0,749 (-1,446)	-4,911 (-9,005)
% Δ production emissions	-	-1,573 (-2,176)	-0,158 (-0,337)	-1,749 (-2,538)
% Δ demand emissions	-	-15,064 (-16,164)	-4,337 (-6,430)	-18,806 (-21,886)
% Δ total emissions.	-	-3,81 (-4,004)	-0,852 (-1,161)	-4,582 (-5,066)

[a]: in billions of 1990 (1995) Euros.

Table IV : **Ecotax effects**

i) Flexible model ($\beta = 1.25$)

ii) With labour tax compensation

Indicators	base situation	(a) 10% ecotax	(b) 15% Δ petrol tax	(a) + (b)
% Δ in labor tax	-	-11,420 (-15,028)	-1,730 (-2,095)	-13,040 (-17,174)
Unemployment in %	16,250 (22,900)	15,620 (22,125)	16,190 (22,885)	15,600 (22,151)
% Δ utility	-	0,050 (0,031)	-0,047 (-0,110)	-0,043 (-0,128)
Equivalent variation[a]	-	-0,126 (0,122)	-0,119 (-0,427)	-0,110 (-0,498)
% Δ production emissions	-	-0,688 (-1,017)	-0,023 (-0,181)	-0,737 (-1,224)
% Δ demand emissions	-	-13,520 (-14,497)	-4,081 (-6,395)	-17,110 (-20,107)
% Δ total emissions	-	-2,820 (-2,778)	-0,697 (-0,993)	-3,457 (-3,691)

[a]: in billions of 1990 (1995) Euros.

Table V : 10 percent energy tax

i) Flexible model ($\beta = 1.25;\ 5;\ \infty$)

ii) With labour tax compensation

Indicators	**base situation**	**(i)** $\beta = 1.25$	**(ii)** $\beta = 5$	**(iii)** $\beta = \infty$
Unemployment in %	22.900	22.125	21.259	20.307
% Δ utility	-	0.031	0.534	1.083
Equivalent variation[a]	-	0.122	2.068	4.194
% Δ production emissions	-	-1.017	-0.369	0.338
% Δ demand emissions	-	-14.497	-14.097	-13.660
% Δ total emissions	-	-2.778	-2.162	-1.490

[a]: in billions of 1995 Euros.