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REGIONAL ENVIRONMENTAL TAX REFORM IN A FISCAL FEDERALISM SETTING

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Abstract: *The increasing attention to climate changes have led national Governments to design environmental tax policies able to face environmental problems and their associated economic consequences as a negative change of GDP. The environmental taxation in particular is considered a powerful instrument of pollution control. More important, it provides public revenue that can be recycled both at State level and Local level in order to attain the reduction of greenhouse gas emissions and the regional double dividend. In this respect, we use a Computable General Equilibrium (CGE) model with imperfect labour market, to assess the regional effects of an environmental fiscal reform designed with the aim of reducing the* CO_2 *emissions in a fiscal federalism setting. In particular, we introduce a local green tax on commodities output with a progressive structure. The tax burden depends on the commodity polluting power and the tax revenue is collected by the Local Government. According to the fiscal federalism principles the Central Government reduces the transfers to the Local Government by the same amount of the tax revenue and compensates the transfer reduction with a cut in Households income tax. The application is done on a bi-regional Social Accounting Matrix for Italy and the results highlights the distributional effects of the reform on macroeconomic variables into the bi-regional income circular flow.*

Key words: *Environmental taxation, Social Accounting Matrix, CGE analysis.*

1. Introduction

From the topic of economic sustainability arises the problem of how to measure the impact that environmental reform generates as a fundamental part of the environmental sustainability issue. In many respects, the environmental policy can generate costs and earnings that are both environmental and economic.

Consequently, the economic sustainability problem requires selection of the best indicators that are able to assess the environmental and economic impacts of a policy characterized by environmental objects [1]. Moreover sustainable development should be analysed within the fiscal federalism reform in order to understand if it can represent a tool for reaching a better institutional setting

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besides environmental improvement. Although according to article 117 of the Italian Constitution, Central Government has the exclusive right to rule on environmental subject, a recent jurisprudence assigns to Local Government a prominent role in protecting and improving environment [2]. The attention of economic research should be focused on the analysis of local policies with respect to fiscal reforms, especially those that can promote environmental protection. Fiscal instruments, which Local Government can activate in order to reach environmental objectives, can be represented by traditional instruments such as Local Government expenditure or local taxes. Moreover, the Local Government might design new incentive mechanisms as "green" taxes specifically created for environmental purpose. The opportunity of using the environmental policy at local level raises the need to verify, in terms of both qualitative and quantitative terms, the effectiveness of the old instruments of fiscal policy in order to evaluate the results obtained by new forms of incentive. An analysis able to highlight the interrelationships between all the local agents in the various phases of the income circular flow is therefore required. The representation of the inter-regional income flows allows to quantify the advantages and disadvantages of the environmental fiscal policy from different viewpoints. First of all, the effects can be quantified looking at the impact of local policies on major economic aggregates (GDP, Local and Central Government balances, disposable income, employment, etc.). On the other hand, it is possible to verify the effectiveness of such local policies in environmental terms. The importance of determining the impacts generated by the environmental fiscal policy through disaggregated analysis depends on the possibility to evaluate the economic effects on the private and public Institutional Sectors within the same region and between the regions considered. The debate on effectiveness of environmental policies both at local or national levels, refers to the "double dividend" theory (Pearce 1991). Indeed, the introduction of new environmental taxes, as well as the amendment of existing local taxes, represents an opportunity for local policy makers to collect tax revenue and use this income to get positive effects on local economy and environment. Reaching the double dividend requires an appropriate definition of local policy which must be drawn through the ex ante evaluation of the possible impacts that the manoeuvre generates on the local budgets, on the environment (reduced local emissions of CO_2) and employment [20]. The assessment of double dividend hypothesis, especially for the European countries, mostly concentrated on the employment second dividend as a consequence of the high unemployment rate which typically affects this area. Indeed most of these analysis that aim to quantify the effects of environmental fiscal reform on labour markets, are developed through the general equilibrium frameworks characterised by rigidity on wages formation and involuntary unemployment.

Empirical studies for several countries, such as Schneider (1997), Bovenberg and De Mooij (1998), Manresa and Sancho (2005), Takeda (2007), Glomm et al. (2008), Bor and Huang (2010) demonstrate the existence of the second dividend and in some cases even a triple dividend [3]. Nevertheless the possibility to get a double/ triple dividend through an environmental policy strictly depends on the existing tax system, the production technology adopted and above all the structure of tax reform. According to Takeda (2007), in a country characterised by economic differences at local and social level, the double dividend may differ among regions or it could not occur for all regions. For this purpose, our analysis will be developed in two main phases: the first one refers to the specification of the appropriate local environmental tax reform [4], the second concentrates on the analysis of the environmental and economic impacts of the policy by means of a multi-sector and bi-regional Computable General Equilibrium (CGE) model. Following the objective "those who pollute more, should pay more" we modelled a local environmental tax with a progressive structure on commodity output according to the level of emissions. As a local tax, the tax revenue is assumed to be entirely managed by the Regional Government and, according to the fiscal federalism principles, the Central Government reduces the transfers to the Regions for the same amount of the environmental tax. Since the price of final goods may increase as a result of the tax, the cut in Regional transfers is balanced by a reduction in the Households income tax to mitigate the effect on Households real disposable income.

The methodology we used to assess the impacts of this regional policy reform is represented by a CGE model based on a bi-regional Social Accounting Matrix (SAM) for Italy. The model answers two main questions:

i) what are the impacts of the environmental policy on macroeconomic variables and Local Government balances;

ii) what are the impact on greenhouse gas emissions once the fiscal reform has been implemented. The multi-sector approach and the CGE model are widely recognized as straightforward instruments to assess the quantitative and distributional impact of alternative fiscal policy reforms [28] and the bi-regional SAM provides the proper full detailed and disaggregated database for the simulations. Besides, the aim to evaluate the compatibility between the environmental and economic objectives for the Italian economy requires the integration of the SAM with the environmental data set concerning CO_2 emissions by each commodity provided by the National Accounting Matrix including Environmental Accounts (NAMEA) [5]. The next section introduces the environmental policy targets for the Italian case and the regional environmental tax reform in order to comply with the current European environmental agreement. The description of the CGE model and the database are presented in section three and the last section shows the results from the application of the environmental fiscal policy proposed in terms of CO_2 emissions, total output, unemployment rate, disposable income and Local and Central Government balances.

2. Environmental tax reform proposal

The international climate agreements ratified by Italian Government fixed stringent objectives on greenhouse gas (GHG) emissions to deal with the climate change issue. We refer in particular to the Kyoto Protocol agreement according to which the Italian economy must reduce the CO_2 emissions by 5.5% in respect to the 1990's level [6]. The environmental policy measures adopted by Italian economy to fulfil Kyoto target should restore the level of CO_2 to 340 million tons within the year 2012 (ISTAT 2010) [7]. We considered an ideal trend of CO_2 emissions from 1990 to 2012 according to the targeted level and we compared this path with the effective amount of CO_2 emissions observed for the Italian economy in each year. As shown in the Figure 1, in the year 2003 the admitted level of CO_2 emissions for the Italian economy is 348 million tons, 39 million tons less than the observed level of emissions (ISTAT 2010). This difference can be easily interpreted as the Italian debit of CO_2 emissions that must be repaired within the 2012 to avoid the EU sanctions.

In order to achieve such an objective, we propose an environmental tax reform that takes into account the polluting power of each commodity and stimulate the reduction of CO_2 without neglecting the economic growth. In particular we simulate the introduction of a local environmental tax on activity output depending on the CO_2 emissions and we impose the tax only on the most pollutant commodities. To be more specific, we consider a "no-tax area" calculated as the ratio between the total level of CO_2 allowed for Italy for 2003 [8] and the number of commodities in the benchmark [9].

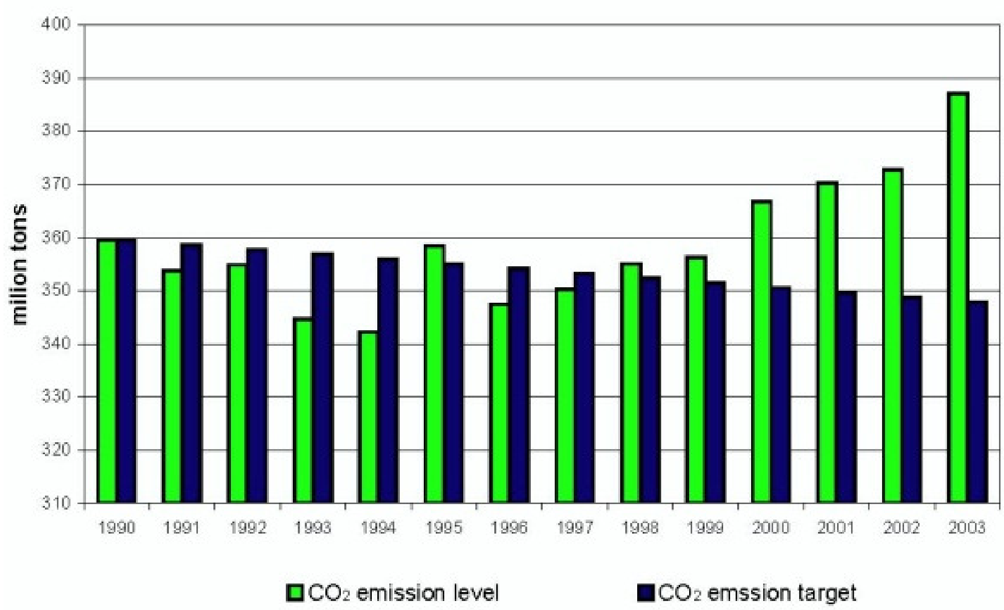

Fig. 1: *CO_2 emissions' target and emissions' level (1990-2003)*

This means that less polluting commodities are not taxed and those commodities which surpass the permitted level (10.8 million tons for each commodity) have an incentive to reduce their emissions to avoid the taxation.

The main feature of the environmental tax concerns its progressive structure: there are 5 tax brackets and a fixed price per ton of CO_2 emissions is established in each bracket. If total emissions by commodity exceed the cut-off point, the commodity is taxed according to the next tax bracket for the emissions in excess. The structure of this eco-tax can be described as follow:

- 0. From 0 to 10.871.958 tons: no-tax area,
- 1. From 10.871.959 tons to 15.000.000 tons: 9 euro per CO_2 tons,
- 2. From 15.000.001 tons to 30.000.000 tons: 16 euro per CO_2 tons,
- 3. From 30.000.001 tons to 50.000.000 tons: 22 euro per CO_2 tons,
- 4. Over 50.000.001 tons: 32 euro per CO_2 tons.

According to the previous scheme, we are now able to calculate the excess in emissions by commodities, we can order the commodities from the most to the less pollutant and then we can assign each commodity to a tax bracket as shown in table 1.

Excess in CO_2 emissions and environmental tax by commodity Table 1

		Commodity	*CO_2 emission excess (ton)*	*Environmental Tax Class*
South Isles	1.	Energy products	42.687.266	**Class 4.**
	2.	Non-metallic mineral products	1.514.619	**Class 1.**
	3.	Transport	-338.692	Class 0. no tax
	4.	Trade	-5.242.652	Class 0. no tax
	5.	Chemical products	-5.377.133	Class 0. no tax
	6.	Government services	-6.598.007	Class 0. no tax
	7.	Products of agriculture	-7.248.319	Class 0. no tax
	8.	Mechanics	-7.728.997	Class 0. no tax
	9.	Food products and beverages	-8.695.869	Class 0. no tax
	10.	Private services	-9.147.173	Class 0. no tax
	11.	Textile	-9.676.312	Class 0. no tax
	12.	Other manufacturing products	-9.701.728	Class 0. no tax
	13.	Construction work	-9.874.778	Class 0. no tax
	14.	Transport equipment	-10.219.012	Class 0. no tax
	15.	Financial services and Insurance	-10.654.837	Class 0. no tax
	16.	Iron and non-iron ore	-10.712.638	Class 0. no tax
North Centre	1.	Energy products	80031531	**Class 4.**
	2.	Chemical products	23067318	**Class 3.**
	3.	Non-metallic mineral products	22787957	**Class 3.**
	4.	Transport	17789289	**Class 2.**
	5.	Mechanics	15285447	**Class 1.**
	6.	Trade	3769657	**Class 1.**
	7.	Textile	-427903	Class 0. no tax
	8.	Other manufacturing products	-1026529	Class 0. no tax
	9.	Government services	-3209956	Class 0. no tax
	10.	Food products and beverages	-3677048	Class 0. no tax
	11.	Products of agriculture	-5536262	Class 0. no tax
	12.	Private services	-6235979	Class 0. no tax
	13.	Transport equipment	-8108208	Class 0. no tax
	14.	Construction work	-8398303	Class 0. no tax
	15.	Iron and non-iron ore	-9765066	Class 0. no tax
	16.	Financial services and Insurance	-10153687	Class 0. no tax

3. The bi-regional CGE model

Our model is a static Computable General Equilibrium (CGE) model developed in order to analyse the effects of an exogenous shock on macroeconomic variables along the income circular flow.

This model describes economic agents who interact among each other through prices that result from markets of goods and primary factors. Then, the equilibrium of the CGE model represents the solution of the simultaneous set of equations by means of a vector of prices, quantities and incomes by each agent.

This is calibrated on the bi-regional SAM for Italy (year 2003), which represents the income circular flow for the whole economy, in terms of intra-regional and inter-regional flows [22], [23]. The SAM considers an open economy with two regions (North-Centre and South-Isles), 16 commodities [10], 2 components of value added (labour and capital) and 9 Institutional Sectors [11] in each Region [26].

A prominent advantage of our model involves the combination of the SAM with environmental indicators provided by the NAMEA (National Accounting Matrix including Environmental Accounts) [12].

We concentrate in particular on CO_2 emissions by commodity and we amended these physical flows in order to match the commodities classification in the SAM. Then we associate the physical flows of CO_2 emissions to each commodity and we calibrate the coefficient of emissions by commodity as the ratio between the CO_2 emissions (tons) and the total output.

According to the structure of our database, the CGE model can be described as an integrated representation of the bi-regional income circular flow [23] where the entire process of generation, primary and secondary distribution of income is described by a system of equations [24] and income constrains for agents that are all maximizers and price takers [16].

In this respect, the solution of the model (as a Walrasian equilibrium model) is represented by commodity final prices, commodity activity levels and income levels that verify the market clearing and the zero profit conditions given the income balance constraints.

The market clearing conditions require that goods and primary factors with positive prices must have balance between supply and demand. This condition is verified for commodities when the total output is equal to the intermediate demand, the final consumption expenditure, final consumption expenditure incurred by the Local and Central Government, the gross capital formation and the exports.

Similarly the market clearing conditions for the primary factors are verified when factor endowments correspond to primary factor demands expressed by the production system.

Fundamental relationship in CGE model Table 2

		South-Isles			North-Centre					
		Commodities	Primary Factors	Institutional Sectors	Commodities	Primary Factors	Institutional Sectors	Central Government	Formation of Capital	Rest of Word
S-I	*Comm.*	$\mathbf{B}^{ss}(x,p)$		$\mathbf{C}^{ss}(rd,p)$ $\mathbf{GL}^{ss}(rd,p)$	$\mathbf{B}^{sn}(x,p)$		$\mathbf{C}^{sn}(rd,p)$ $\mathbf{GL}^{sn}(rd,p)$	$\mathbf{G}^{sg}(rd,p)$	$\mathbf{I}^{s}(p)$	$\mathbf{E}^{sw}(e,p)$
	Fact.	$\mathbf{Y}^{ss}(x,p_l,p_k)$			$\mathbf{Y}^{sn}(x,p_l,p_k)$					
	Ins.Sec.	$\mathbf{T}^{ss}(x)$	$\mathbf{R}^{ss}(y)$	$\mathbf{T}^{ss}(r,t)$ $\mathbf{T}_r^{ss}(r,t)$		$\mathbf{R}^{sn}(y)$	$\mathbf{T}^{sn}(r,t)$ $\mathbf{T}_r^{sn}(r,t)$	$\mathbf{T}_r^{sg}(r,t)$		$\mathbf{t}^{sw}(r)$
N-C	*Comm.*	$\mathbf{B}^{ns}(x,p)$		$\mathbf{C}^{ns}(rd,p)$ $\mathbf{GL}^{ns}(rd,p)$	$\mathbf{B}^{nn}(x,p)$		$\mathbf{C}^{nn}(rd,p)$ $\mathbf{GL}^{nn}(rd,p)$	$\mathbf{G}^{ng}(rd,p)$	$\mathbf{I}^{n}(p)$	$\mathbf{E}^{nw}(e,p)$
	Fact.	$\mathbf{Y}^{ns}(x,p_l,p_k)$			$\mathbf{Y}^{nn}(x,p_l,p_k)$					
	Ins.Sec.		$\mathbf{R}^{ns}(y)$	$\mathbf{T}^{ns}(r,t)$ $\mathbf{T}_r^{ns}(r,t)$	$\mathbf{T}^{nn}(x)$	$\mathbf{R}^{nn}(y)$	$\mathbf{T}^{nn}(r,t)$ $\mathbf{T}_r^{nn}(r,t)$	$\mathbf{T}_r^{ng}(r,t)$		$\mathbf{t}^{nw}(r)$
	C.G.	$\mathbf{T}^{sg}(x)$	$\mathbf{R}^{sg}(y)$	$\mathbf{T}^{sg}(r,t)$ $\mathbf{T}_r^{sg}(r,t)$	$\mathbf{T}^{ng}(x)$	$\mathbf{R}^{ng}(y)$	$\mathbf{T}^{gn}(r,t)$ $\mathbf{T}_r^{gn}(r,t)$			
	F.K.			$\mathbf{S}^{s}(rd)$			$\mathbf{S}^{n}(rd)$	$\mathbf{S}^{g}(rd)$		(+/-)a
	RW	$\mathbf{M}^{ws}(x,e)$	$\mathbf{t}^{ws}(y)$	$\mathbf{T}_r^{ws}(r)$	$\mathbf{M}^{wn}(x,e)$	$\mathbf{t}^{wn}(y)$	$\mathbf{T}_r^{wn}(r)$			

In this respect it is worth to put into evidence the market imperfection for the labor factor represented by initial positive involuntary unemployment rate in each region (u^r) and a "right-to-manage" Nash bargaining aproach [17].

The zero profit conditions require that the value of inputs must be equal to the value of output. In our model, the activities produce a homogeneous good using a nested constant return to scale technology. The total output is produced with fixed coefficients aggregation of domestic and imported commodities [13]. The domestic composite is a Leontief aggregation of intermediate consumption, depending on total output and prices, and the value added that is affected by total output and primary factors' prices.

Then assuming a Constant Elasticity of Substitution (CES) function, the value added is generated by combining capital and labour that are perfectly mobile across activities (the elasticity of substitution derives from econometric estimates for Italy [32].

The income balance constraints require that for each Institutional Sector (Households, Firms, Central and Local Government) the value of income must be equal to the sum of primary factors compensations, net transfers from other Institutional Sectors and tax revenue. To be more specific, we distinguish private sectors (Households and Firms) and public sectors (Central and Local Government).

The primary factors compensations plus the net transfers from Institutional Sectors represent the total net endowments for private sectors. The total tax revenue plus the net transfers from Institutional Sectors represent the total net endowments for public sector. Thus per each Institutional Sector the total endowments must be equal to the final consumption expenditures and savings. Finally the condition on gross capital formation requests that total investments are equal to savings by all Institutional Sectors.

4. Environmental tax reform: policy and results

According to the Kyoto Protocol targets, the local environmental tax reform we suggested, aims to reduce the consumption of polluting goods in order to cut CO_2 emissions and to reach the first dividend (environmental dividend). Moreover a second dividend for the Italian economy can be assessed analysing the income circular flow and the unemployment rate adjustment. The possibility to get the second dividend is strictly connected to the tax revenue recycling scheme applied.

We consider a policy scenario where the environmental tax with a progressive structure on commodity output is introduced. The tax revenue is entirely managed by the Regional Government and according to the fiscal federalism principles, the Central Government reduces the transfers to the Regional Government for the same amount of the environmental tax. Regional transfers cut is balanced by a reduction in the Households income tax to compensate for the loss purchasing power linked to the increase in prices.

The direct and indirect effects of this simulation can be assessed in the phases of the income circular flow and are expressed as percentage changes from the benchmark data (the SAM). Starting from the modifications occurred in the phase of production, we will discuss the effects on CO_2 emissions, value added generation and allocation, secondary distribution of income and final demand.

a) *Production: price and output*

The environmental tax is imposed on commodity output according to the CO_2 excess in emissions. As shown in the table 3 all commodities price increases in both regions.

Since the “Energy products’ and “Non metallic mineral products’ are the most polluting goods in both regions, they pay a higher tax. As a result, their price rises more than all the other commodities (+ 4.268% in South-Isles and +6.082% in North-Centre). The same effect is observed for the price of “Chemical products’, “Mechanics’ and “Transport’ in the North-Centre region. The raise in other commodities price can be interpreted as an indirect effect of the policy.

According to the results showed on table 4, the introduction of the regional environmental tax implies a reduction on total output especially for the South-Isles region. This total effect can be analysed in disaggregate terms focusing on the output change by commodity. As already detected for prices, a significant reduction in output is observed for “Energy products” in both regions. The production of “Non metallic mineral products”, “Chemical products”, “Mechanics” and “Transport” decreases more in the North-Centre than in the South-Isles as a consequence of the taxation scheme. In both regions nevertheless, some commodities output registers a slight increase (e.g. “Products of agriculture”, “Food products and beverages”, “Textiles”, “Construction work”, “Trade” and “Private services”).

b) *Environmental aspects*

The regional environmental policy, that has been introduced in the Italian economy, affects the level of CO_2 emissions as expected and allows the achievement of the environmental (first) dividend. The tax is applied on commodity output and is levied according to the polluting power.

Table 3

Impacts on prices (% change)

Commodity	S-I	N-C
1. Products of agriculture	1.150	0.791
2. Energy products	4.268	6.082
3. Metal and non metal ore	0.723	0.685
4. Non metallic mineral	1.349	2.187
5. Chemical products	0.890	1.281
6. Mechanics	0.939	0.835
7. Transport equipment	0.873	0.715
8. Food prod. & beverages	0.918	0.757
9. Textile	0.770	0.615
10. Other manufacturing	0.925	0.759
11. Construction work	1.160	0.873
12. Trade	1.143	0.771
13. Transport	1.311	0.923
14. Financial serv.&Ins.	1.103	0.731
15. Private services	1.231	0.632
16. Government services	1.606	1.046

Table 4

Impacts on output (% change)

Commodity	S-I	N-C
1. Products of agriculture	0.051	0.037
2. Energy products	-1.601	-1.401
3. Metal and non metal ore	-0.125	-0.328
4. Non metallic mineral	-0.054	-0.720
5. Chemical products	-0.003	-0.457
6. Mechanics	-0.058	-0.287
7. Transport equipment	-0.046	-0.143
8. Food prod.& beverages	0.266	0.140
9. Textile	0.228	0.093
10. Other manufacturing	-0.053	-0.203
11. Construction work	0.060	-0.059
12. Trade	0.145	0.118
13. Transport	-0.089	-0.138
14. Financial ser.&Ins.	-0.120	-0.085
15. Private services	0.040	0.169
16. Government services	-0.290	-0.251
Total Output Change	-0.127	-0.077

From Table 5 we observe that the level of CO_2 emissions decrease in both regions. The best results in terms of reduction are performed by the South-Isles region as a consequence of the policy effects on commodity output level (Table 4). The total output decreases more in the South-Isles and this affects the result in terms of emissions.

Table 5

Impacts on CO_2 emissions (% change) Table 5

South-Isles	-0.809
North-Centre	-0.625
Total Italy	-0.675

c) *Value added generation and allocation: nominal aspects and unemployment rate*

Given the positive results in terms of first dividend, our analysis now requires the check of further benefits associated to the regional environmental policy. We focus in particular on the policy effects on value added generation and allocation. The analysis concentrates on primary factors prices (compensation of employees, compensation of self-employees and operating surplus or capital income) and on unemployment rate.

Table 6 shows an increase in all primary factors compensations in both regions. The changes in employed compensation in particular, affect the unemployment rate change. More specifically, Firms and Labour Union bargain over employed wages. If the wage bargained is higher, the demand of labour by Firms decreases and the unemployment rate rises.

Table 6

Impacts on primary factors compensations and unemployment (% change)

Primary Factors	S-I	N-C
Employed	1.630	0.935
Self Employed	1.144	0.726
Capital	0.820	0.360
Unemployment rate % change Unemployment	1.704	0.939
rate	18.002	4.603

As a consequence of the "right-to-manage" Nash bargaining scheme, in both regions we observe an increase in unemployment rate (+1.704% in South-Isles and +0.939% in North-Centre). This result does not allow us to assess the second employment dividend nor in aggregate, nor in disaggregate terms for the Italian Economy. It has to be stressed that the policy we performed focuses in particular on secondary income distribution. Indeed the regional environmental tax revenue is compensated by a reduction of transfers from the Central Government. This manoeuvre limits the possibility for the Regional Government to implement a specific recycling scheme for the tax revenue. On the other side, the Central Government compensates the cut in regional transfers with a reduction of Households income tax. This recycling scheme focus on disposable income (welfare) results more than on unemployment rate change.

d) *Secondary distribution of income: nominal and real effects*

The environmental taxation is considered a powerful instrument of environmental policy since it allows to collect revenue that can be recycled in the economy. According to the recycling scheme suggested, a second dividend might arise when we focus on Institutional Sectors disposable income as a policy target.

Table 7

Impacts on Households and Firms nominal disposable income (% change)

Institutional Sectors	South Isles	North Centre
Households	1.367	1.064
Firms	0.657	1.075

As expected from the reduction in Households income tax, the Households nominal income increases in both regions as shown in Table 7. A positive effect is detected also in terms of Firms nominal income that increases both in North-Centre and South-Isles. These positive effects can be easily interpreted as a second welfare dividend and depend on two main factors: first, the cut in Households income tax, second the increase in primary factors' compensations which compose the Institutional Sectors total endowments.

The effects of the policy in terms of Households and Firms purchasing power are summarised in Table 8. It shows the positive effects of the policy for the Households real disposable income in both regions.

Table 8

Impacts on Households and Firms real disposable income (% change)

Institutional Sectors	South-Isles	North Centre
Households	0.053	0.135
Firms	-0.195	0.210

The increase is higher in the North-Centre. The real disposable income for Firms decreases in South-Isles and increases in North-Centre. The change in real disposable income confirms the positive effects of the policy in disaggregate terms. This allows us to accept the hypothesis of second dividend represented by the higher nominal and real disposable income for Households in North-Centre region.

Since the environmental policy reform is applied in a fiscal federalism setting, we also consider its effects on Local and Central Government disposable income (balance). The environmental tax revenue is assigned to the Regional Government. On the other side the Central Government reduces the transfers to the Regional Government of the same amount. This modification occurred in the secondary income distribution phase generates different effects in disaggregate terms.

Table 9 shows the percentage change in Local and Government balances.

Table 9

Impacts on Central and Local Government balances (% change)

Institutional Sectors	South Isles	North Centre
Regional Gov.	4.738	1.902
District Gov.	0.157	-0.446
Municipal Gov. 1	0.354	0.220
Municipal Gov. 2	0.202	0.082
Municipal Gov. 3	0.204	-0.030
Municipal Gov. 4	0.263	-0.072
Municipal Gov. 5	0.451	0.555
Central Government	-0.082	

The Regional Government is not affected by the reduction in Central Government transfers and its balance increases both in North-Centre and South-Isles. It is worth to put into evidence the balance change of Municipal Governments that increase in both two regions (with exception of Municipal Governments 3 and 4 in the North-Centre). These results are connected to the positive changes in Households and Firms nominal incomes. Indeed, the Government total endowments are affected by the income taxes therefore when nominal incomes rise, the income tax revenues rise as well.

e) *Final demand formation*

The final demand generated by consumers completes the income circular flow described by the simulations. The Institutional Sectors' net income is re-arranged in terms of final demand according to the classification of the commodities and the results illustrate a general increase in final demand in disaggregate terms in each region.

5. Conclusion

The environmental policy reform proposed deals with the Italian commitment on GHG emissions reduction fixed by International climate agreements. The analysis in particular focuses on the effects of an environmental tax that has been modelled in order to affect the pollution power of each commodity. Following the objective "those who pollute more, should pay more" and the "double dividend" hypothesis, we developed a two step analysis. The first step concerns the description of the regional environmental tax reform; the second step refers to the assessment of environmental and economic benefits (first and second dividends) generated by the policy. In particular, we associate the first dividend with the decrease in CO_2 emissions and the second dividend with the growth of Institutional Sectors disposable income.

The main feature of this analysis is represented by the detailed data base we use, which is characterized by the integration of environmental data (NAMEA) within the economic flows described in the SAM. In particular, disaggregated data on CO_2 emissions enabled us to order commodities according to their polluting capacity and thus allowed us to identify the production processes that exceed the permitted level of emissions. With the aim of restoring the correct level of CO_2 we introduced a regional green tax on commodities output with a progressive structure. This reform would fulfil two main objectives: first, giving an incentive to reduce the CO_2 emissions in order to hold down the tax burden, second testing the convenience of an environmental tax as a fiscal federalism instrument. For this purpose the Regional Government collects the environmental tax revenue and the Central Government reduces the transfers to the Regions by the same amount. At the same time the transfer diminution is compensated by a cut on Households income tax.

The analysis has been carried out using a computable general equilibrium model that is a suitable tool to evaluate the economic impacts of a policy on macroeconomic variables. The results show the importance of using a detailed database in the general equilibrium analysis to detect the different impacts of an environmental fiscal reform within the economic system. Indeed we verified the first environmental dividend in the economy both in North-Centre and South-Isles. As expected the reduction on CO_2 emissions is relevant for the most polluting commodities. Moreover, the environmental target has been integrated by a second economic dividend represented by an increase in Households nominal and real disposable income in both regions.

Besides the assumptions made on tax revenue assignment, secondary income distribution and tax revenue recycling scheme ensure an improvement in the Regional and Municipal Government balances.

Thus if we concentrate on the benefits connected with the environmental policy, the introduction of a regional green tax with a progressive structure and the simultaneous reduction in income tax allows to reach both first and second dividends in aggregate and disaggregate terms. In a fiscal federalism setting the regional green tax can also be considered as a valid instrument to improve the Local Government autonomy. The North-Centre area in particular, shows better results since it has a social and economic structure more suitable for the environmental policy reform.

Appendix A: CGE model specification

In the CGE model the activities produce an homogeneous good using a nested constant return to scale technology. Given the structure described in figure A1, we consider the share form of the production function in order to provide a more convenient calibration process.

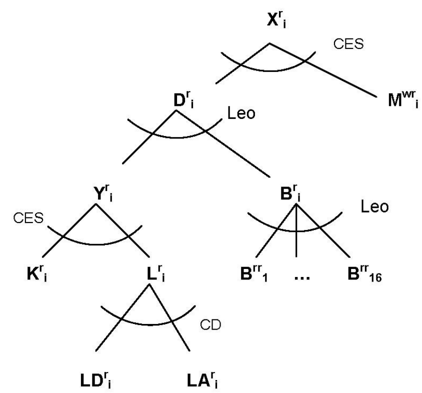

Fig. A1. *The production function*

The sigmas in the figure represent elasticity of substitution between inputs. Starting from the nest on the top, we can obtain the total output price as:

$$p^r_{Xi} = \overline{p^r_{Xi}} \left[\frac{\overline{p^r_{Di}}\,\overline{D^r_i}}{\overline{p^r_{Di}}\,\overline{X^r_i}} \left(\frac{p^r_{Di}}{\overline{p^r_{Di}}}\right)^{1-\sigma_{X^r_i}} + \frac{\overline{p_{M_i^{wr}}}\,\overline{M_i^{wr}}}{\overline{p^r_{Xi}}\,\overline{X^r_i}} \left(\frac{p_{M_i^{wr}}}{\overline{p_{M_i^{wr}}}}\right)^{1-\sigma_{X^r_i}} \right]^{\frac{1}{1-\sigma_{X^r_i}}} \quad (A.1)$$

with $\overline{X^r_i} = \overline{D^r_i} + \overline{M^{wr}_i}$.

The over lined symbols derive from benchmark data (prices in the benchmark are all equal to r one), the other symbols are calibrated by the model. p^r_{Xi} is the commodity final price in region *r* which depends on the price of domestic output (p^r_{Di}) and the price of imported goods ($p_{M_i^{wr}}$). The elasticity of substitution ($\sigma_{X^r_i}$) is different for each commodity [14].

The price of domestic output (second step in the production function nesting) can be calculated as:

$$p_{Di}^r = \frac{\overline{p_{Yi}^r}}{\overline{p_{Di}^r}} \frac{\overline{Y_i^r}}{\overline{D_i^r}} \left(\frac{p_{Yi}^r}{\overline{p_{Yi}^r}}\right) + \frac{\overline{p_{Bi}^r}}{\overline{p_{Di}^r}} \frac{\overline{B_i^r}}{\overline{D_i^r}} \left(\frac{p_{Bi}^r}{\overline{p_{Bi}^r}}\right) \quad \text{(A.2)}$$

with $\overline{D_i^r} = \overline{Y_i^r} + \overline{B_i^{wr}}$.

p_{Di}^r depends on the price of the value added composite p_{Yi}^r and the price of the intermediate demand (p_{Bi}^r). We do not consider the elasticity of substitution σ_{Di}^r since it is equal to zero (Leontief technology).

The price of value added composite is affected by the primary factors' compensations and can be written as:

$$p_{Yi}^r = \overline{p_{Yi}^r} \left[\frac{\overline{p_{Li}^r L_i^r}}{\overline{p_{Yi}^r Y_i^r}} \left(\frac{p_{Li}^r}{\overline{p_{Li}^r}}\right)^{1-\sigma_{Y_i^r}} + \frac{\overline{p_{K_i^r}}(1+t_K)\overline{K_i^r}}{\overline{p_{Yi}^r Y_i^r}} \left(\frac{p_{K_i^r}}{\overline{p_{K_i^r}}(1+t_K)}\right)^{1-\sigma_{Y_i^r}} \right]^{\frac{1}{1-\sigma_{Y_i^r}}} \quad \text{(A3)}$$

with $\overline{Y_i^r} = \overline{L_i^r} + \overline{K_i^{wr}}$.

p_{Ki}^r is the capital income in region r, $t_k$is the capital income tax rate, p_{Li}^r is the compensation for the labor composite and $\sigma_{Y_i^r}$ is the elasticity of substitution. It derives from econometric estimates for Italy [32] and is set equal to 0.52.

The bottom of the nesting production function is represented by labour composite. It is a Cobb-Douglas (CD) aggregation of self-employed (LA_i^r) and employed (LD_i^r) and can be expressed as follows:

$$p_{Li}^r = \overline{p_{Li}^r} \left[\frac{\overline{p_{LAi}^r}(1+t_L)\overline{LA_i^r}}{\overline{p_{Li}^r L_i^r}} \left(\frac{p_{LAi}^r}{\overline{p_{LAi}^r}(1+t_L)}\right)^{1-\sigma_{L_i^r}} + \frac{\overline{p_{LD_i^r}}(1+t_L)\overline{LD_i^r}}{\overline{p_{Li}^r L_i^r}} \left(\frac{p_{LDi}^r}{\overline{p_{LDi}^r}(1+t_L)}\right)^{1-\sigma_{L_i^r}} \right]^{\frac{1}{1-\sigma_{L_i^r}}} \quad \text{(A4)}$$

with $\overline{L_i^r} = \overline{LA_i^r} + \overline{LD_i^{wr}}$.

p_{LDi}^r is the compensation of employees, p_{LAi}^r is the compensation of self-employees and t_L is the payroll tax rate. Since the labour composite is a Cobb-Douglas function of employees and self-employees, the elasticity of substitution (L_i^r) is equal to one. In this respect it is worth to put into evidence the market imperfection for labor factor represented by initial positive involuntary unemployment rate in each region, u^r. Two types of workers, self-employed (LA^r) and employed (LD^r) are considered. The negotiation between Firms and Labour Union concerns only employed compensations (wages) and it is articulated according to a "right-to-manage" Nash bargaining approach [17].

The Labour Union utility function (U_{LU}^r) is described by the equation A5:

$$U_{LU}^r = (1-u^r)\frac{(p_{LD}^r)^{1-\gamma}}{1-\gamma} + u^r \frac{(b^r)^{1-\gamma}}{1-\gamma} \quad \text{(A5)}$$

It depends on the unemployment rate (u^r), the employed wages bargained p_{LD}^r, the unemployment compensation (b^r) and the Labour Union risk aversion represented by the parameter γ. Assuming that Labor Union has monopoly power and risk neutral utility function (γ =0) we derive the following wage setting function as a result of the "right-to-manage" Nash bargain:

$$p_{LD}^r = \frac{\varepsilon_{n,p_{LD}^r} \cdot u^r \cdot b^r}{1+\varepsilon_{n,p_{LD}^r} \cdot u^r} \quad \text{(A6)}$$

where $\varepsilon_{n,pLD}$ is the elasticity of employees to the wage that can be obtained using the Shephard's lemma as:

$$\varepsilon_{n,p_{LD}^{r}} = \sum_{i=1}^{z} -\sigma_{ri} \cdot \Gamma_{ri} \cdot \prod_{j=0}^{i-1} \left(1-\Gamma_{rj}\right) \quad \text{(A7)}$$

where σ_{ri} is the elasticity of substitution between inputs in the nested production function, z is the nesting composite and Γ_{ri} is the total cost associated with the input composite that do not include employees.

The income balance conditions require that the total net income is equal to the "welfare" for each Institutional Sector (Households, Firms, Central and Local Government). We consider the utility function of each Institutional Sectors as if it was a production function of a composite good "wealth". The inputs of this function are the consumption expenditures (C_h^r) and savings (S_h^r) [15]. Therefore the consumption plans are the result of solving the Cobb-Douglas utility function subject to a budget constraint represented by net endowments. We can summarize these conditions as follows:

$$rd_h^r = p_{U_h}^r \, U_h^r \quad \text{(A8)}$$

where rd_h^r is the net income of agent h in region r, U_h^r is the utility of agent h in region r and $p_{U_h}^r$ is the price index for the utility. This last depends on consumption (C_h^r) and savings (S_h^r). Using the share form we obtain:

$$p_{U_h}^r = p_{U_h}^r \left[\sum_{i=1}^{16} \frac{\overline{p_{Xi}^r}}{p_{U_h}^r} \frac{\overline{C_i^r}}{U_i^r} \left(\frac{p_{Xi}^r}{\overline{\overline{p_{Xi}^r}}} \right)^{1-\sigma_{U_h^r}} + \frac{\overline{p_{Si}^r}}{p_{U_h}^r} \frac{\overline{S_i^r}}{U_i^r} \left(\frac{p_{Si}^r}{\overline{\overline{p_{Si}^r}}} \right)^{1-\sigma_{U_h^r}} \right]^{1-\sigma_{U_h^r}} \quad \text{(A9)}$$

with $U_h^r = \sum_{1=1}^{16} \overline{C_h^r} + \overline{S_h^r}$.

The elasticity of substitution $\sigma_{U_h^r}$ is set equal to one (Cobb-Douglas utility function).

Notes and References

1. Indicators should be able to quantify the reduction of CO_2 or other type of polluting emissions as well as to quantify the level of exploitation of natural resources.
2. The Constitutional Court, although affirming the substantial exclusive national competence in the field of environmental legislation, has emphasized the possibility of a local competition on decisions about environmental. Even if Central Government has the exclusive right to rule "[...] the contribution of regional regulations cannot be excluded when this regional rules, based on their jurisdiction, are designed to achieve environmental protection."
3. According to Bovenberg and Goulder (2002) the conditions under which the double dividend occurs can be summarised in: i) pre-existing distortionary taxes on production factors; ii) primary factors inelastically supplied and relatively under taxed; iii) relative international immobility of capital; iv) elasticity of substitution between energy (the environmental input) and labour greater than elasticity of substitution between energy and capital; v) real wages rise little when unemployment falls, so that the reduction in taxes on labour are not offset by wage rises.
4. In this paper the Local Government is assumed to be the Italian Regional Government.
5. The NAMEA supplements the major economic aggregates (total output, value added and final demand) with the GHG emissions data in physical terms according to the input output disaggregation (CE 1994). This approach avoids the difficulties

connected to the valuation of environmental costs in monetary terms.

6. Since the Kyoto Protocol established the reduction of 6.5% of Italian GHG, that are represented by CO_2 for the 85%, the Kyoto target for Italian CO_2 is around 5.5%.
7. We analyze only the CO_2 emission by commodities without considering that comes from the final consumption.
8. The quantity of emissions for 2003 that allows Italy to reach the target of CO_2 within 2012 (reduction of 5.5% of with respect to 1990 levels) is 348 million tons.
9. The benchmark is represented by the SAM for Italian economy for 2003 in which we distinguish 32 commodities (16 for North-Centre area and 16 for South-Isles area).
10. 1. Products of agriculture, 2. Energy products, 3. Metal and non metal ore, 4. Non metallic mineral products, 5. Chemical products, 6. Mechanics, 7. Transport equipment, 8. Food products and beverages, 9. Textile, 10. Other manufacturing products, 11. Construction work, 12. Trade, 13. Transport, 14. Financial services and Insurance, 15. Private services, 16. Government services.
11. I. Households, II. Firms, III. Regional Government, IV. District Government, VI. - IX. Municipal Government.
12. The ISTAT developed the NAMEA for the years 1990-2005 (ISTAT 2010).
13. Following the Armington's hypothesis (1969), imported and domestically produced commodities are not perfect substitutes. This solves the problem that the same kind of good is found to be both exported and imported.
14. The elasticity of substitution is calculated by each commodity considering the data on international commerce from the Economic and Financial Planning Document for 2004-2007 as the ratio between the percentage change in net imports and the percentage change in exchange rate.
15. In our model savings follow a Kaldorian hypothesis according to which Households have a lower saving propensity than Firms and consume a share of their income [30], [27].

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