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Contents lists available at SciVerse ScienceDirect

Research in Economics

journal homepage: www.elsevier.com/locate/rie

Regional double dividend from environmental tax reform: An application for the Italian economy

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ARTICLE INFO

Article history:

Received 18 January 2011

Accepted 6 April 2012

Keywords:

Environmental taxation

Social Accounting Matrix

CGE analysis

ABSTRACT

The greenhouse effect forces national Governments to design environmental tax policies for facing not only global warming but also the negative economic consequences resulting from the reduction of emissions such as a negative change of GDP. This paper aims at verifying the impact of an environmental fiscal reform able to attain both the reduction of greenhouse gas emissions and the regional double dividend. We have decided to follow the computable general equilibrium approach for modelling the multisectoral income circular flow in the case of a bi-regional economy as described by a Social Accounting Matrix we have built for this purpose. The tools of analysis we chose represent suitable and consistent instruments in order to quantify the effects of an environmental tax reform. They can in fact highlight the possible differences in responses between macro regions in terms of regional GDP changes, regional prices and regional employment rate. In fact, the extended multi-sectoral framework, on which the model is developed, represents economic activities, imperfect labour market and institutional sectors behaviours in each macro region. The simulations performed concern the introduction of a progressive and proportional green tax on each type of commodity according to the corresponding level of CO₂ emissions. Furthermore all simulations introduce a recycling scheme of green tax revenues, whose aim is reducing both the income tax and the regional tax on activities (IRAP). The application is done on a bi-regional Social Accounting Matrix for Italy for the year 2003.

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1. Introduction

The debate on the effectiveness of environmental policy mainly focuses on the analysis of the instruments adopted to achieve environmental targets and its economic costs or benefits (Parry, 2004). Among the economic measures adopted by European countries since the Kyoto agreement, emission taxes and emission permits trading have been most frequently used as environmental policy instruments.¹

The environmental taxation, in particular, is considered a powerful tool of pollution control. More important, it provides public revenue that can be recycled both at state and federal level in order to influence the main macroeconomic variables as income and employment (Pearce, 1991).

This approach usually refers to the *double dividend* theory which is based on the hypothesis that environmental taxes have two potentially positive effects: first, they encourage the limitation of environmental damages and, second, they provide additional revenues that can be used to eliminate specific “bad taxes” to obtain economic gains (Bovenberg and Goulder, 2002). Thus, according to this theory, the first dividend (*green dividend*) arises because the environmental taxation

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¹ These are widely known as market-based policy instruments dealing with externalities (Baumol and Oates, 1988).

reduces the amount of greenhouse gas (GHG) emissions. At the same time, a second dividend (*blue dividend*) occurs when the environmental tax revenue is recycled to reduce existing taxes generating several non-environmental benefits (Gimenez and Rodriguez, 2010). The second dividend is usually interpreted as an economic welfare improvement arising when the tax revenue stimulates better performances of economic variables such as production, consumption, inflation or income. When the benefit is represented by the reduction in the unemployment rate, according to the literature we acknowledge specifically the employment second dividend (Goulder, 1995).

The assessment of the double dividend hypothesis, especially for the European countries, mostly concentrates on the employment second dividend, as a consequence of the high unemployment rate which typically affects this area. Indeed most of those analyses that aim at quantifying the effects of environmental fiscal reform on labour markets, are developed through the general equilibrium frameworks characterised by rigidity on wage formation and unintentional 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), and Bor and Huang (2010) demonstrate the existence of the second dividend and in some cases even a triple dividend.²

This further benefit can be represented by a decrease in poverty (Van Heerden et al., 2006) or a rise in efficiency indicators—e.g. utility change on private commodities consumption, (Manresa and Sancho, 2005).³

The possibility of detecting a double and a triple dividend through an environmental policy is realistic but it depends on the pre-existing tax system, the production technology and above all on the structure of the tax reform. Furthermore, in a country characterised by economic differences at the regional and social level, the double dividend could differ between regions or it could not occur for all regions where environmental fiscal reform is implemented (Takeda, 2007). In this respect, empirical studies on environmental tax reforms and double dividend are typically focused on countries rather than regions and accept/refuse the hypothesis of double dividend merely observing the effects of the policy on the macroeconomic variables at national level. In our application the analysis of the environmental tax reform is performed at the regional rather than national level in order to figure out the economic and social differences among regions within the same country and let the regional peculiarities in technologies and habits emerge also in terms of ability in generating ecological dividends.⁴

According to this approach, the paper aims to demonstrate the existence of a “regional” double dividend for the Italian economy when the national Government adopts an environmental fiscal reform. In particular an effort is made to introduce a progressive *green-tax* according to the coefficient of CO₂ emissions by each commodity. Thus the corresponding tax revenue is entirely recycled in order to reduce both the income tax and the regional tax on activities (IRAP). Since the price of final goods may increase as a consequence of the tax burden on total output, the reduction in the income tax has the purpose of mitigating the negative effect of higher prices on households real disposable income. Similarly the reduction in the regional tax on activities is applied to reduce the tax incidence on prices.

The methodology used is represented by a Computable General Equilibrium (CGE) model based on a bi-regional Social Accounting Matrix (SAM) for Italy for the year 2003. The CGE models are widely recognised as straightforward instruments able to assess the quantitative, distributional and allocative impacts of alternative fiscal policy reforms (Radulescu and Stimmelmayr, 2010) and the bi-regional SAM provides the proper full detailed and disaggregated database for the simulations.

Furthermore, the aim to identify the convenient environmentally-oriented tax reform for the Italian economy requires the integration of the SAM with the environmental data set concerning CO₂ emissions by each commodity. The integration between environmental and economic flows is accomplished through the use of the National Accounting Matrix including Environmental Accounts (NAMEA). Indeed, in line with the suggestion of the European Commission, the NAMEA is the basic tool able to supplement 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).⁵

The next section introduces the environmental policy targets for the Italian case and it identifies the most suitable environmental tax reform in order to comply with the current European environmental agreement. The description of the database and the CGE model are presented in Sections 3 and 4. The fifth section shows the results of an application of the environmental fiscal policy proposed for the Italian case in terms of CO₂ emissions, total output, unemployment rate, disposable income and final demand.

2. The environmental tax reform

The analysis developed in this paper has the purpose of verifying the possibility for the Italian economy to approach the objectives of international climate agreements ratified by the European Union. In particular, as the period of this analysis

² 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.

³ These results reject or integrate the results of previous theoretical studies which denied the second dividend existence. Among them it is worth mentioning Goulder (1995), Bovenberg and Goulder (1996, 1997) and Böhringer et al. (1997) which showed that in the presence of a carbon regulation, even if environmental variables improve, the second dividend does not emerge.

⁴ A regional application for environmental tax can be seen in André et al. (2005).

⁵ This approach avoids the difficulties connected to the valuation of environmental costs in monetary terms.

Table 1Distance from the Kyoto target and the Italian debit of CO₂ emissions.

CO ₂ emissions by commodities (1990 = base, Mlt)	360
Kyoto target on Greenhouse emissions (%)	−6.5
Kyoto target on CO ₂ emissions by commodities (%)	−5.5
CO ₂ emissions objective for year 2003 (Mlt)	348
Level of CO ₂ emissions for year 2003 (Mlt)	387
Debit of CO ₂ emissions for the 2003 (Mlt)	39

concerns the phase of the Kyoto Protocol, the subsequent international agreements made by the European Union and ratified by Italy have not been considered. The Kyoto Protocol fixed the objective on GHG emissions for the Italian economy in the reduction of 5.5% of CO₂ emissions for the period of 2008–2012.⁶

Starting from year 1990, when the national CO₂ emissions were 360 million tons (Mlt), the Italian system should have reduced their level of around 0.897 Mlt in each following year in order to achieve the Kyoto target that corresponds to 340 Mlt of CO₂ in year 2012 (ISTAT, 2008).

Indeed, if we interpret the ideal reduction path as a linear decreasing function, we can find the distance between the Kyoto target on CO₂ emissions and the corresponding amount of CO₂ emissions observed for the Italian economy in each year.⁷ We note that Italian CO₂ emissions for the year 2003 were 39 Mlt higher than the annual target. This difference gives the Italian debit of CO₂ with respect to the ideal admitted level of CO₂ emissions that is 348 Mlt (ISTAT, 2008) (see Table 1).

In order to restore the correct level of CO₂ and keep the commitments with the EU target, we simulate the introduction of an environmental tax on commodity output depending on the pollution intensity of each good. The tax is designed following the idea that those who pollute more should pay more and has a progressive structure: there are 5 classes of taxation and a fixed price per ton of CO₂ emissions is established in each class. If the total emissions by commodity exceeds the cut-off point, the commodity is taxed according to the subsequent class of taxation for the emissions in excess. The structure of this tax can be described as follows:

- Class 0. From 0 to 10.871.958 t: no-tax area,
- Class 1. From 10.871.959 t to 15.000.000 t: 9 Euro per CO₂ t,
- Class 2. From 15.000.001 t to 30.000.000 t: 16 Euro per CO₂ t,
- Class 3. From 30.000.001 t to 50.000.000 t: 22 Euro per CO₂ t,
- Class 4. Over 50.000.001 t: 32 Euro per CO₂ t.

Since there are several commodities whose production generates an amount of emissions compatible with the planned reduction path, we consider a “no-tax area” represented by the level of CO₂ emissions permitted to Italy in order to reach the Kyoto Protocol target. The goods charged by the taxation burden are those with a level of CO₂ emissions higher than the top level of 10.8 Mlt as shown in Fig. 1.

The exemption area (Class 0) is calculated as the ratio between the total level of CO₂ allowed for Italy for 2003,⁸ and the number of commodities in the benchmark.⁹ In this way less polluting commodities are not taxed and those commodities which over-pass the permitted level (10.8 Mlt for each commodity) have an incentive to reduce their emissions to avoid taxation.

The other tax ranges are designed in order to reproduce an environmental taxation as similar as possible to the income taxation, which has the typical structure of an inverted pyramid.

As a result, in the North–Centre region, the commodities affected by the green-tax are: ‘Energy products’ (Class 4), ‘Non metallic mineral products’ (Class 3), ‘Chemical products’ (Class 3), ‘Mechanics’ (Class 2), ‘Trade’ (Class 1) and ‘Transport’ (Class 1). In the South region, ‘Energy products’ (Class 4) and ‘Non metallic mineral products’ (Class 1).

According to the Kyoto Protocol targets, this environmental tax reform aims to reduce the consumption of polluting goods in order to cut CO₂ emissions and to reach the first dividend (environmental dividend). Moreover, since the economic system is highly integrated and all variables are connected, it is crucial to evaluate the policy effects on the whole income circular flow and on the unemployment rate. In particular, by simulating different tax revenue recycling schemes it could be possible to assess the existence of a second dividend for the Italian economy. For this purpose, we assume that the tax revenue is completely recycled following two hypothesis:

- in the first scenario s_1 the tax revenue is recycled to reduce income tax;
- in the second scenario s_2 the tax revenue is recycled to reduce regional tax on activities.

⁶ Since the Kyoto Protocol established the reduction of 6.5% of Italian GHG, that are represented by CO₂ for the 85%, the Kyoto target for Italian CO₂ is around 5.5%.

⁷ We consider only the emissions of CO₂ by commodities and not by Households.

⁸ The quantity of emissions for 2003 that allows Italy to reach the target of CO₂ within 2012 (reduction of 5.5% of with respect to 1990 levels) is 348 Mlt.

⁹ The benchmark is represented by the SAM for Italian economy for 2003 in which we distinguish 32 commodities (16 for the North–Centre area and 16 for the South area).

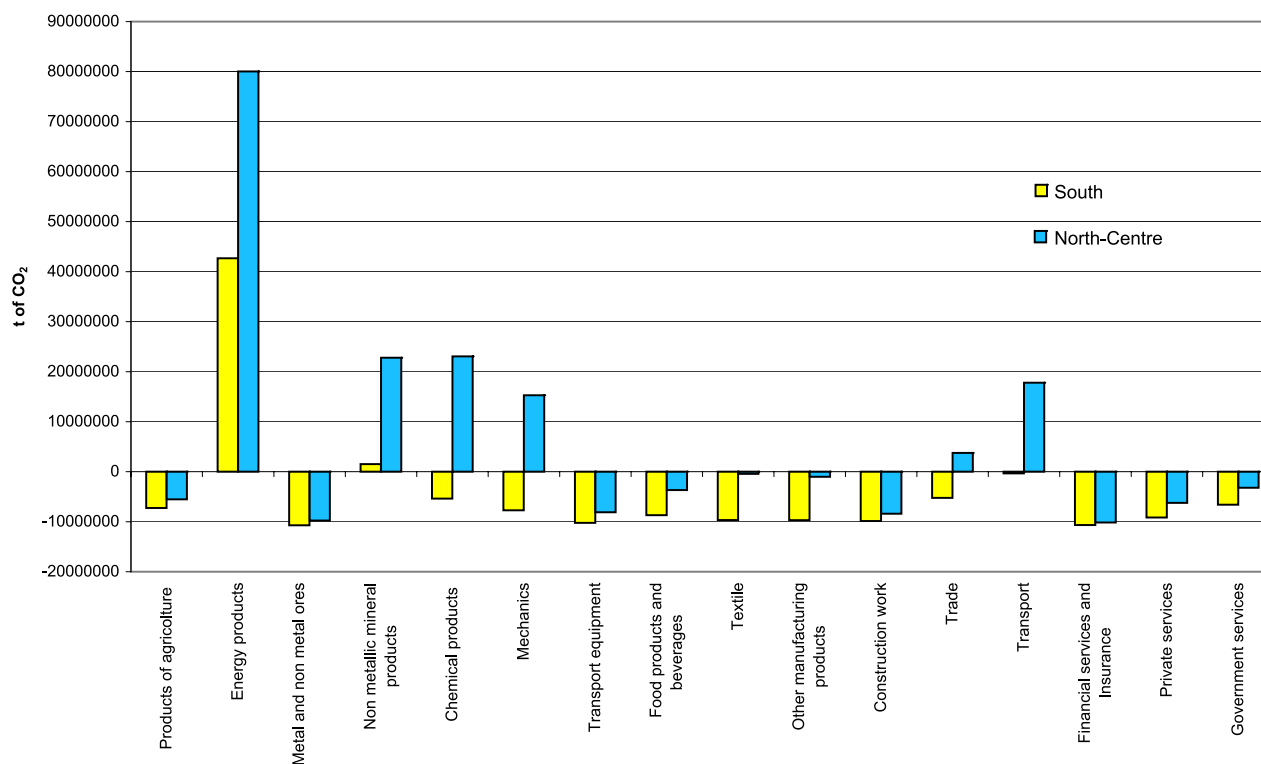


Fig. 1. Emissions of CO₂ by Italian commodities (distance from the exemption level).

Both the recycling schemes are designed with the aim of mitigating the indirect effects of the environmental tax on commodity prices and stimulate primary factors demand and disposable income. To be more specific, since the price of goods may increase as a consequence of the tax burden on total output, the income tax cut should compensate Households for their purchasing power loss. Similarly the reduction of regional tax on activities is applied to reduce the tax incidence on prices formation and at the same time stimulate the demand of labour and capital in the production processes.

3. Bi-regional social accounting matrix for Italy

The analysis is performed 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 (Ciaschini and Socci, 2006, 2007) as shown in Fig. 2.

For assessing economic and environmental impacts of the fiscal reform at the regional level, we need to integrate the SAM data with environmental indicators provided by NAMEA (National Accounting Matrix including Environmental Accounts) developed by ISTAT for the years 1990–2005 (ISTAT, 2008). We concentrate in particular on CO₂ emissions by commodity and amend these physical flows for matching the commodity disaggregation in the SAM. Our manipulation allows us to construct a database in which each economic flow of the 16 commodities¹⁰ in each region (North–Centre and South–Islands) is associated to a specific level of CO₂ emissions. The different polluting power associated to each commodity depends on the technology employed in the production process and is measured by the emissions coefficient.¹¹

Furthermore, the proposed environmental tax reform recycles the tax revenue in the economy through a reduction of existing taxes. In this respect the quantification of the economic flows to institutional sectors, for what concerns specifically the primary income allocation and the secondary income distribution, becomes essential. Our SAM provides a disaggregation of 9 Institutional Sectors¹² in each region while Central Government, Rest of the World and Capital Formation are kept at national level. The institutional sectors flows also allow to distinguish different types of revenues and expenditures. In particular a disaggregation between direct taxes, indirect taxes and transfers among Institutional Sectors in both regions is given (Pretaroli and Socci, 2008).

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 The emissions' coefficient by commodity is the ratio between the amount of CO₂ emissions by commodity and the total output.

¹² I. Households, II. Firms, III. Regional Government, IV. District Government, VI.–IX. Municipal Government.

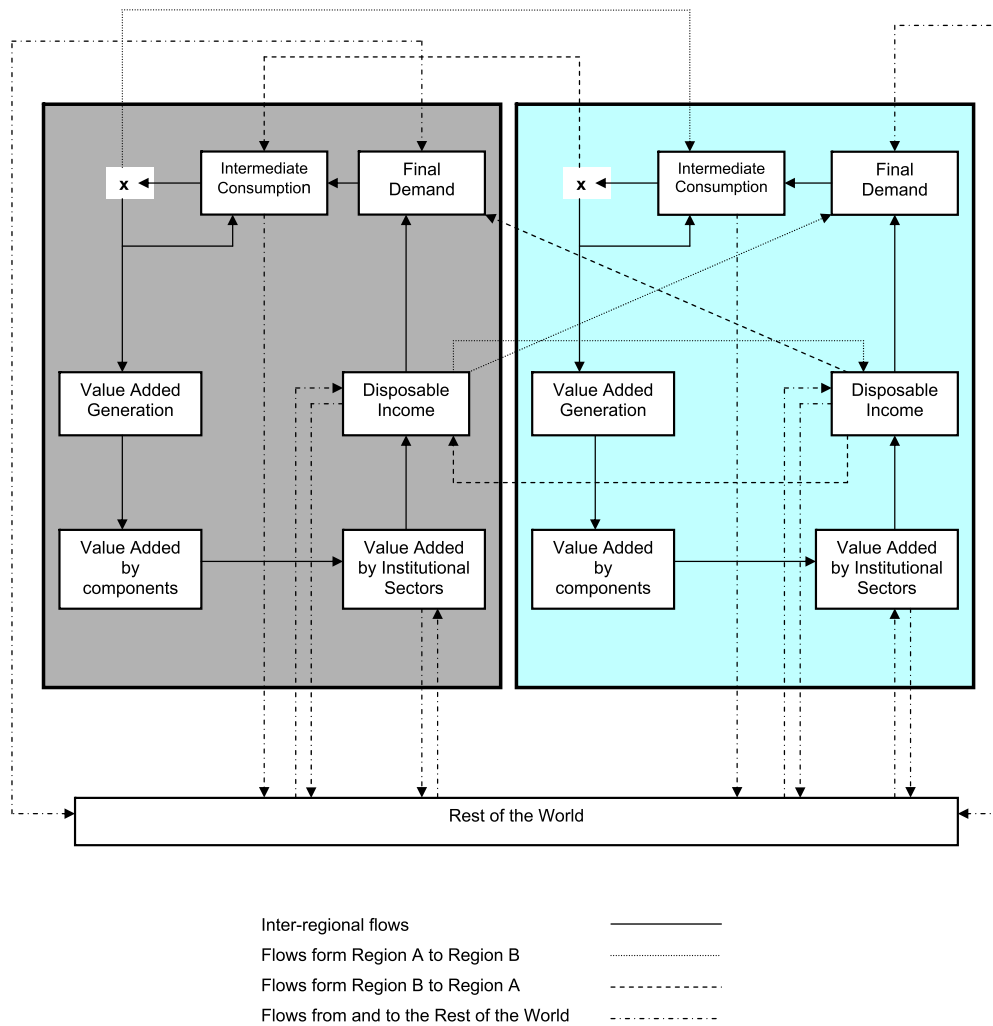


Fig. 2. The bi-regional income circular flow.

4. The bi-regional CGE model

The effects of the environmental tax reform described in the Section 2 are then investigated using a Computable General Equilibrium (CGE) model that is a suitable tool to investigate the economic implications of an exogenous shock when prices change. The model can capture the consequences of a fiscal policy whose effects are transmitted to macroeconomic variables (employment rate, GDP change) and shows how the policy affects the income distribution between institutional sectors (Pretaroli and Severini, 2008). A prominent advantage of our CGE model lies in the possibility of combining detailed and consistent real-world database, the SAM, with environmental data concerning GHG emissions in order to assess the regional double dividend.

Following the structure of the SAM, described in Section 4, the model considers an open economy with two regions (North–Centre and South–Islands), 16 regional commodities, 2 components of value added (labour and capital), 10 Institutional Sectors¹³ with a foreign sector that closes the model. It provides an integrated representation of the bi-regional income circular flow where the entire process of generation, primary and secondary distribution of income is summarised by a system of behavioural equations and income constraints for agents (all maximisers and price takers). The model can also be described by a coordinated set of matrices of flows that take place according to the relationships among the principal economic functions such as production, consumption, redistribution and accumulation by the agents (Pretaroli and Severini, 2009). These specifications of agents behavioural features and factor market interdependencies enable the CGE model to analyse qualitative and quantitative implications of comprehensive policy of reforms (Bjertbaes and Faehn, 2008).

The model is solved through a Walrasian equilibrium solution except for the labour market equilibrium that admits a positive rate of unemployment, u . The solution is described by a vector of prices, that verifies the market clearing conditions for all commodities and primary factors.¹⁴ As shown in Table 2 total output (X), represented by domestic and imported

¹³ The SAM provides the disaggregation of 9 Institutional Sectors in each region and a national relevance for the Central Government.

¹⁴ The numeraire in the model is represented by the price of imports. Given this assumption, the results of the simulations can be interpreted as the results of a policy when there is no imported inflation and the nominal exchange rate is constant.

Table 2
Fundamental relationship in CGE model.

	South-Islands			North–Centre			Central Government	Formation of capital	Rest of world
	Commodities	Primary factors	Institutional Sectors	Commodities	Primary factors	Institutional Sectors			
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.	$\mathbf{T}^{gs}(x)$	$\mathbf{R}^{gs}(y)$	$\mathbf{T}^{gs}(r, t)$ $\mathbf{T}_r^{gs}(r, t)$	$\mathbf{T}^{gn}(x)$	$\mathbf{R}^{gn}(y)$	$\mathbf{T}^{gn}(r, t)$ $\mathbf{T}_r^{gn}(r, t)$			
F. K.			$\mathbf{S}^s(rd)$			$\mathbf{S}^n(rd)$	$\mathbf{S}^g(rd)$		$(+/-)a$
RW	$\mathbf{M}^{ws}(x, e)$	$\mathbf{t}^{ws}(y)$	$\mathbf{T}_r^{ws}(r)$	$\mathbf{M}^{wn}(x, e)$	$\mathbf{t}^{wn}(y)$	$\mathbf{T}_r^{wn}(r)$			

outputs,¹⁵ equals the intermediate consumption (\mathbf{B}^{ri}), the final consumption expenditure of Households (\mathbf{C}^{ri}), the final consumption expenditure of Local and Central Government (\mathbf{GL}^{ri} , \mathbf{G}^{ri}), the gross capital formation (\mathbf{I}^r) and the trade balance with the Rest of the World (\mathbf{E}^{rw} , \mathbf{M}^{rw}) with $r = n, s$ and $i = 1, \dots, 16$.

The market clearing conditions for the primary factors are verified when the factors endowment corresponds to the factors demand expressed by the production system. In this respect it is worthwhile to put into evidence the market imperfection for labour represented by initial positive involuntary unemployment rate, u . Our model distinguishes two types of workers, self-employed and employed and it introduces a Labour Union that bargain over wages.

It has the following utility function (Pissarides, 1998):

$$U = (1 - u) \cdot \frac{w^{1-\gamma}}{1 - \gamma} + u \cdot \frac{b^{1-\gamma}}{1 - \gamma} \tag{1}$$

where u is the unemployment rate observed in the Italian economy for 2003, w is the bargained wage, γ is the parameter that describe the Labour Union risk aversion,¹⁶ and b is the nominal unemployment benefit.

On the other side, the Firms cash flow function is given by:

$$\Pi(n, w) = Y(n) - C(n, w) \tag{2}$$

with $n = (1 - u)$. The negotiation over wages between Firms and Labour Union is modelled as a “right-to-manage” according to the typical Nash bargaining Maximin, that can be described as:

$$f = \delta \cdot \ln(U - U_0) + (1 - \delta) \cdot \ln \Pi(n, w) \tag{3}$$

where δ represents the bargaining power of the Labour Union.¹⁷ The parties bargain only over employed wages and Firms decide over their labour demand at the bargained wage (Böhringer et al., 2005). The wage setting function is therefore given by:

$$w = \left(\epsilon_{n,w} \cdot u \cdot b - \frac{a}{1 + t} \right) \cdot \frac{1}{1 + \epsilon_{n,w} \cdot u} \tag{4}$$

¹⁵ Following the Armington’s hypothesis (Armington, 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.

¹⁶ The Union risk aversion is as higher as the parameter γ is greater than zero. In this paper we assume that the Union has a neutral risk utility function, $\gamma = 0$.

¹⁷ We assume that the Union has monopoly power, $\delta = 1$.

where w is the bargained wage, $\epsilon_{n,w}$ is the elasticity of the employed to the wage, a and t are respectively the constant and the proportional labour tax rate.

The capital and self-employment markets are perfectly competitive.

The balance constraints refer to Institutional Sectors that are distinguished in private sectors (Households and Firms) and public sectors (Central and Local Government) and are verified for private sectors when the total disposable income by sector equals the total expenditure for saving and final consumption. As for public sectors the total government expenditure (\mathbf{GL}^{tr} , \mathbf{G}^{rg} , \mathbf{Tr}^{tr} , \mathbf{Tr}^{g} , \mathbf{Tr}^{wr}) equals the total tax collection (\mathbf{T}^{g} , \mathbf{T}^{tr} , \mathbf{T}^{wr}). Finally the condition on gross capital formation requests that total investments (\mathbf{I}^{r}) equal savings by all Institutional Sectors (\mathbf{S}^{r} and \mathbf{S}^{g}).

Starting from the production function, the activities produce an homogeneous good using a nested constant return to scale technology. In the first step the function is characterised by fixed coefficients and the elasticity of substitution is different for each commodity.¹⁸ Thus, assuming the Leontief production function, the domestic output derives from the combination of intermediate consumptions (\mathbf{B}^{tr}), depending on total output and prices, and the value added that is affected by total output and primary factors prices (\mathbf{Y}^{tr}). Then assuming a CES function, value added is generated by combining capital and labour that are perfectly mobile across activities and the elasticity of substitution derives from econometric estimates for Italy (Van der Werf, 2007).

In the behavioural side, we point out that the remuneration of primary factors (\mathbf{Y}^{tr}) plus the net transfers from Institutional Sectors (\mathbf{Tr}^{tr} , \mathbf{Tr}^{rg} , \mathbf{Tr}^{wr}) represent the total endowments (\mathbf{R}^{tr} , \mathbf{R}^{g}). The utility function of all Institutional Sectors is treated as if it were a production function of a composite good “wealth” whose inputs are consumptions (\mathbf{C}^{tr} , \mathbf{GL}^{tr} , \mathbf{G}^{rg}), savings (\mathbf{S}^{tr} , \mathbf{S}^{g})¹⁹ and transfers to other Institutional Sectors. Therefore the consumption plans are the result of solving the Cobb–Douglas utility function subject to a budget constraint represented by net endowments. This fact ensures that the shares of commodities consumed, savings and transfers remain unchanged in terms of quantity in all simulations.

The Central Government expenditure is given by the production of a public consumption good (\mathbf{G}^{rg}), public investments and transfers to Households, Firms and other public Institutional Sectors (Local Government) (\mathbf{T}_r^{rg}). It is financed through taxes (\mathbf{T}^{gr}), public savings (\mathbf{S}^{g}) and transfers from other Institutional Sectors (\mathbf{T}_r^{gr}), including the Rest of the World ($\mathbf{T}_r^{\text{grw}}$). Taxes can be divided into direct income tax and a set of different indirect taxes (production tax, value-added tax, regional tax on activities and labour tax). The foreign sector utility function closes the model.

5. Double and triple dividends evidence

The introduction of the green-tax on commodity output impacts on the phases of the income circular flow.²⁰ The results of the simulations will be then shown following such phases. We will discuss the effects on the CO₂ emissions, starting from the change occurred in the production phase, and the value added generation and allocation, in the secondary distribution of income and, finally, in the final demand.

(a) Production: prices and outputs

In both scenarios the green-tax is imposed on total output. In particular the burden is on the commodities whose CO₂ emissions exceed the allowed (no-taxed) level. Focusing on the impacts on commodities' price, it is possible to observe that all prices increase in both two regions in every scenario with some exceptions, as shown in the Table 3.

When the tax revenue is recycled to reduce income tax (s_1), the price of ‘Energy products’ and ‘Non metallic mineral products’ rises more than all the other commodities in two regions, with an increase of 3.667% in the South-Islands and 5.605% in the North–Centre. These production processes, in fact, are relatively the most pollutant and they are burdened by higher tax rate. Despite of this trend, the commodities ‘Trade’ and ‘Private services’ in North–Centre region and ‘Financial services and Insurance’ in both regions, detect a decrease in prices.

In the second scenario s_2 the environmental tax revenue is recycled to cut the regional tax on activities. The results showed in Table 3 confirm a general increase in most commodity prices, but the changes observed are smaller than in previous scenario. As expected, the tax burden is higher on the most polluting commodities in both regions (‘Energy products’, ‘Non metallic mineral products’ and ‘Chemical products’) but the reduction on prices is also observed for: ‘Textile’, ‘Construction work’, ‘Trade’ and ‘Financial services and Insurance’ in South-Islands and ‘Trade’, ‘Financial services and Insurance’ and ‘Private services’ in North. This is probably caused by the reduction of the regional tax on activities that more than compensates the environmental tax.

According to the results shown in Table 4, the introduction of the environmental tax causes a general reduction on disaggregate output in both regions and scenarios.²¹ The ‘Energy products’ in particular registers an output reduction of 2.054% in South-Islands and 1.707% in North–Centre in s_1 and -2.066% in South-Islands and -1.712% in North–Centre in s_2 .

¹⁸ 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.

¹⁹ In our model savings follow a Kaldorian hypothesis according which Households have a lower saving propensity than Firms and consume a share of their income.

²⁰ The results are of direct and indirect type and are expressed as percentage changes from the benchmark that is the economy represented by the SAM.

²¹ The only exception is represented by the commodity ‘Government services’ in North–Centre region which registers an increase of 0.044%.

Table 3

Impacts on commodity prices (% change).

Commodity	South-Islands		North-Centre	
	s_1	s_2	s_1	s_2
1. Products of agriculture	0.123	0.108	0.097	0.102
2. Energy products	3.667	3.662	5.605	5.615
3. Metal and non metal ore	0.151	0.066	0.267	0.230
4. Non metallic mineral products	0.312	0.281	1.471	1.462
5. Chemical products	0.198	0.142	0.780	0.760
6. Mechanics	0.069	0.018	0.215	0.207
7. Transport equipment	0.081	0.045	0.136	0.129
8. Food products and beverages	0.140	0.111	0.186	0.177
9. Textile	0.039	-0.012	0.066	0.059
10. Other manufacturing products	0.109	0.037	0.161	0.143
11. Construction work	0.020	-0.012	0.113	0.107
12. Trade	0.024	-0.001	-0.032	-0.032
13. Transport	0.217	0.188	0.135	0.125
14. Financial services and Insurance	-0.113	-0.161	-0.110	-0.135
15. Private services	0.151	0.133	-0.230	-0.218
16. Government services	0.150	0.095	0.094	0.051

Table 4

Impacts on output levels (% change).

Commodity	South-Islands		North-Centre	
	s_1	s_2	s_1	s_2
1. Products of agriculture	-0.187	-0.194	-0.219	-0.222
2. Energy products	-2.054	-2.066	-1.707	-1.712
3. Metal and non metal ore	-0.294	-0.276	-0.299	-0.286
4. Non metallic mineral products	-0.361	-0.355	-0.704	-0.699
5. Chemical products	-0.245	-0.222	-0.587	-0.578
6. Mechanics	-0.327	-0.319	-0.307	-0.302
7. Transport equipment	-0.213	-0.204	-0.258	-0.253
8. Food products and beverages	-0.183	-0.184	-0.268	-0.265
9. Textiles	-0.099	-0.075	-0.152	-0.149
10. Other manufacturing products	-0.198	-0.171	-0.235	-0.226
11. Construction work	-0.382	-0.377	-0.346	-0.346
12. Trade	-0.111	-0.114	-0.149	-0.150
13. Transport	-0.25	-0.249	-0.265	-0.262
14. Financial services and Insurance	-0.222	-0.229	-0.216	-0.221
15. Private services	-0.197	-0.206	-0.062	-0.071
16. Government services	-0.011	-0.066	0.044	-0.022
Total output change	-0.314	-0.324	-0.268	-0.273

Table 5Impacts on CO₂ emissions (% change).

	s_1	s_2
South-Islands	-1.145	-1.150
North-Centre	-0.805	-0.805
Total Italy	-0.898	-0.900

Under the same scenario the difference in output changes between the two regions is the consequence of the greater or lower burden imposed by the environmental taxation on the economy. In the North-Centre region the 'Chemical products' is one of the most penalised while in the South-Islands the same commodity has a relatively small reduction in production. The reasons for this difference are associated with the structure of the taxation which is modelled in order to charge the most polluting commodities that are concentrated in the North-Centre region.

In aggregate terms total output decreases with a higher percentage in the second scenario than in the first in both regions.

(b) Environmental aspects

The environmental policy implemented affects the level of CO₂ emissions as expected, thus it is possible to confirm the presence of the first dividend in both scenarios. The environmental tax on output, levied according to the emissions generated by each commodity, with a proportional and progressive structure, reduces the level of CO₂ emissions as shown in Table 5.

The best results in terms of reduction are performed by the South-Islands region in both scenarios. This depends on the policy effects on output as illustrated in Table 4. Comparing these results with those on emissions, the reasons for which the

Table 6

Impacts on primary factors payments and unemployment (% change).

Primary factors	South-Islands		North-Centre	
	s_1	s_2	s_1	s_2
Employed	0.043	0.025	-0.075	-0.040
Self employed	-0.087	-0.069	-0.201	-0.156
Capital	-0.458	-0.437	-0.486	-0.439
Unemployment rate % change	0.111	0.093	-0.059	-0.028
Unemployment rate	17.75	17.68	4.60	4.56

Table 7

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

Institutional Sectors	South-Islands		North-Center	
	s_1	s_2	s_1	s_2
Households	-0.036	-0.069	-0.101	-0.107
Firms	-0.420	-0.402	-0.399	-0.369

Table 8

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

Institutional Sectors	South-Islands		North-Center	
	s_1	s_2	s_1	s_2
Households	-0.009	-0.400	0.149	-0.306
Firms	-0.556	-0.527	-0.538	-0.495

second scenario reaches better results are apparent. When the environmental tax revenue is used to reduce the regional tax on activities (s_2), total output decreases more than in the other scenario and the emissions fall in the same proportion.

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

The introduction of an environmental tax affects the generation and allocation of value added. In particular the analysis concentrates on primary factors prices (compensation of employees, compensation of self-employees and operating surplus or capital income) and on unemployment rate. The Table 6 illustrates interesting differences among regions and scenarios. Starting from the first scenario s_1 , primary factors payments decrease in North-Centre region while in South-Islands only the compensation of employees raises. This trend is persistent also in s_2 but the changes are lower.

According to the object of our research, the most attractive result of these simulations is related to the unemployment rate change. The environmental policy in fact is implemented in order to assess the double dividend hypothesis for the Italian economy. Once the first dividend has been verified, the aim of the computable exercise is to find out the second dividend that can be interpreted as lower unemployment rate. This assumption is verified in the North-Centre region in both two scenarios. Table 6 shows a reduction in unemployment rate of 0.059% in s_1 and 0.028% in s_2 . On the other side, the level of employment in South-Islands region decreases. This result is related to the specific hypothesis on the labour market structure²² and to the production fall for this area. As for of the tax revenue recycling assumption, it is possible to confirm the employment second dividend in disaggregate terms for North-Centre region.

(d) *Secondary distribution of income: Nominal and real aspects*

One of the reasons making environmental taxation profitable is the possibility to collect revenue and recycle it following different criteria in order to obtain welfare benefits. This can be considered an ambitious purpose but it is achievable if we consider the results in disaggregate terms. In the first scenario s_1 the environmental tax revenue grants a cut of 4.63% in Households income taxes but it does not generate positive results in terms of nominal disposable income. As shown in the Table 7, in both regions Households and Firms incomes decrease especially in North-Centre region, probably as a consequence of the lower primary factors payments that reduce the Households and Firms endowments. A similar outcome emerges in the second scenario s_2 where the reduction of the regional tax on activities affects indirectly the nominal disposable income. Households and Firms nominal incomes decrease more than in s_1 as a result of the lower primary factor compensation.

In order to evaluate the effects of the policy in terms of Households and Firms purchasing power, the Table 8 illustrates the percentage changes in the real disposable income. For simulation s_1 , we observe a decreasing real income for firms in both two regions and a growth in disposable income for households in North-Centre.

In the scenario s_2 , the real disposable income decreases especially in South-Islands region: the reduction of the regional tax on activities does not effect the private purchasing power. The change in real disposable income can be evaluated as a further benefit, a further dividend embodied with the environmental policy. In this respect, if we consider the effects of the

²² The model assumes the presence of Labour Union that bargains wages with Firms maximising his utility function. The Union is neutral to the risk and has monopoly power. This means that when unemployment rate increases, the wage is sustained by the Union.

Table 9
Impacts on Government balances (% change).

Institutional Sectors	South-Islands		North-Center	
	s_1	s_2	s_1	s_2
Regional Gov.	−0.096	−0.397	−0.237	−0.819
District Gov.	−0.114	−0.178	−0.276	−0.430
Municipal Gov. 1	−0.072	−0.131	−0.214	−0.285
Municipal Gov. 2	−0.097	−0.144	−0.246	−0.280
Municipal Gov. 3	−0.097	−0.141	−0.263	−0.284
Municipal Gov. 4	−0.086	−0.134	−0.272	−0.291
Municipal Gov. 5	−0.091	−0.141	−0.235	−0.280
	s_1		s_2	
Central Government	0.072		0.027	

policy in disaggregate terms, we can confirm an effect of redistribution represented by the higher disposable income for Households in North–Centre region.

In relation to the private consumers disposable income, it is possible to analyse the real income performance also for Government Institutional Sectors. In particular we concentrate on Local and Central Government balances. Following the results of Table 9, in both s_1 and s_2 Local Governments manifests a reduction in balances especially in North–Centre region. For the Central Government on the contrary, the balance dimension increases in first and second scenario.

(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. The results illustrate a general reduction in final demand in disaggregate terms in each region for both scenarios.

6. Conclusions

The mainstream literature on double dividend has supported, in recent years, quite a few different positions on the occurrence of double dividend hypothesis related to the environmental taxation. The main conclusion highlighted in literature supports the existence of double dividend only under specific assumptions and above all it demonstrates a different effect across regions.

The paper tries to detect and quantify the existence of a regional *second dividend* that integrates the *first national dividend* when a specific environmental tax reform is introduced. In particular, an environmental policy is implemented for the Italian economy with the aim to affect the pollution power of each activity. The main feature of our analysis is represented by the detailed data base we used, which is characterised by the integration of environmental data within economic flows described in the SAM. This disaggregated data base allows to implement a bi-regional computable general equilibrium model suitable to evaluate the economic agents behaviour in the different markets when an exogenous shock occurs.

The first step of this analysis consists in the definition of the tax structure. In particular, disaggregated data on CO₂ emissions allow us to classify the commodities according to their polluting capacity and thus let us identify the production processes that exceed the permitted level of emissions. In order to restore the correct level of CO₂, we introduce a green tax designed with a progressive and proportional structure on these commodities output. Then two scenarios of tax revenue recycling have been developed: the first refers to the reduction of income tax, the second one concerns the reduction of regional tax on activities.

The second step concerns the assessment of the environmental and the social–economic benefits (the *green* and the *blue* dividends). In particular, we define the first dividend as the decrease of CO₂ emissions and the second dividend as the reduction in unemployment rate.

The results show the importance of using a detailed database in the general equilibrium analysis to detect the impacts of environmental fiscal reforms within the economic system. Indeed we detected the first environmental dividend in the economy as a whole regardless of the revenue recycling, while we found out effects specific to each area (North–Centre and South-Islands) with regard to the second dividend. In particular we identified a second employment dividend in both scenarios but only in the North–Centre region, while the South-Islands region is characterised by growth in the unemployment rates. Similarly, as regards the policy impacts on disposable income of private institutional sectors, the results are diversified within the economic system. When the tax revenue is used to reduce income tax, a positive effect on households real income only manifests in North–Centre region. There can be doubts on the interpretation of this phenomenon either as a real dividend or a simple redistribution effect since it is assessed only in a single region and for a single private institutional sector (Households). Whether this is a “real” triple dividend or a redistribution effect among regions is a question to be further investigated considering that the result depends greatly on the peculiarities of technology and habits in each of the two regions.

Thus if we concentrate on the benefits connected with environmental policy, the introduction of the green-tax with a progressive and proportional structure and the recycling of the tax revenue, by reducing income taxes, allows for the achievement of both green and blue dividends put in evidence by the multiregional and multisectoral framework. The results

show for the North–Centre area, in particular, the major benefits from the environmental policy reform. The South–Islands area presents a more complex social–economic structure characterised by higher unemployment rates, lower production and lower value added than the North–Centre area. Moreover the recycling of the tax revenue within this area is not large enough to trigger a growth in disposable income or employment.

According to the debate on the double dividend, the conditions which warrant the existence of the double dividend cannot be separated from considerations on the economic structure in disaggregated terms. Such information can be obtained through the use of a disaggregated database that allows us to put into evidence the multiregional and multisectoral impacts of an economic policy. Given all this information, then, it is possible to conclude that for the Italian economy a double dividend can be detected at least in one region.

Acknowledgments

The authors gratefully thank the referees for their helpful comments.

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