Environmental tax reform and double dividend evidence

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The increasing attention to environmental damage and the problem of climate changes have led many studies to concentrate on environmental taxation as an incentive-based instrument of environmental policy. Focusing on the relationship among environmental, labour market policies and institutional sectors, this paper aims to investigate the economic effects of a fiscal reform designed with the intent of reducing the Greenhouse gas (GHG) emissions, according to Kyoto Protocol. For this purpose, a static Computable General Equilibrium model is used. The simulations implemented concerns the introduction of a green tax on activities output depending on the level of CO_2 emission by each activities. Tax revenues are than completely distributed to the economy in order to reduce income taxes or to cut the regional tax on activities value added. In this way a revenue-neutral environmental policy is tested and the double dividend or any other effect on national economy are assessed. The application will be done on a Social Accounting Matrix (SAM) for Italy for the 2003 year.

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1 Introduction

The interest concerning environmental sustainability has been growing in economic literature during the last years as a consequence of the strong awareness the Governments are manifesting on the environmental issue. Environmental policy generally consists on a set of measures such as tax penalties, subsidies and incentives oriented to improve efficiency on energy consumption and reduce inefficient behaviours. The adoption of environmental policy reform to reduce the amount of emissions and promote environmental conservation according to international agreements on this issue, is sometimes discouraged by politician and government interests which interpret this instrument as further burdens to economies.

The principal facet about the environmental policy debate concerns the difficult to asses the impact of an environmental policy reform both in term of environmental development and in the economic point of view. Difficulties on the methodology used for the environmental economic evaluation and the effectiveness of the environmental taxation in terms of international competitiveness obstruct the appliance of this instrument. In this respect it seems to be crucial finding out real economic paybacks embodied with environmental benefits. Furthermore the policy on taxation is the most disputed reform within the set of measures against environmental damage and is usually analyzed with the evaluation of a double or triple dividend. If we accept to define the environmental development, for example the reduction of emissions, as the first dividend it is evident that the adoption of environmental taxation should be sustained by the research of a second or a third dividend.

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For this purpose the paper aims to evaluate the double/triple dividend hypothesis by adopting a specific environmental policy for the Italian economic system, using a CGE model based on a 2003 Social Accounting Matrix. The environmental data set concerning Green House Gas (GHG) emissions in physical terms allows to find the convenient pollution tax reform for the Italian economy. In particular an effort is made to evaluate the double/triple dividend hypothesis by adopting a specific environmental tax policy that consist in the eco-tax on CO_2 emissions by Italian activities designed with two different scenarios of application.

In this respect, section 1 shows the methodological arguments on environmental taxation. Section 2 discusses the static General Equilibrium model used. In Section 3 the scenarios of the progressive and proportional environmental tax proposal for the Italian system are described. The section shows also the results of the application for the Italian case in term of environmental improvement and changes in prices of commodities and primary factors, output activities and unemployment rate and income distribution between Institutional Sectors.

2 Efficiency and methodological arguments on environmental taxation

Environmental taxation is one of the incentive-based instruments of environmental policy widely promoted by economists to deal with the problem of climate changes and environmental depleting and degrading. Therefore environmental taxes, also known as "green" or "eco" taxes, should be carefully designed in order to internalize external costs and ensuring that prices reflect social costs of production, including environmental costs (Pigou 1932). Generally an environmental tax policy should reduce or remove perverse subsidies, discourage polluting activities, introduce new environmentally related taxes if needed without neglecting the economic growth. The main aspects of environmental taxation that are strongly debated in current literature can be included in two type of problem: the methodology used for the environmental economic evaluation and the effectiveness of the environmental policy.

The economic assessment of the environmental costs is made complex by the mismatching between the environmental criteria and the traditional accounting scheme. The design of an Environmental tax policy requests a large knowledge about costs of abatement and damages in order to incorporate environmental criteria in economic policy plan. For this purpose, the SNA aggregates may be amended to treat natural resources as capital in the production of goods and services to record the cost of using (depleting and degrading) those resources and to record the implicit transfers needed to account for the imputed cost and capital items (United Nations 1994). As for the methodology concerning the evaluation of the environmental assets it as to be stressed that the System of Environmental Economic Accounts (SEEA) describes the environmental cost of depletion and degradation caused by different economic activities and shows the corresponding effects both on natural and others assets. Furthermore the SEEA introduces an enlarged concept of capital accumulation, which do not only allows incorporation of depletion and degradation effects but it also allows to transfer of natural resources to economic uses. This criteria permit to derive an environmentally adjusted net domestic product (EDP) which is lower than net domestic product (NDP). Much caution should be exercised therefore in the derivation of environmentally adjusted aggregates even though the analysis in physical terms is as useful as environmental accounting in monetary terms, as long as the analysis is carried out in the context of a well-defined framework of satellite accounts.

In this respect the European Commission suggests the employ of the National Accounting Matrix including environmental accounts (NAMEA) as basic tool for the integration between environmental and economic flows. The NAMEA integrates the major economic aggregates - as total output, value added and final demand - with the GHG emissions data according to the input output disaggregation (CE 1994). Concerning the problem of the effectiveness of the environmental policy, it has to be recognised as a complex aspect with more than a few features that cannot be treated here. Environmental or emission taxes in fact, usually attract strong opposition because they are likely to impose further burdens on economies and may have distortional effect on consumption: the change in the relative price of goods and services caused by their introduction can modifies consumers' choices (Panella 2002).

Nevertheless environmental taxation is a powerful instrument because it give the government the possibility to collect revenue and discourage inefficient behaviours. The additional revenues can be used by the government to finance the reductions in pre-existing distortive taxes thus it may achieve benefits also known in literature as dividends (Pearce 1991).

2.1 *The double dividend hypothesis*

The possibility for the government to collect revenue from environmental taxation is the main reason making this kind of taxation profitable: by recycling this revenue it is possible to achieve a "double dividend". Following this hypothesis, the introduction of emission regulations not only improves environmental quality which can be defined as the first dividend, but also increases the efficiency of tax system reaching the so called second dividend. It is worth distinguishing between an economic welfare and an employment second dividend. An economic welfare second dividend arises because the tax changes reduce the distortions in consumer choices and then increases welfare.

On the contrary an employment double dividend would claim a reduction in unemployment if payroll and similar taxes are reduced. This fact depends on how distorted the existing tax system is. The economic literature on European economy has mostly focused on the interaction between environmental and labour market policies in order to achieve the reduction of both unemployment rates and polluting emissions.

The distortionary effect of the increase of green taxes above the level at which the marginal pollution damage is internalized should be compared to the efficiency gains from reducing other taxes. The stepping stone on this analysis is represented by a preliminary theoretical paper based on a CGE model where the markets are all competitive and the labour is the only production factor used(Bovenberg and De Mooij 1994). The results show that environmental tax not only distorts the labour market, but also the commodity market. In conclusion, even if the environmental quality improves, the efficiency dividend does not materialize. It is worth at this point to follow the distinction between *weak* and *strong* double dividend hypothesis (Goulder 1995a). The weak hypothesis refers to the possibility to get better results if the tax revenue is used to reduce distortionary taxes rather than provide lump-sum payments. The strong double dividend imply the reduction of distortionary costs connected to the introduction of the environmental tax.

While the weak form of dividend has been widely assessed, there is no consensus on the strong double dividend hypothesis[1]. However the rigidity on wages formation and the existence of involuntary unemployment, encouraged to find an empirical proof of a strong form of double dividend. Many empirical studies such as Schneider (1997), Bovenberg and De Mooij (1998), Bovenberg and Goulder (2002), Takeda (2007) introduce more factors of production and strategic behaviour on the labour market, e.g. involuntary unemployment. They proved that the hypothesis of strong double dividend can occur under some conditions such as:

- pre-existing distortionary factor taxes;
- the taxation of factors that are inelastically supplied and relatively under taxed;
- the relative internationally immobility of capital;
- the elasticity of substitution between energy (the environmental input) and labour greater than elasticity of substitution between energy and capital;
- the real wages rise little when unemployment falls, so that the reduction in taxes on labour are not offset by wage rises.

[1]Empirical studies after Bovenberg, Goulder (1995b), Bovenberg and Goulder (1996), Bovenberg and Goulder (1997) and Böhringer et al. (1997) have reached the conclusion that the double dividend does not arise.

Table 1. Fundamental relationship in CGE model

	Activity	Primary Factor	Institutional Sectors	Activity	Primary Factor	Institutional Sectors	Govern-ment	Formation of Capital	Rest of Word
Act.	$\mathbf{B}^{ss}(x,p)$		$\mathbf{C}^{ss}(rd,p)$ $\mathbf{G}^{ss}(rd,p)$	$\mathbf{B}^{sn}(x,p)$		$\mathbf{C}^{sn}(rd,p)$ $\mathbf{G}^{sn}(rd,p)$	$\mathbf{G}^{sg}(rd,p)$	$\mathbf{I}^{s}(p)$	$\mathbf{E}^{sw}(e,p)$
Fact.	$\mathbf{Y}^{ss}(x,p_l,p_k)$			$\mathbf{Y}^{sn}(x,p_l,p_k)$					
Ins.Sec.	$\mathbf{T}^{ss}(x)$	$\mathbf{R}^{ss}(y)$	$\mathbf{T}^{ss}(r,t)$ $\mathbf{T}_r^{ss}(r,t)$		$\mathbf{R}^{sn}(y)$	$\mathbf{T}^{sn}(r,t)$ $\mathbf{T}_r^{sn}(r,t)$	$\mathbf{T}_r^{sg}(r,t)$		$\mathbf{t}^{sw}(r)$
Act.	$\mathbf{B}^{ns}(x,p)$		$\mathbf{C}^{ns}(rd,p)$ $\mathbf{G}^{ns}(rd,p)$	$\mathbf{B}^{nn}(x,p)$		$\mathbf{C}^{nn}(rd,p)$ $\mathbf{G}^{nn}(rd,p)$	$\mathbf{G}^{ng}(rd,p)$	$\mathbf{I}^{n}(p)$	$\mathbf{E}^{nw}(e,p)$
Fact.	$\mathbf{Y}^{ns}(x,p_l,p_k)$			$\mathbf{Y}^{nn}(x,p_l,p_k)$					
Ins.Sec.		$\mathbf{R}^{ns}(y)$	$\mathbf{T}^{ns}(r,t)$ $\mathbf{T}_r^{ns}(r,t)$	$\mathbf{T}^{nn}(x)$	$\mathbf{R}^{nn}(y)$	$\mathbf{T}^{nn}(r,t)$ $\mathbf{T}_r^{nn}(r,t)$	$\mathbf{T}_r^{ng}(r,t)$		$\mathbf{t}^{nw}(r)$
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	$\mathbf{M}^{ws}(x,e)$	$\mathbf{t}^{ws}(y)$	$\mathbf{T}_r^{ws}(r)$	$\mathbf{M}^{wn}(x,e)$	$\mathbf{t}^{wn}(y)$	$\mathbf{T}_r^{wn}(r)$			

The possibility to get a double dividend through an environmental policy seems to be much more realistic than expected if specific distortion and economic condition of the system studied are taken into account. Later studies demonstrated the possibility to reach a *triple* dividend. It is represented by decreasing emissions, increasing GDP and decreasing poverty (Van Heerden et al. 2006), or by reduction of CO_2 emissions, increasing employment levels and a better efficiency of tax system (Manresa and Sancho 2005).

3 The model structure

The analysis of the impact of an environmental tax reform requests a proper full detailed accounting scheme that is represented by the bi-regional Social Accounting Matrix (SAM). This disaggregated data base allows to implement a Computational General Equilibrium (CGE) model that is a suitable tool to investigate the economic implications of an exogenous shock when prices change. In fact the model can capture the distributional consequences of a fiscal policy simulation whose effects are transmitted to macroeconomic variables (employment rate, GDP change) and allows to know how the policy affects the income distribution between Institutional Sectors. 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 greenhouse gas (GHG) emission in order to verify the hypothesis of double dividend.

The model is of static bi-regional general equilibrium type and considers an open economy with two regions[2], m regional activities, c component of value added (Labour and Capital), h Institutional Sectors with a foreign Sector that close the model. It can be described as an integrated representation of the bi-regional income circular flow where the entire process of creation and distribution of income are described by a system of behavioural equations and income constrain of agents (that are all maximisers and price takers). The model can be described by a coordinated set of matrices of flows that take place according the relationships between the principal economic functions such as production, consumption, redistribution and accumulation by the agents represented.

[2]The Region s (south) and the Region n (north).

The model is solved through a walrasian equilibrium solution excepted for the labour market equilibrium that admits the possibility of a positive rate of unemployment, u. The solution is described by a vector of prices of output activities and prices of labour and capital that verifies both the "market clear" condition for all commodities and factors. The total output ($\mathbf{X}$) that is the combination of domestic and imported outputs[3], equals the intermediate demand ($\mathbf{B^{ri}}$), private consumption ($\mathbf{C^{ri}}$), local and national government spending for public consumption ($\mathbf{G^{ri}}$), the gross capital formation ($\mathbf{I}$) and the trade balance with the Rest of the World ($\mathbf{E^{rw}}$, $\mathbf{M^{rw}}$) with $r = n$, s and $i = 1,\ldots, m$.

The "market clear" condition for the factors is verified when the factors endowments correspond to the factors demand expressed by the production system. In this respect it is worth to refer to the characteristic of imperfection market for labour factor represented by initial positive unemployment rate, u. Our model distinguish two types of workers, self-employed and employed and introduces a Labour Union that has a monopoly power and a neutral risk utility function. The negotiation over wages between Firms and Labour Union is modelled as a "right-to-manage" Nash bargaining. The parties bargain only over employed wages and Firms decide over their employed demand at the bargained wage (Böhringer et al. 2005). Instead the market for capital and self-employment factors are perfectly competitive.

The balance constrain refers to Institutional Sectors that are distinguish in private sector (Family and Firms) and Government sector (National Public Administration and Local Administration) and is verified when the total disposal income by sectors equals to the total expense for saving and consumption. As for the Government Sector the total government spending ($\mathbf{G^{rr}}$, $\mathbf{G^{g}}$, $\mathbf{Tr^{rr}}$, $\mathbf{Tr^{g}}$, $\mathbf{Tr^{wr}}$) equals the total tax collection from all sources by all agents ($\mathbf{T^{g}}$, $\mathbf{T^{rr}}$, $\mathbf{T^{wr}}$). Finally the condition on gross capital formation requests that total investment ($\mathbf{I^{r}}$) equals 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 characterized by fixed coefficients and the elasticity of substitution are different by each sector[4]. Thus, assuming the Leontief production function, the domestic output derives from the combination of intermediate goods depending on total output and prices and the industry's value added that are affected by total production and Labour and Capital prices ($\mathbf{Y^{rr}}$). Then assuming a CES function, the aggregate value added is generated by combining Capital and Labour that are perfectly mobile across sectors and the elasticity of substitution derives from econometric estimate for Italy (Van der Werf 2007).

In the behavioural side, we point out that the remuneration of primary factors ($\mathbf{Y^{rr}}$) plus net transfers from sectors ($\mathbf{Tr^{rr}}$, $\mathbf{Tr^{rg}}$, $\mathbf{Tr^{wr}}$) represents total endowments ($\mathbf{R^{rr}}$, $\mathbf{R^{rg}}$). The utility function of institutional sectors is treated as if it was a production function of a composite good "wealth" whose inputs are consumptions ($\mathbf{C^{rr}}$, $\mathbf{G^{rr}}$, $\mathbf{G^{rg}}$), saving ($\mathbf{S^{rr}}$, $\mathbf{S^{g}}$)[5], transfers to other institutional sectors. Therefore the consumption plans are the result of solving the Cobb-Douglas utility function subjected to a budget constraint represented by net endowments. This fact ensures that shares of commodities consumed, savings and transfers remain unchanged in terms of quantity during all simulations.

The government expenditure is given by the production of a public consumption good, public investments and transfers to households and firms. It is financed through taxes, public savings and transfers, including the Rest of the World. Taxes can be divided into direct income tax and a set of different indirect taxes (production tax, value-added tax and labour tax). The foreign sector utility function close the model.

[3]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.

[4]The elasticity of substitution are calculated on international commerce data from the Economic and Financial Planning Document for 2004-2007 as the ratio between percentage change in net imports and percentage change in exchange rate.

[5]In our model the savings follow a kaldorian hypothesis according which households have a lower saving propensity than industry and consume a share of their income.

Table 2. Distance from the Kyoto target and the Italian debt of CO_2 emissions

Emission of CO_2 by activities (1990 = base, Mlt)	360
Kyoto target on Greenhouse emission (%)	-6.5
Kyoto target on CO_2 emission by activities (%)	-5.5
CO_2 emissions objective for year 2012 (Mlt)	97
Level of CO_2 emissions for year 2003 (Mlt)	387
CO_2 emissions for year 2003 (basic points)	118
Distance from the Kyoto target (basic points)	6.72
Debt of Emission of CO_2 for the 2003 (Mlt)	39

4 Progressive and proportional Environmental Tax proposal

The simulations aim to verify the double dividend hypothesis for the Italian economy in term of effects that the new environmental tax can generates on the macro variables. The exogenous shock on tax system is introduced with a new environmental tax on output activities with a system of progressive tax in which the percent paid by each activities as tax on CO_2 emissions rises as the amount of emissions rises.

The Kyoto protocol fixed the objective on Green House Emission for the Italian economy in the reduction of 5.5% of CO_2 emission for the period of 2008-2012[6]. Starting from the year 1990 where the national CO_2 were 360 Mlt the Italian system should have reduced it of around 0.897 Mlt in each followed years in order to achieve the Kyoto target that value 340 Mlt of CO_2 in the year 2012 (ISTAT 2008)[7]. In the year 2003, we can see that the Italian CO_2 emissions were 118 Mlt, 39 Mlt more than the annual target. The difference can be easily interpreted as the Italian debit of CO_2 emissions[8] while 348 Mlt represent the admitted level of CO_2 emissions that we interpreted as the exemption for the activities according their coefficient of emission of CO_2 (ISTAT 2008).

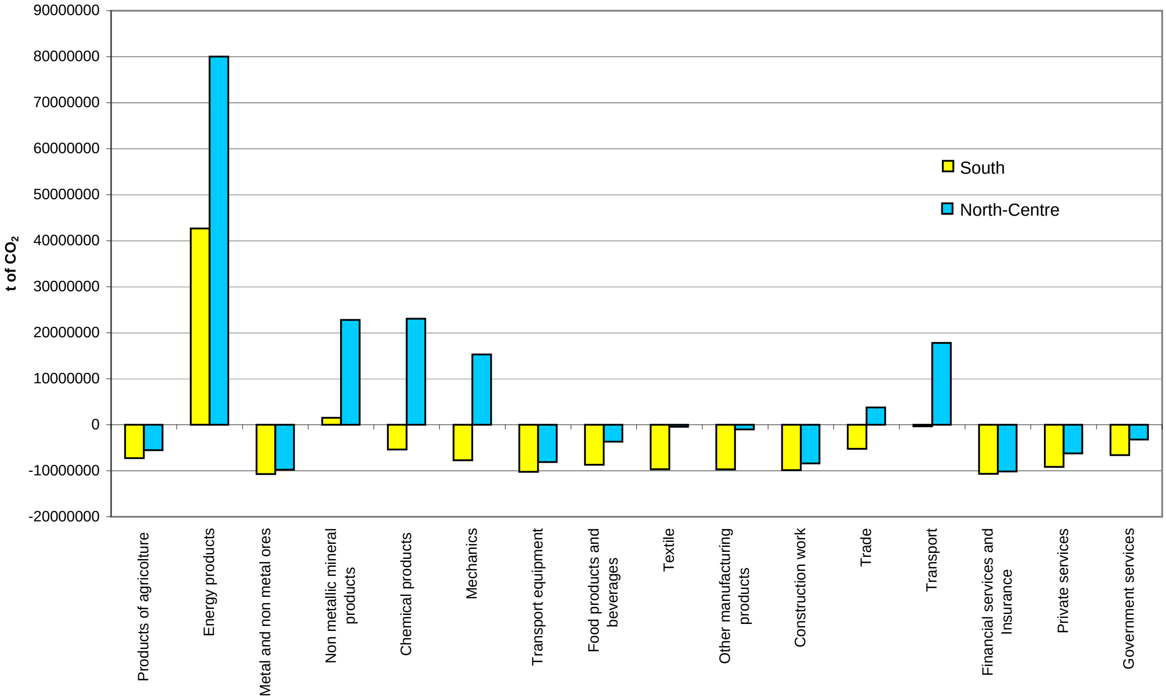
The simulations implemented concern the introduction of an environmental tax on activity output differentiated according to CO_2 emissions of each industry. For this purpose we introduce a "no-tax" area represented by the level of CO_2 emissions permitted to Italy in order reach Kyoto Protocol targets and European Union dispositions on environmental policy. The industries charged by the taxation burden are those with CO_2 emissions higher than the top level of 10.871.958 tons as shown in fig.1.

The exemption area for emissions of each sector is calculated as the ratio between the total level of CO_2 allowed for Italy for 2003[9], and the number of industries in the *benchmark*[10]. In this way less polluting industries are not taxed and those activities which over-pass the permitted level (10.871.958 t for each activities) have an incentive to reduce their emissions to avoid the taxation. The tax is design with a both progressive and proportional structure: there are 5 classes of taxation and industries pay a fixed price for every ton of CO_2 emission in each class. Higher is the class, higher is the burden industries effort. The structure of this *eco-tax* can be described as follow:

- 0. from 0 to 10.871.958 t: no-tax area,
- 1. from 10.871.959 t to 15.000.000 t: 9 euro per CO_2 t,
- 2. from 15.000.001 t to 30.000.000 t: 16 euro per CO_2 t,

[6]Since the Kyoto protocol establish the reduction of 6.5% of Italian GHE that are represented by the 85% of CO_2 the Kyoto target for Italian CO_2 is around 5.5%.
[7]We consider the emission of CO_2 by activities and not by families.
[8]If we interpret the reduction path as a linear reduction we can find the distance from the Kyoto target on CO_2 emissions that is 6.72 base points.
[9]The emissions foreseen for Italy for 2003 by the path of emission reduction to achieve within 2012 a reduction of 6.5% of CO_2 emissions with respect to 1990 levels are 347.902.664 t.
[10]The total industries number is 32. 16 for North-Centre and 16 for South.

Figure 1. Emissions of CO2 by Italian activities (distance from the exemption level)



- 3. from 30.000.001 t to 50.000.000 t: 22 euro per CO_2 t,
- 4. over 50.000.001 t: 32 euro per CO_2 t.

In North-Center region, the activity sectors which pay the eco-tax on output are: Energy goods (4.), Minerals (3.), Chemical goods (3.), Meccanic (2.), Commerce (1.) and Transports (1.). In South region, Energy goods (4.) and Minerals (1.).

The policy aims to force industries to reduce or in some cases take under control the consumption of polluting goods in order to cut CO_2 emissions and reach the first dividend (*environmental dividend*). Moreover, since the economic system is integrated and all sector and variables are connected, it is crucial to evaluate the policy effects on the whole income circular flow and on unemployment rate in order to assess the existence of a second or even a third dividend for the Italian economy. For this purpose, the policies implemented are revenue-neutral, so the tax revenue is completely recycled following two hypothesis:

- in the first scenario s_1 the tax revenue is recycled to reduce households income taxes.
- in the second scenario s_2 the tax revenue is recycled to cut the regional tax on value added activities.

The rationale for this recycling schemes lies on the political sensitive on progressive direct taxes (income taxes) reduction as an instrument to increase households endowments and sustain final demand. On the other side the regional tax on value added activities has been surrounded by many controversies and objection particularly on its legality since its introduction.

4.1 *Simulation results: the Italian case*

The analysis is carried out on the Italian SAM for 2003 (Pretaroli and Socci 2008), which represents the production system features and the circular income flow for the whole economy, in terms of intra-regional and inter-regional flows. A set of rows and columns of the SAM are headed to 16 industries and 9 Institutional Sectors[11] in each region. The rows and columns

[11] I.Households, II.Firms, III.Regional Government, IV.District Government, 5 type of VI.-IX.Municipal Government.

of Central Government, the Rest of the World and the Capital formation, that have national relevance, close the accounting scheme.

The CGE model requires a disaggregation of Institutional sectors flows in order to distinguish different type of revenues and expenditures. These details are requested mainly for Government sectors flows in order to introduce the implementation of various fiscal policies straightforward. The introduction of an eco-tax on activities output modeled taking into account CO_2 emission capacity of each production process in proportional and progressive terms, generates effects in all phases of the income circular flow[12]. In this respect, the simulation results are described following this framework.

a) *Production: prices and outputs*

The eco-tax base in both scenarios is the level of output for those industries whose CO_2 emissions exceed the no-tax level allowed. Focusing on the effects of the simulations on goods prices, it is evident the attempt of the industries involved by the policy to translate the tax burden on prices. As shown in the table 3, almost all prices of commodities increase in both regions in every scenarios with some exception.

Table 3. Impacts on commodity prices (% change)

Industry	South		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

When the tax revenue is recycled to reduce households income taxes (s_1) the prices of "2 Energy products" and "4 Non metallic mineral products" rise more than all the other goods in both regions, with an increase of 3.667% in the South and 5.605% in the North-Centre. These production processes in fact are relatively the most pollutant and thus they pay a relatively higher tax rate. Nevertheless the increase of the other prices is strictly correlated to the inter-sector bond with these taxed production processes. Despite of this trend some activities as "12 Trade" and "15 Private services" in North-Centre region and "14 Financial services and Insurance" in both two regions, detect a decrease in prices.

The second scenario s_2 in table 3 shows the impacts of the fiscal environmental policy on commodities' price when the revenue is recycled to cut a particular regional tax on activities value added. The results confirm a general increase in prices for almost every commodity even though changes observed in this scenario are smaller than in previous one. As expected, the tax incidence is more relevant on the most polluting activities in both regions ("2 Energy products", "4 Non metallic mineral products" and "5 Chemical products") but there are a little bit more industries characterised by a reduction in commodities price: "9 Textile", "11 Construction work", "12 Trade" and "14 Financial services and Insurance" in South and "12 Trade", "14 Financial services and Insurance" and "15 Private services" in North. This is probably caused by

[12]The results are of direct and indirect type and expressed as percent changes from the *benchmark* that is the economy represented by the SAM.

the reduction of the distortive regional tax on activities value added that more than compensate the environmental taxation.

The policy impacts on the production sphere refer not only to prices modification, but also to output changes. The results on table 4 show that the introduction of an environmental tax with progressive and proportional structure cause a general reduction on disaggregate output in both regions in each scenario[13]. The percentage changes have small entity for all the commodities and are included in -0.7% in both scenario with the exception of the "2 Energy products" goods. This industry registers an output reduction of 2.054% in South and 1.707% in North-Centre in s_1 and a little bit more in s_2, -2.066% in South and -1.712% in North-Centre.

Along the same scenario the differences in output percentage of variations between the two Regions, due to the more or less burden imposed by the environmental taxation, confirm the diversities on production processes with respect to CO_2 emissions[14]. In North-Centre region the "5 Chemical products" output is one of the most penalized while in South this sector has a relatively small reduction in production. The reasons for these modifications are always associated with the structure of the taxation which is modelled in order to charge most polluting activities.

Table 4. Impacts on output levels (% change)

Industry	South		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

As a consequence of this production reduction, the aggregate output decreases with a superior percentage in South, in the second scenario more than in the first. This mean that at least in aggregate terms, the reduction of the regional tax on activities value added with the "eco-tax" revenue (scenario s_2) does not compensate the burden imposed by the policy. But in disaggregate terms this compensation seems to be real for many industry with exception of "1 Agriculture" "2 Energy products", "12 Trade", "14 Financial services and Insurance", "15 Private services" and "16 Government services", even though is not enough to avoid the reduction in output levels.

b) *Environmental aspects*

The environmental policy applied generates the expected impacts on CO_2 emissions thus it is possible to confirm the presence of the first dividend (better environmental quality) in both two scenarios. An environmental tax on output which take into account the emissions of each activity process and is modelled with proportional and progressive criteria considering an exemption area for emissions under the top level allowed, reduces the level of CO_2 emissions as shown in table 5 according to the policy intent.

The best results in terms of reduction are performed by the South region in both two scenarios. This depends on the policy effects on output as illustrated in table 4. Comparing these results

[13]The only exception is represented by the industry "16 Government services" in North-Centre region which observe a growth of 0.044%.

[14]The analysis does not consider the government behaviour.

Table 5. Impacts on CO_2 emissions (% change)

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

with those on emissions, the reasons for which the second scenario reaches better results are evident. When the compensation of the environmental tax passes through a reduction of the regional tax on activities value added (s_2), the total output decreases more than the other scenario and than the level of emissions followes the same path.

c) *Value added generation and assignment: nominal aspects and unemployment rate*
The consequences of introducing an environmental tax reflects on value added generation and distribution. In particular the analysis concentrates on primary factor prices changes (Employed, Self Employed and Capital income) and on unemployment rate. The table 6 illustrates interesting differences in the results among regions and scenarios. Starting from the first scenario s_1, primary factors payments decrease as a whole in North-Centre region while in South "Employed" labour payments raise. This trend is persistent also in s_2 but the percentage changes are lower.

Table 6. Impacts on primary factors payments and unemployment (% change)

Primary Factors	South		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

According to the exigencies of our research, the most attractive result of these simulations is related to the unemployment rate change. The environmental policy in fact is simulated in order to assess the double dividend hypothesis for Italian economy. Once the first dividend has been verified, the aim of the computational exercise is finding 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. The table 6 shows a reduction of unemployment rate of 0.059% in s_1 and 0.028% in s_2. On the other side, the level of employment in South region decreases. This result is related to the specific hypothesis on the labour market structure[15] and to the production dampen for this area. Regardless of the tax revenue recycling assumption, it is possible to confirm the "employment" second dividend in disaggregate terms for North region.

d) *Secondary distribution of income: nominal and real aspects*
One of the reason making the 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 intention but it is realizable if we consider the results in disaggregate terms. In the first scenario s_1 the environmental tax revenue distribution grant a cut of 4,63% in households income taxes but it seems to be not enough to grant positive results in terms of nominal disposal income. As shown in the table 7, in both two regions Households and Firms income decreases specially in North-Centre region. This is probably the consequence of the lower primary factor 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 value

[15]The model assume the presence of Labour Union that bargain wages with Firms maximising his utility function. The Union is neutral to the risk and has monopoly power. This mean that when unemployment rate increase, the wage is sustained by the Union.

added effects indirectly the nominal disposal income. Households and Firms nominal incomes decrease more than in s_1 and this may depend as already seen from the minor primary factor remuneration.

Table 7. Impacts on Households and Firms nominal disposal income (% change)

Institutional Sectors	South		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

In order to provide an evaluation of the policy in terms of Households and Firms purchasing power let examine the results on the table 8 which describes the percentage changes in the real disposal income. The prices of final goods effects these results that show the private consumers purchasing power. From the scenario s_1 it comes out a lowering real income for Firms in the two regions but with respect to Households, in North-Centre it is possible to observe a positive growth in real disposal income.

Table 8. Impacts on Households and Firms real disposal income (% change)

Institutional Sectors	South		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

In the scenario s_2 , all real disposal incomes decrease especially in South region: the policy with the reduction of the regional tax on activities value added has no way positive effects on private purchasing power. Real disposal income can be considered as the variable to refer to in order to evaluate any possible further dividend embodied with the environmental policy. In this respect, if we consider the effects of the policy in disaggregate terms, we can accept the hypothesis of "third" dividend represented by the higher income for Household in North 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 Government expenditure capacity in both two scenarios paying particular attention to the distinction among Local and National Government sectors. The table 9 describes a quite a little encouraging scenarios. In both s_1 and s_2 Local Government assess decreasing levels of income especially in North region. Only the Central Government verifies a gain in income in the first and in the second scenario in spite of the Local Government that manifests in s_2 the worst income performance.

e) *Final demand phase*
The final demand formation process completes the circular flow of income described by the simulations. The institutional sector net income is re-arranged in terms of final demand according to the classification of the production activities. The results illustrate a general reduction in final demand in disaggregate terms in each region for both scenarios.

5 Conclusions

The different polluting power of production processes, expressed in terms of CO_2 emissions, justifies the multi-sector approach and Input-Output analysis technique we used. The implementation of environmental satellite accounts as NAMEA and SEEA which are seen as basic

Table 9. Impacts on Government balances (% change)

Institutional Sectors	South		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	

tool for the integration between environmental and economic flows, confirms the validity of this approach. Economic impacts of any environmental policy in fact, must be assessed in order to evaluate the profitability of the policy and benefits can be verified even in terms of disaggregate circular flow of income. That confirm the adoption of an accounting scheme and disaggregate models along the multisectoral analysis.

This paper started from the implementation of a well-detailed data base, which is characterised by the integration of environmental data within economic flows described in the SAM. This disaggregated data base allowed to implement a Computational General Equilibrium (CGE) model that is a suitable tool to evaluate the economic agents behaviour in the different markets when an exogenous shock manifests. These specific features of the multisectoral scheme make this approach suitable to analyse the impacts of an environmental fiscal policy applied to an economic system.

The first step of our analisys (defined ”ex-ante”) refers to the determination of the tax base and the structure of the imposition. Disaggregated data on emissions allowed to classify the production sector according to their polluting capacity and than model the proper taxation according to this classification. The second step (defined ”ex-post”) concerns the search of the environmental profit (first dividend) and the social-economic benefit (second dividend). These latter aspects can be analysed only with a data base and a model oriented on the income circular flow. In particular, this study aimes to verify: the fall in CO_2 emissions as first dividend, the reduction in unemployment rate as second dividend and the growth in disposable income for institutional sectors as the third dividend.

As we showed the environmental tax was imposed on industries output in relation to the quantity of CO_2 emissions. The policy fixes 5 classes of taxation: the first class correspond to the no-tax area and the others admit a growing price per every ton of CO_2 produced. The price in each class depends on the Carbon quotation in brown certificate market. In this respect it is possible to calculate average tax rate for every activity and simulate the environmental policy with regard to proportional and progressive imposition structure.

This environmental policy was included in the Computational General Equilibrium model that is built on the bi-regional SAM for Italy for 2003 in order to verify and assess the existence of the double or triple dividend. For this purpose two scenario have been simulated: the first refers to the destination of the entire environmental tax revenue for the reduction of Households income taxation, the second one concern the recycle of the tax revenue to reduce the regional tax on activities value added. For this purpose two scenario are simulated: the first refers to the destination of the entire environmental tax revenue for the reduction of Households income taxation, the second one concern the recycle of the tax revenue to reduce the regional tax on activities value added.

The results verified the ”first” ”environmental” dividend in the economy as a whole and in disaggregate terms that regardless the different type of revenue distribution. Then we made an effort to identify a second ”employment” dividend represented by a reduction in unemployment rate in both two scenarios looking for the effects along the whole income circular flow. That was verified only in the North-Centre region, while South is characterized by the growing of unemployment rates. It was worth to put in evidence the impact of the policy implemented on Private Institutional sectors disposable income especially when it is considered in real terms. When the policy maker used the tax revenue to reduce income tax, a positive effect on Households real income manifests but only in North region. That can be interpreted as the "third" dividend even if it is assessed only in a single region and for a single private institutional sector. Thus if we are interested in looking for the major number of benefits connected with environmental policy, the distribution of the tax revenue by reducing income taxes may be the better solution because it allow to reach a first dividend for the whole economy and second and third dividend in disaggregate terms.

The approach we adopt in the study of production process and environmental issue, may represent the preliminary attempt in the EDP determination. The cost that the economic system has to effort after the introduction of an environmental tax, can be considered as the first revision in the GDP valuation.

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