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Abstract

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 Computable General Equilibrium (CGE) model is used with imperfection market for labour factor and a green tax on commodity output depending on the level of CO_2 emission is introduced. Tax revenues are than completely distributed to the economy in order to reduce the income tax or to cut the regional tax on commodity value added. In this way a revenue-neutral environmental policy is tested and the double dividend and 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

In recent years environmental sustainability has been representing an important economic policy objective for European countries as a consequence of the strong awareness for climate changes and the ensuing environmental damage. Environmental policies generally consist on a set of measures such as tax penalties, subsidies and incentives oriented to improve efficiency on energy consumption and reduce inefficient behaviours. The use of such instruments, aimed to reduce the amount of emissions and promote environmental conservation according to international agreements, in some cases is still discouraged by politicians and governments which interpret this measures as burdens to economies.

The debate around the implementation of an environmental policy and the property of the instruments involved, mostly concerns the difficulties to asses their impact in terms of environmental development and economic growth. To be more specific, differences among the methodologies used for the environmental economic evaluation and the effectiveness of the environmental instruments in terms of competitiveness obstruct their appliance. In this respect it seems to be crucial finding out real economic paybacks embodied with environmental benefits. Furthermore the environmental taxation is the most disputed reform within the set of measures against environmental damage and his profitability is usually connected 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.

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 (SAM). The environmental data set concerning Green House Gas (GHG) emissions by commodities in physical terms allows to find the convenient tax reform environmentally oriented 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 consists in the eco-tax on CO_2 emissions by Italian commodities designed with two different scenarios of application.

In this respect, section 2 shows the methodological arguments on environmental taxation. Section 3 discusses the static General Equilibrium model used. In Section 4 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, changes in prices of commodities and primary factors, in total output, 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. Environmental taxes, also known as "green" or "eco" taxes, should be carefully designed in order to internalize external costs and ensure that prices reflect all social costs of production, including environmental costs (Pigou 1932). In this way it is possible to discourage polluting activities without neglecting the economic growth.

The main aspects of environmental taxation that are strongly debated in current literature, refer both to 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 general System of National Accounts (SNA) concepts of cost, capital formation and stock of capital should be integrated with additional data in physical terms in order to incorporate environmental cost and the use of natural assets in production or, in alternative, amended through the incorporation of these effects in monetary terms (United Nations 1994). Notwithstanding the general agreement on this orientation, the existing approaches differ considerably in terms of methodology. The System of Environmental Economic Accounts (SEEA) suggests one comprehensive approach that integrates and synthesizes as far as possible all the others. It identifies two types of environmental costs, for degradation an depletion and for environmental protection, and introduces an enlarged concept of capital accumulation which include the reduction in the capital stock, as a result of depletion and degradation, and the transfer of natural assets between economic uses, as a result of production decisions. This criteria permits to derive an Environmentally adjusted net Domestic Product (EDP) which is lower than Net Domestic Product (NDP). Even though this new aggregate can be considered as the benchmark for environmental policies, much caution should be exercised in the derivation of environmentally adjusted aggregates especially when the valuations are made in monetary terms.

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 supplements the major economic aggregates - total output, value added and final demand - with the GHG emissions data in physical terms according to the input output disaggregation (CE 1994). This approach avoids the difficulties connected to the valuation of environmental costs and assets in monetary terms.

As for the problem of the effectiveness of the environmental policies, it has to be stressed that it represents a complex aspect with more than a few features that cannot be fully treated here. Generally it is known that environmental taxation attracts strong opposition because it is likely to impose further burdens on economies and may have distortional effect on the consumption: the change in the relative price of goods and services caused by the introduction of an environmental tax on pollutant commodities, can modified consumers' choices (Panella 2002). Nevertheless environmental taxation is a powerful instrument because it gives the government the possibility to collect revenue and discourage inefficient behaviours. The additional revenues can be used by the government to finance the reduction in pre-existing distortive taxes in order to achieve a more than a singular benefit, 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 in fact, it is possible to achieve a *double dividend.* Following this hypothesis, the introduction of emission regulations not only improves environmental quality, that 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 change reduces 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. In both two cases, the evidence of the second dividend strictly 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, as a consequence of growing unemployment rates, in order to achieve the reduction of polluting emissions and get an employment second dividend.

The distortionary effect of increasing 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. In literature it is commonly accepted 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 be verified under some conditions such as:

- pre-existing distortionary factor taxes;

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

- 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.

The possibility to get a double dividend through an environmental policy seems to be much more realistic than expected if specific distortions and economic conditions 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 reducing 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 impacts 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. The model, in fact, 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 GHG emissions 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 commodities, c component of value added (labour and capital), h Institutional Sectors with a foreign sector that closes the model. It can be described as an integrated representation of the bi-regional income circular flow where the entire process of creation and

[2]The region s (South) and the region n (North-Centre).

distribution of income is described by a system of behavioural equations and income constrains for 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 to the relationship among the principal economic functions such as production, consumption, redistribution and accumulation by the agents represented.

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 final commodity prices, that verifies the *market clearing* conditions for all commodities, and by a vector of factors prices. The total output ($\mathbf{X}$), that is the combination of domestic and imported outputs[3], equals the intermediate demand ($\mathbf{B^{ri}}$), the private consumption ($\mathbf{C^{ri}}$), the local and central government spending for public consumption ($\mathbf{GL^{ri}}$, $\mathbf{G^{ri}}$), 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 clearing* conditions for the factors are verified when the factors endowment corresponds to the factors demand expressed by the production system. In this respect it is worth to put into evidence the market imperfection for labour factor represented by initial positive involuntary unemployment rate, u. Our model distinguishes 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 (Bohringer et al. 2005). Instead the market for capital and self-employment factors are perfectly competitive.

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

[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.

Table 1: Fundamental relationship in CGE model

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

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 is different by each commodity[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 value added aggregate that is affected by total production and factors 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 estimates 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 institutional sectors ($\mathbf{Tr^{rr}}$, $\mathbf{Tr^{rg}}$, $\mathbf{Tr^{wr}}$) represent total endowments ($\mathbf{R^{rr}}$, $\mathbf{R^{rg}}$). The utility function of all institutional sectors is treated as if it was a production function of a composite good "wealth" whose inputs are consumptions ($\mathbf{C^{rr}}$, $\mathbf{GL^{rr}}$, $\mathbf{G^{rg}}$), savings ($\mathbf{S^{rr}}$, $\mathbf{S^{g}}$)[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 the shares of commodities consumed, savings and transfers remain unchanged in terms of quantity in all simulations.

The government expenditure is given by the production of a public consumption good, public investments and transfers to Households, Firms and other public sectors. 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 closes the model.

4 Progressive and proportional Environmental Tax proposal

The simulations aim to verify the double dividend hypothesis for the Italian economy by measuring the impact of a the new environmental tax on the

[4]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.

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

macro variables. The exogenous shock on tax system is introduced with a new environmental tax on commodity output with a progressive structure in which the rate paid by each commodity rises when the amount of CO_2 emissions rises.

The Kyoto protocol fixed the objective on GHG for the Italian economy in the reduction of 5.5% of CO_2 emissions for the period of 2008-2012[6]. Starting from the year 1990, when the national CO_2 emissions were 360 Mlt, the Italian system should have reduced them of around 0.897 Mlt in each followed year in order to achieve the Kyoto target represented by 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 basic points, 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 commodities according to their coefficient of CO_2 emission (ISTAT 2008).

The simulations implemented concern the introduction of an environmental tax on commodity output differentiated according to CO_2 emissions. For this purpose we introduce a "no-tax area" represented by the level of CO_2 emissions permitted to Italy in order to reach Kyoto Protocol target. The goods charged by the taxation burden are those with CO_2 emissions higher than the top level of 10.8 Mlt as shown in fig.1.

The exemption area is calculated as the ratio between the total level of CO_2 allowed for Italy for 2003[9], and the number of commodities in the *benchmark*[10]. 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 the taxation. The tax is designed with a both progressive and proportional structure: there are 5 Classes of taxation and every commodity pays a fixed price per ton of CO_2

[6]Since the Kyoto protocol established the reduction of 6.5% of Italian GHG, that are represented by CO_2 for the 85%, the Kyoto target for Italian CO_2 is around 5.5%.

[7]We consider the emission of CO_2 by commodities and not by families.

[8]If we interpret the reduction path as a linear decreasing function we can find the distance from the Kyoto target on CO_2 emissions that is 6.72 basic points.

[9]The emissions foreseen for Italy for 2003 by the path of emission reduction to achieve within 2012 a reduction of 5.5% of CO_2 emissions with respect to 1990 levels are 348 Mlt.

[10]The commodities number is 32 (16 for North-Centre area and 16 for South area).

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

Emission of CO_2 by commodities (1990 = base, Mlt)	360
Kyoto target on Greenhouse emission (%)	-6.5
Kyoto target on CO_2 emission by commodities (%)	-5.5
CO_2 emissions objective for year 2003 (Mlt)	348
Level of CO_2 emissions for year 2003 (Mlt)	387
Debt of Emission of CO_2 for the 2003 (Mlt)	39
CO_2 emissions objective for year 2012 (basic points)	97
CO_2 emissions for year 2003 (basic points)	118
Distance from the Kyoto target (basic points)	6.72

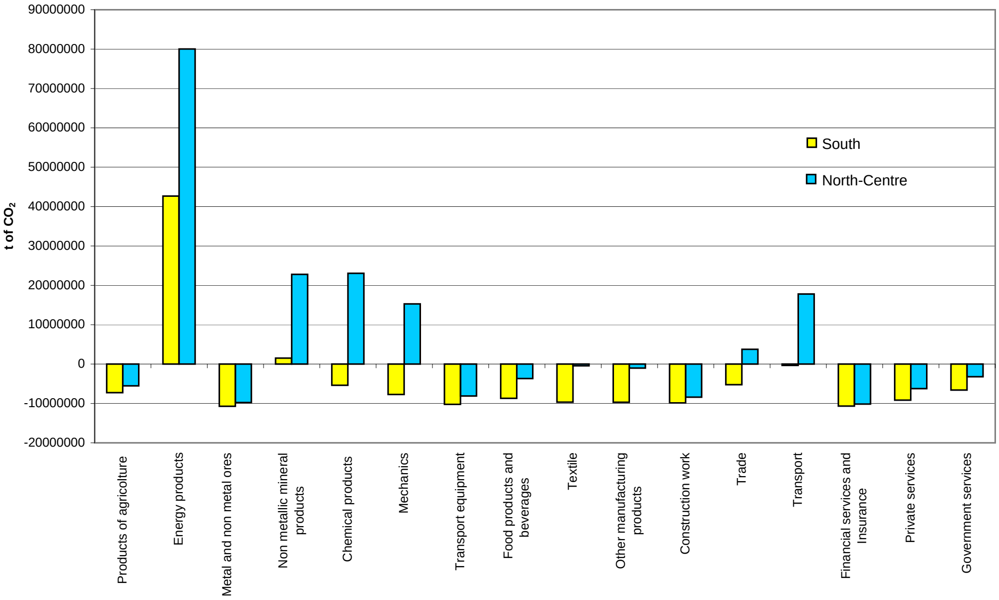
emission. The higher is the class, the higher is the burden efforted by the commodity. The structure of this *eco-tax* can be described as follow:

- 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 CO_2 t,
- Class 2. from 15.000.001 t to 30.000.000 t: 16 euro per CO_2 t,
- Class 3. from 30.000.001 t to 50.000.000 t: 22 euro per CO_2 t,
- Class 4. over 50.000.001 t: 32 euro per CO_2 t.

In North-Center region, the commodities which pay the eco-tax on output 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 South region, 'Energy products' (Class 4) and 'Non metallic mineral products' (Class 1).

The policies aim to promote the reduction in polluting goods consumption in order to cut CO_2 emissions and reach the first dividend (environmental dividend). Moreover, since the economic system is integrated and all variables are connected, it is crucial to evaluate the policies 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

Figure 1: Emissions of CO2 by Italian commodities (distance from the exemption level)



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 tax;
- in the second scenario s_2 the tax revenue is recycled to cut the regional tax on commodities value added;

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 commodities value added 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 commodities and 9 Institutional Sectors[11] in each region. The rows and columns of Central Government, the Rest of the World and the Capital Formation, that all 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 commodity output levied according to the CO_2 emission capacity of each production process in proportional and progressive terms, impacts 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*
In both two scenarios the eco-tax is imposed on total output. In particular the burden is on the commodities whose CO_2 emissions exceed the allowed (no-taxed) level. Focusing on the impacts on prices, it is evident the attempt of the commodities involved by the policy to translate the tax burden on prices. As shown in the table 3, almost all prices increase in both regions in every scenario with some exceptions.

When the tax revenue is recycled to reduce Households income tax (s_1) the prices of 'Energy products' and 'Non metallic mineral products' rise more than all the other commodities in both two 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 pay relatively higher tax rate. Despite of this trend some commodities as 'Trade' and 'Private services' in North-Centre region and 'Financial services and Insurance' in both two regions, detect a decrease in prices.

In the second scenario s_2 the environmental tax revenue is recycled to cut the regional tax on commodities value added. The results showed in table 3 confirm a general increase in most commodities price, 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 many

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

[12]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.

Table 3: Impacts on commodity prices (% change)

Commodity	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

reduction on prices are also observed: 'Textile', 'Construction work', 'Trade' and 'Financial services and Insurance' in South and 'Trade', 'Financial services and Insurance' and 'Private services' in North. This is probably caused by the reduction of the distortive regional tax on commodities value added that more than compensate the environmental taxation.

According to the results showed on table 4, the introduction of an environmental tax with progressive and proportional structure causes a general reduction on disaggregate output in both two regions in each scenario[13]. The percentage changes are included in -0.7% in both scenarios with the exception for the 'Energy products'. This commodity registers an output reduction of 2.054% in South and 1.707% in North-Centre in s_1 and -2.066% in South and -1.712% in North-Centre in s_2.

[13]The only exception is represented by the commodity 'Government services' in North-Centre region which registers an increase of 0.044%.

Table 4: Impacts on output levels (% change)

Commodity	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

Along the same scenario the differences in output changes between the two regions are the consequences of the more or less burden imposed by the environmental taxation on the economy. In North-Centre region the 'Chemical products' is one of the most penalized while in the South the same commodity has a relatively small reduction in production. The reasons for these differences are associated with the structure of the taxation which is modelled in order to charge most polluting commodities that are concentrated in North-Centre region.

As a consequence of this production reduction, the aggregate output decreases with a higher percentage in South in the second scenario than in the first. This means that at least in aggregate terms, the reduction of the regional tax on commodities value added with by recycling the eco-tax revenue (scenario s_2), does not compensate the burden imposed by the policy. But in disaggregate terms this compensation occurs for many commodities with

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

exception of 'Agriculture' 'Energy products', 'Trade', 'Financial services and Insurance', 'Private services' and 'Government services'.

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, levied according to the emissions generated by the production of each commodity, with a proportional and progressive structure, reduces the level of CO_2 emissions as shown in table 5.

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 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 commodities value added (s_2), the total output decreases more than the other scenario and than the level of emissions diminishes according the same path.

c) *Value added generation and assignment: nominal aspects and unemployment rate*
The consequences of introducing an environmental tax reflect on value added generation and distribution. In particular the analysis concentrates on primary factors 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 payment raises. This trend is persistent also in

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

s_2 but the changes are lower.

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 implemented 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[14] and to the production dampen 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 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

[14]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 mean that when unemployment rate increase, the wage is sustained by the Union.

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

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

it is realizable if we consider the results in disaggregate terms. In the first scenario s_1 the environmental tax revenue distribution grants a cut of 4.63% in Households income taxes but it does not generate positive results in terms of nominal disposal income. As shown in the table 7, in both two regions Households and Firms incomes decrease specially 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 commodities value added affects indirectly the nominal disposal income. Households and Firms nominal incomes decrease more than in s_1 as a result of the minor primary factor remuneration.

In order to provide an evaluation of the policy in terms of Households and Firms spending capacity, the results on the table 8 describes the percentage changes in the real disposal income. Observing the results of simulation s_1, it comes out a lowering real income for Firms in both two regions and a growth in disposable income for Households in North-Centre.

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	

In the scenario s_2, all real disposal incomes decrease especially in South region: the reduction of the regional tax on commodities value added has no positive effects on private spending capacity. The change in real disposal 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 policy in disaggregate terms, we can accept the hypothesis of *third* dividend represented by the higher 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 Government expenditure capacity in both two scenarios focusing on the distinction among Local and Central Government sectors. The table 9 describes a quite a little encouraging scenarios. In both s_1 and s_2 Local Governments manifests a reduction in balances especially in North region. For the Central Government on the contrary, the balance dimension increases in first and second scenario.

e) *Final demand phase*

The final demand generated by consumers completes the circular flow of income 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.

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 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 the 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.

The analysis we propose in this paper derived 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 analysis (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 permitted to model the proper environmental 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 aims 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 commodities output in relation to the quantity of CO_2 emissions embodied in their production process. The policy fixes 5 classes of taxation: the first class corresponds 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 commodity 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 are simulated: the first refers to the destination of the entire environmental tax revenue for the reduction of Households income taxation, the second one concerns the recycle of the tax revenue to reduce the regional tax on commodities value added.

The results verified the *first environmental* dividend both in the economy as a whole and in disaggregate terms regardless of 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. 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 welfare* dividend even if it is assessed only in a single region and for a single private institutional sector. Thus if we concentrate on 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 allows to reach a first dividend for the whole economy and second and third dividend in disaggregate terms.

The approach we adopted in the study of production process and environmental issue, represents the preliminary attempt in the EDP determination. The costs that the economic system has to effort after the introduction of an environmental tax, can be considered as the first environmental oriented revision of the GDP.

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