ESAM Based Regional Economic Policy

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Abstract

Regional economic problems should increasingly take account of environmental problems. A useful tool for inserting them into the macroeconomic framework is represented by the Regional Environmentally Extended SAM (RESAM). As it is possible to dispose of an ESAM for the Sardinia Region (Italy), based on it, this papers intends to design and compute a Regional Equilibrium (RE) Model which accounts for environment, in order to elaborate a useful instrument for regional economic environmental policy.

1 Introduction

Nowadays, all over the world, the countries are affected by water, air and soil pollution, as a result of economic development.

Environmental damage particularly occurs in poor and developing countries and areas - where unfortunately a clear consciousness of the relevance of the problem is still absent or just at the first steps - even more than in developed countries, where the crucial importance of the problem and the need for a rigorous environmental policy is increasingly perceived by people and governments as a key challenge for a sustainable social and economic future development, as testified by Kyoto protocol.

The above problems are more evident in industrial areas, although they are now spread practically everywhere, with heavy consequences on daily people's life, and even on artistic and archeological heritage, because of the damages historical buildings,monuments, sculptures and paintings are suffering by pollution.

Environmental issues, besides representing social and sanitary problems, involve heavy economic implications as they entail strong costs

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due to the hard impact pollution abatement has on the economic systems as well as benefits derived from cleaning activity that are shared among all the economic agents.

These economic questions should be managed by governments in the framework of their general policy decisions, above all through the fiscal tool, which has to be used in a properly balanced way, in order, on one hand, to preserve the environment for future generations, and, on the other hand, not to depress to much the economic development to the aim of struggling poverty and ensuring acceptable welfare conditions to all people.

In recent years, the need for suitable environmental policy has been perceived to sub-country administrative levels, such as regional level, and the concerned regional governments have started to devote to environmental questions much of their attention. This is basically due to the need of preserving overall good living conditions, a need which is particularly perceived in naturalistically, artistically, and historically gifted regions, with the economic implications springing from the derived tourist vocation.

Sardinia, a region of Italy, does not escape this fate. On the contrary, it is nearly entirely pervaded by the above tourist character, as being one of the naturalistic paradise of the Mediterranean sea.

Sardinia regional government is increasingly absorbing the idea of the key role that environment will play on regional economic development and willing to design a policy which puts it at the center of the political and economic debate.

One of the best manner to achieve the above objective is commonly believed to be represented by the fiscal tool, provided it is properly used. For it to be used in a well balanced way, it is necessary to look at it in an overall context, which allows to account for all the economic interdependencies, reactions and effects.

To this aim, an economic analysis conducted in a general equilibrium framework has proved to be the most suitable one. More specifically, it is widely accepted that a quantitative analysis carried out through a Computable Regional Equilibrium (CRE) Model may provide the regional policy makers with the proper information for the most suitable fiscal and overall economic decisions.

CRE Models should be based on Regional Environmentally Extended Social Accounting Matrices (RESAM).

Since a RESAM for Sardinia is now available (Ferrari, Garau, Lecca, 20065), it is possible to elaborate an CRE, although still rough and in some sense provisional, as a tool Sardinia government can have at its own disposal for its eventual use in the regional economic planning.

Objective of this paper is just the elaboration of a CRE for Sardinia. The structure of the paper is as follows: in paragraph 2, the CRE model is specified and each single block concerning the model is analyzed, although by focusing on the most significant equations; in paragraph 3 the model is calibrated, whereas in paragraph 4 some concluding remarks are drawn.

2 Model Specification

According to Partridge and Rickman (1998), in a regional model, production creates demand for value added factors, goods and services used as intermediate inputs consisting of both inputs and locally produced goods and services. The demand for value-added factors interacts with factor supplies to determine factor prices. The product prices derived by the margin of the firms and the factor costs which are determined by the taxes and the transportation costs. Factor rates of return and ownership of factor supplies determine personal income, which influences demand for imports and locally produced goods and services.

To the purpose of examining the environmental impact in Sardinia regional scenario, a static CRE model is employed, based on the RE-SAM for Sardinia and solved using GAMS software (Brooke et al., 1998). It takes into account 14 sectors, including three waste sectors: urban, dangerous and special waste.

Typically the model shows a nested production structure, which utilizes a flexible functional form (Perroni, Rutherford, 1998).

A neo-classical behavior by the economic actors, such as firms, household and government, is assumed. Also perfect competition is assumed in the market of factor inputs and outputs and each agent is a price taker in its own market so that the equilibrium is reached at prices which equate, on one hand, the demands and the supplies for goods and services, and, on the other hand, the demand for factors with factor supplies.

Alterations of firms' decisions in production process and of households' decisions in consumption behavior due to environmental damage are accounted through the three waste accounts.

Figure 1, which is an adaptation of Xie and Salzman (2000),shows a regional economy-wide circular flow of goods and services where the environment is taken into account.

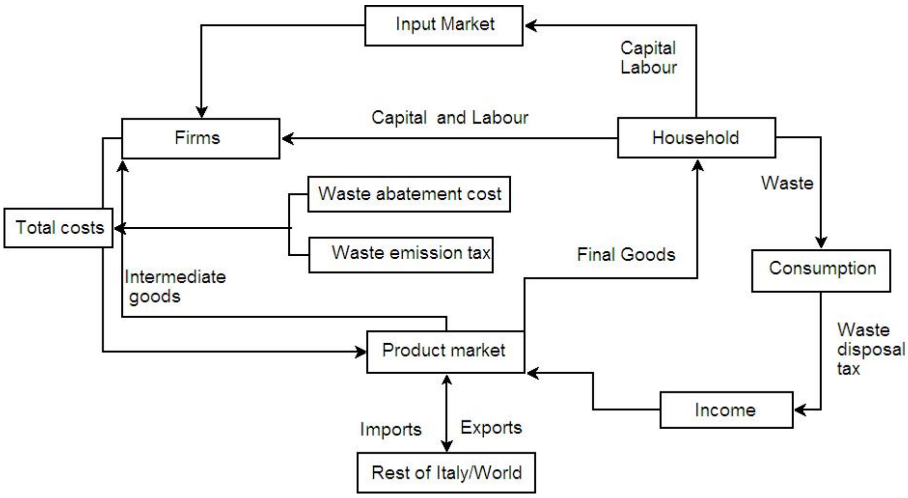

Figure 1: Environment economy system

On production side, the firms determine their optimal output level by minimizing the costs of his inputs and maximizing the profits of his outputs.

As waste is caused by production, national environmental protection law [1] introduced a waste taxation on production that increases production costs. Production costs are increased by waste disposal as well.

As a result, the firms determine a new output level which takes into account these new costs. No technological change in the production function is assumed.

On consumption side, the households modify their consumption from utility maximization problem because of the impact of waste. The effect is perceived in a household utility decrease as much as urban waste is produced and *consumed* and in a modification of the disposable income due to the introduction of a trash tax.

To the aim of taking account of pollution, the model utilizes a waste abatement sector which, in turn, produces the waste clean up, bought by firms and households, the polluting sectors, in order to reduce the waste level.

Waste disposal enters the production process in determining the optimal output level. Waste disposal price is assumed to be determined by the market. This assumption is plausible if one considers waste disposal firms that stay in the market like the other firms.

[1] Government law: Decreto legislativo n.22 del 5 febbraio 1997

2.1 Price system

The price system is rich because it takes into account all the different types of outputs, (imports, exports and domestics outputs)(Robinson et al.,1991). On the import side, the assumption of small country is made; that is, Sardinia market has an infinitely elastic supply curve of imports goods (this means that the world price is exogenous):

$$PM_a = pwm_c(1 + tm_a)EXR \tag{1}$$

In the equation, PM_a is the price of imports, including transaction costs, pwm_c the c.i.f. world import price, tm_a the import tariff rate, EXR the exchange rate.

Similarly the export price is:

$$PE_a = pwe_a(1 - te_a)EXR \tag{2}$$

where PE_a is the price of exports, pwe_a the f.o.b export world price, te_a the export tax rate.

The equation of composite goods PQ_a is represented by:

$$PQ_a = \frac{PD_a * QD_a + PM_a * QM_a}{Q_a} \tag{3}$$

where $(PD_a{*}QD_a)$ is the value of the domestic sales and $(PM_a{*}QM_a)$ the values of imports, while Q_a represents the CES aggregation function of imports and domestic goods supplied in the domestic market. The following function describes the average price of output PX_a:

$$PX_a = \frac{PD_a * QD_a + PE_a * QE_a}{X_a} \tag{4}$$

where $(PE_a * QE_a)$ is the values of exports and X_a represents the CES aggregation function of goods supplied to the exports markets and goods sold in the domestic market.

The price of valued added PVA_a is defined as:

$$PVA_a = PX_a(1 - ta_a) - \sum_{a'} PQ_{a'} a_{aa'} \tag{5}$$

where ta_a are indirect taxes and $(PQ_{a'} a_{aa'})$ is the unit cost of intermediate inputs, based on the fixed input-output coefficients $a_{aa'}$.

$$PK_a = \sum_{a} PQ_a * b_{aa'} \tag{6}$$

is the price of capital input. The Consumer Price Index $\overline{CPI}$, which is an exogenous variable, is determined as:

$$\overline{CPI} = \sum_{c} PQ_c * cwts_c \tag{7}$$

where $cwts_c$ is the weight of commodities in the $\overline{CPI}$.

Equation (8) shows the weight of environment which enters the production, that is, the composition of the production cost:

$$\begin{aligned} PX_a * QX_a + \overline{SUB}_a \quad &= ta_a(PVA_a * QX_a) \\ &+ (QX_a \sum PQ_a * a_{aa'}) \\ &+ \sum_w WETAX_{a,w} + \sum_w WCOST_{a,w} \end{aligned} \tag{8}$$

where $(PX_a * QX_a)$ is the product sale income, QX_a the domestic output, $\overline{SUB}_a$ the government subsidy, $WETAX_{a,w}$ the waste emission tax and $WCOST$ the waste abatement cost.

2.2 Production system

As RCE models are supported by the neoclassical theory, the factor demands - depending on both output and relative prices - cannot be represented by linear functions of output. The only exception is made for the treatment of the goods and services that are used as intermediate inputs. In this case, Leontief input-output production function is used to represent production of output with fixed proportions of composite primary factors and composite intermediate inputs. Nevertheless, in RCE models the composite primary factors allow factors substitution.

This production framework can properly be modeled as a nested production process. The function used is the Constant Elasticity of Substitution (CES) one.

In the CES function all the factors have the same elasticity of substitution between any pair of factors. However, the nested framework of production function allows for differing elasticity between sets of factors if each level of the function contains a set of factors and their own corresponding elasticity of substitution. In this manner, the use of the nested structure allows to utilize both fixed coefficients and price responsiveness in the CES functions (De Melo, Robinson, 1981).

Figure 2 shows the nested three level production function utilized in the model.

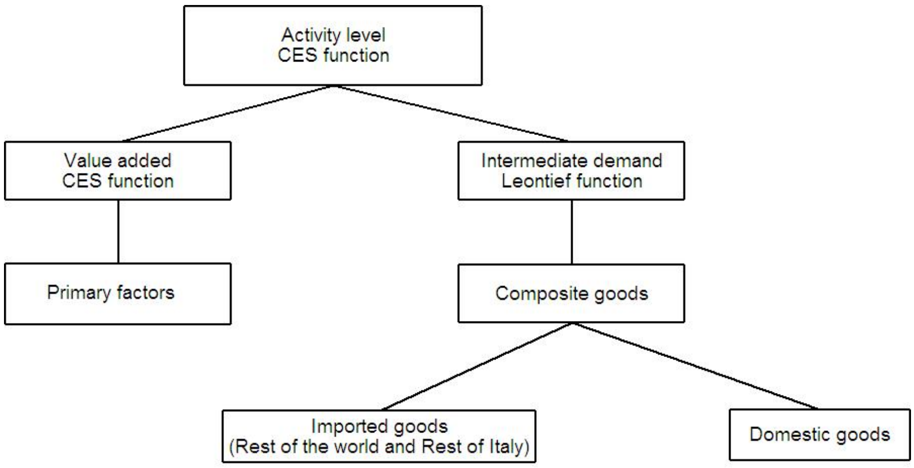

Figure 2: Production System

At the first level, there is a CES production function of the value added and of the aggregate intermediate inputs. In particular, the following equation represents the CES technology:

$$QA_a = \alpha_a^a \left(\delta_a^a * QVA_a^{-\rho_a^a} + (1-\delta_a^a) * QUINTA_a^{-\rho_a^a}\right)^{-\frac{1}{\rho_a^a}} \tag{9}$$

where QA is the level of domestic activity, QVA the quantity of value added and $QUINTA$ the quantity of aggregate intermediate input. The optimal mix between intermediate inputs and value-added is a function of relative prices of this two quantities. At a lower level, the structure that regulates the substitution between the valued added and the factors inputs, which in our case are represented by capital and labor, is again a CES:

$$QVA_a = \alpha_a^{va} \left(\sum_f \delta_{f,a}^{va} * QF_{f,a}^{-\rho_a^{va}}\right)^{-\frac{1}{\rho_a^{va}}} \tag{10}$$

where QF indicates the factor inputs. In equilibrium, the activity demand factors is determined at the point where the marginal cost of each factors is equal to the marginal cost of revenue product of the factor. The demand for disaggregated intermediate input is given by a Leontief function:

$$QUINT_{c,a} = ica_{c,a} QUINTA_a \tag{11}$$

as the level of aggregate intermediate input multiplied by a fixed quantity of intermediate input coefficient.

According to Armington assumption, it is admitted that goods produced in different regions are imperfect substitutes. The intermediate goods from different regions are used as inputs and combined at the second level of production to form composite intermediate goods (De Melo, Tarr, 1992) . The relationship between the two categories of intermediate inputs is represented by means of a CES function.

$$QQ_c = \alpha_c^q \left(\delta_c^q * QM_c^{-\rho_c^q} + (1 - \delta_c^q) QD_c^{-\rho_c^q} \right)^{-\frac{1}{\rho_c^q}} \tag{12}$$

where α is an efficiency parameter, QQ the quantity of composite goods, QM the quantity of intermediate goods imported and QD the regionally produced intermediate goods. The imperfect substitutability between imports and regional production depends on the parameter $(\rho = \sigma - 1/\sigma)$; when $(\sigma = \infty)$ the two goods are perfect substitutes; if $\sigma = 0$ the two goods are used in fixed proportion.

In the commodity market, both regional and export markets should be considered.

Within the region, commodity supplies depend both on regional production sectors and on out of region sources, that is, imports. These commodities are bought by all the economic agents, that is, by industries, in the form of intermediate inputs, by households and by government. While the inter-industry commodity flows are modeled with a CES function, output markets utilize a Constant Elasticity Transformation (CET) function. The CET function permits to consider the export accounts and the regional productions. Price ratios and elasticities of transformation determine the levels of output exported and sold in the region. The function is represented as:

$$QX_c = \alpha_c^t \left(\delta_c^t * QE_c^{\rho_c^t} + (1 - \delta_c^t) QD_c^{\rho_c^t} \right)^{\frac{1}{\rho_c^t}} \tag{13}$$

where QX is the aggregate domestic output, QE represents the supply for exports in each sectors, α_c^t is the shift or efficiency parameter, δ_c^t the share parameter and $(\rho_c^t = \sigma + 1/\sigma)$ the output substitution parameter, σ is the elasticity of transformation. The value of (ρ_c^t) has a lower bound of 1, because the variation rage of $\sigma is 0 < \sigma < \infty$. Each firm allocates its output following a maximization of profit subject to the CET function. The export/domestic supply is a function of the export/domestic price, which ensures that an increase in the export/domestic price generates an increase in the export/domestic supply.

2.3 Household Consumption and Savings

Households wish to attain a certain consumption level at the lowest possible expenditure. They choose among various commodity bundles, depending on relative prices, to achieve this consumption level. Household consumption is modeled through a Linear Expenditure System (LES).

Consumption expenditure is considered as disposal income. LES demand function is derived by maximizing a Stone-Geary utility function subject to budget constraint:

$$\begin{aligned} \max U &= \prod (C - C_{min})^{\alpha} \\ sub\ EH_h &= (1 - \sum_i shii_{i,h})(1 - MPS_h) HWDTAX (1 - TINS_h) YI_h \end{aligned} \tag{14}$$

where α is the budget share of each good demanded, C_{min} the subsistence consumption, EH the household consumption expenditure, $TINS$ the direct tax rate and MPS the marginal propensity to save for domestic non government institution, that is, households and firms, $HWDTAX$ is the household waste disposal tax, while YI is the household income and $shii_{i,h}$ the share of net income. There are 6 categories of household by income class. This aggregation reflects the base data structure and is utilized to assign different elasticities of substitution to each class.

The model distinguishes the commodities in two types: market commodities, which are purchased at market prices and home commodities, which are produced in the domestic market and valued at their opportunity costs. For this reason, we need two different equations for the two different types of expenditure utilized.

$$\begin{aligned} PQ_c * QH_{c,h} &= PQ_c * \gamma^m_{c,h} \\ &+ \beta^m_{c,h} * (EH_h - \sum_{c'} PQ_{c'} * \gamma^m_{c',h} \\ &- \sum_a \sum_{c'} PXAC_{a,c'} * \gamma^h_{a,c',h}) \end{aligned} \tag{15}$$

Equation (15) shows households expenditure in market commodities. QH represents the market goods, PQ is the price of composite good, and $PXAC$ is the domestic price that determines the optimal quantity of product from each activity. As regards expenditure in home commodities, it is a function of total household consumption calculated at their opportunity cost, that is at the activity-specific producer price (Dervis, De Melo, Robinson, 1982).

2.4 Government Revenues and Savings

A way of regarding government role consists of looking at its function as a resources allocator. Government is also a producer of public goods and, in the meantime, a consumer that demands public goods and investment.

In particular, government derives income from its endowment of capital and taxes (direct and indirect); this means that total government revenue is basically the sum of revenues which come from taxes (on institutions YI, on factors YF, on value added $(PVA_a * QVA_a)$, on activities $(PA_a * QA_a)$, on sales $(PQ_c * QQ_c)$, on imports $(QM_c * EXR)$, on exports $QE_c * EXR$), factors $YIF_{gov,f}$ and transfers from the rest of the world $(trnsfr_{gov,row} * EXR)$.

$$\begin{aligned} YG \; &= \textstyle\sum_i (TINS_i * YI_i) \\ &+ \textstyle\sum_f (tf_f * YF_f) \\ &+ \textstyle\sum_a (tva_a * PVA_a * QVA_a) \\ &+ \textstyle\sum_a ((ta_a + TA2_a) * PA_a * QA_a) \\ &+ \textstyle\sum_c (tm_c * pwm_c * QM_c) * EXR \\ &+ \textstyle\sum_c (te_c * pwe_c * QE_c) * EXR \\ &+ \textstyle\sum_c (tq_c * PQ_c * QQ_c) \\ &+ \textstyle\sum_f (YIF_{gov,f}) \\ &+ \textstyle\sum_{f,a} (TFA_{f,a} * WF_f * WFDIST_{f,a} * QF_{f,a}) \\ &+ trnsfr_{gov,row} * EXR \end{aligned} \tag{16}$$

Government consumption demand is a fixed quantity, whose main component is represented by the services provided by the government labor force.

$$QG_c = \overline{GADJ} * qbarg_c \tag{17}$$

In the equation, $\overline{GADJ}$ is government consumption adjustment factor which is defined as an exogenous variable; in fact, government consumption demand, QG_c is computed at the base year quantity demand, $qbarg_c$.

As equation (17) shows, it has been decided to keep the government quantity of consumption fixed, in order to keep a fiscal neutrality, that means that private utility (the utility index of private consumption) has little meaning if government consumption changes. As an example, an increase in government consumption will use real resources that will reduce private utility because those resources are then unavailable for private consumption, but the increased provision of public goods itself increases welfare. Without specifying a social welfare function that models how welfare is determined from private utility and government consumption, it is important to keep government consumption constant. Therefore, any increase or reduction in real government revenues is transferred to or from the government. The direct consequence is that private utility can be used as a proxy of social welfare.

2.5 Waste System

The model presents three types of waste goods: urban waste *consumed* by household, and dangerous and special waste produced and consumed by firms.

As previously discussed, modeling moves from the assumption that pollution forces the optimal choice made, in the utility maximization process, by the consumers and, in the profit maximization process, by the producers. The government has at its own disposal two types of possible interventions, not necessarily mutually exclusive, to adjust this market bias: (i) to use its taxation power to introduce a tax on waste emission that is directly linked to the production. In this case. the tax puts on firms and on households concerned with urban waste; (ii) to impose a compulsory waste disposal to be paid by firms. In particular, waste emission tax $WTAX$ is defined as:

$$WTAX_{w,c} = trw_w * QD_c(1 - DS_w)qw_w \tag{18}$$

where trw_w is the tax rate of waste emission, DS_w the quantity of disposal waste from each sector and qw_w the waste emission from each sector. The waste disposal cost $WCOAST$ is defined as:

$$WCOAST_{w,c} = PW_w * qw_w * QD_c * DS_w \tag{19}$$

where PW_w is the price of waste emission.

2.6 Markets

In the model, there are three types of market goods: the domestic market goods, the market of extra regional goods, (those from the rest of Italy), and the market of goods from the rest of the world.

Exports, extra regional goods and goods from the rest of the world, are represented by a CET function.

All the three markets are in an equilibrium modelled by:

$$QQ_c = \sum_a (QINT_{c,a}) + \sum_h (QH_{c,h}) + QG_c + QINV_c + qdst_c + QT_c \tag{20}$$

where QQ_c is the composite goods supply which is function of the intermediate use $QINT_{c,a}$, the household consumption $QH_{c,h}$, the government consumption QG_c, the fixed investment $QINV_c$, the stock change $qdst_c$ and the trade input use QT_c. In particular the composite goods supply pushes demands for domestic markets, extra regional markets and the rest of the world markets.

2.7 Model Calibration

So far, the structure of this regional environmental model has been described. At this level, the paper doesn't long for describing each individual equation involved in the model, but just to focus and emphasize its state of art.

The modeling process doesn't concern the definition of a system of equations that describes the relations among the economic agents in the markets, but, instead, a sequence of steps which are described in the following Figure 3.

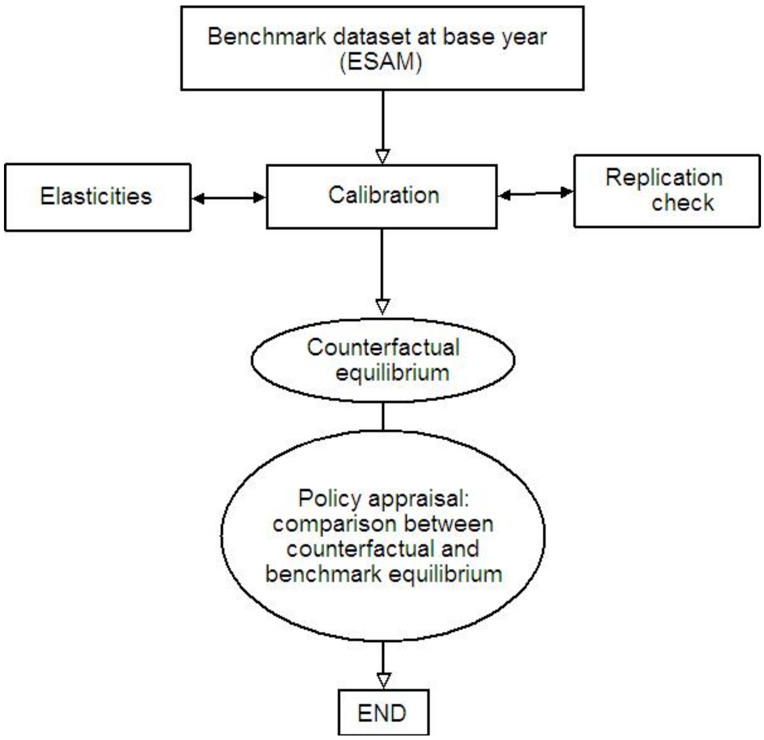

Figure 3: CGE Modelling Process

The first step consists of using a dataset, which should be micro consistent, since it is assumed that the economy is in equilibrium (Mansur, Whalley, 1984). This is what in the literature is called *benchmark dataset*. In the present regional model, the benchmark equilibrium is represented by the 2005 RESAM for Sardinia, reported in Tables 1 and 2.

In the second step, the parameters of the model are chosen by a *calibration procedure* to support the benchmark equilibrium. After selection of the functional forms, previously described, the RCE model for the parameters which allow to reproduce exactly the RESAM must be solved.

This phase involves a point estimation without degree of freedom because the parameters are computed starting from the benchmark equilibrium. In particular, by considering the CES production function:

$$QY_a = \alpha_a[\delta_a QK_a^{-\rho_a} + (1-\delta_a)QL_a^{-\rho_a}]^{-\frac{1}{\rho_a}} \tag{21}$$

In (21), α_a is a constant defining the unity of measurement, δ_a is the share parameter, $\sigma_a = 1/(1+\rho_a)$ is the elasticity of substitution. One can take all the data one needs; from the RESAM the values of QK_a and QL_a, calculate the factor tax rates t_a^K and t_a^L, and know the prices associated with the dataset equilibrium. In this case the values of the share parameters are obtained from:

$$\delta_a = \left[\frac{QK_a^{1/\sigma_a}(1+t_a^K)}{QL_a^{1/\sigma_a}(1+t_a^L)}\right] / \left[1 + \left(\frac{QK_a^{1/\sigma_a}(1+t_a^K)}{QL_a^{1/\sigma_a}(1+t_a^L)}\right)\right] \tag{22}$$

This procedure has been used for the complete benchmark equilibrium dataset to generate the parameter values for production and demand functions (*replication check*). In this way, the equilibrium computed by the model replicates exactly the benchmark dataset. As underlined earlier, this procedure produces a non stochastic determination of the parameters values.

The calibration process needs also elasticity values which are usually taken externally or, in the best case, estimated. In this case, substitution elasticities are taken from the existing literature wherever possible. In particular, on the demand side the elasticities of substitution between commodities by household are set at different values for the different classes of income; Armington elasticity of substitution between domestic and the two types of imported goods is set at 0.6, which allows a level of substitutability relatively small. On the supply side, the elasticity of substitution between domestic and exports is set at 1.25.

At this level, the modeling process continues with the *counterfactual experiment*: the parameters can be used to solve alternative equilibrium for policy experiments. The last step allows to evaluate the effect of the policy experiment comparing the benchmark and the counterfactual equilibrium.

2.8 Conclusion

This paper has dealt with the impact of environmental problems caused by pollution to the economic system of the Italian region Sardinia.

This impact has been regarded in the framework of a RCE model, in order to verify the weight of environmental damage in the economic development and the interrelationships among all the concerned agents operating in the regional economic system.

The RCE model has been purposively specified as one consisting of a price system, a production system, household consumption and saving, government revenue and saving, waste system and markets. It has been basically regarded from the fiscal point of view, in an attempt to analyze the potential of tax in designing a proper regional economic-environmental policy.

The RCE model has been calibrated on the base of a 2005 RESAM for Sardinia by means of GAMS software.

The equations presented and discussed are the most significant for the understanding of the model, which is composed by a number of other formal relations that are not presented here, but will represent object of analysis and discussion in an extended version of the paper.

Table 1: Sardinia ESAM

	Production	Abatement Sector	Factors	Institutions	Env. subsidies	Invest.	Env. Invest.	ROW
Production	Intermediate inputs	Intermediate inputs for Abatement		Consumption		Investment	Environmental investment	Export
Clean up	Payment for clean up services			Consumption of clean up services				
Factors	Factor payment	Factor payment						Factor Income from ROW
Institutions			Income to Institutional sectors	Transfers	Subsisidies			Transfer from ROW
Environmental Subsidies	Subsidies	Subsidies						
Investment	Depreciation			Institutional Savings				Foreing savings
Environmental Investment								
ROW	Imports		Factor Income to ROW					

Table 2: Sardinia ESAM

	Description	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
1	Agricolt., fishes and link fac.	175	0	464	5	0	16	1	1	47	5	16	0	0	0	730	0	0	0	0	0	0	0	0	0	53	66	57	97	27	43	0	1	1	0	0	797	6	1880
2	Mining	0	23	2	1023	1	63	197	25	0	1	1	0	0	0	1336	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	167	18	1536
3	Food, drink and tabacco	122	0	355	28	0	3	0	0	367	5	33	0	0	0	913	0	0	0	0	0	0	0	0	0	280	347	294	507	142	224	0	5	0	0	0	945	145	3805
4	Coke, Petroleum and Chemical	68	16	14	711	20	198	121	55	371	83	466	3	8	0	2134	0	0	0	0	0	0	0	0	0	78	135	110	207	72	78	0	0	0	0	0	968	1530	5312
5	Machinery and equipm. transp.	4	9	13	23	227	43	25	131	315	70	155	3	11	0	1029	0	0	0	0	0	0	0	0	0	74	129	141	261	104	139	0	0	1971	23	0	459	79	4416
6	Other manufacturing	11	25	107	127	244	1074	16	909	310	150	148	5	15	0	3141	0	0	0	0	0	0	0	0	0	156	282	275	514	196	312	0	0	301	0	0	1560	306	7034
7	Electr., gas and water supply	33	19	41	111	17	197	267	25	242	62	145	0	1	0	1160	0	0	0	0	0	0	0	0	0	105	122	118	178	59	83	0	5	0	0	0	40	0	1870
8	Construction	0	1	3	7	4	17	120	414	62	38	208	1	2	0	877	0	0	0	0	0	0	0	0	0	4	4	4	6	3	4	0	0	2845	0	0	21	0	3770
9	Wholes., retalil, hotels and cater.	84	26	273	276	112	365	46	192	1144	405	355	5	17	0	3300	0	0	0	0	0	0	0	0	0	638	948	1303	2283	849	960	0	27	494	0	0	258	594	11655
10	Finan. Interm., R and D, other busin.	81	25	123	170	117	304	72	291	1517	2002	1272	18	55	2	6049	0	0	0	0	0	0	0	0	0	86	160	153	397	120	210	0	360	352	0	0	194	24	8101
11	Other activities	1	8	8	16	12	33	7	26	408	286	624	4	12	0	1445	0	0	0	0	0	0	0	0	0	479	523	556	794	360	427	0	6948	103	0	0	299	54	11993
12	Urban waste disp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	10	9	13	8	13	0	19	2	0	0	0	1	79
13	Special waste disp.	0	0	3	123	0	48	40	0	12	0	0	0	16	0	242	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	245
14	Special dangerous waste disp.	0	0	0	3	0	3	0	0	1	1	1	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
15	Total intermediate inputs	584	150	1406	2624	754	2368	914	2069	4793	3110	3426	39	136	4	22377	0	0	0	0	0	0	0	0	0	1958	2726	3020	5257	1940	2493	0	7365	6083	23	0	5708	2757	61705
16	Labour income	208	66	122	159	135	427	149	434	1928	1031	3535	14	44	2	8254	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8253
17	Self-employed income	288	0	97	3	39	179	0	272	1194	225	529	2	6	0	2834	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2835
18	Capital income	168	23	20	215	85	196	229	428	1787	1494	2838	3	11	0	7497	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7497
19	Actual and imputed social contr.	20	29	48	59	46	155	69	156	502	304	1377	3	10	0	2778	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2781
20	Self-employed social contr.	65	0	10	0	4	21	0	35	134	30	49	0	1	0	349	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	350
21	Taxes on production	7	3	294	653	5	6	110	43	2	373	3	3	8	0	1510	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1510
22	Subsidies on product	-103	-134	-41	-2	-15	-196	-21	0	-735	0	-1316	0	0	0	-2563	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-2565
23	VAT	15	0	130	136	68	180	84	195	663	204	30	1	3	0	1709	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1712
24	Additional waste payments	0	0	-1	-122	0	-50	-39	1	-2	45	32	10	16	1	-108	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-108
25	9300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	855	0	859	288	0	0	0	0	0	14	0	0	0	0	0	116	756	0	0	0	0	10	2899
26	9300-12400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	938	337	1112	316	42	0	0	0	0	0	33	0	0	0	0	267	1737	0	0	0	0	24	4807
27	12400-15500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	435	1099	890	147	136	0	0	0	0	0	0	14	0	0	0	117	759	0	0	0	0	11	3607
28	15500-24800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3271	535	1822	1102	66	0	0	0	0	0	0	0	23	0	0	189	1232	0	0	0	0	17	8258
29	24800-31000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1116	230	542	376	28	0	0	0	0	0	0	0	0	7	0	58	379	0	0	0	0	5	2742
30	over 31000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1638	634	715	552	78	0	0	0	0	0	0	0	0	0	6	52	336	0	0	0	0	5	4015
31	Corporations	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	890	0	0	0	0	0	0	82	90	42	315	108	158	179	44	0	0	0	0	64	1972
32	Government	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	667	0	0	1510	-2565	1712	-108	339	330	35	1232	414	571	885	2721	7578	0	125	0	21	15467
33	Investment	258	137	164	131	48	241	324	103	797	623	1247	2	6	0	4081	0	0	0	0	0	0	0	0	0	499	1619	490	1403	265	774	47	0	0	-23	0	1719	2784	13661
34	Environmental investment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	Taxes on imports	3	0	14	22	67	17	0	0	0	0	0	0	0	0	123	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	125
36	Interegional Imports	204	206	1158	781	1434	2584	33	21	283	564	155	1	2	0	7426	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7426
37	Foreing Imports	166	1055	384	652	1744	906	17	12	311	96	88	1	2	0	5434	0	0	0	0	0	0	0	0	0	7	7	3	26	9	13	62	139	0	0	0	0	0	5697
38	Total	1880	1537	3805	5311	4415	7035	1870	3770	11655	8100	11993	79	245	9	61704	8253	2835	7497	2781	350	1510	-2565	1712	-108	2899	4807	3607	8258	2742	4015	1972	15467	13660	0	125	7425	5697	154645

Endogenous Variables

PM_c	$Import\ price\ (domestic\ currency)$
EH_h	$Consumption\ spending\ for\ household$
EXR	$Exchange\ rate\ (LCU\ per\ unit\ of\ FCU)$
$HWDTAX$	$Household\ waste\ disposal\ tax$
MPS_i	$Marginal\ propensity\ to\ save\ for\ domestic\ non$ $government\ institution\ (exogenous\ variable)$
PD_a	$Activity\ price\ (unit\ gross\ revenue)$
PE_a	$Export\ price\ (domestic\ currency)$
PM_c	$Import\ price\ (domestic\ currency)$
PQ_c	$Composite\ commodity\ price$
PVA_a	$Value-added\ price\ (factor\ income\ per$ $unit\ of\ activity)$
PX_a	$Average\ price\ of\ output$
$PXAC_{a,c}$	$Producer\ price\ of\ commodity\ c\ for$ $activity\ a$
QD_c	$Quantity\ sold\ domestically\ of\ domestic\ output$
QE_c	$Quantity\ of\ exports$
$QF_{f,a}$	$Quantity\ demanded\ of\ factor\ f\ from\ activity\ a$
$QH_{c,h}$	$Quantity\ consumed\ of\ commodity\ c\ by\ household\ h$ $of\ commodity\ c\ from\ activity\ a\ for\ household\ h$
$QINTA_a$	$Quantity\ of\ aggregate\ intermediate\ input$
$QINT_{c,a}$	$Quantity\ of\ commodity\ c\ as\ intermediate\ input\ to\ activity\ a$
$QINV_c$	$Quantity\ of\ investment\ demand\ for\ commodity$
QM_c	$Quantity\ of\ imports\ of\ commodity$
QQ_c	$Quantity\ of\ goods\ supplied\ to\ domestic\ market\ (composite\ supply)$
QVA_a	$Quantity\ of\ (aggregate)\ value-added$ $commodity\ c\ from\ activity\ a$
$TINS_i$	$Direct\ tax\ rate\ for\ institution\ i(i \in INSDNG)$
$WTAX_{a,w}$	$Waste\ emission\ tax\ by\ activity\ for\ each\ waste\ type$
$WCOST_{a,w}$	$Waste\ abatement\ cost\ by\ activity\ for\ each\ waste\ type$
YF_f	$Income\ of\ factor\ f$
YG	$Government\ revenue$
YI_i	$Income\ of\ domestic\ nongovernment\ institution$
$YIF_{i,f}$	$Income\ to\ domestic\ institution\ i\ from\ factor\ f$

Exogenous Variables

$\overline{CPI}$	$Consumer\ price\ index$
	$(= 0\ for\ base;\ exogenous\ variable)$
$\overline{GADJ}$	$Government\ consumption\ adjustment\ factor$
$\overline{IADJ}$	$Investment\ adjustment\ factor$
$\overline{SUB}$	$Government\ subsidy$

Parameters

α_a^a	$Shift\ parameter\ for\ top\ level\ CES\ function$
α_c^q	$Shift\ parameter\ for\ Armington\ function$
α_c^t	$Shift\ parameter\ for\ CET\ function$
α_a^{va}	$Shift\ parameter\ for\ CES\ activity\ production\ function$
	$home\ commodity\ c\ from\ activity\ a$
$\beta_{c,h}^m$	$Marginal\ share\ of\ household\ consumption\ on\ market\ commodity\ c$
$cwts_c$	$Weight\ of\ commodity\ c\ in\ the\ CPI$
δ_a^a	$Share\ parameter\ for\ top\ level\ CES\ function$
δ_c^q	$Share\ parameter\ for\ Armington\ function$
δ_c^t	$Share\ parameter\ for\ CET\ function$
$\delta_{f,a}^{va}$	$Share\ parameter\ for\ CES\ activity\ production\ function$
	$from\ activity\ a\ for\ household\ h$
$\gamma_{c,h}^m$	$Per-cap\ subsistence\ consumption\ of\ marketed\ commodity\ c\ for\ hhd\ h$
$ica_{c,a}$	$Quantity\ of\ c\ as\ intermediate\ input\ per\ unit\ of\ activity\ a$
	$produced\ and\ sold\ domestically$
pwe_c	$Export\ price\ (foreign\ currency)$
pwm_c	$Import\ price\ (foreign\ currency)$
$qbarg_c$	$Exogenous\ (unscaled)\ gonernment\ demand$
qw_w	$Coefficient\ for\ waste\ emission$
$shii_{i,i'}$	$Share\ of\ net\ income\ of\ i'\ to\ i\ (i' \in INSDNG';i \in INSDNG)$
ρ_a^a	$CES\ top\ level\ function\ exponent$
ρ_c^q	$Armington\ function\ exponent$
ρ_c^t	$CET\ function\ exponent$
ρ_c^{va}	$CES\ activity\ production\ function\ exponent$
ta_a	$Tax\ rate\ for\ activity\ a$
te_c	$Export\ tax\ rate$
tf_f	$Direct\ tax\ rate\ for\ factor\ f$
tm_c	$Import\ tariff\ rate$
tq_c	$Rate\ of\ sales\ tax$
$trnsfr_{i,f}$	$Transfer\ from\ factor\ f\ to\ institution\ i$
trw_w	$Tax\ rate\ of\ waste\ emission$
tva_a	$Rate\ of\ value-added\ tax\ for\ activity\ a$

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