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Efficiency in the Use of Natural Non-renewable Resources and Environmental Federalism in Italy. Evidence from Regional Management of Mining and Quarrying

Provisional Version, not for quotation

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Abstract

The separation of powers and responsibilities has evolved over time in Italy given that political reasons have been pushing towards a greater decentralization since last twenty years. Under environmental federalism issues, an interesting case of study - capable of being empirically treated - is the attribution of power to the Regional governments over the management of mining and quarrying. This process, however, is started in the '70s with the Presidential Decree N. 616 of 1977. By examining Regional Laws, this paper highlights how misleading is the perception of policy makers, of the real value of raw mineral resources domestically extracted that seem closer to *common goods* rather than to *public goods*. By using official statistics, the aim of our econometric analysis is to verify both the existence of an inverse supply curve between mining and quarrying domestic producer price index - considered as dependent variable - and no-energy producing mineral quantity extracted and the effect of Italian Regions Responsibility about mining and quarrying activity on mining and quarrying domestic producer price index, controlling for construction sector value added, R&D national expenditure and Openness to international trade in the period 1980-2009.

JEL classification: H41, H7, Q3

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1. Introduction

The separation of powers and responsibilities between the central government and the local governments, which involves financing, regulation and administration, may be welfare improving if responds to some principles. Namely, as it is well established in the specialized literature, national public goods whose benefits accrue to all citizens in a country, have to be provided by the central government to reach efficiency.

When local public goods are concerned, i.e. benefits are limited to citizens living in a locality, the presumption is less clear since their provision can be assigned either to central or to local authorities. Since the seminal article by Tiebout (A Pure Theory of Local Expenditure, Journal of Political Economy 1956), we know that competition among local governments may lead to efficiency in the provision of local public goods. Environmental public goods are no exception to the efficiency rules in their provision; they simply require great attention in defining them as local, national and international ones.

The division of responsibilities evolves over time and as it is now the case in Italy, political reasons are pushing towards a greater decentralization. In this paper we first investigate whether some features of environmental federalism are actually already in place in our country. We found as an interesting case of study, capable of being empirically treated, the attribution of powers to the regional governments over the management of mining and quarrying. This process, however has been taking place since the ’70s with the Presidential Decree N. 616 of 1977.

The case of mining and quarrying no-energy producing minerals activity, that we have investigated, is particularly interesting both from a theoretical point of view and an empirical one. From the point of view of the governance theory, it represents an application of a non-renewable natural resource optimal use combined with an application of how to treat externalities or how to protect the environment. From an empirical point of view, this sector may play a non marginal role in our country especially for its linkage with a *heavy sector* such as the construction sector and its economic development in the last thirty years.

Furthermore it highlights how misleading is the perception of the policy makers, about the value of such non-renewable resources. In other words, raw materials extracted seem closer to the definition of “*common goods”* rather than to “*public good”*. This is particularly true if we consider how these raw materials have been managed by Italian Regions for several years and how low has been the value assigned to these goods reflected in very low licenses’ costs.

On the other hand only a correct awareness of these non-renewable resources as public goods can help choosing the appropriate government level to which management responsibilities should be assigned.

In order to verify to what extent the management of local public goods, such as mineral resources, by local governments in Italy has been efficient/ inefficient so far, we have run an econometric analysis by combining official statistic data on mining and quarrying production with data on local governance. As shown in the paper, we analyze on the one hand the existence of an inverse supply curve between mining and quarrying domestic producer price index (considered as dependent variable) and no-energy producing mineral extracted quantities; on the other hand we analyze the effect of Italian Region Responsibility about mining and quarrying activity on mining and quarrying domestic producer price index in the last thirty years (controlling for quantities of construction minerals extracted from the national territory, construction sector value added, R&D National Expenditure and Openness to International Trade).

As regards variables used to construct our data set, they are drawn from ISTAT and Eurostat data sets, since they are well known and easily available. We have had to develop a variable about Italian Region Responsibility on the bases of regional legislation, as we will describe later on in the paper. Data cover the period between 1980 and 2009 although some data are missing.

2. Regional legislation on quarries and mines: a brief historical perspective

Going back to the legislative starting point represented by the Royal Decree 29 July 1927 N. 1443 and arriving at both the Presidential Decree N. 616/77 and the Legislative Decree N. 112/98, which have transferred the administrative and legislative functions relating to subject quarries, peat bogs and mines from the State to the Regions[4], and taking into account regional laws, we analyse whether this feature of environmental federalism has had a positive effects on the conservation and management of Italian mining and quarrying raw minerals (Sertorio 2002 and 2004).

Since the late ’70, regional laws have been approved with the aim of trying to regulate this sector activities which have had so important implications for the landscape alterations. Moreover, from the boom economic period and over twenty years, Italy has lived a great urbanization

[4] A legislative competence of the Regions with respect some fields emerged from the reform of the Title V of the Italian Constitution (Constitutional Law n. 3/2001).

development and considerable amount of materials has been required to construct residential and no-residential buildings.

By analysing the legislation on mining and quarrying in each of the Italian Regions it emerges a fragmented , heterogeneous and incomplete setting (Sepe 2007). Many areas of Italy are lacking adequate regulation as well as a Plan for the management of the use of raw materials and for protection of the territory. According to the law, Regions have to produce and make available to the citizens their Regional Program of Development (in harmony with the objectives of national economic planning and with the assistance of lower level local authorities according to the conditions' set by the regional statutes). Such Programs must include a specific Regional Plan of Extractive Activities (called PRAE) in order to efficiently manage the extraction sites at every stages from the recognition identification phase to the exploitation and remediation ones. After the introduction of legislation autonomy, each Region shows its ability in managing and using natural resources as well as in protecting the quality of their territory through time (Giordanengo 2003).

After thirty years of experience, we should be able to draw some conclusions the most important of which could be the presence of a heterogeneous system among Italian Regions.

Table 1 summarizes the most important Regional Laws on mines and quarries updated to year 2010: a variegated picture comes out, not necessarily reproducing the well known dualism among northern and southern Regions.

At a first sight, the result is not too much comforting. The ability of local institutions in managing efficiently natural resources is bound to some Italian Regions, while there are still nine Regions where PRAE is lacking: Piemonte, Veneto, Friuli Venezia Giulia, Abruzzo, Molise, Campania, Basilicata, Calabria, and Sardegna. In particular the South of Italy appears devoid of defined rules and regulations despite the presence of substantial exploitation of these non-renewable natural resources. As a matter of fact Italian southern local administrations do not identify the sites where it is allowed to extract raw materials, or the amount and the typology of resources should be extracted from mines and quarries. Puglia is the only Region in the south of Italy which has PRAE while in Campania the approved PRAE was deleted by TAR (Regional Administrative Court) in 2008, just two years after its issuing with a regional law. As Sicily is concerned, it is important to

Table 1. Main legislation on quarries and mines in the Italian Regions

Regions	Regional Law	Quarry Plans adoption

Piemonte	L.R. 69/1978 – L.R. 44/2000	NO Provincial Plans which must follow the DPAE (Programming Document of Extractive Activities) are adopted only in three Provinces
Valle d'Aosta	L.R. 44/1982 – L.R. 15/1996 – L.R. 17/2008	Three Plans referring to different typologies of material
Lombardia	L.R. 14/1998	Provincial Plans (PPAE) adopted in all Provinces
Provincia Autonoma di Trento	L.P. 7/2006	Provincial Plan
Provincia Autonoma di Bolzano	L.P. 32/1976 – L.P. 7/2003 – L.P. 10/2009	Provincial Plan
Veneto	L.R. 44/1982 – L.R. 15/1983	NO
Friuli Venezia Giulia	L.R. 35/1986 – L.R. 25/1992 – L.R. 6/2011	NO within one year after entry into force of the L.R. 6/2011 (25 May), upon Regional Council Resolution, PRAE will be approved by Decree of President of Region
Emilia Romagna	L.R. 17/1991 – L.R. 20/2000	Provincial Plans
Liguria	L.R. 12/1979 – L.R. 21/2001	YES
Toscana	L.R. 78/1998	YES and Provincial Plans
Umbria	L.R. 2/2000 – L.R. 34/2004	YES
Marche	L.R. 33/1999 – L.R. 15/2003	YES and Provincial Plans
Lazio	L.R. 27/1993 – L.R. 17/2004 and Regional Council Resolution 20/04/2011	YES as the recent PRAE approval in 2011, Provinces have one year to adjust the Territorial Plans
Abruzzo	L.R. 54/1983 – L.R. 8/1995	NO
Molise	L.R. 11/2005	NO
Campania	L.R. 54/1985 – L.R.17/1995	NO PRAE approved by Region in 2006 was canceled by TAR in 2008: is currently subject to litigation
Puglia	L.R. 37/1985 – L.R. 21/2004	YES
Basilicata	L.R. 12/1979 (modified with L.R. 17/2005)	NO
Calabria	L.R. 40/2009	NO
Sicilia	L.R. 127/1980 – L.R. 19/1995 (modified in 1999) – Decree of President of Region 5/11/2010	YES
Sardegna	L.R. 30/1989 – L.R. 28/1991	NO

Source: "Bollettino Ufficiale delle Regioni" - Regional Laws and Provincial Laws

notice that the PRAE actually pays no attention to very relevant aspects of the administrative *iter* such as pre-impact assessment and consistency check with the management Plans of Nature Network 2000 (European Commission 2010). The Lazio Region has finally approved its PRAE on April 2011 which allows to extract a large amount of raw materials, confirming the leader position of this Region in the domestic production of quarrying raw materials (Legambiente 2008 and 2011).

Focusing on the group of Regions that have already approved their PRAE, we observe the huge time gap between the national law (Presidential Decree N. 616/77), with which responsibilities for quarries and mines are assigned to local governments, and the issuing of regional laws (Sertorio 2002 e 2004). As already underlined, the process has started in the second half of the '90s with only three Regions involved in the deliberation and adoption of a defined Regional Plan on Extractive Activities (Valle d'Aosta, Lombardia, and Toscana). It is necessary to wait until year 2004 to have ten Regions and year 2011 to have a total of thirteen Regions adopting a Quarry Plan.

3. Raw minerals extracted are treated as common or public goods?

Considering non-renewable natural resources as public goods can be the appropriate method for selecting the most efficient government level to which mining and quarrying management responsibilities should be assigned. To assess whether the transfer of responsibilities to the Regions has improved efficiency in natural resources use and environmental conservation, as expected by the legislator, we separate the issue of considering mining and quarrying raw materials to be national or local public goods, from the problem of the externalities produced by mining and quarrying activities. In fact, the latter are local in nature and need to be cared for by local institutions which are supposed to be more efficient at implementing local policies because of their closeness to the problems of their land and citizens. With this distinction in mind and making use of administrative data and information mostly drawn by legislative acts of local governments, our study explores in more detail several empirical local evidences to check whether raw minerals extracted are economically treated as *common goods* or *public goods*.

To this end, we started from reviewing regional legislations which regulates the *licences* for the cultivation of mining and quarrying. As far as local environmental taxes in Italy are concerned, it is interesting to underline that not all taxes are taken into consideration in official statistics. There are several local taxations which currently have no place in Environmental Taxation Reports, despite their importance. An example could be the "Regional Tax on State licenses on domain properties and unavailable assets" (Law. 281/70 and Dlgs. 230/91). It is applied on licenses for the

occupation and use of State properties and unavailable assets: cultivation of quarries and mines, coastal and forest area properties of the State. In theory, the license fees have a para-commutative nature of payments tied to the benefits obtained, in this case gains can derive from activities connected with the use of granted Government property (Zatti 2011).

This is a category of revenue with intermediate characteristics between "proper fees" and "traditional taxes". In a decentralized fiscal system in which externalities exist at the local level and in which sub-national governments have the power to provide local public services and to choose tax instruments, theory suggest that is better to give the control of environmental tax to local governments. Moreover, license fees for the cultivation of mining and quarrying also have the nature of regulation tool because through this mechanism, local governments can restrict and control activities that could have important effects on the landscape and the environment. In fact, license and fee structure intend to reduce the incentive – as in Pigouvian theory – on taking hazardous behaviours affecting negatively the environment and the enforcement of environmental protection.

By analysing recent Regional Deliberations, we collected data and information concerning the current fees - by type of mining and quarrying material - to be paid, obtaining licences in each Region. Fees mainly consist of tariffs of the right of excavation per cubic meter of inert material extracted to be charged by mining firms. We have considered mining and quarrying construction minerals (such as sand, gravel, clay and peat) separated from ornamental stones (such as marble, travertine, porphyry etc,) because of the higher unit value of latter materials (Table 2). Only in two cases tariffs are proportional to the area of the mine (Autonomous Province of Trento and Puglia). Until now conditions contained in such acts appear clearly not to reflect the value of virgin material and its scarcity. Surprisingly, we have found that at date some Regions allow companies to extract materials for free (Valle d'Aosta, Basilicata, Calabria, Sicilia and Sardegna).

However, even if there is a tariff on the quantity extracted to be paid to Regions, the level is so low to be impossible to consider it as an appropriate raw mineral price. In the majority of Regions license fees of inert material are very low. As license fees don't reflect the scarcity of these non-renewable resources, local governments leave most of the rent to the licensed firms, although they know the importance for local institutions to be financial self-sufficient by looking for own financial resources. Benefits resulting from the exploitation of local public resources are subtracted to communities and for this reason also a principle of social fairness appears threatened.

Table 2. Current License Fees (€/m3) and the existence of Plans for Environmental Recovery of abandoned quarries in the Italian Regions

Regions	License fees*		Existence of Plans for Environmental Recovery
	sand and gravel, limestone, clay, peat	ornamental stones	
Piemonte	0.51	0.78	NO
Valle d'Aosta	0.30	FREE	NO
Lombardia	0.72	3.50	YES
Provincia Autonoma di Trento	Licenses fees decided on the basis of the size of the quarry		YES
Provincia Autonoma di Bolzano	0.53	0.55	NO
Veneto	0.53	0.75	YES
Friuli Venezia Giulia	0.47	0.65	NO
Emilia Romagna	0.67	unavailable	YES
Liguria	0.77	0.82	NO
Toscana	0.35	fixed by municipalities	YES
Umbria	0.39	0.45	YES
Marche	0.71	0.80	YES
Lazio	0.35	2	YES
Abruzzo	0.89	9.70	
Molise	0.58	2	YES
Campania	0.93	1.60	NO
Puglia	Licenses fees calculated on the basis of the mining area		NO
Basilicata	FREE	FREE	NO
Calabria	FREE	FREE	NO
Sicilia	FREE	FREE	YES
Sardegna	FREE	FREE	YES

Source: Regional Laws, Provincial Laws, and Administrative Acts containing data and information

* Licence fees referring to "*sand and gravel, limestone, clay and peat*" is estimated as average of the fees of these different types of materials

License and fee structure also can reduce the incentive, as in Pigouvian theory, on taking hazardous behaviors against the environment, due to regulating tools on m&q activities. Low fees instead seem to indicate the low value attributed to raw mineral and its scarcity. Some Regions allow companies to extract all materials for free and even if there is a tariff on the quantity extracted, the level is extremely low

Moreover, figures show almost half of the Regions does not require strict commitments for

extraction techniques, for waste disposal and intervention at the end of the extraction activity and finally for recovery of abandoned sites. The consequence is both an negative environmental impacts and damage to the community.

As public goods is characterized by the absence of rivalry and excludability in consumption – according by the definition proposed by Samuelson in 1954 – adequate revenues by using these non-renewable resources could be enjoyed by the entire community. In the economic theory, *common goods* are instead considered as rival but non excludable goods so that individuals do not pay for resource use and they tend to exploit them excessively. Within the rivalry hypothesis, this behavior could recall the "*tragedy of commons*" example in which natural resources are used in an inefficient way from the point of view of social welfare. The inefficiency comes from negative externalities caused by exploitation of a common resource by an agent that reduces the possibility for the rest of the community to enjoy the same natural resource and thus threatens natural environment conservation. To solve the problem Government can issue regulations and/or impose taxes. So that license and fee structure can reduce the incentive on taking hazardous behaviors against the environment.

In Italy the interest of local governments in reducing the negative externalities appears very weak and mottled distributed, as just over half of the Regions have adopted Plans for Environmental Recovery only over the last ten years. These evidences arising in the Italian Regions, from the amount of the fees and recovery plans set, allow us to think that raw materials extracted from mining and quarrying activities are treated as *common goods* and not as *public goods* because of the low value attributed to them by local governments. In Italy the handover of responsibilities from the central government to the Regional ones seems to have had so far many shadows and critical issues and not improved either conservation or efficient use of natural non-renewable resources.

4. Data on mining and quarrying activities in official statistics

In order to reach some conclusion on the inefficiency in the supply of local public goods such as mineral resources by local governments in Italy, we extend the analysis by integrating data from official statistics on mining and quarrying production with administrative data as described. Data on quantities of raw minerals extracted allows to identify the economic dimension of the quarries phenomenon and therefore to better verify in our empirical analysis if and to what extent management of local public goods can be considered inefficient.

As shown in the next paragraph, we would analyze the effect of Italian Regions Responsibility about mining and quarrying activity – i.e the capability degree of Regions in being legislative self-governing - on mining and quarrying domestic producer price index during the last thirty years, controlling for quantities of construction minerals extracted from national territory, construction sector value added, R&D National Expenditure and Openness to International Trade. The variables used in our analysis are mainly drawn from ISTAT and Eurostat datasets, while Italian Region Responsibility is a variable defined in our study on the bases of information deirved from Regional legislation. Having in mind that there are some missing data, the period of our analysis covers the years from 1980 to 2009.

Using information by Regional Laws and Resolutions, we have constructed the variable Italian Regions Responsibility, as cumulative number of Regions that have adopted a Regional Plan of Extractive Activities (PRAE) per year in the period, as a good proxy for the governance degree of mining and quarrying resource used and environmental protection. In this sense, we indirectly want to verify if the regional license fees (basic element in the calculation of revenues that local authorities can perceive from these public resources used) are decoupled from the dynamics of minerals market prices and of the construction sector in the period observed. It is necessary to clarify that statistical data on the quantities of domestic extraction of minerals are available only at national level, as regional time series are not complete and continuous in the period examined. This requires us to conduct our econometric analysis at aggregate level. Data on quantities of domestic extraction of minerals are taken from Satellite Environmental Accounts and in particular from Economy-wide Material Flows Accounts (MFA) compiled in ISTAT through estimation procedures that have been setup by exploiting information from various sources and trying to integrate them, to have a complete coverage of extraction activities concerning these materials, as described briefly below[5].

Referring to official statistics on mining and quarrying production, by law Regions have also to compile (in addition to PRAE) the Mining Public Register, as part of the Regional Information System. The Mining Public Register represents the basis for the recognition and collection of detailed data necessary for managing and monitoring mining activities in their land (i.e. locations

[5] In the ISTAT web-site, MFA Methodological Notes explain specifically the statistical procedures to calculate the item “materials extracted from quarries”, which gives on average 95% of total construction minerals’ input from domestic extraction in Italy. The remaining 5% is soil from excavation activities which is reused in construction.

and number of active and abandoned sites by Province). Production of regional statistics is also planned to be sent to Ministry of Economic Development (ex Ministry of Industry) and ISTAT (Italian National Institute of Statistics). Data are provided yearly on provincial basis through a survey named "Statistics of quarries and peat bogs" and are reported until year 1986 in a publication of the Ministry of Industry named "Report on mining and statistics of the extractive industries in Italy". The survey questionnaires contain several sections: number of active sites, employees, hours worked, accidents at works, production in quantity and in value, consumption of materials and energy, mechanical systems used. Unfortunately, the Report on mining is no more compiled after shifting the legislative powers on this activity were handed over to the Regions although the application of environmental federalism, as foreseen by law, would ensure also an improvement in information concerning extractive activity, both from a qualitative point of view and a quantitative point of view.

These data would be essential to detect dimension and characteristics of mining activities and to evaluate both economic aspects and pressures on natural environment in each Region over time, thus also being a valid informative support for economic policy decisions at local and central government. From '90s to date, the questionnaires supplying the Report mentioned continued to arrive at the Ministry and at ISTAT but the number of provinces, which provide these information, gradually decreases over time As a result, statistical data and information at regional level became over time discontinuous, incomplete and uneven in the variables investigated and in the time series, so that they cannot support the construction of the data set used in our econometric analysis.

The survey on quarries is no longer the main source of information on the phenomenon, as nowadays more complete information on quarries' production is supplied by the PRODCOM[6] (Community Production) survey that since 1997 provides structural data of industrial production on yearly basis, in accordance with the of EU Regulation N. 3924/91 containing all the provisions that Member States should follow for the statistical observation. The PRODCOM survey - part of the

[6] The questionnaire for the PRODCOM survey collects data required by the Regulations. The PRODCOM list represents the harmonized list of industrial products to detect and has been adapted to the new classification of economic activities NACE Rev. 2, which entered into force January 1 year 2008. For each item only the production made in Italy must be declared but not goods produced abroad for the company. Data must be disaggregated for each local unit of production. Multi-localized companies, characterized by the presence of two or more local units of production in the country, are required to fill out a separate questionnaire for each of them. Furthermore the companies contacted are required to respond to the survey pursuant to art. 7 of Dlgs. N. 322/89, which provides for administrative penalties for violations of this obligation, and the Decree of the President of the Republic November 15/09.

National Statistical Programme - involves all the Italian industrial companies with 20 employees and a sample of firms with number of employees between 3 and 19. As the majority of companies operating in the mining sector in Italy are characterized by a small size in terms of number of employees, not all firms of the mining sector are sampled. For this reason official statistics on mining and quarrying are significant at national level only.

It is just the availability of both these old survey's questionnaires and PRODCOM data for the last years that made an integration of the two sources possible at ISTAT (Greca G. and Vignani D. 2005). Through the methodology of the Economy-wide Material Flows Accounting (EW-MFA)[7], *physical flows of no-energy producing minerals extracted from quarries* are calculated yearly at national level (Eurostat 2001).

In the last fifteen years national official statistics have gradually provided more complete information on physical flows, required for the functioning of social-economic systems as the lack of environmental data has reduced the opportunity for studies and analysis on some specific issues related to the environment-economy interaction and growth sustainability (Costantino, Femia and Vignani 2008, Auci and Vignani 2011).

Consistently with this approach, a Satellite Accounting System of National Accounting has been constructed and adopted at international level. Within this framework, Environmental Accounting contains a system of accounts specifically dedicated to measure natural resources extracted by Nature and given back in altered forms named Material Flow Accounts (MFA).

All items of the accounts are expressed in units of weight. Italy[8] has very actively contributed and contributes to these international developments through ISTAT which began to develop EW-MFA[9] since the beginning of this decade (Femia and Vignani 2005a, 2005b, 2006a, 2006b and 2007) by compiling a system of accounts dedicated to natural resources on yearly basis, estimating

[7] The account system described is one of the main blocks of New Handbook of Integrated Environmental and Economic Accounts SEEA, that will soon be adopted as International Standard of the official statistics. Within Material Flow Accounts (MFA), Economy-wide Material Flow Accounting (EW-MFA) is now (with air emission and environmental taxation accounts) one of the three top-priorities in European Official Statistics' Environmental Accounting, which are object of EU Regulation N.691/2011. The OECD issued a 3-volumes Manual and two Council Recommendations on the matter (OECD 2004).

[8] Italy is one of the countries that has mostly supported this initiative. Importance has been given to EW-MFA as a tool for policies so that material flows-based indicators have been used in the Action Plan Strategy on sustainable development for Italy approved by CIPE in 2002.

[9] MFA time series 1980-2008 are published in www.istat.continazionali.contiambientali.

the quantities of materials moved by the Italian socio-economic system by typology, thus offering an overall view of the phenomena that give rise to environmental pressure and contribute over time to change Global morphology and terrestrial ecosystem (Valero A., Valero A. and Martinez A. 2011).

5. Descriptive findings

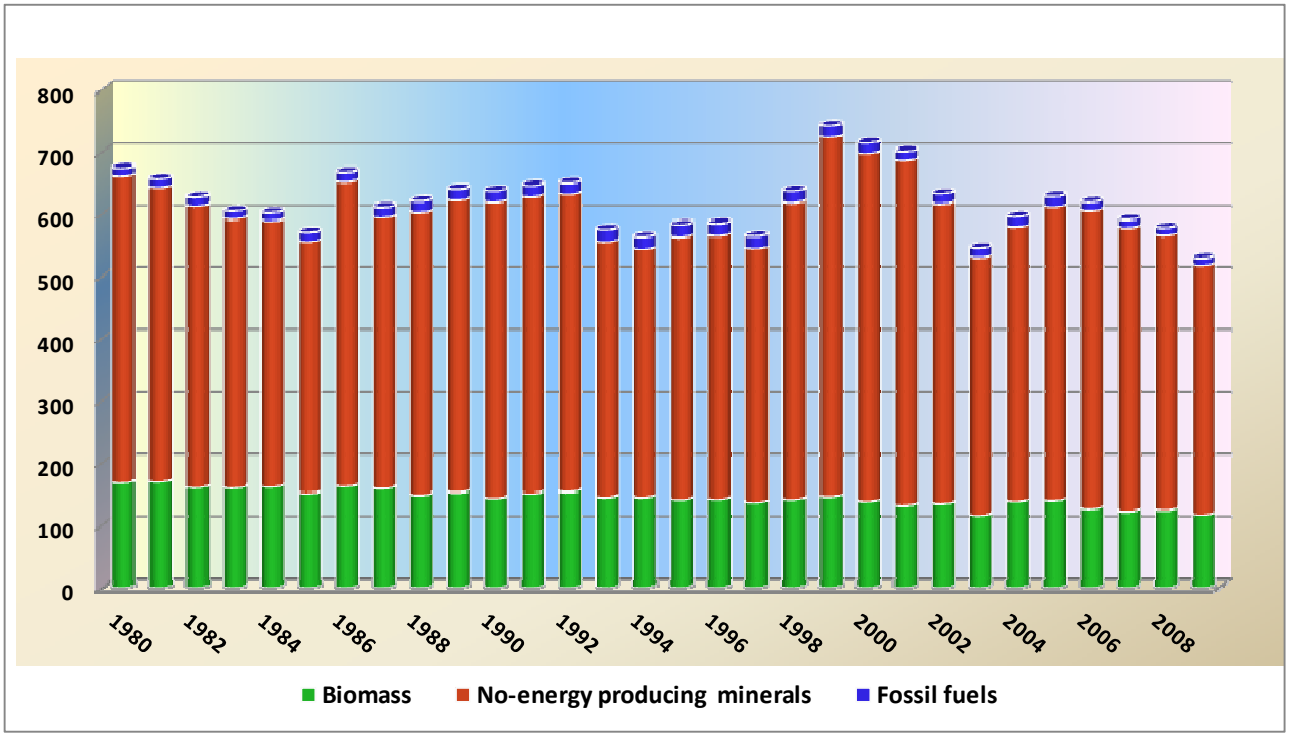
In the Material Flows Accounts (EW-MFA) one of the basic aggregate is represented by *Domestic Extraction of Material Used* (DEU). Expressed in units of weight, it accounts for all materials extracted from Natural Environment in a country, to be incorporated into products. These materials are divided into three main typologies: quantities of biomass, fossil fuels and no-energy producing minerals (Costantino 2010, Femia and Vignani 2010). Time series data of the latter item will be used in our econometric analysis renamed M&Q quantity extracted variable.

As can be seen in Figure 1, from 1980 to 2009, total physical flows are decreased almost by 21,4% although some variations occurred and a maximum point was reached in 1999 with 742 million tonnes. In particular no-energy producing minerals are, so far, the main component among materials extracted from Italian natural environment, as accounted by Domestic Extraction Used.

In the period examined, on average the quantity extracted of no-energy producing amounts to 460 million tonnes per year (Femia, Marra and Vignani 2011).

We build our sample by drawing a time series dataset of Italy from Italian National Institute of Statistics (ISTAT) and European Statistical Office (EUROSTAT) dataset. Data are collected yearly from 1980 to 2009, but with some missing data.

Figure 1. Domestic Extraction of Material Used (DEU) by components: Biomass, Fossil Fuels and No-energy producing minerals - Italy years 1980-2008 (million tonnes)



Source: ISTAT – National Accounts, Satellite Environmental Accounts

The Table 3 reports the descriptive statistics of all variables included into the estimation model. Consistently with our aim, we develop Q_Plan variable to catch the ability of Italian Regions to manage mining and quarrying sites and consequently the environmental recover of the same sites and then we select - in addition to mining and quarrying quantity and price index - the following control variables as potential determinants of mining and quarrying price: i) value added of construction sector as the main source of demand of raw materials extracted; ii) R&D expenditure as a proxy of the ability of reuse non-dangerous wastes from construction and demolition (C&D); and finally iii) openness to measure the international effect on mining and quarrying output where the domestic market is prevalent.

Table 3. Descriptive statistics

	M&Q quantity extracted	M&Q producer price index	VA Construction sector	R&D	Q_Plan	Openness
Mean	463.9886	77.23133	54511.63	12598.26	3.516129	0.3234089
p50	456.958	79.395	53594.98	12693.67	0	0.3346774
Sd	52.86304	20.47286	3896.89	2498.145	4.567063	0.1519516

Min	398.3068	41.53	49903.12	7405.46	0	0.0980347
Max	619.0599	111.64	62379.1	16400.19	12	0.5905086
N	29	30	30	30	31	31

Variable legend: ***M&Q quantity extracted****: Mining and quarrying quantity extracted (millions of tons);* ***M&Q producer price index****: Mining and quarrying domestic output price index (annual data 2005=100);* ***VA Construction sector****: Value added at base prices of construction sector (millions of euro; chain-linked volumes with reference to year 2000);* ***R&D****: R&D expenditure (millions of PPS at 2000 prices);* ***Q_Plan****: Existence of quarrying plan (cumulative number of Regions per year);* ***Openness****: National degree of Openness (the ratio between the sum of Import and Export and GDP)*

From this table we can observe that in Italy, on average, the mining and quarrying quantity extracted is about 463 millions of tonnes. The mining and quarrying producer price index shows a value (77.23) less than the based year in 2005. However, the price index of raw materials extracted increased constantly over time; this could be attributed to the characteristic of this good: a non-renewable resource. The Q_Plan variable, instead, represents the number of Italian Regions that have started to manage actively these issues, during the period analysed. In fact, before 1995 there was no Region interested in managing the mining and quarrying sites. Only after 1996 some Italian Regions start to be interested in obtaining a fee from the extraction of raw materials and in imposing environmental standards for the recovering of the abandoned sites. For this reason we can observe that on average we have only between 3 and 4 Regions and the maximum level is reached in 2010 with 12 Italian Regions.

6. The empirical model

To evaluate the effects of Italian Regions increased autonomy, namely their acquired responsibility about mining and quarrying activity, we use the mining and quarrying producer price index and estimate the following model:

$$M\&Q\ producer\ price\ index_t = \alpha_0 + \alpha_1\ M\&Q\ quantity\ extracted_t + \alpha_2\ Q\_plan_t + \alpha_3 Openness_t + \alpha_4 VA\ Construction\ sector_t + \alpha_5 R\&D_t + u_t$$

Where M&Q producer price index is the logarithm of the mining and quarrying domestic output price index based on the 2005 year; M&Q quantity extracted is the logarithm of the Mining and quarrying quantity extracted measured in millions of tonnes; Q_Plan represents the presence of Quarrying Plan (PRAE) in the different Italian Regions, constructed as described in the previous paragraphs; Openness measures the degree of openness of Italy, expressed in logarithm term; VA

Construction sector is the logarithm of the value added of the construction sector, that represents the most important sector in the use of raw materials and finally R&D is the logarithm of the R&D national expenditure, and u_t represents the error term.

As we will verified in the next paragraph, all the variables can be assumed to follow a random walk behavior with the error term u_t following a unit root distribution. So to obtain consistent estimators we will run a first difference regression, because in this way we regress a stationary variable on a stationary variable, and the classical statistical theory applies.

6.1 Results from unit root and cointegration tests

In a time-series dataset, there should be several problems both with error terms and variable behaviors. On the one hand there should be autocorrelation or serial correlation of the disturbance across periods and on the other hand there should be non-stationary in the mean because variables follow a random walk with drift.

For this reason, before estimating the model, we have to test for the presence of unit roots in our variables. In Table 4, we show the critical value of the augmented Dickey-Fuller (ADF) test for unit roots. The null hypothesis is that the variable contains a unit root (g=1), and the alternative is that the variable was generated by a stationary process (g<1).

We test all the variables of our empirical analysis by assuming that the dynamics in the data have an ARMA structure, following three different models: i) model with a lagged difference terms equals to 1 and without both intercept and trend; ii) model with a lagged difference terms equals to 1 and with an intercept, but without trend; iii) model with a lagged difference terms equals to 1 and with intercept and trend[10].

The test reveals that the majority of the variables in our analysis have unit roots in their time series dimension. In particular, the t values of the logarithm of M&Q producer price index are inferior to all critical values (10%, 5% and 1%) in the second and third model. While the ADF test is accepted for the M&Q quantity extracted only for the first and the third model considering all the critical value together. As regard the most important variable for our analysis – Q_Plan – we can observe that even in this case the unit root test is accepted in the second and in the third model with

[10] We have estimated the three models also with a lagged difference terms equals to 2. The results are very similar to those reported in Table 4.

respect to all the critical values. However, the presence of unit root is verified even in the first model if we consider the 1% critical value.

For the majority of the additional variables, which we have introduced in our specification as control variables, we identify the presence of unit roots in all specifications of the ARMA process.

Table 4. Augmented Dickey-Fuller Unit Root Test with a lagged variable of one period

		Augmented Dickey-Fuller test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
M&Q producer price index	Model with no intercept and no trend	2.075	-2.655	-1.95	-1.601
	Model with intercept, but without trend;	-1.156	-3.73	-2.992	-2.626
	Model with intercept and trend;	-3.108	-4.352	-3.588	-3.233
M&Q quantity extracted	Model with no intercept and no trend	-0.234	-2.657	-1.95	-1.601
	Model with intercept, but without trend;	-3.207	-3.736	-2.994	-2.628
	Model with intercept and trend;	-3.219	-4.362	-3.592	-3.235
Q_Plan	Model with no intercept and no trend	2.138	-2.654	-1.95	-1.602
	Model with intercept, but without trend;	1.169	-3.723	-2.989	-2.625
	Model with intercept and trend;	-1.462	-4.343	-3.584	-3.23
Openness	Model with no intercept and no trend	-3.534	-2.654	-1.95	-1.6
	Model with intercept, but without trend;	-1.509	-3.723	-2.989	-2.625
	Model with intercept and trend;	-2.643	-4.343	-3.584	-3.23
VA Construction sector	Model with no intercept and no trend	-0.296	-2.655	-1.95	-1.601
	Model with intercept, but without trend;	-2.763	-3.73	-2.992	-2.626
	Model with intercept and trend;	-3.444	-4.352	-3.588	-3.233
R&D	Model with no intercept and no trend	1.267	-2.655	-1.95	-1.601

		Augmented Dickey-Fuller test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
	Model with intercept, but without trend;	-2.518	-3.73	-2.992	-2.626
	Model with intercept and trend;	-3.408	-4.352	-3.588	-3.233

Note: The null hypothesis of the test is the existence of unit root for the variable (H_0: $\rho=1$) against the alternative of no presence of unit root (H_1: $\rho\neq1$), and thus the variable was generated by a stationary process.

Because of the presence of unit roots, we need to test whether these variables are cointegrated (i.e. share a common stochastic trend) in order to obtain meaningful regression results with estimates in levels. The test, we perform, is based on the Augmented Engle and Granger (AEG) cointegration test. The null hypothesis of this test is that the series are not cointegrated, so that if we reject the null hypothesis, we will consider that the residual is stationary, i.e. that the series are indeed cointegrated.

The test considers the cointegration of the variables included in our estimation model. We introduce one variable at time, considering three different models: i) model with intercept; ii) model with intercept and where we assume an AR(1) for the error term; iii) model with intercept and trend and an autocorrelation model for the error term.

In Table 5, the test statistics are reported for all the models considered. We can observe that the AEG test value is in the majority cases less than the three different critical values, in all the specifications considered. Thus, we can conclude that the variables of our estimation are not cointegrated among each other. For this reason we estimate our model using the first difference manipulation to reduce the variables to stationary.

Table 5. Augmented Engle and Granger Cointegration Test with a lagged variable of one period in the errors

		Augmented Engle and Granger test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
M&Q producer price index and M&Q quantity extracted	Model with intercept	-1.403	-3.7	-2.976	-2.628
	Model with intercept and autocorrelation of error	-0.726	-3.7	-2.976	-2.628

		Augmented Engle and Granger test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
	Models with intercept and trend and autocorrelation of error	-3.814	-4.34	-3.588	-3.229
M&Q producer price index and M&Q quantity extracted and Q_Plan	Model with intercept	-2.755	-4.333	-3.572	-3.205
	Model with intercept and autocorrelation of error	-2.092	-4.333	-3.572	-3.205
	Models with intercept and trend and autocorrelation of error	-5.661	-4.948	-4.149	-3.768
M&Q producer price index and M&Q quantity extracted and Q_Plan and Openness	Model with intercept	-2.598	-4.872	-4.071	-3.687
	Model with intercept and autocorrelation of error	-3.345	-4.872	-4.071	-3.687
	Models with intercept and trend and autocorrelation of error	-4.54	-5.421	-4.582	-4.181
M&Q producer price index and M&Q quantity extracted and Q_Plan and Openness and VA Construction sector	Model with intercept	-3.08	-5.366	-4.527	-4.127
	Model with intercept and autocorrelation of error	-3.891	-5.366	-4.527	-4.127
	Models with intercept and trend and autocorrelation of error	-4.053	-5.871	-4.992	-4.574
M&Q producer price index and M&Q quantity extracted and Q_Plan and Openness and VA Construction sector and R&D	Model with intercept	-3.051	-5.83	-4.952	-4.535
	Model with intercept and autocorrelation of error	-3.84	-5.83	-4.952	-4.535
	Models with intercept and trend and autocorrelation of error	-4.087	-6.303	-5.385	-4.948

Note: The null hypothesis of the test is no cointegration (H_0: d=0) against the alternative hypothesis of cointegration (H_1: d ≠0).

6.2 Econometric findings

The first difference estimation can help us to control for the unit root problem and moreover the residual plots of these estimations[11] confirm the stationary of the regressions.

In Table 6, we report the empirical results of the first difference estimations. We can observe that the relationship between mining and quarrying domestic price index and mining and quarrying quantity domestically extracted has a negative sign and it is significant in all the regressions considered. A first consideration of this puzzled phenomenon could be explained by the no-respect of one hypothesis of the standard microeconomic theory. In fact, this estimated supply curve does not seem to follow one of the main properties of output supply. Our estimation seems to failure to comply with the *own-price effect* property which says that output supply is increasing in product price (p) because the profit function is convex in "p".

Another important explanation of our results could be related to the fact that this *public good* seems to be considered as a *common good.* In the economic theory, *common goods* are considered as rival but non excludable goods so that individuals do not pay for resource use and they tend to exploit them excessively. Within the rivalry hypothesis, this behavior could recall the "tragedy of commons" example in which natural resources are used in an inefficient way from the point of view of social welfare. The inefficiency comes from negative externalities caused by exploitation of a common resource by an agent that reduces the possibility for the rest of the community to enjoy the same natural resource and thus threatens natural environment conservation.

To solve the problem Government can issue regulations and/or impose taxes. So that license and fee structure can reduce the incentive on taking hazardous behaviors against the environment. All these reasons can suggest that the behavior of a natural non-renewable resource market could be steered by a bundle of forces rather different from the usual market forces as explained in the microeconomic theory.

Finally, our estimation of the relationship between natural non-renewable resource quantity

and m&q domestic producer price index could highlight a dynamic choice by economic agents. In each period, decisions about quantities of minerals to be extracted or preserved for the future depend on economic agents' dynamic choices based on the comparison of benefits that come

[11] The residual plot of all the estimations is not reported just to avoid making our presentation heavier. If anyone is interested the results can be delivered.

from the m&q activity and benefits from an alternative choice such as investing in the financial market. In fact, if we considered a two period model, the dynamic choice of agents is based on the comparison of today profit value with tomorrow profit value of extracting natural resources. So, if the profit today is greater than the profit tomorrow, economic agents will gain from extracting and selling today more natural resources than tomorrow and from investing the rent in the next period. In the first period, economic agents will tend to increase raw natural resource supply and consequently this could tend to reduce the natural resource price and vice versa in the opposite case.

Table 6. First difference estimation. Dependent variable: D1.M&Q producer price index

	(1)	(2)	(3)	(4)	(5)
D1. M&Q quantity extracted	-0.27*	-0.27*	-0.21**	-0.22**	-0.23**
	[2.38]	[2.31]	[3.26]	[3.28]	[3.42]
D1.Q_Plan		-0.01	-0.02*	-0.02*	-0.01
		[1.49]	[1.80]	[2.27]	[2.25]
D1.Openness			0.43**	0.45**	0.45**
			[3.43]	[3.61]	[3.40]
D1. VA Construction sector				0.44	0.47
				[1.65]	[1.49]
D1.R&D					-0.08
					[0.41]
Constant	0.04**	0.04**	0.02	0.01	0.02
	[3.90]	[3.58]	[1.27]	[1.27]	[1.37]
Observations	27	27	27	27	27
R-squared	0.25	0.29	0.55	0.60	0.60

*Note: Robust t-statistics in brackets and * significant at 5% level; ** significant at 1% level*

If we observe the Q_Plan variable, we find that the relation with the dependent variable is negative but the significance is reached only in the last two columns when we put all the control variables of our model. The insufficient significance of the variable can be explained considering some weaknesses in managing environmental resources by Italian Regions. In the last twenty years a greater decentralization of powers and responsibilities should have minimized the so called "tragedy of commons" related to no-energy producing raw minerals through the use of laws, regulations and administrative tools such as PRAE plans and license fees.

However, it should be recalled that PRAE plans have been adopted only in the last ten years and only by half of the Italian Regions. The low level of mining and quarrying license fees, provided by local institutions, should have contributed to both the excessive natural resource exploitation and the impossibility to distribute equally benefits throughout the society.

In our estimation the degree of openness seems to have a positive and significant effect on the mining and quarrying domestic price index. This relationship confirms that the dynamic supply curve has a negative slope because if Italy opens to the international trade than price index increases and this could push economic agents to give up the extraction of raw minerals because the today profit is less than the tomorrow profit. On the basis of this comparison economic agents will tend to reduce the supply of raw natural resources even if the price tends to increase.

Finally, both last two control variables of our regression are not significant, but the value added of construction sector shows a positive sign, while the R&D expenditure presents a negative sign. The reason of a positive relationship between mining and quarrying price index and value added of construction sector could be explained by the fact that this sector has shown an increasing demand of raw minerals in order to satisfy an increasing demand of residential and non-residential buildings, especially in the period 1980-2000. But m&q supply does not adjust immediately under the pressure of the demand and the main effect is an increase of prices.

The irrelevant and negative sign of R&D expenditure could be another proof of the inappropriateness in the use and conservation, in an efficient way, of these non-renewable resources by local governments. Moreover, the peculiar m&q production structure of Italy based on small firms - in terms of employees and capital invested - could be another explanation of this relationship. These small firms are not able to spend a lot of money in R&D to innovate or improve the technology of extraction of raw materials.

7. Conclusions

In the last twenty years, political reasons have been pushing towards a greater decentralization of powers in Italy. Regions have been given more autonomy in terms of legislation and responsibilities by the central government, particularly on issues linked to environmental protection and national use of resources. Under an incomplete environmental federalism structure, an interesting case of study is represented by the attribution of powers over the management of mining and quarrying activity.

By analysing Regional laws, administrative data and official statistics, our aim was to verify whether in Italy the shifting of powers had improved efficiency either in the use of no-energy producing minerals or in the protection of the environment or in both.

For this reason, in the first part of the paper we analysed the process of devolution of powers to Regions over mining and quarrying from the perspective of laws and regulations. Reference points are: i) the Presidential Decree N. 616 of 1977, ii) the Legislative Decree N. 112/98 which strengthened the first one, and iii) several Regional Laws issued during the last fifteen years.

We highlight as the time gap between the Pres. Decree N. 616/77 and the issuing of Regional laws is wide. By examining Regional legislations setting on m&q in details, we found a regulation structure heterogeneous and incomplete, but the usual dualism among northern and southern Regions did not emerge. Moreover, our analysis shows that policy makers have a little awareness of the value of raw mineral resources domestically extracted. Actually, using the available data which unfortunately are rather limited, our analysis finds that m&q resources are treated as *common goods* rather than *public goods* . As a confirmation of this fact we draw the attention on the license fees for m&q cultivation: they are extremely low and independent of the quantities extracted. Moreover very few Regional Plan of Extractive Activities (PRAE) have been issued by Regions notwithstanding the fact that the Plans would be instrumental to reach efficiency in managing the extraction sites at every stages (identification, exploitation and remediation phases), in using extracted raw materials and in protecting the environment. The interest of local governments in reducing negative externalities related to the extraction of raw materials and in protecting the environment appears weak and faint judging by the number of regions involved in the deliberation of a PRAE . They were only three in the ’90s, just ten in 2004 and in 2010 the number of twelve Regions was reached against a total of twenty . As Pigouvian theory teaches us, an appropriate structure of licenses and fees could reduce the incentive on taking hazardous behaviours against the environment. This effect can be strengthened by tightened regulations on m&q activities. On the contrary, some Regions allow companies to extract raw minerals for free thus leaving most of the rent to firms and without considering that in so doing they give up a source of revenues while Regions should be financially self-sufficient in a federalism structure.

We also find that both Regions and Central Government do not seem to put enough attention to the production of official statistical data at regional level. After having shifted legislative powers on m&q activities to Regions, we have observed discontinuity and non homogeneity on mining and quarrying officla statistical data. In particular from the ’90s, national survey questionnaires about

m&q activities have continued to be sent by Regions to the Ministry and to the ISTAT, but the number of provinces providing complete information, gradually decreases over time. The environmental federalism, as foreseen by law, would have also ensured an improvement of information concerning extractive activity, both from a qualitative point of view and a quantitative point of view. The collection of these data would be essential to understand better mining and quarrying activities in each Italian Region and to evaluate the economic aspects and the pressures on natural environment. Thus this information could be useful to policy makers to take the best decisions on sustainable use of natural resources of their own territory.

Since 1997, more complete information on m&q production is supplied by the PRODCOM (Community Production) sample survey. It provides yearly structural data of industrial production at national level. By integrating the two sources, old surveys' questionnaires and PRODCOM data, ISTAT could have compiled a long time series (1980-2009), only at national level, on physical flows of *no-energy producing minerals* domestically extracted, based on Economy-wide Material Flows Accounts (EW-MFA) methodology.

Our analysis is completed by doing an econometric exercise combining data on local governance with official statistics of Economy-wide Material Flow Accounts (EW-MFA) for the period 1980-2009. The aim of this analysis is to verify both the existence of an inverse supply curve between m&q domestic producer price index (as dependent variable) and no-energy producing mineral quantity domestically extracted and the effect of Italian Regions Responsibility about m&q activity on m&q domestic producer price index controlling for Construction Sector value added, R&D national expenditure, Openness to international trade.

The results observed are at first sight weird. The relationship between mining and quarrying price index and mining and quarrying quantity extracted is significant but the sign is negative. The no-respect of the *own-price effect* property seems the main reason of this no-standard supply curve. However, we have to take into consideration that there could be other two aspects that can influence the slope of the curve. Firstly, this *public good* seems to be considered as a *common good* by local governments and economic agents. This implies that on the basis of rivalry hypothesis, natural resources are used in an inefficient way and the excess of exploitation of a common resource reduces the possibility for the rest of the community to enjoy the same natural resource as described in the well known "tragedy of commons" example. Secondly, the dynamic choice of economic agents implies that on the basis of the comparison of today and tomorrow benefits of m&q activity, an individual can choose to extract or not raw minerals in the first period. If it is convenient to

extract natural resources then economic agents will tend to increase the supply and consequently this could reduce the natural resource price.

If we observe the Italian Region Responsibility variable, we find that the relation with the dependent variable is negative, but the significance is reached only when we put all the control variables of our model. This variable can explain the weaknesses in managing environmental non-renewable resources by Italian Regions. In the last twenty years the choice of decentralized powers and responsibilities should have minimized the so called "tragedy of commons" related to no-energy producing raw minerals by using laws, regulations and administrative tools such as PRAE plans and license fees, but this seems not the case that occurs in reality. One reason of this delay should be linked to the slowness in adopting a PRAE plan by Italian Regions. Only half of the Italian Regions have adopted a PRAE plan since 2000. Another reason should be the low level of the mining and quarrying license fees, which should have contributed to the excessive natural resource exploitation.

In our estimation the degree of Openness seems to have a positive and significant effect on the mining and quarrying domestic price index. This relationship confirms that the dynamic supply curve has a negative slope because if Italy opens to the international trade than domestic price index increases and this could push economic agents to give up the extraction of raw minerals in order to gain more profit tomorrow. According to the neoclassic theory, liberalization of international trade has positive net effects in terms of well-being for a country. However, if markets are imperfects the liberalization of international trade could not have positive effects on the efficient allocation of natural resources. A possible negative effect of openness could be the inefficiency in managing natural non-renewable resources (i.e. *common tragedy*) by decreasing the capability of local institutions in using raw minerals in a sustainable way.

Finally, the irrelevant and negative sign of R&D expenditure could be another proof of the inefficiency in the use and conservation of these non-renewable resources. Since Italy is characterized by a m&q production structure based on small firms, in terms of employees and capital invested, R&D spending on new technology to extract raw materials is not very high because of the lack of financial resources.

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