The relationship between economic growth and environmental quality: the contributions of economic structure and agricultural policies

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Jel Classification: Q01, Q15, R11

Abstract

Objectives of this paper is to verify whether the relationship between the level of per capita income and the environment quality, for the Italian regions, follows the prescription of an Environmental Kuznets Curve (EKC), taking into account the contribution of agriculture and rural areas. The Arellano-Bond two-step dynamic panel data GMM estimator has been applied to a data set of the 20 Italian administrative regions referred to the 2000-2006 period. The environment quality is represented by the level of per capita CO_2 emissions from the whole economy and by the level of per capita CO_2 emissions from agriculture. The regression results show that i) the EKC prescription holds for the Italian regions, ii) the more agricultural regions are found on the rising section of the curve; iii) a greater intensity of expenditure, under the RDP regional agro-environmental and forestry measures, is positively associated to a more degraded environment.

Keywords: *Environmental Kuznets Curve, agricultural policies, regional planning, environmental degradation.*

Résumé

L'objectif de ce travail est d'évaluer si la relation entre niveau de revenu par habitant et qualité de l'environnement dans les régions italiennes respecte la prescription de la courbe environnementale de Kuznets (CEK), en considérant l'apport de l'agriculture et des zones rurales. On a appliqué la méthode GMM en panel dynamique suivant la démarche d'Arellano et Bond, utilisant un jeu de données relatives à 20 régions italiennes dans la période 2000-2006. La qualité environnementale est représentée par le niveau d'émissions de CO_2 par habitant provenant de tout le circuit économique et le niveau d'émissions de CO_2 par habitant provenant du secteur agricole. Les résultats de la régression montrent que 1) la prescription de la CEK s'applique aux régions italiennes, 2) les régions plus agricoles se situent sur la portion ascendante de la courbe ; 3) il existe une relation positive entre l'intensité plus élevée de la dépense, dans le cadre des mesures agro-environnementales et forestières régionales du PDR, et un environnement plus dégradé.

Mots-clés: Courbe environnementale de Kuznets, politique agricole, planification régionale, dégradation de l'environnement

1. Introduction

The EU has a strong track record in climate action with its commitment to tackle the climate change threat and to lead the world in demonstrating how this could be done (European Commission, 2010). In 2002 the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) was approved by the Council, on behalf of the European Community (Decision 2002/358/EC). The Emissions Trading System (ETS) was established in 2003 (Directive 2003/87/CE) and then revised and strengthened (Directive 2009/29/EC). In January 2008, the European Commission proposed binding legislation to implement the 20-20-20 targets that is to cut its greenhouse gas (GHG) emissions of 20% from 1990 levels by 2020, together with a 20% renewables' target and a reduction target in energy consumption by 20%. This 'climate and energy package' was agreed by the European Parliament and Council in December 2008 and became law in June 2009.

Land use, land use change and forestry (LULUCF) and/or Agriculture, Forestry and Other Land Use (AFOLU) activities were not included in the 2008 climate and energy package because uncertainties in calculation (lack of data or of agreed measuring techniques for carbon in forest and agricultural soils) and volatility (large impact of variable weather conditions) make short term predictability of LULUCF activities and their contribution to EU targets difficult to assess. The LULUCF sectors have higher uncertainties than other sectors because transient environmental conditions, anthropogenic or natural, can turn them from a GHC source into a GHG sink and vice versa. Furthermore, emissions and removals associated with land use activities occur together with those of natural origin, and it is not always straightforward how only to estimate the anthropogenic components (Eggleston, 2010). Together with sectors such as transport, housing and waste, agriculture has not been covered by the ETS, then sequestration in agricultural soils has not been permitted to produce carbon sequestration credits under the Kyoto Protocol. However, the potential of agricultural soils is recognized for additional emission reductions and for a growing contribution to the mitigation effort through improved cultivation methods and forestry management.

Agriculture may play an active role in mitigating GHG net emission through agronomic practices, devoted to enhance soil carbon retention and sequestration, by increasing the return of plant biomass carbon to the soil (McCarl, 2010). These practices include improved crop varieties, extending crop rotations, inclusion of perennial crops,

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tillage/residue and nutrient management, water management and land use change to grasslands or forest (Ostle *et al*., 2009). Even if the sequestered carbon is lost in 20-40 years, agriculture may provide a low-cost option for carbon sequestration bridging to an even lower-cost set of options in the future. Land management practices, promoted by proper land use policy, can protect existing carbon stocks and ensure the resilience of carbon sequestration in agricultural soils. In case property rights and the lack of a clear single-party ownership in certain areas may inhibit implementation of management changes, contract terms and liability for discounting carbon-preserving practices could be effective for the adoption of mitigating GHG practices. However, farmers will not adopt unprofitable agricultural mitigation practices in the absence of incentives. Dynamic models of land base interactions between forests, agriculture and urban development show that receipt of significant carbon-related payment by landowners in agriculture and forestry has substantial impacts on the levels of terrestrial carbon sequestration. Uncertainty in the amount of carbon sequestered could be dealt with by making credits claimable only to the extent that there is a given certainty (for example, 95%) in the amount of carbon sequestered or by giving incentives in the form of risk managing insurance (Marland *et al*., 2001).

The Common Agricultural Policy has introduced the cross-compliance conditions for eligibility to the Single Farm Payment that could be used to incentive farmers to move towards mitigating GHG practices. Aids for the adoption of environmental friendly techniques are also provided through the annual agro-environmental payment included in the regional Rural Development Plans (RDPs).

Objective of this paper is to verify the role played by the Italian rural regions in the mitigation of environment degradation and their contribution to the choice of a sustainable development path for the territory where they are located in.

The definition of rural areas is the one commonly used in literature that refers to fragile economic systems which need public support, aimed at overcoming their social and economic problems: depopulation, productive specialization mainly based on agriculture and general difficulty of implementing local policy able to ignite an endogenous process of economic development. On the other hand, rural areas have to cope with the same problems of industrial and urban areas, such as the scarcity of natural resources and the environmental degradation. However, rural economic systems may potentially contribute to guarantee a path of sustainable economic development more than the urban ones.

Recently many Italian rural areas have experienced strong structural changes towards integrated economic systems which have diversified their productive activities mainly through the development of agricultural services supply. This process was facilitated by the network of relations between farms and local actors and by valorizing the cultural identity of communities, the local tourist attractions and the landscape resources (OECD, 2009; ECORYS, 2010).

The quality of natural resources, therefore, can be the key-variable of the new production mix since rural areas have strong economic incentives to properly manage natural, cultural and human capital resources, which are the inputs of the new services. Environment preservation and economic growth in rural areas can, therefore, be complementary, with a bidirectional causal relationship and it may be crucial to investigate this relationship specifically for rural areas.

Several empirical research works regress some indicators of environmental quality on the level of per capita income, showing a correlation between economic growth and environmental quality. This relation assumes the form of an inverted U, namely increasing levels of per capita income lead initially to a degradation of the environment and then, after a certain level of per capita income, to an improvement in environmental quality. This empirical regularity is called the Environmental Kuznets Curve (EKC).

This relationship stresses that the improvement in the population living standard, associated to economic development, increases the awareness of the problems due to the environmental degradation and brings to a higher demand for and supply of environmental quality. The resulting changes in the production side are the use of cleaner technologies and the loss of economic importance of traditional and less environmental friendly sectors.

The present paper intends to verify whether and how the Italian rural development and the evolution of the Italian agriculture have generated a positive impact on the environmental quality. Particularly, the paper intends to verify whether rural areas have reinforced or not the effect of the economic growth on environmental quality and what the contribution of rural policies has been in this respect.

The Kuznets relationship has been studied by using a regional panel data referred to the period 2000-2006. Pollution is represented by the level of per capita emissions of CO_2 regressed on the level of GDP per capita of the Italian regions and on other variables reflecting the kind of rural development and the intensity of agricultural policies.

The paper is organized as follows. Section 2 briefly reviews the theoretical debate and the empirical evidence on the relationship growth-environmental quality. Sections 3 and 4 illustrate the applied methodology by focusing on the econometric approach and on our data. Section 5 describes the results while Section 6 reports some concluding remarks.

2. The Sustainable Growth and the EKCs

The broad debate on the relationship between economic growth and environment is deeply rooted in the concept of economic scarcity, developed by the classics of the economic theory, particularly in the Malthusian and neo-Malthusian theories, and by more recent authors, such as

Georgescu Roegen (1971). This latter stated that, given the physical limits of nature, a model based on continuing economic growth will exponentially increase the pressure on natural resources up to their exhaustion. Economic growth is sustainable in the long run only in a model based on negative growth rates.

In the '70s some researchers introduced the energy, the natural resources and the environmental pollution in the neo-classical theory of growth and reached the conclusion of an unsustainable growth that gave birth to the pessimistic prescription of the Rome Club (Meadows *et al.,* 1972). Afterwards, during the '90s, together with other studies, the Brundtland Commission report (World Commission on Environment and Development, 1987) introduced the idea that economic growth has to be environmentally sustainable.

The endogenous growth theory has focused on the conditions that make economic growth sustainable in the long run (Aghion and Howitt, 1998). More precisely the Schumpeterian endogenous models introduce the presence of a research sector which produces vertical innovation and is cleaner than the material good sector. The growth is sustainable if the rate of accumulation of cleaner technologies is higher than the rate of accumulation of physical capital (Cavallaro, 2002).

Within this debate, the Environmental Kuznets Curves have been imposed as a tool useful for the empirical evaluation of environmental impact of growth and of public policies. The idea behind this curve, empirically tested, is that the relationship between economic growth and environmental quality follows an inverted U shape.

The EKC relation shows that different stages of economic development have different impact on the environment, indicating that as the per capita income (or per capita wealth) increases, the economy shows first an increase in pressure on the environment, in terms of more pollution and of a more intensive use of natural resources. Then, at a certain level of income, called *the turning point*, there is a trend reversal, which results in a virtuous cycle of improvement and of reduction in the economic pressure on the environmental resources.

The EKC path has been originally observed for some phenomena of air pollution (particulates, SO_2, NOX and CO_2) and river water since the '90s. Several studies have tested the EKC with a cross-country approach, using data on products from *General Environmental Monitoring System* (GEMS), which contains information on the contamination of air and water from the most common pollutants actually known (Dasgupta *et al*, 2002).

Among those who have first estimated the EKC, Grossman and Krueger (1993) explain the relation by the *scale effect* of growth, that is increasing returns, associated to growth, make technology more efficient and reduce the cost of pollution abatement; at the same time, the *substitution effect* makes it possible to shift to cleaner and non-renewable resource-saving techniques; finally, because of the *composition effect* of output, consumption of polluting products is reduced and the weight of the cleaner tertiary sector is increased.

These models seem to suggest a path of *laissez-faire* (Andreoni and Levinson, 2001), that is increasing income automatically will ensure the improvement of environmental quality.

However, many empirical studies are skeptical in this respect emphasizing the importance of policies to protect the environment (Dasgupta *et al*., 2002; Panayotou, 1997) and stressing the limits of the family of estimated EKCs for the following aspects.

First of all, the data concern mainly the developed countries and are scarce for developing countries. In fact, some researchers point that the relationship is first increasing and, after a certain level of income, becomes constant (*Race to the Bottom Scenario*), because pollution is decreasing in the developed countries but increasing in the developing ones. This result is mainly due to the world economic globalization that leads to a "specialized production", in which much polluting technologies are utilized in countries with low incomes and, therefore, with little or no regulation and less social attention to environmental problems. The relocation of more polluted firms in countries, with weak or absent environmental regulations, and the increasing imports from them because of lower costs (*environmental dumping*) brings to no reduction in world pollution (Cavallaro, 2002).

Furthermore, it is emphasized that the EKC doesn't fit with all the pollutants. In general, the data of many types of pollutants are scarce everywhere, there is no information about approximately 100 types of potentially toxic materials, both in terms of toxicity degree and of countries' level. Many researchers suggest that the curve has a steady growth path since, against the reduction of some conventional pollutants which are monitored, many others, newly introduced *(New Toxics)*, are ignored and would actually increase the level of the existing pollution (Dasgupta, 2002). They refer to certain persistent organic pollutants, which are recognized as very dangerous because they cause a major damage to human health and they accumulate in plants and animals becoming difficult to eliminate (for example, the dioxins).

3. The Methodology

3.1. The empirical specification of the EKCs

In the present paper, the following functional specification of the EKC has been adopted to examine the impact of per capita GDP on the level of pollution in the Italian regions observed from 2000 to 2006 (1):

$$LnCO2_{i,t} = LnGDP_{i,t} + LnGDP_{i,t}^{2} + \bar{X}_{i,t} + U_{i,t} \qquad (1)$$

Where:

- $LnCO_{2i,t}$ is the natural logarithm of CO_2 per capita emissions at time (t) in region (i);
- $LnGDP_{i,t}$ and $LnGD_{i,t}^{2}$ are the natural logarithms of per capita GDP at time (t) in region (i) and its square;

- $\bar{X}_{i,t}$ is a vector of covariates utilized as proxies to explain the role of economic structure, of agriculture and of agricultural policies;
- $U_{i,t}$ is the error term at time (t) for region (i).

Several econometric problems may arise from estimating equation (1).

Time-invariant region characteristics (fixed effects), such as geography and demographics, may be also correlated with the explanatory variables. The fixed effects are contained in the error term in equation (1), which consists of the unobserved region-specific effects, v_i, and the observation-specific errors, $e_{i,t}$: $U_{i,t} = v_i + e_{i,t}$

In panel data, the lagged dependent variable ($LnCO_{2i,t}$ in our case) is correlated with the unobserved region-specific effect residuals (v_i).

In large-T panels, a shock to the region's fixed effect, which shows in the error term, will decline with time. Similarly, the correlation of the lagged dependent variable with the error term will be insignificant.

In small-T panels, such as the panel dataset of this paper, which has a short time dimension ($T = 7$) and a larger individual dimension ($N = 20$), the Arellano-Bond two-step dynamic panel data GMM estimator is recommended to overcome the above-mentioned problems.

Equation (1) has also been used to investigate the relation between the level of CO_2 emissions from agriculture and the level of *GDP*, taking into account the structure of regional agriculture and the agricultural policies.

Specifically, the role of agriculture and of rural development is investigated through the following variables:

- the degree of urbanization (Urban population rate)
- the share of areas classified as "rural" in the regional Rural Development Plans (Rural areas *per capita*)
- the payments for agro-environmental and forestry measures provided in the RDP (Agro-environmental outlay on Agricultural Value Added, VA)
- the incidence of agro-tourism (Number of agro-tourism *per capita* and per farm)
- the incidence of organic farms (Number of organic farms *per capita* and per farm).

3.2. The proxies for environmental quality

In this paper the environmental quality is represented by the level of the carbon dioxide emissions, estimated for the Italian regions by ENEA (ENEA, 2010). Carbon dioxide emissions represent the pollutant most responsible for the greenhouse effect. In fact, in 2007, greenhouse gases were quite totally due to the CO_2 emissions, which amounted to 475,302 Gg and represented around 86% of total emissions of greenhouse gases (ENEA, 2010). For this reason, this gas level is estimated at a regional level, with a privileged analysis with respect to other gases.

The methodological path, followed by ENEA in order to estimate the inventory of polluting emissions, is based on the direct ratio between energy consumptions, estimated on the chosen local scale, and the emission factors. At a regional level, ENEA estimates the activity sources, derived from the data of the Annual Regional Energy that ENEA processes each year, multiplied by the emission factor. This latter is appropriate for specific emission coefficients, expressed in tons of substance emitted per ton of equivalent fuel consumed (ENEA, 2010). The sources of activities are represented by the combustion processes of the energy industries (power generation, refineries, etc.), manufacturing industries and construction, transport and other sectors (commercial, residential, agriculture and fisheries). This group, called "Energy" sector, releases polluted gases: it is the most responsible for the greenhouse effect. Regional estimates of CO_2 emissions' inventory, utilized in this study, refer to the CO_2 resulting from these energy processes; so the regional levels depend on the energy sources used (production, processing and final uses) and on solutions for their reduction, therefore, they are different at a regional level. Also, the Italian regions are very different in GDP *per capita,* in economic structure and in their agriculture; then there is enough heterogeneity to estimate the contribution of agriculture and of rural areas to the growth-environment relationship.

Table 1 reports the descriptive statistics of the data used in the study.

Table 1 - *The descriptive statistics of the variables.*

Variable	Obs. [1]	Mean	Std. Dev.	Min	Max
CO_2 *per capita* emissions (t/inhabitants)	140	8.050	2.657	2.964	14.989
CO_2 *per capita* agricultural emissions (t/inhabitants)	140	0.149	0.064	0.016	0.351
GDP *per capita* (2000 based €/inhabitants)	140	20,430	4,995	13,020	27,885
Agricultural Value Added weight	140	0.031	0.014	0.011	0.067
Agricultural Value Added *per capita* (2000 based €/inhabitants)	140	570.	179.	302.	1,108
Urban population rate	140	0.189	0.136	0.000	0.522
Rural areas *per capita* (km2/ inhabitants)	140	0.004	0.007	0.000	0.027
Number of organic farms *per capita* (N./inhabitants)	140	0.001	0.001	0.000	0.008
Number of agro-tourisms *per capita* (N./inhabitants)	140	0.000	0.001	0.000	0.003
Number of organic farms *per farm* (N./total farms)	140	0.024	0.016	0.002	0.086
Number of agro-tourisms *per farm* (N./total farms)	140	0.010	0.013	0.001	0.076
Agro-environmental RDP expense *per capita* (€/inhabitants)	140	8.927	9.815	0.602	50.752
Environmental public expense *per capita* (€/inhabitants)	140	362	317.	168	1,917

[1] Regional values weighted per year
Source: own elaborations on ISTAT, ENEA, INEA-BD VISPA data.

4. The results

The dependent variable in the first model is the logarithm of CO_2 emissions *per capita;* the main results of the regressions are reported in Table 2.

First, the prescription of the *Kuznets curve* holds for the Italian regions, whose 'turning point' is around 21,000 (2000-based) € level of *per capita* GDP; the regions, at the left of the turning point, are: Abruzzo, Basilicata, Calabria, Campania, Molise, Puglia, Sardegna, Sicilia and Umbria. The regions, positioned in the descending portion of the predicted curve, are: Piemonte, Friuli V. G., Veneto, Lazio, Emilia R., Trentino A.A., Valle d'Aosta, Liguria, Marche, Toscana and Lombardia.

Table 2 - *The results of the Arellano Bond dynamic two-step estimation of Log CO_2 emissions per capita.*

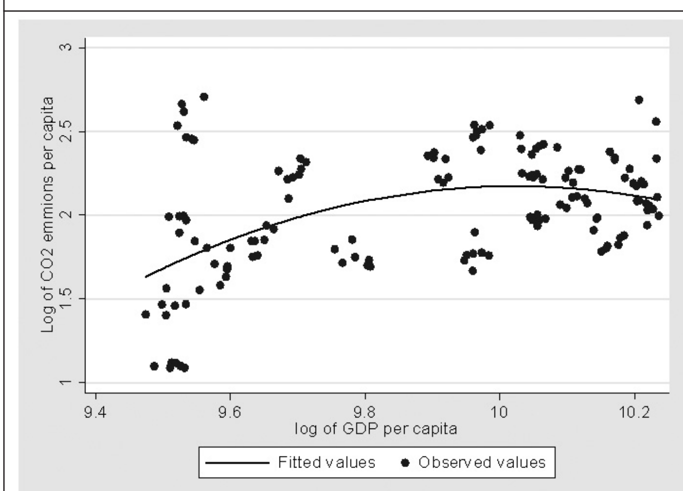
Variables	(1) Model	(2) Model	(3) Model
Lag of log CO_2	0.537***	0.221***	0.276***
	(0.055)	(0.069)	(0.073)
Log GDP *per capita*	47.636***	48.454***	48.077***
	(11.738)	(11.624)	(13.342)
Log GDP *per capita* squared	-2.409***	-2.441***	-2.419***
	(0.593)	(0.590)	(0.683)
Urban population rate	7.385***	13.270***	13.075***
	(2.371)	(3.539)	(3.484)
Number of organic farms *per capita*	-19.236***	-16.472***	-18.341***
	(3.200)	(1.422)	(1.130)
Number of agro-tourisms *per capita*	421.917***	203.794	
	(86.872)	(145.914)	
Agro-environmental outlay on Agric. VA	1.905**	2.613***	2.239**
	(0.794)	(0.723)	(0.951)
Rural areas *per capita*		-525.330***	-518.188***
		(145.076)	(100.063)
Observations	100	100	100
Number of regions	20	20	20
Number of years	6	6	6
Number of instruments	21	22	22
Wald Chi2	7986.45	7767.63	27463.67
Chi2(14)-Sargan test[1]	14.66	9.897	10.52

Standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$
[1] Sargan test of overidentifying restrictions, H0: overidentifying restrictions are valid.
Source: own elaborations.

Specifically, in Figure 1, which reports the predicted curve and plots the observed regional data, we can see that in the increasing section of regional *EKC* there is more dispersion, with regions polluting much more then the predicted value; while in the decreasing portion of the curve there is less dispersion.

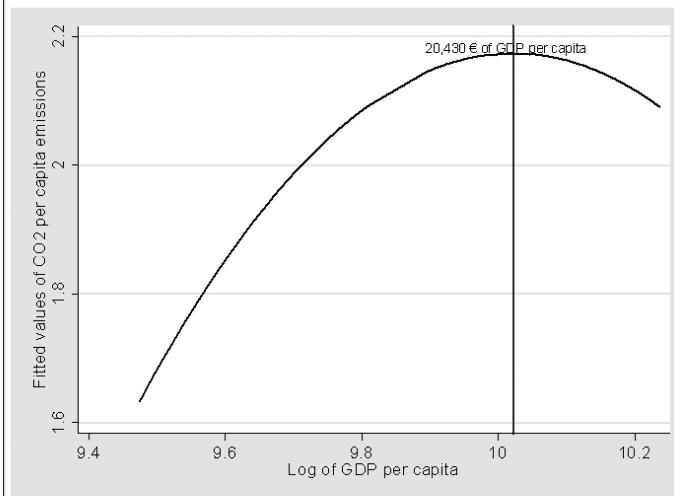
The *elasticity* of pollution is calculated with respect to the level of the mean income that is the average value of the natural logarithm of GDP *per capita* in the sample, which corresponds to 20,430 (2000-based) €. Elasticity of pollution onto *per capita* income is equal to -0.90.

Figure 1- *Predicted and observed regional pollution (in logarithm) in relation with per capita GDP (in logarithm).*



Source: Own elaborations.

Figure 2 - *Predicted path of the growth-environment relationship for a "mean region".*



Source: Own elaborations.

Regarding the other variables, we can see that regions with more rural land *per capita* pollute less than the predicted value. Also, the highest presence of organic farms *per capita* improves environmental quality, while the agro-tourism displays a negative impact. As regards the agricultural policy, the regression shows that a greater intensity of expenditure under the RDP regional agro-environmental measures is positively associated to a more degraded (in terms of CO_2) environment, therefore this specific policy seems to be "therapeutic" rather than preemptive.

The dependent variable in the second model is the logarithm of the level of agricultural CO_2 emissions *per capita,* the main results of the regressions are reported in Table 3.

The results of the second set of regressions show that the '*turning point*' predicted for the CO_2 emissions from agriculture is around 24,000 (2000 based) € level of *GDP* per capita, highlighting that, after a certain level of *per capita* income, agriculture also uses more environmental friendly technologies. This turning point is higher than the previous one: in order to observe a less polluted environment, for the Italian regions, it is necessary to overcome a level of *per-capita GDP* equal to 20,430 (2000 based) € but agriculture contributes to pollution reduction only after a level of *per-capita* GDP of 24,000 (2000 based) €. Then, richer regions have a more sustainable agriculture.

A greater intensity of expenditure under the RDP regional agro-environmental measures doesn't improve the environmental performances of agriculture, thus confirming that agricultural policy has not been an environmental policy since environmental quality has not been addressed effectively (Bureau and Mahé, 2008). The agro-environmental measures were unattractive because of small payments relative to conventional agriculture, of large implementation and information costs and of frequent changes in schemes with a burden in terms of predictability, efficiency and administrative costs. At the same time, the cross-com-

Table 3 - *The results of the Arellano Bond regression. Dependant variable Log emissions per capita from agriculture.*

Variables	(1) Model	(2) Model
Lag of log CO2	-0.102***	-0.0906***
	(0.00678)	(0.00468)
Log GDP *per capita*	120.0***	102.8***
	(20.60)	(15.22)
Log GDP *per capita* squared	-5.969***	-5.073***
	(1.071)	(0.792)
Number of organic farms *per farm*	-0.344	
	(0.501)	
Number of agro-tourisms *per farm*	-5.051	-6.265*
	(3.434)	(3.482)
Agro-environmental outlay *per farm*	0.000447***	0.000587***
	(0.000127)	(4.74e-05)
Rural areas *per capita*	-1,464***	-1,499***
	(196.9)	(65.23)
Observations	100	100
Number of regions	20	20
Number of years	6	6
Number of instruments	21	20
Wald Chi2	4737.61	1762.21
Chi2(14)-Sargan test[1]	14.28	15.20

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
[1] Sargan test of overidentifying restrictions, H0: overidentifying restrictions are valid.
Source: own elaborations.

pliance conditions have not been proportional to the production of environmental services but perceived as a negative constraint only creating a control-threat syndrome (Bureau and Mahé, 2008).

Finally, the negative and weakly significant coefficient of the number of the agro-tourisms *per farm* seems to suggest that in contexts where agriculture is new demand-oriented, the primary sector displays a lower polluting impact, highlighting how these processes trigger bi-directional causality between the "multifunctional agriculture" and the environmental quality.

In Italy, few regions (Trentino A. A., Valle d'Aosta, Lombardia, Piemonte and Basilicata) have chosen an environmental friendly path for agricultural development in their RDPs since the 2000-2006 years (Mantino, 2008). The choice of an effective environmental friendly path for agricultural development requires consensus of regional socio-economic actors as the preliminary discussion about the allocation of the regional plan funds for rural development involves representatives of the farming and agri-food industries but also of consumer and environmental associations. Organized citizen-consumers have been recently very active in the realization of short (km 0) supply chains giving an example of how preferences can act as a regulatory instrument (Brennan, 2006). An important role is also played by the public research and extension systems for the realization of geography-specific socially and environmentally sustainable production processes (Ascione *et al*., 2006) which should be complementary with the strategy chosen in the RDPs.

On the other hand, the policy design, addressed to environment improvement through GHG mitigation, should be multi-regional and multi-annual. Adoption of certain agricultural mitigation practices may reduce production within implementing regions but the production can shift to regions unconstrained by GHG mitigation objectives, resulting in no net reduction of emissions with a leakage effect. Other important elements, such as the substantial variability between seasons and between locations (Jonas *et al*., 2010) and the reduction in monitoring costs as the area sampled increase in size, suggest that the geographical extent and duration of the target unit should increase through multi-region and multi-years contracts (Smith *et al*., 2007).

5. Concluding remarks

Objective of this paper was to verify whether the relationship between the level of *per capita* income and the environment quality, for the Italian regions, follows the prescription of an Environmental Kuznets Curve (EKC), taking into account the contribution of agriculture and rural areas.

The Arellano-Bond two-step dynamic panel data GMM estimator has been applied to a data set of the 20 Italian regions referred to the 2000-2006 period. Environment quality is represented by the level of per capita CO_2 emissions from the whole economy and by the level of per capita CO_2 emissions from agriculture.

The regression results show that the EKC prescription holds for the Italian regions. The turning-point is equal to a level of per capita income of around 21,000 (2000-based) € for the pollution sourced from the whole economy and to a level of 24,000 (2000-based) € for the pollution sourced from the primary sector.

This means that agriculture is the other economic sectors' follower in the adoption of environmental friendly techniques. In fact, more agricultural regions are found on the rising section of the curve with a higher dispersion of regions than in the descending section where more environmental friendly regions are concentrated.

Finally, the agricultural policy is not an environmental policy since a greater intensity of expenditure under the RDP regional agro-environmental and forestry measures is positively associated to a more degraded (in terms of CO_2) environment thus confirming that essential public policy stakes are not addressed effectively, "... they are mainly cosmetic measures and rhetoric or lip service" (Bureau and Mahé, 2008).

A sustainable management of rural public goods could be obtained through an agricultural policy which changes the logic of cross compliance conditions towards payments tied to commitments made by operators in order to push a real change in farmers' behaviour and to effectively influence entrepreneurs' production decisions.

The implementation of an environmental friendly path for agricultural development require consensus of regional socio-economic actors involved and consistency of the choice made in the RDPs with the allocation of the regional funds for rural development research. On the other hand, an effective agricultural environmental policy, which addresses environment improvement through GHG mitigation, should be designed through multi-regional and multi-annual schemes.

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