Economic Convergence with Divergence in Environmental Quality? Desertification Risk and the Economic Structure of a Mediterranean Country (1960-2010)

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Economic Convergence with Divergence in Environmental Quality? Desertification Risk and the Economic Structure of a Mediterranean Country (1960-2010)

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Abstract

The present study investigates the relationship between land vulnerability to desertification and the evolution of the productive structure in Italy during the last fifty years (1960-2010). The objectives of the study are two-fold: (i) to present and discuss an original analysis of the income-environment relationship in an economic-convergent and environmental-divergent country and (ii) to evaluate the impact of the (changing) productive structure and selected socio-demographic characteristics on the level of land vulnerability. The econometric analysis indicates that the relationship between per capita GDP and land vulnerability across Italian provinces is completely reverted once we move from a cross section analysis to panel estimates. While economic and environmental disparities between provinces go in the same direction, with richer provinces having a better land, over time the growth process increases the desertification risk, with the economic structure acting as a significant variable.

Keywords: Environmental quality, Economic growth, Land degradation, Regional disparities, Italy, Panel data.

JEL codes: C23, Q24, Q56, R11

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1. Introduction

The increasing importance of the 'local' and 'regional' dimensions in environmental policies and sustainable development strategies reflects the multifaceted interactions among the economic sphere and the ecological systems (Franceschi and Kahn 2003; Briassoulis 2005; Dasgupta et al. 2006). While impacting both emerging and developed countries, the degradation of the environment induced by biophysical and socioeconomic drivers is strongly influenced by the territorial disparities observed between countries or regions (Galeotti 2007). Although the environment-economy debate is mainly based on the question whether a continued economic growth is a sufficient condition to reduce the human pressure on the environment (Dasgupta et al. 2002), socioeconomic disparities have been a growing concern in sustainable development issues (Zuindeau 2007). Moreover, land resource polarization in healthy and disadvantaged regions determined spatially-diverging rates of environmental degradation (Boyce 1994; Barrett and Graddy 2000; Fingleton 2001; Heerink et al. 2001; Kahuthu 2006).

Decreasing pressure on the environment may therefore depend on a combination of policy and economic factors oriented towards the reduction of socioeconomic disparities among regions. Assessment has taken place and evidence found in the convergence of economic variables, population and social factors, life quality indicators, environmental governance and policy strategies (Rupasingha et al. 2004; Paudel et al. 2005; Papyrakis and Gerlach 2007; Ranjan and Shortle 2007). However, convergence in variables depicting environmental degradation processes has less frequently been assessed in developed countries (Cavlovic et al. 2000; Aldy 2005; Chimeli 2007).

The hypothesis about the existence of a U-shaped relationship between environmental degradation and income, the so called Environmental Kuznets Curve (EKC), has fostered increasing interest among scientists and politicians for the (supposedly) beneficial role of rising income for environmental quality (Caviglia-Harris et al. 2008). According to the EKC hypothesis, accelerated wealth creation by economic growth is a precondition for the technological progress that, in turn, would provide a better environment (Magnani 2000, 2001; Bimonte 2002). At lower income levels consumers prefer commodities other than the environment which results in the lack of ‘greening’ of products and policies (Spangenberg 2001; Vona and Patriarca 2011). Such a relation could be linear (de-coupling hypothesis) or polynomial (re-linking hypothesis). The EKC hypothesis, however, has received critical responses from both the theoretical and empirical perspective (Chimeli 2007; Galeotti

2007; Muller-Furstenberger and Wagner 2007). Moreover, there are few theoretical grounds to support the existence of an EKC relationship for other specific processes like soil resource depletion, land degradation and desertification risk (Salvati et al. 2011).

The present study is aimed at contributing to these knowledge gaps by investigating the relationship over time and space between a (divergent) process of environmental degradation and a (convergent) process of economic growth during the last fifty years (1960-2010) in Italy, a southern European country with different levels of land vulnerability and marked socioeconomic disparities. The investigated process is land degradation, a complex phenomenon induced by natural and anthropogenic drivers occurring in both developing and emerging countries (Sommer et al. 2011). Their ultimate outcome is the drastic reduction of land productivity with important socioeconomic consequences (Romm 2011). Global warming, landscape transformations and population growth are responsible for triggering large-scale processes of land degradation (Geist and Lambin 2004). The Mediterranean region was recognized as a critical hotspot for land degradation due to the synergic impact of these factors in the last decades (Hill et al. 2008). By investigating a time span of fifty years, Salvati et al. (2012) found an increasing environmental gap between 'structurally vulnerable' lands and non-vulnerable lands in Italy. Moreover, the long-term economic path of the country has been characterized by a continuous internal economic convergence from World War II to the end of the 1970s followed by a substantial stability in the average growth rate among regions. Beyond these facts stylized by two simplified indicators of income and environmental degradation, the Italian economic structure was changing drastically towards service-oriented activities and the 'made in Italy' industry, agricultural firms developed through quality production determining an overall reduction of utilized crop surface and socio-demographic dynamics modified rapidly the urban-rural axis traditionally observed before the 1980s: all these processes could have important consequences on the environment (Salvati and Zitti 2009).

The present study contributes to these issues exploring, with an empirical panel analysis based on six time observations (1960, 1970, 1980, 1990, 2000 and 2010), the relationship between the (possibly divergent) level of land vulnerability to degradation observed in the Italian provinces and the spatially-heterogeneous income growth correcting for changes in the economic structure. The objectives of the paper are two-fold: (i) to present and discuss an original analysis of the income-environment relationship in an economic-convergent and environmentally-divergent country and (ii) to evaluate how the (rapidly changing) economic structure impacts this relationship. The structure of the paper is as follows: in section 2 we provide descriptive evidence on the economic and environmental processes in Italy; in section 3 we describe our dataset and provide an econometric estimation of the impact of socio economic determinants on the desertification risk while section 4 we provide summary conclusions and policy implications.

2. Environmental divergence and economic convergence in Italy (1960-2010): the overall picture

Environmental quality has many different dimensions. All these dimensions have strict connection with each other while each single dimension has different links with economic phenomena. In this paper we focus on the aspect of environmental quality concerning desertification risk. We thus use as indicator of land vulnerability the ESAI indicator presented in the section below.

According to Salvati et al. (2012), the average ESAI score increased at the national scale from 1.34 in 1960 to 1.36 in 2010 indicating higher land vulnerability to desertification in the most recent period. Such increase was concentrated along the Adriatic coast, the Po plain, Apulia and northern Sardinia; stable or weakly decreasing ESAI scores have been observed in the remaining Italian areas. The extent of the spatial disparities on land vulnerability to desertification can be summarized by calculating the Gini coefficient of the distribution of the ESAI index across italian provinces. From 1960 to 2010 the Gini coefficient of the ESAI increased by 4.2% indicating an overall divergence in the level of land vulnerability. Besides, by looking at the infra-period evolution, a more fragmented and interesting picture emerges. During the period from 1960 to 1980 a process of sharp divergence occurred since the Gini coefficient increased monotonically by 25%. In the following period an opposite process of convergence (-17%) took place.

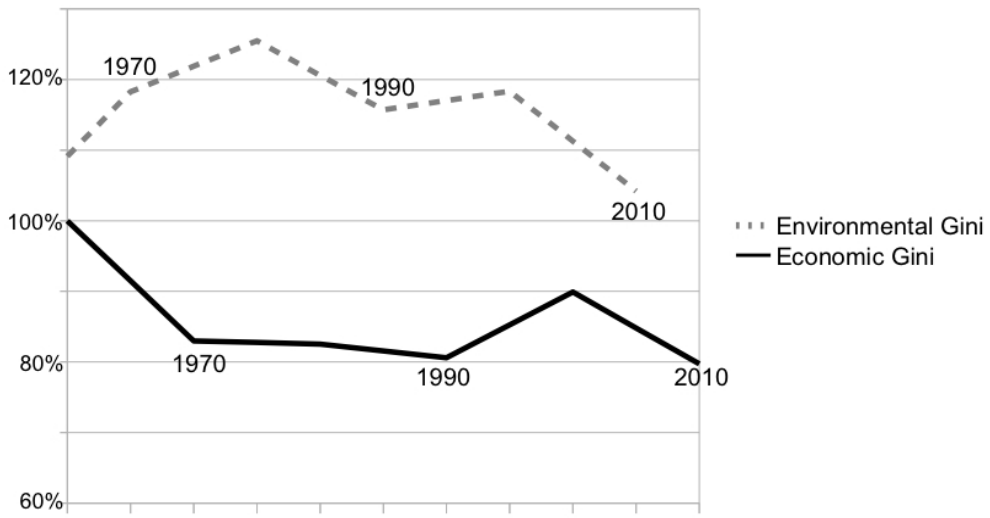
The geographic distribution of Economic Environmental disparities in Italy have strong similarities, in particular the relevance of the North-South axis. However, economic and environmental disparities have experienced opposite patterns. This is the starting point of our analysis that can be explained referring to Figure 1 where we plot the annual Gini coefficient of the Italian provinces per capita GDP (economic Gini) and the five years lagged[1] ESAI Gini (environmental Gini). The economic Gini shows a fairly opposite pattern compared to the ESAI. Indeed regional economic inequalities, have decreased

[1] We lag the ESAI in the figure by 5 years since we consider the process of growth to act in-time. The non-lagged correspondent is not significantly different.

during the process of industrialization of the South, while on the contrary land vulnerability was diverging, and then turn back to higher levels after the 80's, while environmental conditions were converging.

In our view, this puzzle can be solved once we make the two following hypotheses: (i) poorer regions are usually characterized by higher land vulnerability while better environmental conditions correspond to higher income regions; (ii) the specific path of economic growth occurred in Italy from the sixties on had a negative impact (eventually lagged) on land vulnerability: high growing areas experience increasing land degradation. Indeed, if these hypotheses were true, we can provide an explanation to the evidence in Figure 1. During the first part of the time-span considered a process of economic catch-up occurred and thus poorer regions (with lower environmental quality) have grown more with a resulting higher land depletion then increased cross sectional inequalities in land vulnerability to desertification. An exactly opposite argument hold for the following period of economic divergence and environmental convergence. Note that the two hypotheses shed a different light on the EKC literature since an opposite link emerges when we move from a static perspective (between regions) to a dynamic one (within each region in time). While the first hypothesis concerns the descriptive side of the economy-environment links, the other hypothesis refers to a purely dynamic concern. In the next section we will test the two hypotheses.

Figure 1. Evolution of the Gini Index of the ESAI and the GDP between Italian provinces.



Source: own elaboration on ISTAT and CRA data.

3. Desertification risk and socio-economic dynamics in Italy: empirical analyisis

3.1 Study area

Italy is a Mediterranean country covering 301,330 km^2 of which 23% is flat, 42% is hilly and 35% is mountainous (Salvati and Bajocco 2011). The geographical partition into three divisions (North, Centre and South) reflects territorial disparities in the country with northern Italy, being one of the most developed regions in Europe and southern Italy, including Sicily and Sardinia, being one of the most disadvantaged regions in southern Europe. Italy shows disparities in population density, settlement distribution and natural resource availability, and represents a paradigmatic case study to address the importance of the (changing) economic structure influencing the spatial distribution of vulnerable land to desertification (Costantini et al. 2009; Santini et al. 2010; Bajocco et al. 2011).

3.2 Assessing desertification risk in Italy

Vulnerable and non-vulnerable land have been identified following the Environmental Sensitive Area (ESA) scheme (Basso et al. 2000). This methodology is considered a standard procedure to assess the level of land vulnerability to desertification using spatial analysis (Ferrara et al. 2012). The ESA approach assesses changes in selected environmental quality dimensions (e.g. climate, soil, vegetation) considered the most important factors related to land degradation processes (Salvati and Bajocco 2011). The reliability of the ESA procedure to discriminate vulnerable and non-vulnerable areas was verified on the field through the use of independent indicators of desertification in several study areas throughout Mediterranean Europe (Ferrara et al. 2012).

The ESA approach integrates more than ten variables into a composite index of land vulnerability called the ESAI. The considered variables include (i) average annual rainfall rate, aridity index and aspect as proxies for climate quality, (ii) soil depth and texture, slope and the nature of the parent material as proxies for soil quality, and (iii) the degree of vegetation cover, fire risk, protection offered by vegetation against soil erosion, and the degree of resistance to drought shown by vegetation as proxies for vegetation quality (Bajocco et al. 2011). All variables have been derived at the lowest available spatial resolution from official sources including meteorological statistics, population and agricultural censuses, Corine Land Cover maps, and a soil quality map provided by the

European Joint Research Centre (Salvati and Bajocco 2011). Variables have been determined for six years during the time period encompassing 1960 and 2010 (1960, 1970, 1980, 1990, 2000 and 2010) since strictly comparable data with national coverage and detailed spatial resolution were available at those dates only.

A weight was then applied separately to each variable to quantify the possible contribution to the level of land vulnerability to desertification (Basso et al., 2000; Lavado Contador et al., 2009; Salvati and Bajocco, 2011). This score system (ranging from 1 to 2) was based on the estimated degree of correlation between the mentioned variables and independent field indicators of land degradation measured in several pilot areas in southern Europe (Bajocco et al. 2011). The minimum spatial unit has been selected according to Basso et al. (2000). The ESAI score ranges from 1 (the lowest land vulnerability to degradation) to 2 (the highest vulnerability to degradation). Italian land was classified into three levels of vulnerability (‘non-affected or potentially affected’, ‘fragile’, and ‘critical’) according to the ESAI score (Salvati and Bajocco 2011). The average value of the ESAI has been calculated at the six investigated years using a spatial domain of analysis (i.e. NUTS-3 provinces) which is coherent with the geographical resolution of the collected socioeconomic variables (see below). Statistics on the ESAI (and particularly the average value by province) have been calculated using the ‘zonal statistics’ tool provided with the software ArcGIS (ESRI Inc., Redwoods, USA) after the overlap between the ESAI map and the shape-file describing the distribution of each domain of analysis was carried out. The 'zonal statistics' procedure computes a surface-weighted average of the raster values (i.e. recorded on each elementary pixel) belonging to the analyzed spatial unit.

3.3 Socio-economic variables

The variables used in the present study have been made available at the NUTS-3 province scale (110 administrative units actually existing in Italy) from data provided by official statistical sources (mainly obtained from censuses of agriculture, population, and industry carried out by the Italian National Statistical Institute). A total of seven indicators has been calculated from the collected variables for each province. The chosen indicators are: GDP per capita, the shares of agriculture, industry and services in provincial GDP (AgrShare, IndShare and SvcShare), population density (PopDens), the total surface of agricultural land (TasShare) expressed as the percentage of the total surface area, and the average farm size (TasFirm). The selection of variables, the procedure for the construction of indicators, and the identification of the thematic dimensions adequate to describe the territorial context possibly influencing the level of land vulnerability at the local scale have been set up according to the indications provided in Vogt et al. (2011). Although the indicators selected in the present study cannot be considered as an exhaustive description of the local socioeconomic context in Italy, they provide a broad qualification of the economic structure, social traits and urban/rural characteristics observed in the Italian provinces. All selected indicators are easily and freely available from national statistical sources and regularly updated through time, allowing for full replicability of the illustrated approach.

3.4 Econometric analysis

The econometric analysis is developed with the aim to assessing the relationship between land vulnerability to desertification, as measured by the ESAI, and the economic characteristics and performances of Italian provinces. More specifically, we carried out two different analyses: in the first one we test the relation between the ESAI and GDP; in the second one, we assess the determinants of changes over time of the ESAI, where primary importance is given to the growth performance of the Italian provinces. The between province relation of the ESAI with the per-capita income is assessed by estimating a simple quadratic function as in the following equation:

$$e_{it} = \alpha + \beta_1 y_{it} + \beta_2 y_{it}^2 + \beta_3 d_{it} + \eta_t + \varepsilon_{it} \quad (1)$$

Where the land vulnerability indicator *e* is a quadratic function of per capita GDP (expressed in deviation from the national mean) plus a noise term ε. We further also add a full set of time dummies η and, as a control variable, the population density *d.* The latter is introduced since the GDP is expressed in per-capita terms and thus, this variable allows to take into account the impact of the effective anthropogenic pressure. The quadratic term is introduced, according to the EKC literature, in order to control for non-linearities in the relation as in the case of a L-shaped or U-shaped curve. In both cases we would expect a positive quadratic term together with a negative linear coefficient, implying that for low levels of GDP per capita the relation is negative while the curve become flatter or even increasing when the average income increases above a certain level. Because the ESAI is an index ranging between 1 and 2, OLS regressions might not be appropriate as they could return predicted values outside this range. A solution would be to apply a log odd transformation to the rescaled (between 0 and 1) ESAI. Such procedure did not altered the estimation results (available upon request), hence we preferred to use the standard form of the index because estimated coefficients have a clearer interpretation.

Because of the panel structure of the data, the use of a simple pooled OLS would return biased results as within and between provinces changes cannot be disentangled. To solve this problem, we use a between groups estimator, which eliminates within groups changes by estimating equation (1) on group means calculated over the 6 time intervals. The between group estimates indicate the average relation across provinces over the period 1960-2010, but given the strong time span, this relation may change over time. For this reason we run OLS regressions of equation (1) for each of the six waves. We used a panel of 92 provinces for 6 time periods (1960-1970-1980-1990-2000-2010)[2] for a total of 552 observations. As the number of Italian provinces increased over time, we proceeded to a re-aggregation of provincial data to the structure existing in 1960 for the purpose of not loosing important information on the administrative units subject to changes. The second step of the analysis is to assess the determinants of the evolution of the ESAI within each province over time. This is done by estimating equation (1) in a panel framework as in equation (2):

$$e_{it} = \alpha + \beta_1 y_{(i,t-1)} + \beta_2 y^2_{(i,t-1)} + BX_{(i,t-1)} + \eta_t + \epsilon_{it} + \nu_i \qquad (2)$$

where *v* are the fixed effects and X is the vector of control variables. We carried out five panel estimates adding sequentially four control variables selected form the indicators described in the previous section. The first two variables allow to take into account the sectoral composition of production: the share of value added in agriculture (AgrShare), and the ratio of the value added in the industrial sector to the value added in the service sector (Ind/Ser). The other two control variables are the average spatial dimension of agricultural firms (TasFirm) and the ratio of agricultural land over the total surface (TasShare). All these additional variables were tested in the cross-section estimates but have been dropped since all the correspondent coefficients were found non-significant.

As we already introduced above, the impact of economic processes on the environment has a relevant time dimension. Coherently, all regressors were lagged by one period (10 years). This formulation avoid problems of simultaneous causality – in particular for AgrShare,

[2] As we are using variables at 10 years intervals, problems of non stationarity of the series and possible spurious results are ruled out.

TasFirm and TasShare – which may lead to biased coefficients.[3] In addition, this choice is justified on a theoretical ground by considering the typical slowness of environmental processes in response to changes in socioeconomic conditions. Besides, the estimates with the contemporaneous values of the independent variables confirm the main results and are included in Appendix II.

3.5 Results

Between groups estimates suggest the existence of a non linear relation between per capita GDP and land vulnerability across Italian provinces (Table 1), while population seems to play no role in explaining such differences. The linear coefficient for GDP is negative while the square coefficient is positive and both are significant, indicating a significant non linear relation between land desertification and economic growth. According to the coefficients of column 1, the turning point of the quadratic relation is reached for a GDP per capita above the national average by 17%, implying that most of the observations lie in the range for which the ESAI-GDP relationship is negative while a minority of other observations concern regions located in the flat part of the, actually "L-shaped", curve for which the effect is negligible.

Table 1. Between group estimates.

	1	2
$GDPpc_{i,t-1}$	-0.582***	-0.541**
	[0.155]	[0.166]
$(GDPpc_{i,t-1})^2$	0.247**	0.224**
	[0.080]	[0.087]
$Density_i$		0.011
		[0.016]
Constant	1.676***	1.657***
	[0.071]	[0.077]
R^2between	0.316	0.32
N	552	552

Standard errors in brackets; * significant at 10% level; significant at 5% level; significant at 1% level.

[3] Simulatenous causality can be better addressed by using an IV type estimator, but unfortunately, due to the peculiarity of the dataset (Italian provinces over 50 years) we could not find suitable instruments.

The estimates for each wave (Table 2) confirm this relation for the years between 1980 and 2010, while for 1960 and 1970 the negative relation prevails since the quadratic coefficient is lower and less significant. These results suggest that poorer provinces are associated with a lower land quality. Nonetheless, starting from the 1980s the difference between rich and poor provinces was less pronounced because of the changing performances due to the process of economic convergence experienced in most of the second half of the last century. To sum up, the cross section analysis points to an overall negative, although eventually convex, relationship between per-capita GDP and the ESAI.

Table 2. OLS estimates by year.

	1960	1970	1980	1990	2000	2010
$GDPpc_i$	-0.215**	-0.362**	-0.631**	-0.542**	-0.720***	-0.748***
	[0.084]	[0.158]	[0.205]	[0.162]	[0.113]	[0.206]
$(GDPpc_i)^2$	0.071*	0.130	0.274**	0.225**	0.321***	0.365**
	[0.036]	[0.078]	[0.109]	[0.080]	[0.056]	[0.113]
$Density_i$	0.022	0.012	0.013	0.017	0.013	-0.005
	[0.014]	[0.011]	[0.011]	[0.011]	[0.011]	[0.012]
Constant	1.477***	1.588***	1.699***	1.657***	1.735***	1.720***
	[0.048]	[0.078]	[0.094]	[0.081]	[0.055]	[0.093]
R^2	0.191	0.229	0.325	0.266	0.36	0.264
N	92	92	92	92	92	92

Standard errors in brackets; * significant at 10% level; significant at 5% level; significant at 1% level.

Compared with the cross-section estimates, the fixed effect estimates (Table 3) provide a different picture. The relationship between per capita GDP and the ESAI is strictly positive and linear as the squared term is never significant. This means that, once checking for the variation within the geographical areas, economic growth impact negatively the environment, in line with the de-coupling hypothesis, contributing to land degradation in Italy, a process that has consequently been stronger in fast-growing provinces. The reliability of the fixed effect formulation is confirmed by the Hausman test shown at the bottom of Table 3. The coefficient of per capita GDP is always significant and increases when controlling for the economic structure, passing from 0.039 to 0.056.

Among the other variables, population density and the share of agriculture in provincial GDP increase the degree of land vulnerability whereas a higher share in industry relative to services was associated to lower values of the ESAI. While the land consumption effects of the primary sector is straightforward, the latter result is not trivial as common wisdom would suggest that the development of service activities deteriorates the environment less than industry. Finally, the estimates with contemporaneous regressors (Appendix II, table A1) give the same sign for the value added coefficient, confirming our main result whereas the other variables are not significant, proving the effectiveness of our specification in eliminating the endogeneity bias.

Table 3. Fixed effect estimates with lagged regressors

	1	2	3	4	5
$GDPpc_{i,t-1}$	0.039***	0.056***	0.055***	0.052***	0.052***
	[0.008]	[0.009]	[0.009]	[0.009]	[0.009]
$(GDPpc_{i,t-1})^2$	-0.009	-0.011	-0.006	-0.003	-0.003
	[0.014]	[0.016]	[0.016]	[0.017]	[0.017]
$Density_{i,t-1}$	0.090***	0.079***	0.073**	0.076***	0.075***
	[0.023]	[0.019]	[0.022]	[0.022]	[0.021]
$GDP^I_{i,t-1}/GDP^S_{i.t-1}$		-0.028***	-0.020**	-0.018**	-0.017**
		[0.008]	[0.008]	[0.009]	[0.009]
$AgrShare_{i,t-1}$			0.070**	0.063**	0.064**
			[0.026]	[0.027]	[0.028]
$SatFirm_{i,t-1}$				0.000	0.000
				[0.000]	[0.000]
$SatShare_{i,t-1}$					0.000
					[0.000]
Time dummies	Yes***	Yes***	Yes***	Yes***	Yes***
Constant	1.298***	1.295***	1.291***	1.298***	1.295***
	[0.009]	[0.009]	[0.010]	[0.012]	[0.018]
R^2within	0.139	0.165	0.18	0.183	0.184
N	460	460	460	460	460
Hausmann test	90.7***	93.5***	98.2***	110.7***	95.24***

Standard errors in brackets; * significant at 10% level; significant at 5% level; significant at 1% level. The Hausmann test indicates the validity of the Fixed Effect estimator against the Random Effects.

4. Conclusions

In the present study we analyzed the relationship between the level of land vulnerability to desertification and the economic structure of the Italian provinces during a period encompassing fifty years, from 1960 to 2010. The focus on the productive structure of Italian provinces was therefore conducted with the aim of verifying if changes in the economic base at local scale may impact the spatial distribution (and variations over time) of a process of environmental degradation strongly linked to the socioeconomic local context (Salvati and Zitti 2009). In this perspective, the time span investigated here is particularly meaningful since it encompasses different phases of the post-war Italian economic system: from the process of industrialization to the shift towards a post-modern, sector-centered society (Antrop 2000).

As the econometric analysis figured out, from a cross section perspective, economic variables and land vulnerability levels have a similar geographical distribution: poorer regions are usually characterized by higher land vulnerability while better environmental conditions correspond to higher income regions. Such inequalities had slightly reduced along the whole period considered. However, the analysis of time changes allowed by the fixed-effects panel estimates depicts a different framework since high growing areas have experienced increasing land degradation. Among the other variables used as controls, population density, the share of agricultural activities and the relevance of the service sector significantly increase the level of land vulnerability. Thus, we can conclude that the specific path of economic growth occurred in Italy from the 1960s onward had a positive impact on the desertification risk taking the form of a net land consuming process of growth.

If we were interested in locating such results inside the EKC literature, we could say that from a static perspective Italy is located in the increasing side of the curve with economic and environmental distributions having similar features, while the specific economic process that occurred during the last half of the 20th century was located in the decreasing side of the same curve. Besides, our findings show the limits of the theoretical approach *à la EKC* and stress instead the importance of territorial disparities (Ansuategi 2003, Bruvoll and Medin 2003, Maddison 2006, Auffhammer and Carson 2008) and specific processes of structural change from both the economic and the environmental side (Patriarca Vona 2013).

While the income variable still provides a valuable indication of the development stage of a territory with a direct impact on the level of land vulnerability, changes in the economic structure at the local scale should be considered as a possible driver of desertification especially due to (indirect) feedback effects on the environment (Mukherjee and Kathuria 2006). Developmental policies should incorporate measures to reduce the impact of rapid changes in the economic base, especially as far as the society shifts from traditional rural systems, with low population density and limited accessibility, to service-oriented, high-density territories (Tan 2006). Results indicate that these processes can consolidate the environmental gap between rich and poor regions (Salvati and Zitti 2009), thwarting possible beneficial effects of development on the environment or even promoting negative feedbacks, as indicated by rural poverty-LD spirals possibly observed in some southern Italian districts.

Coordination between multi-target policies specifically aimed at contrasting the spiral between desertification and poverty, economic marginality and socio-demographic polarization seems an effective strategy to reduce environmental disparities and socioeconomic inequalities (Briassoulis 2011, Patriarca and Vona 2012). To promote a more spatially-equitable and polycentric development (Zuindeau 2007), these integrated policies should avoid approaches stimulating the development of single economic sectors through state-induced industrialization, as occurred during the post-war phase (1950-1990) in southern Italy.

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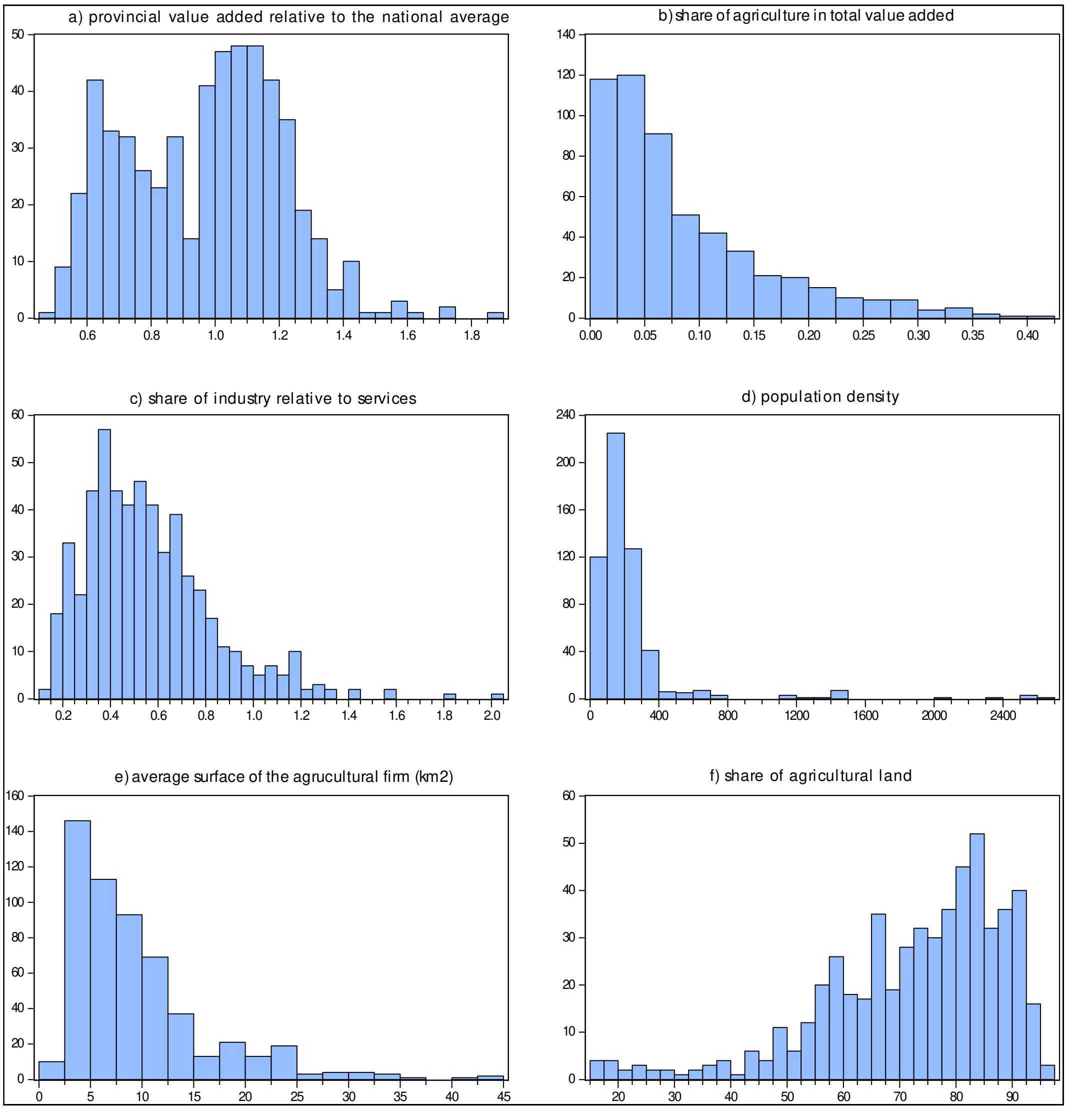
Appendix I

Figure A.1 Distribution of the selected socioeconomic indicators



Source: own elaboration on ISTAT and CRA data.

Appendix II

Table A.1 Fixed effect estimates (contemporaneous regressors).

	1	2	3	4	5
$GDPpc_{i,t-1}$	0.037***	0.039***	0.039***	0.037**	0.036**
	[0.010]	[0.011]	[0.011]	[0.012]	[0.011]
$(GDPpc_{i,t-1})^2$	0.003	0.003	0.003	0.006	0.004
	[0.015]	[0.015]	[0.015]	[0.015]	[0.015]
$Density_{i,t-1}$	0.109***	0.107***	0.107***	0.109***	0.107***
	[0.026]	[0.026]	[0.026]	[0.026]	[0.025]
$GDP^I_{i,t-1}/GDP^S_{i.t-1}$		-0.004	-0.003	-0.002	-0.001
		[0.007]	[0.007]	[0.008]	[0.008]
$AgrShare_{i,t-1}$			0.005	0	0.005
			[0.026]	[0.027]	[0.028]
$SatFirm_{i,t-1}$				0	0
				[0.000]	[0.000]
$SatShare_{i,t-1}$					0
					[0.000]
Time dummies	1.285***	1.286***	1.285***	1.284***	1.276***
Constant	[0.012]	[0.012]	[0.015]	[0.015]	[0.019]
	0.271	0.271	0.271	0.273	0.274
R^2within	552	552	552	552	552
N	127.7***	123.3***	160.6***	154.4***	134.9***

Standard errors in brackets; * significant at 10% level; significant at 5% level; significant at 1% level. The Hausmann test indicates the validity of the Fixed Effect estimator against the Random Effects.