In-between regional disparities and spatial heterogeneity: a multivariate analysis of territorial divides in Italy

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Processes such as economic polarization, social disparities and the asymmetric distribution of natural capital are becoming progressively more interlinked in developed countries and may reflect the uneven decline of the ‘centre-periphery’ model. The assessment of regional disparities and spatial heterogeneity in socioeconomic phenomena is a key issue in regional studies and takes advantage of the use of multi-domain frameworks and decision support systems. We performed an exploratory analysis of 133 indicators assessing seven thematic domains (demography/settlements, labour market, economic structure, quality of life, agriculture/rural development, landscape/water, environment/soil resources) with the aim of investigating regional disparities in Italy in the light of territorial changes driven by urbanization, industrial decentralization, agricultural intensification and land abandonment. The results of our study indicate that latitude, elevation and urban gradients have determined a complex spatial pattern in both socioeconomic and environmental variables in Italy. The proposed approach provides an overall assessment of the intensity of territorial disparities on a regional scale for each thematic domain, and of intra-region spatial heterogeneity for each indicator, representing a decision-making tool for policies targeting a sustainable and spatially balanced development.

Keywords: Indicators; exploratory data analysis; spatial heterogeneity; municipality; Italy

1. Introduction

The progressive shift towards a service-oriented economy has consolidated the gap between developed and economically weak societies influencing the spatial distribution of wealth and poverty (Hudson 2007; Zuindeau 2007; van Well 2012). In some cases, the persisting disparities driven by asymmetric economic growth of wealthier and economically disadvantaged countries have been recomposed partly in recent decades (Terrasi 1999; Cano 2001; Arbia and Paelinck 2003; D’Uva and De Siano 2011). In many other cases, territorial disparities emerged as the result of a polarized development influenced by the unbalanced spatial distribution of economic capital, population and natural resources (Longhi and Musolesi 2007; Felice 2010; Kyriakou and Roca-Sagalés 2014).

Territorial disparities usually reflect gaps among regions which involve an ample set of social, economic, demographic, cultural, political and environmental phenomena (e.g. Liao and Wei 2012; Salvati and Zitti 2011; Riddlesden and Singleton 2014). Unsustainable development may generate (or consolidate) disparities in economic and social variables as well as in other relevant territorial factors (Benyaklef 1997). Being
addressed jointly by an increasing literature on demographic polarization, economic convergence and social inequalities (Huby, Owen, and Cinderby 2007; Blancas et al. 2011; Morse, Vogiatzakis, and Griffiths 2011), unsustainable development in wealthiest countries requires a thorough monitoring of the spatial behaviour of several variables together in order to identify a spatially balanced growth (Zuindeau 2006, 2007; Cellini and Torrissi 2014).

The relation between regional disparities and the underlying spatial configuration that most likely determines socioeconomic polarizations has been primarily investigated through linear and univariate (or bivariate) approaches (e.g. Dixon, Shepherd, and Thomson 2001; Ezcurra, Pascual, and Rapún 2007a, Esposti 2011). The importance of basic geographical gradients has been less frequently tested when analysing intensity and trends in regional disparities of a given variable or socioeconomic dimension (but see also Cano 2001; Lois 2009; Prodromidis 2014). In line with such approaches, income distribution or disparities in the unemployment rate have been taken as relevant target variables when developing policy strategies to contrast economic polarization and socio-spatial disparities (Pehkonen and Tervo 1998; Terrasi 1999; Proietti 2005; Iuzzolino, Pellegrini, and Viesti 2013; Prodromidis 2014). Nevertheless, the inherent complexity of local contexts in terms of demographic, social and political factors, brings into question the reliability of linear and single-variable approaches to the analysis of regional disparities (e.g. Arbia and Paelinck 2003; Patacchini 2008; D’Uva and De Siano 2011) and outlines the need for alternative and comprehensive assessment frameworks (Zuindeau 2006, 2007; Salvati and Zitti 2007; Salvati and Carlucci 2014). Multidimensional approaches seem to be particularly suited to explore the socioeconomic gaps persisting among regions and to contribute to design effective development strategies taking into account spatial heterogeneity and the complexity of the different dimensions involved (see Nourry 2008; Hamdouch and Zuindeau 2010; Blancas et al. 2011; Morse, Vogiatzakis, and Griffiths 2011). Ezcurra, Pascual, and Rapún (2007b) have showed how economic polarization has progressively decreased in Europe, as a consequence of factors working at various spatial scales – mainly local – in opposite directions. Ertur, Le Gallo, and Baumont (2006) have showed that spatial heterogeneity matter in the estimation of convergence processes among European regions over recent decades. The study by Yamamoto (2007) reveals multiple dimensions of regional disparities in the United States and highlights the importance of scalar effects as a possible source of local heterogeneity, identifying systematic patterns of cross-scalar dynamics at the same time.

Based on these results, regional disparities and local-scale spatial heterogeneity in relevant socioeconomic dimensions should be investigated jointly. This will provide a comprehensive framework to understand patterns and mechanisms underlying spatial divides (Carneci and Mauro 2002; Hudson 2007; Nourry 2008) and to inform policies promoting territorial cohesion (Davoudi 2005). Territorial disparities in multiple socioeconomic dimensions have been largely studied in Europe (e.g. Cuadrado, Garrido Yserte, and Mancha Navarro 1999; Arbia and Paelinck 2003; Zuindeau 2007; Felice 2010). However, despite the great deal of academic contributions, this issue remains an intriguing matter of investigation for the Mediterranean countries (Benyaklef 1997). Due to rapid changes in economies and societies (Giannakourou 2005), the geography of southern Europe progressively changed in the last decades as far as income level and distribution, population density, infrastructure and land use are concerned (e.g. King, De Mas, and Beck 2001; Proietti 2005; Lois 2009; Prodromidis 2014). While economic polarization, social disparities and the asymmetric distribution of natural capital remain
important factors shaping local communities (Cano 2001; Dunford and Greco 2007; Felice 2010; Esposti 2011), their evaluation requires original and more integrated, multidimensional approaches designed to inform policies adhering to a spatially balanced development perspective (Zuindeau 2006, 2007; Dunford 2008; Nader, Salloum, and Karam 2008; Blancas et al. 2011).

Italy is a country with pronounced territorial disparities in both socioeconomic and environmental phenomena, in turn characterized by different spatial patterns influenced by multiple geographical gradients. Persistent disparities were observed in per-capita value added (Proietti 2005), unemployment (Carmeci and Mauro 2002), industrial development (Dunford 2008), labour productivity (Patacchini 2008), agricultural productivity (Esposti, 2011), degree of sustainable development (Dallara and Rizzi 2012), socioeconomic resilience (Cellini and Torrisi 2014), urban functions and competitiveness (Bonavero, Dematteis, and Sforzi 1999), among others. Together with the decline of the ‘centre-periphery’ model (Salvati and Carlucci 2014), these factors have also determined increased pressure on the environment, triggering land abandonment in fragile and marginal rural districts and population concentration in more accessible districts (Dunford and Greco 2007; Falcucci, Maiorano, and Boitani 2007; Esposti 2011; Dallara and Rizzi 2012).

The mosaic of differentiated socioeconomic contexts observed in Italy represents a unique case to study the latent relationship between regional divides and spatial heterogeneity at the local scale. Brida, Garrido, and Mureddu (2014) found a clear division between a high performance club consisting of regions from Central and Northern Italy and a low performance club composed by regions from Southern Italy, reflecting the distribution of economic activities and the structural attributes of the regional economies. Gagliardi and Percoco (2011) highlighted the eminent role of human capital shaping regional disparities in per-capita income between northern and southern Italy, since World War II. Based on a long-term (1890–2009) regional analysis, Cellini and Torrisi (2014) have documented huge and persistent territorial differences in Italy identifying only few economic shocks with different impact across regions. According to Lagravinese (2015, 331), “the recent crisis has exacerbated the strong imbalances between the North and South making rebalancing policies necessary to place the country on a sustainable growth path.”

Based on these premises, the role of multiple (i.e. socioeconomic and environmental) factors at the base of regional disparities and their local-scale spatial heterogeneity require further investigation in Italy (e.g. Bonavero, Dematteis, and Sforzi 1999; Dunford 2002; Floridi et al. 2011). Approaches exploring territorial disparities from a multidimensional perspective are especially needed to shed light on the most recent transformations driven by e.g. polarized urbanization (Bonavero, Dematteis, and Sforzi 1999), industrial decline (Dunford 2008), economic decentralization (Rodriguez Pose and Ezcurra 2009), asymmetric socio-spatial dynamics (Benyaklef 1997), agricultural intensification/extensification (Brunori and Rossi 2007) and environmental degradation (Salvati and Zitti 2009a). Indicators assessing together socioeconomic and environmental dimensions are particularly useful in these studies. Large datasets of socioeconomic indicators were already used e.g. to implement composite indexes of sustainable development (Salvati and Carlucci 2014) or to assess the impact of local communities on desertification risk in Italy (Salvati 2014).

Following Salvati and Zitti (2007), Sanna and Gemmiti (2012) and Salvati (2014), our study hypothesizes that social, economic and environmental disparities in Italy are primarily associated with the north—south divide, the urban—rural continuum and the
elevation gradient. From this perspective, we performed an exploratory analysis of 133 indicators assessing seven thematic domains (demography/settlement, labour market, economic structure, quality of life, agriculture/rural development, landscape/water, environment/soil resource) considered as the basis of regional disparities in Italy. Going beyond traditional econometric approaches centred on individual target variables (see also Brida, Garrido, and Mureddu 2014), our study is basically descriptive and exploratory in its scope, introducing a multivariate analysis of a large set of indicators representative of key socioeconomic aspects typically recognized in the regional disparities literature (demography and settlements, labour market, economic structure, quality of life) and less explored dimensions dealing with agricultural systems and rural development, landscape and water, environment and soil resources.

The analysis (i) provides a multidimensional picture of the territorial divides in Italy investigating a large set of socioeconomic and environmental indicators and assessing the influence of the three abovementioned gradients on the spatial pattern of each investigated domain and (ii) correlates local-scale spatial heterogeneity to regional disparities for each indicator’s domain, shedding light in the latent structure of socioeconomic and environmental divides in Italy. The results of our study contribute to design a multi-domain strategy for spatially balanced development in wealthy but divided countries. The proposed approach may become part of a decision-making tool informing national and regional policies for the mitigation of territorial disparities in socioeconomic and environmental fields.

2. Methodology

2.1. Study area

Italy (302,070 km²) shows consolidated disparities in the spatial distribution of population, settlements and natural resources accentuated by different climate, soils, vegetation and cropping systems across the country (Salvati and Zitti 2008). The spatial distribution of representative economic variables, such as per-capita income or unemployment rate, represents Italy as a divided country, with the most developed areas concentrated in Northern Italy and the most disadvantaged areas relegated to the Southern part of the country (Figure 1). Regional disparities consolidated over time and are still persistent across the country. For example, Figure 2 illustrates the ratio of southern Italy per-capita value added in the country’s value added between 1861 and 2014 based on official statistics disseminated by Istituto Guglielmo Tagliacarne (Rome). Disparities between Northern and Southern Italy increased between 1861 and 1936 stabilizing (or rising slowly) since the end of World War II.

2.2. Data and variables

Data used in the present study were provided by official sources (mainly the Italian National Statistical Institute, Istat) for 2000 or 2001 (see also Istat 2006). Considering data for more recent years prevents us from elaborating a comparably large number of indicators at a sufficiently detailed spatial scale (e.g. municipality) due to recent changes in census techniques or data collection, the incomparability of some time series data and the unavailability of a small number of representative variables at the desired geographical scale. The use of 2000–2001 data allows for a direct comparison with some key environmental variables collected along the 1990s and the early 2000s, which constitute the
information base for soil and natural resources in Italy. Appropriate indicators describing regional disparities were selected following Salvati (2014) according to the suggestions given by King, De Mas, and Beck (2001) and Trisorio (2005). A total of 133 indicators were elaborated on the basis of more than 200 elementary variables collected for each Italian municipality and assigned to a specific research domain (Demography and settlements, Labour market, Economic structure, Quality of life, Agriculture and rural development, Landscape and water, Environment and soil resources; see Table 1). Domains were identified according to Salvati (2014) and Salvati and Carlucci (2014) based on the specificity of the Italian socioeconomic and environmental context. Three supplementary variables (Ele, Sou and Urb) were included in the analysis (see the Appendix [online supplemental data]) to, respectively, assess the elevation gradient, the north–south gradient

Figure 1. Variables depicting the three geographical gradients in Italy (left: north–south, middle: elevation (m), right: urban–rural based on population density (inhabitants/km²)).

Figure 2. The ratio of southern Italy per-capita value added in the country’s value added between 1861 and 2014.
2.3. Assessing regional disparities and spatial heterogeneity in Italy

According to the working hypothesis that sees the north-south gradient as one of the most relevant factors shaping regional disparities in Italy (Proietti 2005; Floridi et al. 2011; Iuzzolino, Pellegrini, and Viesti 2013), spatial gaps and heterogeneity in each individual indicator were assessed calculating the ratio of the average value observed in southern Italy to the average value observed in northern Italy. An index of territorial disparities (TDI) was obtained for each thematic domain by averaging the ratio observed for each indicator assigned to that domain. The index ranges from 0 to 1; one indicates, on average, similar conditions in Northern and Southern Italy for a certain indicator (or thematic domain). Spatial heterogeneity was assessed by studying the variability in the statistical distribution of each indicator by municipality. An index of spatial heterogeneity (SHI) was finally calculated as the coefficient of variation (the ratio between standard deviation and the mean) of each indicator averaged by domain. The SHI ranges from 0 to 1; zero indicates homogeneous conditions across the country for a certain indicator (or thematic domain). The ratio of TDI to SHI was also calculated for each domain. A scatterplot ordering the seven thematic domains by TDI and SHI was finally produced.

2.4. Multivariate analysis

A second-step principal component analysis (PCA) was performed (i) to identify groups of indicators describing latent factors which reflect territorial disparities at the local scale and (ii) to evaluate the latent relationship between regional disparities and spatial heterogeneity of the selected socioeconomic and environmental

| Thematic domain                        | Analysis dimension                                      | Number of indicators |
|----------------------------------------|---------------------------------------------------------|----------------------|
| Demography and settlements (P)         | Population structure and dynamics, settlement characteristics | 15                   |
| Labour market (L)                     | Job market, Education                                   | 20                   |
| Economic structure (E)                | Economic specialization and competitiveness, tourism    | 23                   |
| Quality of life (Q)                   | Income and wealth, crime and society                    | 17                   |
| Agriculture and rural development (A) | Crop intensity, land tenure, human capital, innovation/quality in agriculture | 26                   |
| Landscape and water (W)               | Landscape structure and composition, water resource availability | 14                   |
| Environment and soil resources (S)    | Natural resources, soil quality, land degradation       | 18                   |
indicators (Section 2.2) in Italy. The use of second-step PCAs (Salvati and Zitti 2009b) is justified with the high number of input variables in the full data matrix (133 variables × 8101 municipalities).

2.4.1. Exploring latent patterns of regional disparities in the individual indicators
The first-step PCAs were carried out separately for each thematic domain on a variable number of input indicators by column (see Table 1) and the 8101 municipalities by row. The number of significant axes (m) was chosen by retaining the components with eigenvalue > 1 according to the correlation matrix. The Keiser–Meyer–Olkin (KMO) measure of sampling adequacy, which tests whether the partial correlations among variables are small, and Bartlett’s test of sphericity, which tests whether the correlation matrix is an identity matrix, was used to assess the quality of the PCA outputs. An index evaluating the goodness of representation of the input matrix (calculated as the ratio of the cumulated variance expressed by the extracted components to the proportion of the extracted components on the total number of input indicators) was used to assess the overall performance of each PCA (Salvati and Zitti 2011). Loadings ≥ 0.5 were considered when assessing the correlation of each individual indicator with the selected components.

2.4.2. Regional disparities and the importance of selected geographical gradients
The second-step PCA was run on the component score matrix extracted in the precedent step for each municipality retaining components with eigenvalue > 1. Component scores were used to identify latent factors shaping regional disparities in Italy and especially to assess the role of two geographical gradients (elevation and urban–rural continuum) in addition to the north–south divide. The supplementary variables describing these gradients (Ele, Sou, and Urb: see Section 2.1) were correlated with the scores of each principal component using non-parametric Spearman rank coefficients testing at \( p < 0.001 \) after Bonferroni’s correction for multiple comparisons.

3. Results
3.1. Assessing regional disparities and spatial heterogeneity in Italy
High TDI scores were observed for demography, settlement, labour market and environment/soil resource domains and contrast the much lower scores observed for quality of life indicators. Economic structure and landscape/water domains showed, on average, moderate north–south disparities, while agriculture/rural development indicators were the most stable across the country (Table 2). The SHI totalized the highest score for the indicators assessing agriculture and rural development, environment/soil resources and economic structure. Overall, the SHI score decreased with the TDI score. Territorial disparities and spatial homogeneity were found higher for labour market and demography/settlement domains, while medium-low disparities with relatively high spatial heterogeneity were observed for the other five domains (environment/soil resources, landscape and water, economic structure, quality of life, agriculture/rural development).

The indicators with the highest disparities between northern and southern Italy (Figure 3a) include participation and activity rate, unemployment rate, proportion of
Table 2. Territorial disparities (TDI) and spatial heterogeneity (SHI) indexes by domain in Italy.

| Dimension      | TDI | SHI | Ratio |
|----------------|-----|-----|-------|
| Population     | 2.8 | 1.5 | 1.8   |
| Labour market  | 1.9 | 0.8 | 2.4   |
| Economy        | 1.2 | 2.4 | 0.5   |
| Quality of life| 0.6 | 1.2 | 0.5   |
| Agriculture    | 1.0 | 2.9 | 0.4   |
| Landscape      | 1.1 | 1.5 | 0.7   |
| Environment    | 1.9 | 2.5 | 0.8   |

Figure 3. Indicators’ ranking according to the TDI in Italy: (a) the twenty indicators with the highest disparities and (b) the twenty indicators with the most stable spatial pattern between northern and southern Italy (see the Appendix [online supplemental data] for abbreviations).
illiterate people (labour market and education variables), forest fires, sensitivity of land to desertification, soil salinization risk (environmental variables), percentage of compact urban settlements (demography/settlement), percentage of workers in fishing, education and public sector (economic structure), farm size, perennial crop area, changes in the agricultural utilized area over time, organic farming and economically marginal farms (agricultural/rural development). The indicators with the most homogeneous distribution along the north–south gradient (percentage of temporary workers and population density) are primarily from the labour market and the demography/settlement domains (Figure 3b).

The highest spatial heterogeneity was observed for agriculture indicators (livestock density, livestock organic farms, agricultural quality and certified production, woodland distribution, changes over time in the agricultural utilized area), environmental indicators (forest fires, grazing index, salinization risk), economic structure (percentage of workers in fishing, mining and energy sectors, average number of beds in hotels, agro-tourism density, camping occupancy rate) and percentage rate of population growth (Figure 4a).

Figure 4. Indicators’ ranking according to the SHI in Italy: (a) the 20 indicators with the highest spatial heterogeneity and (b) the 20 indicators with the lowest spatial heterogeneity (see the Appendix [online supplemental data] for abbreviations).
By contrast, a relatively low spatial heterogeneity was observed for labour market (unemployment rate, education level), environment (soil and land degradation indexes), demography/settlement (dependency ratio, female to male rate, average family size) and quality of life (per capita disposable income, availability of private cars, subscription to television channels) indicators (Figure 4b).

Figure 5 illustrates the position of each indicator along two axes representing regional disparities and spatial heterogeneity. Despite a relatively high variability, the disparity-heterogeneity plot identified four clusters with specific patterns in terms of spatial polarizations and heterogeneity: (i) thematic domains with moderate regional disparities and low spatial heterogeneity (population and human settlements), (ii) domains with evident regional disparities and moderate spatial heterogeneity (environment/soil resources and labour market), (iii) domains with spatially heterogeneous indicators showing no evidence for regional disparities (agriculture/rural development) and, finally, (iv) domains with both high spatial heterogeneity and regional disparities in the composing indicators (quality of life and local economic structure).

3.2. Exploring latent patterns of regional disparities in the individual indicators

The results of the PCA run separately on each domain (first-step PCA) are illustrated in Table 3. The number of relevant components extracted by the PCA ranged between 4 and 8 with a cumulated variance between 50% and 73%. The representation index ranged between 1.67 and 2.92 indicating that the most satisfactory extraction from the input data matrix was obtained for labour market, quality of life and demography/settlement indicators. Based on the number of input variables and the variability of the indicators evaluated in each thematic domain, a 50% variance extracted for each domain’s PCA was considered the minimum threshold for the following analysis. Indicator loadings are reported in Table 4 for
each component extracted. Most indicators correlated significantly with at least one component. The highest number of non-correlated indicators was observed for the agriculture/rural development domain with 16 indicators correlated to at least one component out of 26 (61.5%). Overall, the first-step PCA (run separately on every domain) extracted 38 components to which 101 indicators (out of 133 indicators) are (positively or negatively) correlated (75.9%).

3.3. Regional disparities and the importance of selected geographical gradients

The second-step PCA was run on the scores of the 38 domain’s components (see Section 3.2) calculated for each Italian municipality. Six components with eigenvalue >1 were extracted in the second-step PCA cumulating 43% of the total variance (Table 5). These components were described using loadings and scores and proved useful to identify the factors associated with regional disparities and spatial heterogeneity in Italy. Component 1 (12% of the total variance) correlated with seven first-step components associating indicators from all thematic domains except landscape/water. Component 2 (10% of the total variance) correlated with seven first-step components representing indicators from all domains.

The two components extracted in the second-step PCA allow for a detailed description of the selected indicators’ spatial pattern. By contrast, principal components from 3 to 6 extracted a lower variance (14%) and were associated with specific domains (PC3: economic structure, PC4: labour market, PC5: demography/settlement, PC6: agriculture/rural development and landscape/water). The scores for the six extracted components were mapped at the municipal scale (Figure 6). A correlation analysis with the supplementary variables (latitude, elevation, population density) was finally performed (Table 6). While component 1 correlated positively with the north—south gradient, component 2 was associated positively with elevation and negatively with population density. The remaining components were not correlated to any supplementary variable. This result confirms that the first two components represent the most relevant territorial divides in Italy according to a wide set of socioeconomic and environmental indicators. The maps of the Italian municipalities based on the scores of components 1 and 2 illustrate the north—south gradient and the elevation gradient associated with different levels of population density (see Figure 1).

| Domain       | No. of variables | No. of components extracted | Cumulated variance (%) | Representation index |
|--------------|------------------|-----------------------------|------------------------|----------------------|
| Population   | 15               | 4                           | 59.7                   | 2.24                 |
| Labour       | 20               | 5                           | 73.1                   | 2.92                 |
| Economy      | 23               | 7                           | 50.4                   | 1.67                 |
| Quality of life | 17              | 4                           | 65.0                   | 2.77                 |
| Agriculture  | 26               | 8                           | 58.9                   | 1.91                 |
| Landscape    | 14               | 5                           | 66.3                   | 1.86                 |
| Environment  | 18               | 5                           | 54.5                   | 1.96                 |

Table 3. Results of the first-step principal component analysis extraction by domain.
Table 4. First-step PCA loadings by domain (the component with the highest loading and the relative sign was reported for each elementary indicator: see abbreviations in the Appendix [online supplemental data]).

| Population | Labour | Economy | Quality of life |
|------------|--------|---------|----------------|
| I1         | 3−     | L1      | 1+             | S1             | 1+ | Q1 |
| I2         | 1+     | L2      | 1+             | S2             | 1+ | Q2 | 1− |
| I3         | 4−     | L3      | 1−             | S3             | 6+ | Q3 | 1− |
| I4         | 1−     | L4      | 1−             | S4             | 6− | Q4 | 1− |
| I5         | 2+     | L5      | 1+             | S5             | 1− | Q5 | 1− |
| I6         | 2−     | L6      | 1+             | S6             | 1+ | Q6 | 1− |
| I7         | 4−     | L7      | 1−             | S7             | 1− | Q7 | 1− |
| P1         | 1+     | L9      | 3+             | S9             | 3+ | Q9 |
| P2         | 1−     | L10     |                | S10            | 2+ | Q10 |
| P3         | 1−     | L11     | 5+             | S11            | 7− | Q11| 1− |
| P4         | 1−     | L12     | 4+             | S12            |     | Q12| 1− |
| P5         | 1−     | L13     | 5+             | S13            |     | Q13| 1− |
| P6         | 2+     | L14     | 4+             | S14            | 1− | D1 |
| P7         | 3+     | F1      | 2+             | S15            |     | D2 | 4+ |
|            |        | F2      | 2+             | S16            | 7+ | D3 | 3+ |
| Agriculture|        |         |                |                |     |    |
| SR-A1      | 3−     | F4      | 2−             | T2             | 2+ |    |
| SR-A2      | 1+     | F5      | 1−             | T3             | 2+ |    |
| SR-A3      | 3−     | F6      | 1−             | T4             |     |    |
| SR-A4      |        |         |                |                |     |    |
| SR-A5      | 3−     |         |                |                |     |    |
| SR-A6      | 4−     |         |                |                |     |    |
| SR-M1      |        |         |                |                |     |    |
| SR-M2      | 5+     |         |                |                |     |    |
| SR-M3      |        |         |                |                |     |    |
| SR-M4      | 1−     |         |                |                |     |    |
| SR-Q2      | 2−     |         |                |                |     |    |
| SR-Q3      | 2−     |         |                |                |     |    |
| SR-Q4      | 7+     |         |                |                |     |    |
| SR-Q5      |        |         |                |                |     |    |
| SR-Q6      | 2−     |         |                |                |     |    |
| SR-Q7      | 5+     |         |                |                |     |    |
| SR-Q8      | 3+     |         |                |                |     |    |
| SR-Q9      |        |         |                |                |     |    |
| SR-Q10     |        |         |                |                |     |    |
| SR-L1      | 4−     |         |                |                |     |    |
| SR-L2      |        |         |                |                |     |    |
| SR-L3      | 6+     |         |                |                |     |    |
| SR-L4      |        |         |                |                |     |    |
| SR-L5      |        |         |                |                |     |    |
| SR-L6      | 1−     |         |                |                |     |    |

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Table 5. Results of the second-step principal component analysis (input variables are the domain’s components extracted in the first-step PCA, see Table 3; e.g. ‘P1’ indicates the first component extracted for the ‘demography and settlement’ domain: see Table 1 for domain’s acronyms).

| Variable | PC 1      | PC 2      | PC 3      | PC 4      | PC 5      | PC 6      |
|----------|-----------|-----------|-----------|-----------|-----------|-----------|
| P1       | -0.21     | -0.68     | -0.22     | 0.46      | -0.05     | 0.15      |
| P2       | -0.67     | 0.24      | 0.25      | 0.03      | -0.06     | 0.27      |
| P3       | 0.35      | 0.27      | 0.12      | 0.40      | -0.34     | 0.06      |
| P4       | 0.08      | 0.05      | 0.15      | 0.14      | 0.62      | 0.14      |
| L1       | -0.90     | 0.17      | -0.09     | 0.03      | -0.10     | 0.14      |
| L2       | 0.05      | 0.15      | -0.38     | -0.64     | 0.05      | -0.03     |
| L3       | -0.09     | -0.65     | -0.27     | 0.14      | -0.06     | 0.01      |
| L4       | -0.02     | 0.24      | 0.24      | -0.14     | 0.10      | -0.11     |
| L5       | 0.02      | -0.04     | -0.21     | 0.05      | 0.18      | -0.01     |
| E1       | -0.66     | -0.49     | -0.04     | 0.10      | -0.02     | 0.08      |
| E2       | -0.11     | 0.12      | -0.65     | -0.23     | -0.26     | -0.04     |
| E3       | 0.35      | -0.61     | -0.20     | -0.22     | 0.12      | -0.11     |
| E4       | -0.25     | 0.01      | 0.01      | -0.15     | 0.19      | 0.17      |
| E5       | -0.07     | 0.00      | -0.22     | 0.05      | 0.44      | -0.29     |
| E6       | -0.15     | 0.15      | 0.07      | -0.45     | 0.00      | 0.07      |
| E7       | -0.06     | 0.08      | -0.21     | 0.05      | -0.04     | -0.07     |
| Q1       | 0.64      | 0.20      | 0.44      | 0.23      | 0.17      | 0.06      |
| Q2       | 0.50      | -0.56     | -0.13     | -0.04     | -0.15     | -0.05     |
| Q3       | 0.23      | 0.02      | -0.28     | -0.07     | 0.27      | -0.11     |
| Q4       | -0.16     | -0.29     | 0.39      | 0.16      | -0.02     | 0.08      |
| A1       | 0.18      | 0.52      | -0.33     | 0.38      | -0.03     | -0.46     |
| A2       | -0.12     | -0.43     | -0.14     | 0.24      | 0.37      | -0.17     |
| A3       | 0.38      | 0.10      | -0.36     | 0.08      | 0.06      | 0.65      |
| A4       | -0.71     | 0.32      | -0.22     | -0.01     | 0.10      | 0.20      |
| A5       | -0.06     | -0.21     | -0.27     | -0.02     | -0.17     | 0.06      |
| A6       | -0.07     | -0.11     | -0.24     | -0.06     | 0.09      | -0.05     |
| A7       | -0.01     | 0.16      | 0.03      | 0.12      | 0.01      | 0.11      |
| A8       | 0.12      | 0.07      | -0.05     | -0.20     | 0.46      | 0.01      |
| W1       | -0.08     | -0.67     | 0.49      | -0.16     | -0.04     | 0.06      |
| W2       | -0.45     | -0.05     | 0.15      | -0.16     | -0.05     | 0.60      |
| W3       | 0.28      | -0.32     | -0.08     | -0.33     | -0.10     | 0.26      |
| W4       | -0.03     | -0.22     | -0.35     | 0.26      | -0.26     | -0.12     |
| W5       | -0.08     | -0.06     | -0.11     | 0.05      | 0.17      | 0.24      |
| S1       | 0.07      | 0.80      | -0.29     | 0.24      | 0.00      | 0.13      |
| S2       | 0.67      | 0.01      | 0.04      | -0.10     | -0.11     | 0.06      |
| S3       | 0.27      | 0.06      | 0.06      | -0.03     | -0.25     | -0.04     |
| S4       | 0.03      | 0.18      | 0.20      | -0.37     | -0.22     | 0.01      |
| S5       | 0.22      | -0.07     | -0.27     | -0.06     | 0.08      | 0.20      |

| Cum. Var% | 11.6 | 22.6 | 29.2 | 34.4 | 38.7 | 42.9 |

Note: The relevant component loadings $>0.5$ are marked in bold.
4. Discussion

The analysis of territorial patterns in socioeconomic indicators allows identifying spatially balanced development paths seen as a relevant contribution to local sustainability (sensu Zuindeau 2006, 2007; Salvati and Carlucci 2014). A multi-domain approach evaluating territorial disparities is particularly suited to disentangle the complex interaction between environmental factors, economic performances, socio-cultural dynamics and the local context (Huby, Owen, and Cinderby 2007; Salvati and Zitti 2007; Malkina-Pykh and Pykh 2008; Morse, Vogiatzakis, and Griffiths 2011). The methodology illustrated here is a promising tool to assess the intensity of territorial disparities and spatial heterogeneity using multiple-domain indicators and to compare

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**Table 6. Correlation matrix between the second-step PCA scores and the three geographical gradients in Italy.**

| Variable | North—south | Elevation | Urban—rural |
|----------|-------------|-----------|-------------|
| PC1      | 0.758*      | 0.340     | -0.386      |
| PC2      | -0.348      | 0.590*    | -0.586*     |
| PC3      | 0.024       | -0.110    | -0.225      |
| PC4      | 0.059       | 0.206     | -0.002      |
| PC5      | 0.009       | -0.060    | 0.255       |
| PC6      | -0.103      | -0.030    | 0.169       |

*Significant correlations at $p < 0.0001$ after Bonferroni’s correction for multiple comparisons.
them at the country scale. A multidimensional approach was preferred to consolidated procedures centred on single-variable analyses (e.g. changes over time in gross domestic product or unemployment rate) or traditional convergence analysis (Pehkonen and Tervo 1998; Terrasi 1999; Dixon, Shepherd, and Thomson 2001; Ezcurra, Pascual, and Rapún 2007a, Patacchini 2008) since it allows insight into the increasingly complex geography of socioeconomic-environmental relations at the basis of newly emerging spatial divides (Van Well 2012). Our approach is alternative to the use of composite indexes (Blancas et al. 2011; Floridi et al. 2011; Dallara and Rizzi 2012) and it can be applied to variables at sufficiently detailed geographical scales and covering long time intervals (Nader, Salloum, and Karam 2008; Nourry 2008; Salvati and Carlucci 2014). The indicators selected in this study provide a comprehensive assessment of the multifaceted socioeconomic contexts and environmental conditions observed in Italy at the local scale (Salvati 2014). Additional domains can be identified and considered within the proposed analysis framework, allowing joint investigation of spatial diversity, heterogeneity and complexity of relevant indicators profiling local communities (Salvati and Zitti 2007).

Our study reveals spatially persistent disparities between developed and marginal districts pin-pointing the interaction between socioeconomic variables and environmental factors (Zuindeau 2007). This underlines the complexity of the Italian local contexts as a result of recent socioeconomic changes, possibly impacting the spatial organization of the entire northern Mediterranean region (Governa and Salone 2005). Relevant gradients (such as elevation and the urban—rural continuum) shaping regional disparities and contributing to spatial heterogeneity add to the classical north—south gap observed in Italy since World War II (Dunford 2008; Felice 2010; Iuzzolino, Pellegrini, and Viesti 2013). For example, urban—rural divides in socioeconomic and environmental variables reflect a consolidated spatial pattern based on the dichotomy between local districts featuring manufacture, high-input agriculture and advanced services (mainly situated in northern Italy) and areas with subsistence agriculture, state-driven industry and traditional services typically observed in southern Italy (Floridi et al. 2011). A comprehensive understanding of the north—south divide in Italy, based on a multivariate set of socioeconomic and environmental indicators, reveals wide-range impacts and causes of the latitude gap (Esposti 2011), encompassing well-known economic factors (such as income, unemployment, economic structure, infrastructure and investments: Terrasi 1999; Dunford 2002; Proietti 2005; Patacchini 2008; Felice 2010), and involving processes related to mixed cultural, institutional, social and demographic factors (Salvati and Zitti 2008). Environmental factors (intended here as the distribution of natural resources and the state/quality of the environment) are important elements contributing to the socioeconomic divide between Italian regions (Salvati and Zitti 2009a). Taken together, high-heterogeneity thematic domains in Italy showed moderate-to-low regional disparities and vice versa. The inverse relationship observed between spatial heterogeneity and regional disparities is an interesting issue that deserves further investigation.

Evaluating the contribution of various thematic domains to regional disparities is a necessary information when planning integrated strategies for a spatially balanced development in a divided country like Italy. In the light of sustainable development, a regional configuration can be defined as balanced if all (or many of) the characterizing dimensions have reached similar levels (Zuindeau 2006). Reliable, timing and disaggregated information are therefore required in the assessment of regional disparities...
and sustainable development (Zuindeau 2007). The Lisbon strategy and the European Union new high-level strategy Europe 2020 have underlined the importance of these issues adding territorial cohesion to the long-established objectives of economic and social cohesion (Hamdouch and Zuindeau 2010; Territorial Agenda 2011; ESPON 2014). At the same time, the European Spatial Planning Framework has put the need for a spatially balanced development at the heart of the policy agenda (Davoudi 2003, 2005; Faludi 2006). The ESPON 2013 Programme – the European Observation Network for Territorial Development and Cohesion adopted by the European Commission on November 2007 – was set up to provide basic information to support policy development (ESPON 2014). At the country scale, framework programmes promoting a re-balance of the most relevant socioeconomic disparities in Italy actually concentrate on internal districts, intended as particularly vulnerable areas exposed to global crisis (e.g. Russo 2009). From this perspective, the joint assessment of economic performances, socio-demographic dynamics and environmental quality can be regarded as a basic tool for country-level policies sustaining a spatially balanced development (Dallara and Rizzi 2012). Approaches shedding light on multiple dynamics of growth and change are requested to work on different spatial scales, among which administrative partitions, statistically relevant domains and ad-hoc regional systems are relevant units (Janin Rivolin 2010).

Our study definitely points out the urgent need for a planning vision oriented towards a spatially balanced development for Italy. Policies promoting a spatially balanced development should take into account (i) the emerging relationship between the different organizational models of the economic space, (ii) the underlying demographic context, (iii) the rapidly evolving social structure and (iv) the latent environmental changes (Hamdouch and Zuindeau 2010). The interaction among such components determines a sort of mismatch between the economic structure – evolving under rules and practices defined at national and supra-national scales – and the socio-environmental context shaped by long-term human-nature interactions at the local scale (Zuindeau 2007). This latent mismatch may consolidate territorial divides influencing negatively the sustainable development path of local districts, regions or countries (Zuindeau 2006).

5. Conclusions

The joint assessment of socioeconomic and environmental trends is increasingly required to provide a truly integrated and comprehensive analysis of regional disparities in southern Europe and, more generally, in the entire continent. Providing an objective way to identify factors that determine socioeconomic disparities based on their potential for change is definitely seen as a relevant contribution to regional science. The exploratory analysis developed in this study has illustrated the complex relationship between multiple dimensions of a given local system, possibly informing policies aimed at reversing territorial disparities. The proposed assessment tool is useful as a first-step mechanism to identify relevant geographical gradients influencing spatial divides in different socioeconomic and environmental dimensions. The approach can be integrated with local-scale qualitative (or mixed) analyses to identify more precisely regional disparities from spatial heterogeneity. Further investigation can promote an integrated analysis of territorial divides merging sustainable development issues with a traditional regional science perspective centred on territorial divides and spatial heterogeneity. Spatially disaggregated indicators that are comparable over long time periods are an indispensable tool when designing and implementing these studies.
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No potential conflict of interest was reported by the authors.

Supplemental Data
Supplemental data for this article can be accessed here.

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