A composite index of sustainable development at the local scale: Italy as a case study

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ABSTRACT

In the present study a methodology integrating geographic information systems and multivariate statistics was illustrated with the aim to provide a measure of sustainable development at the local scale. The Factor Weighting Model (FWM) originally proposed by Salvati and Zitti (2008) was used to compose 99 variables (relevant to different research domains such as economic structure, labour market, population dynamics, social characteristics, agriculture and environment) into an index of sustainable development at the municipality scale in a rich but polarized European country (Italy). A Principal Components Analysis has been carried out to explore the relationship among indicators and to estimate their contribution to an a priori defined sustainability target by way of an objective weighting system. Labour market, income and wealth, population dynamics and social structure accounted for the highest weights. The derived index of sustainable development shows a spatially complex distribution in Italy with a marked north–south gradient reflecting the classical socioeconomic disparities observed between competitive and disadvantaged regions. Results can be used as an informative base to implement sustainability policies in countries characterized by persistent socioeconomic disparities.

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1. Introduction

Based on a conceptual framework which evaluates the performance of a system within three domains (economy, society, environment), the assessment of sustainable development has been conducted mainly through the use of proxy indicators depicting several research dimensions (Ronchi et al., 2002; Nourry, 2008; Nader et al., 2008). These indicators have usually been aggregated into composite indexes of sustainable development (for a detailed description of procedures, see OECD, 2008) and mainly used to compare the performance of a set of countries (or, more rarely, regions). Based on a number of interconnected causes analysed without hierarchical causality, this approach tries to capture the complexity of processes and aspects of sustainability in rapidly changing societies (Khatun, 2009). Even if the procedure to build up a composite index of sustainable development is prone to the risk of subjectivity, nevertheless "these indices remain invaluable in terms of their ability to simplify complex measurement constructs, to focus attention and to catch the eye" (Booysen, 2002).

The complexity of the 'sustainability' concept represents a limitation for monitoring, spatial modelling and scenario approaches (Salvati and Zitti, 2008).

The multifaceted and somehow overlapping content of its components at different geographical scales makes the already difficult measure of sustainable development an impossible task (Gidding et al., 2002), Thus, analyses devoted to exploring the spatial variability of these indexes at the local scale and the disparities existing at the regional and national scale are still scarce (Niemeijer, 2002).

Factors contributing to sustainable development include economic, social and environmental variables among which the most relevant are: (i) transformations in the economic structure at the local scale, possibly due to urban expansion and changes in land prices, (ii) changes in income and consumption patterns, (iii) infrastructures and accessibility, (iv) labour market structure, (v) demographic and household changes, (vi) migration, segregation, filtering, (vii) changes in lifestyle and behaviours, (viii) public regulations (e.g. taxes, subsidies, land-use planning, housing policies), (ix) the socio-environmental context at large and (x) the economic viability of the primary sector (Casadio-Tarabusi and Palazzi, 2004; Nader et al., 2008; Nourry, 2008; Siche et al., 2008).

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Table 1
A scheme illustrating the number of indicators selected by theme and research dimension.

Themes	Research dimensions	Indicators
Demography	Population structure (P)	6
	Territorial characteristics and urban structure (U)	13
Human capital	Education (F)	5
	Labour market (L)	12
Local development and competitiveness	Economic structure (S)	6
	Tourism specialization (T)	5
Quality of life	Income and wealth (W)	13
	Crime (D)	4
Rural development and environment (A)	Water management	6
	Land tenure	5
	Rural landscape	11
	Crop intensity	6
	Quality and innovation in agriculture	5
	Human capital in agriculture	4

The illustrated factors can be quantified using indicators, thus allowing for an objective assessment of the territorial contexts favouring sustainability. The procedure should be characterized for simplicity in model building and flexibility in the use of relevant variables (OECD, 2008). Basic assumptions of the framework include the substitutability among the indicators considered and (ii) the hypothesis of equal weighting of the thematic indicators used. Formulating alternative approaches is problematic due to the hardness of positing hypotheses that are free of subjective, ex-ante choice (Salvati and Zitti, 2008).

Due to the multidimensionality of the sustainability issue, an integrated approach based on multivariate analysis and geographic information systems may better explore latent spatial patterns and trends of the main factors affecting sustainability over large areas (Khatun, 2009), providing an objective procedure to estimate the importance of single components contributing to the target concept (Salvati and Carlucci, 2011). The choice of relevant variables, the method used to develop the indicators representing the components of the target concept, and the weighting techniques adopted to estimate the importance of the single components, may have a considerable influence on the estimation of the level of sustainable development and need to be further investigated (e.g. Yli-Viikari et al., 2007; Nourry, 2008; Siche et al., 2008, and references therein).

In the present study a Factor Weighting Model (FWM) was introduced to estimate the importance of a set of variables composing an index of sustainable development. The derived index is intended to provide an overview of sustainability at a detailed spatial scale (e.g. municipalities and local communities) and with a national coverage. Italy was selected as a case study characterized by diverging socioeconomic and environmental contexts possibly influencing the sustainable development of local communities (Ronchi et al., 2002). This objective has been achieved through the following steps: (i) selecting proxy variables and integrating the information associated to the investigated dimensions; (ii) translating variables into adequate indicators of sustainability; (iii) estimating a weight for each indicator and each dimension of sustainability through a multivariate approach; and (iv) producing a ranking of Italian municipalities according to the level of sustainable development achieved over time. Results can be used as an informative base to implement sustainability policies in both developed and emerging countries characterized by socioeconomic disparities.

2. Methodology

2.1. Study area

Italy is a Mediterranean country covering 301,330 km^2 of land composed of nearly 23% flat areas, 42% hilly areas, and 35%

mountainous areas. Northern Italy is one of the most developed regions in Europe and occupies the whole Po valley. Central Italy, separated from northern Italy by the Apennines mountain is a polarized region with a relevant divide in dense and dispersed settlements (Salvati and Carlucci, 2011). Southern Italy, together with Sicily and Sardinia, is a disadvantaged region with an economic structure centred on low- and medium-income agriculture, constructions and traditional tertiary activities (including, commerce, and the public sector). Italy shows relevant disparities in population density and growth, settlement form and density, crop intensity, tourism concentration with impact on the distribution of natural resources (Salvati and Zitti, 2008).

2.2. Sustainability indicators

The variables used in the present study were derived from data provided by official statistical sources: in particular, we mainly used structural data obtained from censuses carried out by the Italian National Statistical Institute [Istat] in 2000 or 2001, together with other economic and environmental information referring to the years immediately preceding or following. A total of 99 indicators has been calculated from the collected variables at the municipal scale (8100 administrative units in Italy) and classified into six main themes and 14 research dimensions (Tables 1 and 2). The selection of variables, the procedure for the construction of indicators, and the identification of the thematic dimensions suited to describe the context influencing the sustainability of the local development have been set up according to the indications provided in Ronchi et al. (2002). Although the indicators selected in the present study cannot be considered an exhaustive description of the different Italian socioeconomic contexts, they provide a broad qualification of the economic structure, social traits and environmental characteristics observed in the Italian municipalities.

2.3. Building-up the composite index of sustainable development

As reported in Fig. 1, the procedure implemented to build up the composite index of sustainable development consists of seven steps including variables' selection, data transformation, multivariate statistical analysis, weight derivation, indicators' composition and descriptive statistics of the obtained index. According to OECD (2008) data transformation was carried out according to four rules; variables' weighting and indicators' composition were carried out each based on two different rules, generating eight procedures underlying the composition of the sustainable development index (Table 3).