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Accessibility and rurality indicators for regional development

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ABSTRACT

The development of a region is affected, inter alia, by concepts linked to the ability to displace and reach other locations (accessibility) efficiently and to lagging economic conditions connected to contemporary countryside activities (rurality). These topics and their relationships have attracted the interest of scholars who have scrutinized the implications of accessibility and rurality for policy making and planning.

The aim of this paper is to contribute to the theoretical modeling of accessibility and rurality and to develop an empirical study of their spatial patterns, with reference to the municipalities of the region of Sardinia, Italy. We study accessibility through an indicator constructed using a doubly constrained spatial interaction model and propose the Composite Index of Rurality that aims to evaluate rurality in a regional setting employing multivariate analysis. We investigate the spatial dependence of these indicators through general and local spatial autocorrelation analysis to verify the hypothesis that scarcely accessible spatial units are classifiable as rural areas. The results show that, for the case study of Sardinia, this hypothesis is not always true, as some urban areas are not always highly accessible.

1. Introduction

Regional development scientists are currently interested in expanding concepts that include a variety of phenomena that can be evaluated through quantitative and efficacious indicators. Accessibility and rurality fall into this category and concern a number of key concepts. The first key concept refers to the ability of a given society *latu sensu*, i.e., including a certain set of individuals, places, institutions and infrastructures, to allow each citizen to reach locations in a reasonable time and cost. "Changes in accessibility lead to changes in the value of a region's economic potential" (Vickerman, 1995, p. 227). It is not surprising that the simplicity of this concept has attracted the interest of a rich panorama of studies directed to the construction of suitable models and indicators to elucidate accessibility (De Montis & Reggiani, 2012, 2013). Remote places are usually scarcely accessible because they are negatively constrained by high travel costs. Commuters, i.e., workers who travel daily to reach workplaces located in different zones from their home, are one of the categories of individuals affected by issues connected to scarce accessibility and high remoteness. The capability to move easily in a territory is crucial for increasing the share of citizens in our contemporary societies (Sampaio, Neto, & Sampaio, 2008). Remoteness is indeed a crucial issue in the definition of rurality. The detection of rural regions is connected to the level of development of a country. A coordinated national development perspective also implies a correct approach to improve lagging regions. In this vein, many researchers have focused on the definition of rurality to scrutinize various concepts, including subsidy distributions, premium attributions, and lagging region status acknowledgement.

The interplay between accessibility and rurality has been the focus of many studies that develop the hypothesis that accessibility is inversely correlated with the rurality of a place (Barnett et al., 2000; Morrissey, Clarke, Ballas, Hynes, & O'Donoghue1, 2008).

Against this background, the aim of this paper is to scrutinize the relationships between regional accessibility and rurality. For this purpose, we use two indicators. We study accessibility through an indicator constructed using a doubly constrained spatial interaction model (SIM). We propose the Composite Indicator of Rurality (CIR) exploiting multivariate analysis techniques. We test the two indicators for the case study of municipalities in Sardinia, Italy. Finally, the spatial dependence of these indicators is investigated through global and local spatial autocorrelation analyses (SAAs).

The contents of this paper are presented as follows. In the next section, we recall some of the main research findings about the three key issues of this paper: accessibility, rurality and SAA. In

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the third section, we illustrate our contribution to the field by proposing a combined index of accessibility and the CIR, and we introduce the reader to SAA. The accessibility indicator is obtained as a weighted linear combination of the incoming and outgoing commuting accessibilities calibrated through a doubly constrained SIM. The CIR is a multi-component indicator obeying a weighted linear combination. Weights in both accessibility indicator and CIR are derived through principal component analysis. In the fourth section, we present the results from the application of the two indicators for the case study of Sardinia and study their spatial correlation. The fifth section concludes this paper with comments and final remarks on the main results of our investigation.

2. State-of-the-art summary

Accessibility is a crucial concept in transport and city planning. The widespread adoption of this concept stems from the pioneering works of Hansen (1959) and Weibull (1976), who defined it for the first time with a systematic approach. The main idea underlying these studies is that accessibility can be measured as a potential of opportunities, which can be reached from a given place at the cost of overcoming the friction associated with the movement through space/time. A number of studies have applied this concept and developed several methods and indicators of accessibility (see, inter alia, Baradaran & Ramjerdi, 2001; De Montis & Reggiani, 2012, 2013; Geurs & van Wee, 2004; Handy & Niemeier, 1997; Jones, 1981; Martín & Reggiani, 2007; Wu & Hine, 2003). In this respect, the spatial interaction models introduced by Wilson (1970) are currently broadly adopted to scrutinize accessibility. With reference to the aim of this paper, some studies have focused on studying accessibility patterns for commuters (see, inter alia, Caschili & De Montis, 2013; Patuelli, Reggiani, Gorman, Nijkamp, & Bade, 2007). In this case, accessibility also appraises the efficiency of transportation systems, as commuters make use of transport infrastructure for their daily home-workplace-home trips. O'Kelly and Lee (2005) have used spatial interaction modeling to study the implied benefits of relatively accessible locations for commuters and verified the hypothesis that '*locational advantages and accessibility can be inferred from a spatial interaction process*'. Thus, accessibility modeling is a crucial factor for scholars and practitioners in the field of transport policy planning and making.

Another important concept in regional planning is linked to the description and assessment of a reliable measure of rurality. Contemporary landscapes are characterized by a variety of land uses that cannot be encapsulated through traditional dichotomous concepts such as city and countryside. Hybrid spaces emerge and lead researchers to coin new concepts such as peri- or rur-urbanization (see, inter alia, Sobrino, 2003; Sullivan, Anderson, & Taylor Lovell, 2004; Theobald, 2001; Zacharian, 1988). The construction of a quantitative indicator of rurality is crucial to guide decision makers in distributing public subsidies for disadvantaged regions: severe shortcomings may arise if the indicator is poorly defined (see, inter alia, Sherval, 2009). Hence, an interesting stream of research focuses on methodologies useful for designing and constructing suitable rurality indicators. A number of works has shown a general tendency that takes into account (i) the insurgence of hybrid spaces, and (ii) the multi component character of those spaces. Studies in this respect have been proposed by Bogdanov, Meredith, and Efstratoglou (2008), Dijkstra and Poelman (2008), Higgs and White (2000), Mountrakis, AvRuskin, and Beard (2005), Perlín (2010), Pizzoli and Xiaoning (2007), Smith and Parvin (1973), van Eupen et al. (2012) and Waldorf (2006).

Finally, it is of interest for this work to recall the background of SAA that we use to evaluate spatial patterns of accessibility and rurality in a regional setting. SAA consists of a group of techniques able to detect the geographical proximity and spatial distribution of a given variable. In other words, SAA helps one to assess whether a variable shows spatial dependences, i.e., similar (in case of positive) or different (in case of negative) spatial patterns in neighboring locations. A very popular measure of global spatial autocorrelation is the index introduced by Moran (1950); the local spatial autocorrelation (LISA) was first introduced by Anselin (1995) and is still broadly adopted to investigate spatial correlations on the local scale. Our interest in this paper is directed to spatial analyses of commuter movements between towns. Many authors have applied spatial autocorrelation analysis to ascertain the geographical dependence of commuter behavior. Griffith (2007) studied commuting in Germany at the NUTS3[1] level and found that distance decay and spatial autocorrelation are highly intermingled. Vandenbulcke et al. (2011) applied spatial autocorrelation analysis in conjunction with other spatial statistical tools to inspect bicycle commuting in Belgium. Wang (2001) developed a number of statistical analyses to study the intra-urban variations of average commuting time and distance in Columbus, OH, USA. His goal was to reduce the distortive effects of positive spatial autocorrelation among intra-urban data by introducing a spatially lagged dependent variable. Kawabata and Shen (2007) developed spatial analyses to investigate the association between job accessibility and commuting time for public transit and private cars within the San Francisco Bay area. With respect to SAA applications in the realm of rurality and rural issues, we acknowledge a rich panorama of case studies in various geographical contexts. Ceccato and Dolmen (2011) investigated the determinants of crime in rural Sweden and adopted SAA to analyze spatial agglomeration of illegal misbehavior in certain zones. Ceccato and Persson (2002) applied SAA to study the dynamics of employment in rural areas of Sweden. Pizzoli (xxxx) applied SAA to study the distribution of rurality in Italian municipalities. Benson, Chamberlin, and Rhinehart (2005) used SAA to scrutinize geographical patterns of poverty in rural areas of Malawi. Do Vale and da Silva (2011) applied SAA to inspect rurality in northeastern Brazil on the local scale of municipalities. Liu and Li (2010) developed SAA to understand the criticalities of per capita income growth in rural areas of China at the provincial level.

Starting from this theoretical background, in the next section, we introduce the index of accessibility and the CIR, which we apply to the case study of the Region of Sardinia.

3. Methods: spatial interaction model, multivariate analysis and spatial autocorrelation analysis

The analyses developed for this manuscript are based on three methodologies. First, we calibrate a doubly constrained spatial interaction model to construct an indicator of accessibility at the municipal level. Subsequently, we apply multivariate analysis to construct the Composite Indicator of Rurality. Finally, we use SAA to study the geographical patterns of the two above indicators. In the following subsections, we introduce the methodologies applied in developing this work.

3.1. Accessibility and spatial interaction model

We consider two different versions of accessibility indicators, which are based on the framework of spatial interaction models (Hansen, 1959; Wilson, 1970). We define the outgoing accessibility indicator Acc_i^{out} as the potential of opportunities for interaction of municipality i with other municipalities j of our domain.

[1] NUTS is the acronym for Nomenclature of Units for Territorial Statistics, which is a geocode standard for referencing the subdivisions of European countries for statistical purposes.