



Research Paper

Distance matters: Land consumption and the mono-centric model in two southern European cities

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H I G H L I G H T S

- We used the mono-centric model to analyze urban morphology and land-use changes.
- Urban form and population dynamics influence long-term land-use patterns.
- The mono-centric model is associated with low per-capita land consumption.

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The mono-centric city model has been proposed to assess the relationship between urban morphology and land-use changes along the urban gradient. Although several studies have shown how compact cities are reorganizing towards a more dispersed morphology, indicators investigating the efficiency in the use of land were rarely used to test the assumptions of the mono-centric model. The present paper compares population dynamics and land-use changes between 1960 and 2010 in two European Mediterranean regions characterized by different morphology and socioeconomic structure. Two indicators of land-use changes have been analyzed in order to quantify the absolute and the per-capita surface areas of three basic uses of land (urban, agricultural, forest). Trends in absolute and per-capita indicators diverged in the two regions suggesting that city's structure influences long-term land-use and population dynamics. The present study contributes to the debate on urban forms indicating that the mono-centric model is associated with a lower per-capita land consumption rate compared to spatial structures that show deviations from mono-centricity.

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1. Introduction

Urban economics derives from the location theories of von Thünen, Alonso, Christaller and Lösch (e.g. Alonso, 1964; Capello & Nijkamp, 2004; Coulson, 1991; O'Sullivan, 2002). As an example, Von Thünen's nineteenth century writings (Hall, 1966), which emphasize the role of distance to a central market, have shaped generations of land-use models. Looking at the distribution of the different uses of land, urban economists seek to analyze the spatial organization of activities within cities (Gargiulo Morelli & Salvati, 2010). Urban development, however, involves multiple research dimensions and a number of underlying factors (Chorianopoulos, Pagonis, Koukoulas, & Drymoniti, 2010). As a consequence, themes

such as urban morphology, compactness, exurban development and land consumption have attracted and are still attracting the interest of many researchers, with the objective to define the nature, dynamics, and consequences that the phenomenon of urban expansion is having on social and natural capitals (Aguilar, 2008; Cakir et al., 2008; Catalàn, Sauri, & Serra, 2008; Cho, Jung, Roberts, & Kim, 2012; Sutton, Goetz, Fildes, Forster, & Ghosh, 2010).

Spatial organization of activities within cities appears to be closely connected with spatial variations of land prices, socioeconomic forces that caused the spread of employment from the central core of cities outward, and land-use control and planning (O'Sullivan, 2002). Economic analysis has heavily relied on a particular model of urban spatial structure, the mono-centric city model pioneered by Alonso (1964), Muth (1969) and Mills (1972). The land-use spatial arrangement in the mono-centric model features – a Central Business District (CBD) in the core area of the city where the employment is concentrated (Capello & Nijkamp,

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2004); population density, land values, house prices and the capital-land ratio falling with distance from the city centre – have been the subject of repeated empirical testing (e.g. Coulson, 1991).

Recently, the mono-centric city model is no longer viewed as an accurate depiction of urban spatial structure. This is partly due to the unrealistic nature of model's assumptions. In fact, due to urban expansion, exurban development and changes in the socioeconomic relationships between the central city and the surrounding rural area, urban regions may be viewed more aptly as poly-centric rather than mono-centric entities (Munafò, Norero, Sabbi, & Salvati, 2010). Mono-centricity assumptions have been relaxed over time due to changes in technology, particularly due to faster and cheaper transportation (which makes it possible for commuters to live farther from their jobs) and communications (which allow the allocation of back-office operations out of the inner city). Therefore, recent research has tried to explain poly-centric expansion in models that account for factors such as utility gains from lower average land rents and increasing (or constant) returns due to economies of agglomeration (Camagni, Gibelli, & Rigamonti, 2002; Capello & Nijkamp, 2004; Muñoz & Galindo, 2005). Nevertheless, deviations from the mono-centric assumptions (possibly indicating a more poly-centric urban region) are still considered an important result to explain the spatial structure of a city (Salvati and Sabbi, 2011).

Exurban development is usually defined as a pattern of urban expansion that reflects new car-dependent, low density settlements further away from the fringe of consolidated urban areas (Bruegmann, 2005). While in the last century exurban development has been a normal trend in advanced countries, it is a relatively novel phenomenon in southern Europe, a region characterized by compact cities and mono-centric urban systems (Antrop, 2004; Kasanko et al., 2006; Schneider & Woodcock, 2008; Schwarz, 2010). Compared to northern and western Europe (e.g. Ahlfeldt, 2011; Helbich, 2012; Helbich & Leiter, 2010), the partial failure in promoting a poly-centric spatial asset in the Mediterranean may reflect the persistence of peculiar socioeconomic and territorial traits such as settlement compactness and density, population ageing, planning deregulation, the interplay between formal and informal economic activities and 'locked' institutional assets (e.g. Gargiulo Morelli & Salvati, 2010).

However, since the 1990s several Mediterranean cities started sprawling with the consequent relocation of population along the fringe (Muñoz & Galindo, 2005) and important changes in morphology and socioeconomic structures (Dura-Guimera, 2003; Gospodini, 2009; Longhi & Musolesi, 2007; Turok & Mykhnenko, 2007). Urban diffusion in southern Europe has reduced the amount of high-quality agricultural areas and natural landscapes (Cakir et al., 2008; Catalàn et al., 2008; Jomaa, Auda, Abi Saleh, Hamzé, & Safi, 2008; Munafò et al., 2010; Paul & Tonts, 2005; Weber, Petropoulou, & Hirsch, 2005). However, policies mitigating land consumption revealed their weakness in peri-urban areas regardless of the country they belong to, despite the markedly different planning systems enforced at the national scale (Giannakourou, 2005).

Although exurban development and land consumption have been regarded as key issues in the European policy agenda since the early 2000s (European Environment Agency, 2006) and a number of indicators has been proposed to monitor land-use changes in peri-urban areas (e.g. Hasse & Lathrop, 2003), approaches linking urban economic models to land-use and sprawl indicators have rarely been developed to our knowledge (Adolphson, 2009; Burger & Meijers, 2012). In particular, a simplified indicator that can be tested for mono-centricity is the ratio of the growth rate of land development near the outer suburbs to the growth rate of population in the metropolitan area (Couch, Petschel-held, & Leontidou, 2007; Kasanko et al., 2006; Terzi & Bolen, 2009). A large imbalance between spatial expansion and population change (where the

former increases much more rapidly than the latter) is not unusual in large city-regions and growth of this sort produces a lower density outcome, with people and their residential and commercial buildings taking up more space at the expense of agricultural and natural land (Gargiulo Morelli & Salvati, 2010; Gill et al., 2008).

Based on these premises, the present study tests the mono-centric model using long-term land-use changes observed in two of the largest Mediterranean cities (Athens and Rome) characterized by a different morphology: strictly compact and dense in Athens, more scattered and discontinuous in Rome. By assessing the expansion pattern of the two cities over the last fifty years (1960–2010), the study estimates the rate of agricultural and natural land consumed by urban expansion and verifies if (i) land-use changes have been influenced by the diverging spatial organization of the two urban regions and if (ii) land consumption rate is higher in urban regions with a mono-centric or a poly-centric structure.

2. Methodology

2.1. The study areas

Rome (Italy) and Athens (Greece), two large capital cities in southern Europe, have been investigated in the present study along fifty years between 1960 and 2010 (Fig. 1). In both cases, the investigated area corresponds to the prefecture administered by that city and encompasses the boundaries of the related 'Urban Atlas' region (European Environment Agency, 2010). Municipalities and urban districts have been selected as the basic domain of analysis to collect comparable data among regions. In both regions, the urban area was determined according to the definition provided by the national statistical office (ISTAT in Italy and ESYE in Greece). The remaining municipalities in the metropolitan area of both cities were defined as peri-urban on the base of their settlement and land-use characteristics (Salvati & Sabbi, 2011; Salvati, Sateriano, & Bajocco, 2013). Municipality data allows for a detailed analysis of land-use and population dynamics covering a long time period and based on official statistics (Salvati & Sabbi, 2011). Urban development has followed different patterns in the two cities and in the two time intervals analyzed.

The Greek study area covers nearly 3000 km² for a total of 115 municipalities (of which 58 formed Athens' urban area which covers 430 km²). The region consists of both mountains bordering the urban conurbation of Athens and coastal plains (Messoghia, Thriasio and Marathon) located outside the urban area.

Restricted land availability due to the mountainous topography of the region and rapid population growth had determined a compact settlement expansion around the main centres of Athens and Pireaus between the 1960s and the 1990s (Salvati, Sateriano et al., 2013). The economic structure of these cities was mainly centred on manufacture industry and traditional services (construction, commerce, public sector), and vertical and horizontal class segregation was observed throughout Athens' urban region (Couch et al., 2007). After 1990, population growth slowed down, and a strong de-concentration in the city centre coupled with the expansion of dispersed settlements was observed (Chorianopoulos et al., 2010). In these years, the 2004 Olympic Games had a major impact on the development of the city in terms of investment and infrastructure (Beriatos & Gospodini, 2004). Before crisis, Athens' economy was largely service-oriented in sectors such as finance, banking, insurance and real estate. A slightly more balanced social structure was observed on the regional scale (Gospodini, 2009).

The Italian study area covers a surface area of 5355 km² and 121 municipalities all belonging to Rome's administrative province. Rome's municipality extends for 1285 km² and it is further divided into 115 urban districts with a size comparable to the remaining

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