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# Urban Concentration, Agglomeration Economies and the Spatial Structure of Italian Local Labor Market Areas

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**Abstract**

This study investigates the evolution of local labor systems (1996-2005) in Italy by introducing an indicator of economic agglomeration (per-land value added) with the aim to identify changes in urban hierarchy. Factors promoting local competitiveness in a traditionally-divided country such as Italy were also identified based on a joint analysis of economic growth and population increase over time. The spatial distribution of per-land value added standardized by population density was studied using a Moran's index of spatial autocorrelation identifying urban clusters and economically-dynamic rural districts. An index of economic competitiveness based on the ratio of changes over time of per-land value added to population density was proposed with the aim to evaluate direction and intensity of variation in the Italian urban hierarchy. This index was finally contrasted with background socioeconomic variables characterizing local labor systems with the objective to propose a multivariate analysis of urban concentration and hierarchy based on multiple criteria and territorial attributes. The proposed index was found correlated with variables assessing the economic structure of labor markets during 1996-2000 and with territorial variables assessing socio-spatial issues, accessibility and settlement characteristics during 2001-2005. Per-land value added could differentiate local labor systems along urban-rural gradients, evidencing a marked north-south divide when standardized to population density. Results of this study candidate per-land value added as a reliable proxy of the (changing) urban hierarchy in a given country or region.

**Keywords:** Economic development, Local district, Elasticity index, Mediterranean Europe.

## 1. Introduction

Understanding determinants of the spatial distribution of wealth is a key issue in applied economics (Barro and Sala-i-Martin, 2004), urban sociology (Henry, 1999), economic geography and regional planning (King et al., 2001). Indicators of local competitiveness (Turok, 2004), socioeconomic sustainability (Huggins and Thompson, 2015) and territorial cohesion (Becchetti and Rossi, 2000; Bagella and Becchetti, 2001; Barkley, 2009), are commonly used in the analysis of regional disparities (Dunford, 1993; Liargovas and Fotopoulos, 2009; Lukovic, 2009) and effectiveness of developmental policies (Terrasi, 1999; Arbia and Paelinck, 2003; Boschma, 2004; Proietti, 2005). Changes in the economic structure of countries and regions have been evaluated using time series of regional value added (Niebuhr and Stiller, 2003; Becchetti et al., 2007; European Commission, 2014). The investigation of regional disparities has also benefited from the analysis of indicators derived from district income or per-capita value added estimated at disaggregated spatial scales (Viesti et al., 2011; Fernandez-Vazquez and Rubiera-Morollón, 2013; Fernandez-Vazquez et al., 2014).

Direct and indirect indicators were proposed to estimate the level of regional income by computation on total value added, disposable income, revenues from personal taxes and consumption levels (Lawn, 2003; Casadio Tarabusi and Palazzi, 2004; Salvati and Zitti, 2007). Relevance of the elementary spatial unit has been evaluated according to policy targets (Salvati and Bajocco, 2011; Rae, 2012; Partridge et al., 2015). Indicators computed at a spatially-disaggregated scale are being increasingly diffused and provide detailed analysis of the geographic distribution of wealth, reflecting the level of economic development in a given region. Per-head value added has been sometime intended as a proxy for the overall socioeconomic dynamics of a given regional system (Arbia and Costantini, 2006). Salvati and Carlucci (2014) demonstrated that district value added in Italy is correlated with a number of socioeconomic indicators and reflects the level of sustainable development at the local scale, as already proposed in earlier studies (Liargovas and Fotopoulos, 2009).

Based on the assumption that value added is function of capital, labor and land, emphasis was given to production factors, intended as appropriate variables to standardize value added and, consequently, to derive indicators of economic performances. In this sense, value added has been frequently standardized using statistical aggregates such as: (i) population (i.e. per-head value added: Mucciardi and Bertucelli, 2012), (ii) workforce (i.e. per-worker value added: Jianyong, 2007; Andersson, Grasjo and Karlsson, 2008) or (iii) land (i.e. per-land value added: Salvati, 2013). The use of different indicators of value added was demonstrated to provide a comprehensive picture of territorial disparities and urban competitiveness, representing the spatial structure of personal income and wealth (Curran et al., 2011).

While urban hierarchy has been extensively studied evaluating spatial distribution of population density along urban-to-rural gradients (e.g. van Criekingen, 2010; Haase et al., 2010; Kabisch and Haase, 2011), relatively few studies were devoted to develop multivariate approaches based on economic indicators of urban centrality, economic polarization and spatial concentration of agglomeration factors. A functional approach to the analysis of

metropolitan hierarchy in rapidly changing urban systems, with special focus on developed countries, may contribute to identify latent development patterns characterizing urban systems with marked socioeconomic disparities. Taken as a response to economic growth, socio-spatial changes are a typical attribute of core cities, distinguishing them from rural areas (Markusen and Schrock, 2006).

Based on these premises, our study investigates the spatial distribution of per-land value added intended as an indicator describing agglomeration factors and thus contributing to identify the evolving urban hierarchy in a divided country such as Italy. Per-land value added was also standardized by population density and correlated with 18 background variables along two time periods (1996-2000 and 2001-2005) in 686 local districts in Italy. Local districts were intended as a spatially-homogeneous and economically-relevant analysis' unit. The multiple relationships among indicators were explored using a data mining technique evidencing local-scale impacts of spatially-varying socioeconomic backgrounds, with the final objective to highlight changes in urban hierarchy and latent patterns of economic development.

## 2. Methodology

### *2.1 Study Area*

We investigated the Italian territory (301,330 km$^2$) at the spatial scale of Local Labor Market Areas (LLMAs). LLMA districts reflect economically homogeneous areas (Giusti and Grassini, 2007) and are considered the elementary analysis' unit in this study. A total of 686 districts were defined by the Italian National Statistical Institute (Istat) according to data collected in 2001 National Census of Population (Istat, 2006). The proportion of commuters who cross the district boundary on their way to work was adopted as the key variable when identifying LLMA districts, intended as sub-regional areas where activities can find the largest workforce to match with offered jobs. These spatial domains respond to the need for meaningful comparison of sub-regional labor market areas for statistical reporting and analysis (Pellegrini, 2002).

### *2.2 Data, Variables, Indicators*

Per-land value added, derived from national accounts, was proposed as a territorial indicator of urban hierarchy and presence of relevant agglomeration factors. Additional background indicators were made available at the district scale from official statistics collected by Istat for 1996 and 2005. Indicators were derived from the Italian system of regional economic accounts and from the national census of population and households (Istat, 2006).

### *2.3 Analysis of Spatial Autocorrelation*

Moran's global and local indexes of spatial autocorrelation were calculated with the aim to explore the structure of per-land value added for 1996 and 2005. The global Moran's index was calculated at 9 distance ranges (10, 25, 50, 75, 100, 125, 150, 175 and 200 km), producing $z$-scores and significance levels for spatial autocorrelation at $p < 0.05$. Considering

multiple distances allowed us to estimate the extent to which interactions between spatial units occur (Patacchini, 2008). While global Moran's index reflects the dominant auto-correlation regime at the regional scale (De Dominicis et al., 2013), local spatial autocorrelation statistics provide disaggregated estimates allowing assessment of the dependency relationship across space (Ali et al., 2007). Positive values of the local Moran's index (*z*-score) identify spatial clustering of similar values (high or low), whereas negative values indicate spatial clustering of dissimilar values between an area and its neighbors. We classified spatial units (municipalities) in four groups according to a Moran scatterplot (Salvati and Carlucci, 2014): (i) units with a high value surrounded by units with high values (hereafter, HH), (ii) high value surrounded by low values (HL), (iii) low value surrounded by high values (LH), and (iv) low value surrounded by low values (LL). Units classified as HH and LL indicate spatial clustering of similar values; HL and LH conditions reflect spatial clustering of dissimilar values.

### *2.4 Multivariate Exploratory Analysis*

A Principal Component Analysis (PCA) was run on a full data matrix (18 variables * 686 districts) for both 1996-2000 and 2001-2005 to evaluate the (evolving) urban hierarchy in Italy in the light of socioeconomic gradients underlying differences in the spatial distribution of value added. The selection of relevant factors (m) was based on an *ex*-ante variance threshold (eigenvalue > 1). Districts were separated into homogeneous groups based on a component score plot (Salvati and Zitti, 2009). An elasticity index calculated as the ratio of changes over time in per-land value added to changes over time in population density was calculated and correlated pair-wise with background socioeconomic variables characterizing local labor systems with the objective to propose a multivariate analysis of urban concentration and hierarchy based on multiple criteria and territorial attributes. Correlation analysis was based on non-parametric Spearman coefficients testing at $p < 0.05$ after Bonferroni's correction for multiple comparisons.

## 3. Results

The spatial distribution of value added in Italy (Figure 1) highlights a latitude gradient with the highest income districts being concentrated in the Po plain (northern Italy) and a more heterogeneous distribution of wealth observed in central and southern Italy. High per-land value added districts consolidated in northern Italy especially in the Po plain (the industrial 'triangle' of Milan, Venice and Bologna), in lowland Tuscany (between Pisa and Florence), along the Adriatic sea coast (from Rimini to Pescara) and in metropolitan regions of Rome and Naples. A more heterogeneous distribution of wealth was observed in Apulia, Calabria, Sicily and Sardinia, with the highest income districts being concentrated in coastal areas. Considering per-land value added as an indicator of urban concentration and economic agglomeration, Figure 2 illustrates the Italian urban hierarchy by considering districts with value added higher than 100,000 euros per square kilometer as 'urban'. Regional head cities emerged from this analysis for 1996 and a more heterogeneous geography was evidenced for 2005, outlining an aggregated spatial distribution of urban districts in the Po plain especially

along the axes connecting Milan with Venice and Bologna.

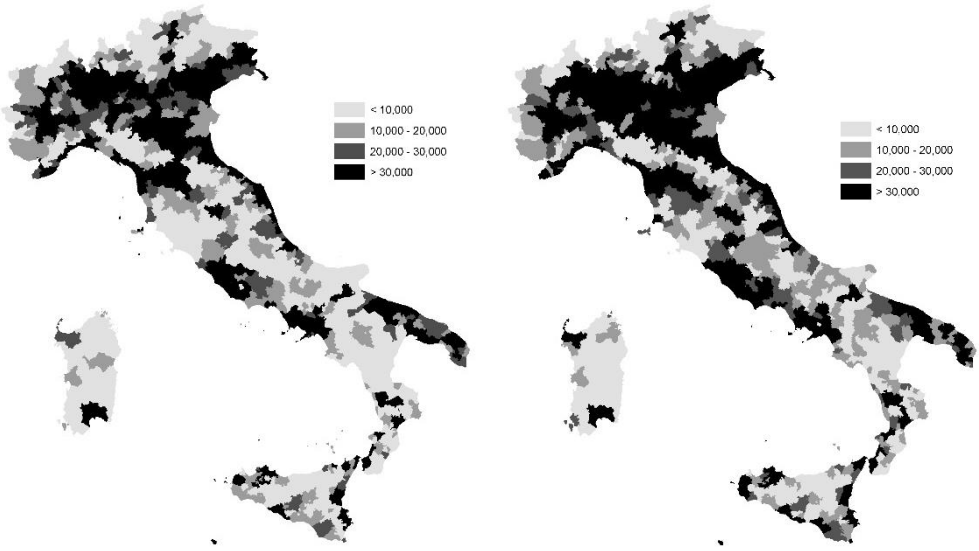


**Figure 1.** The spatial distribution of per-land value added (Euros per hectare) in the Italian local labor systems by year (left: 1996; right: 2005)

Districts with value added between 50,000 and 100,000 euros per square kilometer were considered as 'peri-urban' and were concentrated around the big cities of northern Italy, being scarcer in central and southern Italy, where rural districts are dominant (value added < 50,000 per square kilometer). An economic performance indicator (the ratio of per-land value added to population density) illustrated the north-south gradient in Italy (Figure 3) consolidating during the study period (1996-2005).

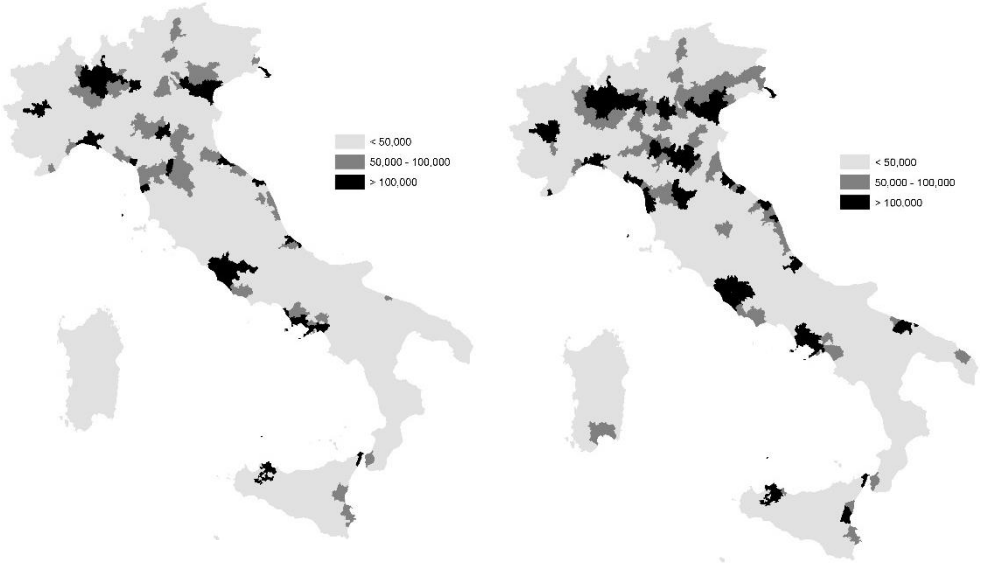


**Figure 2.** A dynamic representation of the Italian urban hierarchy considering local labor systems with high per-land value added (> 50.000 euros per hectare) by year (left: 1996; right: 2005)

Moderate differences in the Italian districts were observed for 1996, outlining the homogeneous distribution of wealth in northern and central Italy (with a ratio structurally higher than 1.05 for 2005). Districts situated in central Italy showed a more heterogeneous spatial distribution of value added, alternating high productivity areas (urban and coastal districts) with low productivity areas (rural and inland districts). In southern Italy, large cities were put in evidence against less dense, internal or agricultural-specialized districts.

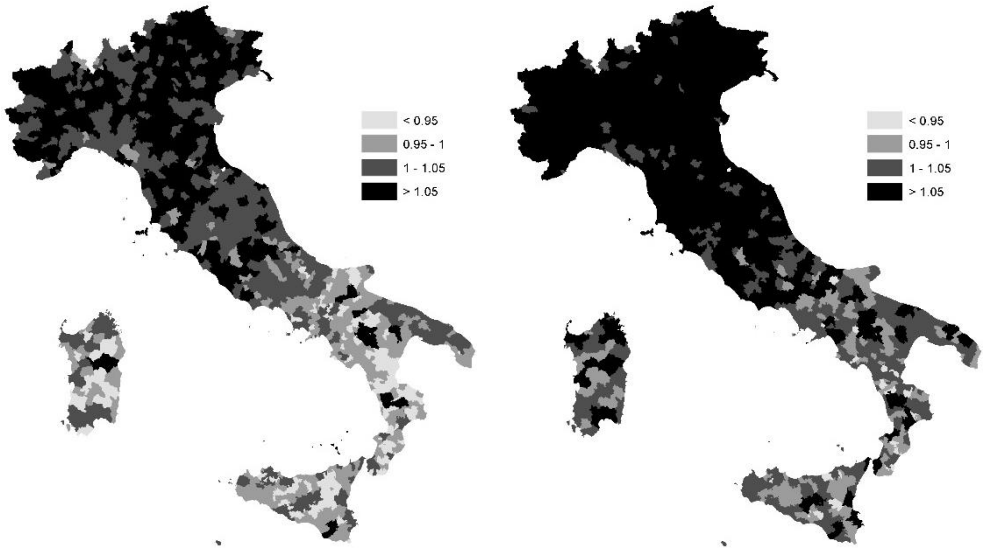


**Figure 3.** The spatial distribution of (log-log) ratio of per-land (hectare) value added to population density (per hectare) in Italian local labor systems by year (left: 1996; right: 2005)

Changes (%) in the elasticity ratio of per-land value added to population density (Figure 4) indicated a heterogeneous distribution of gains in economic performance across Italy.

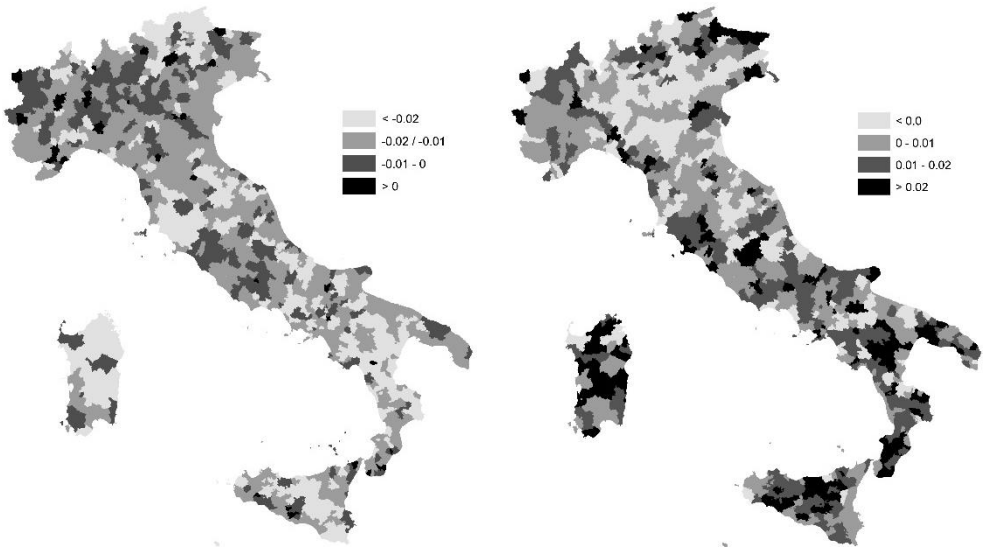


**Figure 4.** The spatial distribution of (log-log) elasticity ratio of changes in per-land (hectare) value added over time to changes in population density (per hectare) over time in the Italian local labor systems by year (left: 1996-2000; right: 2001-2005)

During 1996-2000, increases in economic performances were more likely observed in northern Italy, being relatively scarce in central and southern Italy. In the following period (2001-2005), the highest elasticity ratios were observed more frequently in marginal and internal districts of central and southern Italy, possibly indicating economic convergence in less performing areas of the country.

Global Moran's coefficients (Table 1) indicate a significant spatial structure of autocorrelation for per-land value added in Italian districts at both 1996 and 2005, with the highest values reached for a 75 kilometers bandwidth in 1996 and 50 km bandwidth in 2005. Based on these results, local Moran's coefficients (Figure 5) were thus calculated for a 50 kilometers bandwidth (stable results obtained with 75 kilometers bandwidth). In 1996, significant high-high autocorrelation regimes were detected for several metropolitan regions in northern Italy including Milan, Venice, Bologna, Turin as well as for the coastal agglomeration of Pisa-Livorno in central Italy and of Naples in southern Italy.

In 2005, significant high-high spatial autocorrelation regimes were detected only in the largest metropolitan regions of northern Italy including Milan and Venice and in isolated districts of Bologna, Pisa, Rimini and Naples. Rome was the only district showing a high-low autocorrelation regime. These results may indicate a substantial re-organization of the urban spatial structure in Italy between 1996 and 2005, with agglomeration economies being concentrated in the largest cities in northern Italy. In southern Italy, Naples was the only metropolitan region showing an economic size suitable to influence the spatial arrangement of neighboring districts. Results for Rome metropolitan region indicate the consolidation of a mono-centric model based on a strong gravitation of job and economic agglomeration in the capital city, still producing a marked urban-rural gradient with the surrounding districts.

**Table 1.** Moran's global index of spatial autocorrelation (z-score) of per-land value added in Italian local labor systems by year and bandwidth (km); * significant coefficient at $p < 0.001$.

| Bandwidth (km) | 1996 | 2005 |
|---|---|---|
| **10** | 3.1 | 4.0 |
| **25** | 13.0* | 13.7* |
| **50** | 21.1* | 20.8* |
| **75** | 21.9* | 20.6* |
| **100** | 21.3* | 20.2* |
| **125** | 21.2* | 19.6* |
| **150** | 21.3* | 19.3* |
| **175** | 21.5* | 19.0* |
| **200** | 21.8* | 19.2* |

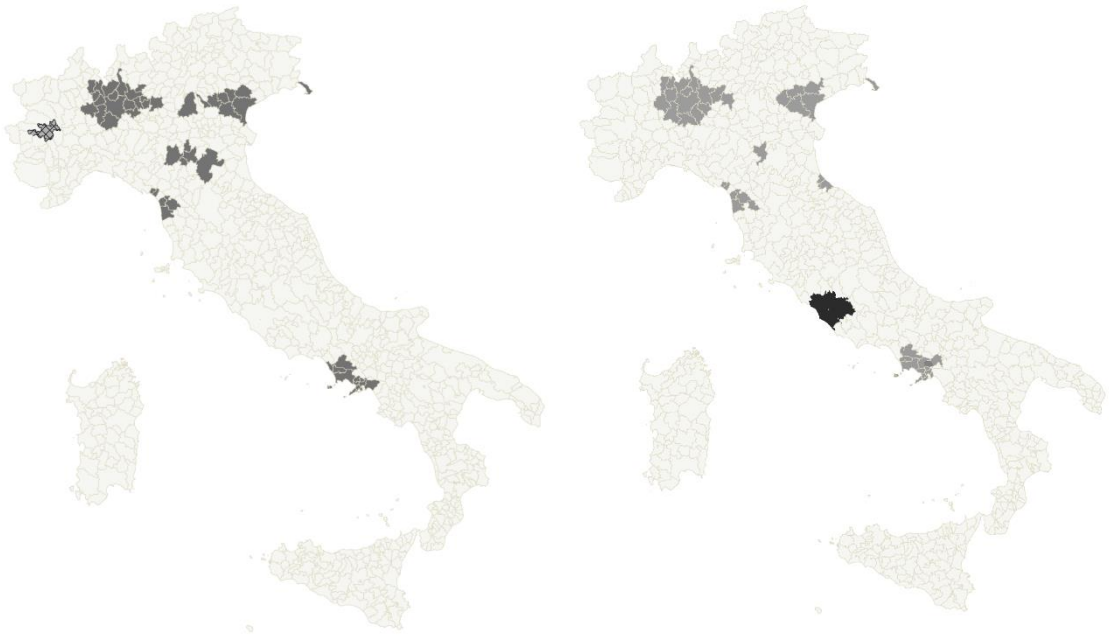

**Figure 5.** Moran's local index of spatial autocorrelation of per-land value added in Italian local labor systems (left: 1996; right: 2005); grey and black indicates respectively high-high and high-low autocorrelation regimes

Separate PCAs were run for the two-time periods investigated (1996-2000 and 2001-2005), extracting respectively 7 and 6 relevant components that explain 75% and 77% of total variance (Table 2). For the first-time period, component 1 identified a gradient opposing districts with industrial specialization to districts devoted to agriculture. This axis was typically associated to district value added, in turn oriented along the north-south gradient in Italy, outlining the socioeconomic divide between northern and southern regions and the concentration of economic agglomeration factors especially in central-northern Italy. Component 2 identified districts with the highest increase of value added, mainly depending on services' expansion, in turn counter-correlated with growth in the primary sector, primarily observed in economically-disadvantaged districts. Population density, districts specialized in 'made in Italy' productions and tourism districts were uniquely associated to components 3, 4 and 5, respectively. Growth of secondary sector and elasticity ratio of per-land value added to population density were respectively associated to component 6 and 7.

**Table 2.** Loadings on principal components summarizing multiple relationships between elasticity index (change over time in per-land value added to change over time in population density) and selected background indicators at district scale by time interval

| Variable | 1996-2000 | | | | | | | 2001-2005 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PC 1 | PC 2 | PC 3 | PC 4 | PC 5 | PC 6 | PC 7 | PC 1 | PC 2 | PC 3 | PC 4 | PC 5 | PC 6 |
| **Agricultural share in total value added (%)** | -0.64 | | | | | | | -0.72 | | | | | |
| **Industrial share in total value added (%)** | 0.67 | | | | | | | | | | | | |
| **Ratio of service to industry product** | | | | | | | | 0.74 | | | | | |
| **Agricultural value added (% change over time)** | | -0.63 | | | | | | | -0.65 | | | | |
| **Industrial value added (% change over time)** | | | | | | 0.75 | | | | | | | 0.81 |
| **Service value added (% change over time)** | | 0.80 | | | | | | | 0.80 | | | | |
| **Per-capita district value added (log)** | 0.85 | | | | | | | 0.90 | | | | | |
| **Per-capita value added (% change over time)** | | 0.72 | | | | | | | 0.76 | | | | |
| **District surface area (log)** | | | | | | | | | | | | 0.64 | |
| **Southern district (dummy)** | -0.75 | | | | | | | -0.69 | | | | | |
| **Industrial district** | 0.63 | | | | | | | | | | | | |
| **Unspecialized district** | -0.68 | | | | | | | -0.72 | | | | | |
| **Turism district** | | | | | -0.64 | | | | | | | -0.73 | |
| **District specialized in 'Made in Italy' products** | | | | 0.60 | | | | | | | 0.62 | | |
| **Per-land value added (log)** | 0.72 | | | | | | | 0.73 | | | | | |
| **Population density (log)** | | | 0.70 | | | | | | | 0.71 | | | |
| **Population density (% change over time)** | | | | | | | | 0.71 | | | | | |
| **Ratio of per-land value added (% change over time) to population density (% change over time)** | | | | | | | 0.78 | -0.72 | | | | | |
| **Explained variance (%)** | 25.4 | 11.3 | 10.2 | 9.0 | 7.0 | 6.5 | 5.7 | 31.4 | 14.5 | 10.7 | 9.4 | 6.9 | 5.9 |

For the second-time period, variables' loadings to both components 1 and 2 were substantially comparable to what was observed 10 years earlier. The same results were observed for components 3 and 4. Component 5 opposed large districts (mainly identifying metropolitan regions) to tourism-specialized districts, mainly of small-size and with low population density. Finally, component 6 isolated the contribution of industrial growth over time in the overall matrix variance (Figure 6). Empirical results indicate that urban hierarchy, local socioeconomic structure and income divides in Italy have underwent moderate changes in the short-term, preserving latent relationships between value added and social background.

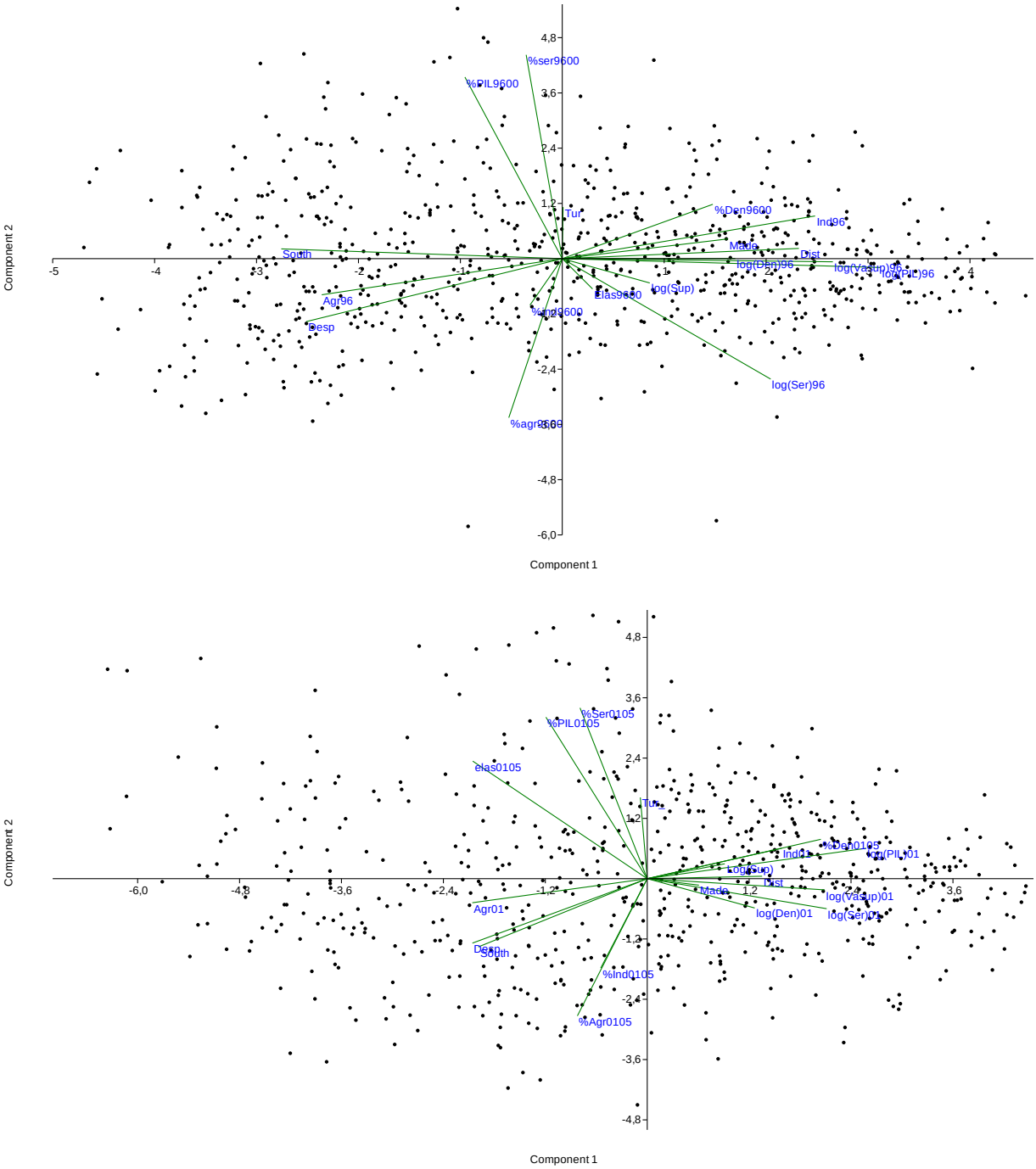


**Figure 6.** Biplot of Principal Component Analysis by year (upper: 1996; lower: 2005)

Results of a non-parametric correlation analysis was proposed in Table 3 illustrating a substantially different correlation regime between the elasticity ratio (per-land value added to population density), considered an indicator of economic performances in Italy and selected background variables. During the first time period, the elasticity ratio increased with population growth and decreased with per-capita income growth. This indicates a spatial pattern with economic performances concentrated in peri-urban, dynamic areas attracting

population but with an intermediate wealth distinguishing them from both consolidated cities and marginal rural districts. During the second time period, all variables were found associated to the elasticity ratio, revealing a quite different spatial pattern compared with the earlier time interval. The highest elasticity values were observed in districts mainly situated in southern regions, with economic expansion in agricultural and service sectors, medium-low population density, specialization in tourism or diversification in the economic activities.

**Table 3.** Spearman non-parametric correlation coefficients between elasticity index (change over time in per-land value added to change over time in population density) and selected background indicators at district scale by time interval

| Variable | 1996-2000 | 2001-2005 |
|---|---|---|
| Agricultural share in total value added (%) | | 0.37 |
| Industrial share in total value added (%) | | -0.34 |
| Ratio of service to industry product | | -0.47 |
| Service value added (% change over time) | | 0.54 |
| Per-capita district value added (log) | | -0.53 |
| Per-capita value added (% change over time) | -0.11 | 0.83 |
| District surface area (log) | | -0.15 |
| Southern district (dummy) | | 0.33 |
| Industrial district | | -0.28 |
| Unspecialized district | | 0.35 |
| Tourism district | | 0.11 |
| District specialized in 'Made in Italy' products | | -0.11 |
| Per-land value added (log) | | -0.49 |
| Population density (log) | | -0.33 |
| Population density (% change over time) | 0.12 | -0.52 |

* Significance was tested at $p < 0.05$ after Bonferroni's correction for multiple comparisons; the impact of agricultural and industrial shares in total product (percent change over time) on the elasticity index was not significant for both time intervals.

## 4. Discussion

High-resolution spatial units, target indicators and data mining have been successfully applied to the analysis of local competitiveness (Annoni, 2013), territorial disparities (Tombolini et al., 2015) and agglomeration factors (Giusti and Grassini, 2007), possibly influencing metropolitan hierarchy in developed countries. The present study provides insights in the comparative analysis of economic spatial structures along a urban-rural gradient in Italy, a developed country with important economic divides. Local districts showed appreciable features to satisfy the need of data integration, reliability and relevance to socio-spatial issues (Salvati and Zitti, 2009). Integrating multiple indicators in a spatial approach allows deriving a comprehensive picture of metropolitan spatial structures underlying different economic performances and territorial backgrounds (Fernandez Vazquez

et al., 2013).

Our results show a complex geography of the metropolitan hierarchy in Italy reflected in multiple relationships between the spatial distribution of per-land value added and heterogeneous socioeconomic profiles (Dunford, 2008). Urban areas and districts with an economic structure centered on advanced services occupied a clear position in the metropolitan hierarchy of Italy, distinguishing from economically-disadvantaged, rural areas of central and southern Italy with low-skilled workers and a production structure based on construction, commerce and the public sector (Dunford and Greco, 2007). Consolidating metropolitan systems involve processes guided by economic factors (Cumbers et al., 2007; MacKinnon et al., 2009, 2016), together with organizational, institutional, social and cultural factors (Dunford, 2008). Multiple factors of growth and change in metropolitan districts need specific monitoring efforts based on local-scale indicators and geographic information systems supporting decision-making, planning measures and developmental policies (Cracolici et al., 2007). Value added indicators may also offer a novel contribution to the study of urban concentration in the light of sustainable development (Eckerberg and Mineur, 2003; Zuindeau, 2006, 2007; Karlsson, 2007).

Over the last decades, especially since the mid-1990s, Italian government has paid little attention to an analysis of the state of the country's metropolitan system and an evidence-based, informed debate is increasingly required to address the latest urbanization challenges and to cope with the most relevant socioeconomic and environmental problems at both urban and regional scale. Implementation of effective socioeconomic policies is molded by an incomplete understanding of the mutual interaction between drivers of local development, urban competitiveness and metropolitan growth (possibly distinguishing compact and dispersed expansion) that act differently across space (Bonavero et al., 1999).

## 5. Conclusions

The empirical results of this study suggest that per-land value added is an appropriate indicator evaluating the economic dimension of urban agglomerations and can be used jointly in a comprehensive analysis of regional disparities influencing urban spatial structures. Permanent monitoring of socioeconomic conditions on a local scale may benefit from a systemic framework integrating multi-scale exploratory approaches and spatial econometric models with qualitative analysis of urban change.

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