CITY SIZE AND COMPETITIVENESS FOR THE CITIES OF SÃO PAULO: A SPATIAL STATISTICS ANALYSIS

Abstract

The objective of this article is to develop a competitiveness index for the 645 cities of the state of São Paulo, Brazil (ICM-SP), using a Principal Components Methodology (PCA). We ranked cities according to the overall competitiveness index and each one of the five dimensions of competitiveness. Moreover, we performed an Exploratory Spatial Data Analysis (ESDA) in the ICM-SP. Our results show that medium sized cities have in general higher competitiveness than large cities. Moreover, we found that cities with similar competitiveness levels tend to locate near each other. That is, competitiveness spillovers are geographically located. We also noticed that the majority of municipalities with high competitiveness tend to locate in the São Paulo and Campinas Metropolitan Regions, and alongside the Anhanguera, Bandeirantes, Washington Luis and Dutra highways. Moreover, cities on the bottom of the overall competitiveness tend to concentrate in the southern, in the eastern and in the western borders of the state. The contribution of this article is twofold: it provides a city competitiveness index which includes an innovation dimension, as well as environmental and institutional variables. Moreover, it provides a competitiveness index for the municipalities of the state of São Paulo, all measures that were previously unavailable.

Keywords

City competitiveness; Principal Components Methodology; competitiveness index; Exploratory Spatial Data Analysis.

JEL Classification

R12; C14

Tamanho da Cidade e Competitividade dos Municípios de São Paulo: uma Análise de Estatística Espacial

Resumo

O objetivo deste artigo é desenvolver um índice de competitividade para os 645 municípios do estado de São Paulo (ICM-SP), utilizando a metodologia de Análise dos Componentes Principais (ACP). As cidades foram classificadas de acordo com um índice de competitividade geral e de acordo com suas cinco dimensões da competitividade. Além disso, foi realizada uma Análise Espacial de Dados Exploratória (AEDE) com os dados do ICM-SP. Nossos resultados mostram que as cidades médias têm uma competitividade geral maior do que as grandes cidades. Além disso, verificou-se que as cidades com níveis de competitividade semelhantes tendem a se localizar próximas a outras. Nota-se também que a maioria dos municípios com alta competitividade tendem a localizar nas Regiões Metropolitanas de São Paulo e de Campinas, e ao lado das rodovias Anhanguera, Bandeirantes, Washington Luís e Dutra. Além disso, as cidades com níveis de competitividade geral baixos tendem a concentrar-se nas fronteiras ao sul, leste e oeste do estado. A contribuição deste artigo é dupla: fornece um índice de competitividade para os municípios que inclui uma dimensão para a inovação, além de variáveis ambientais e institucionais. Além disso, fornece um índice de competitividade para os municípios do estado de São Paulo, não disponível anteriormente.

Palavras-chave

Competitividade municipal; Análise dos Componentes Principais; Índice de Competitividade; Análise Espacial de Dados Exploratória.

Classificação JEL

R12; C14

Competitiveness Index for the Cities of São Paulo: a Spatial Statistics Analysis

1. Introduction

Companies are increasingly involved in a fiercer competition on global product and service markets. In these times of deepening globalization, the integration of markets for goods and services, markets of location sites for economic activities, markets of production factors as technologies and information affects differently the regions which those companies are located. As these regions are involved in the globalization process to a different extent depending on their structure and specialization (CAPELLO; FRATESI, 2013, p. 15), their regional governments have been trying to create more favorable conditions for the economic agents that are located there (KOURTIT; NIJKAMP; SUZUKI, 2013, p. 67).

For Zhang (2010), businesses rely on a favorable local environment to become more competitive. Cities that are able to provide a better business environment are likely to have more competitive private businesses. Thus, local policy makers need to understand the factors that private businesses regard as important, and pursue policies to improve the local business environment and promote local economic development.

But how can one view and measure the potential and performance of these cities? Porter (1990) has created a theoretical framework in which the determinants of city competitiveness are related to four sets of attributes that it might possess (Porter's "Diamond" model): factors conditions; demand conditions; correlated and support Industries conditions; and strategy, structure and rivalry conditions. Moreover, these four sets of conditions are influenced by chance and by government (national, regional and local) policies.

On the other hand, there have been many different proposals to create a classification or ranking of cities based on their actual competitiveness performance (such as WORLD ECONOMIC FORUM, 2014; MBC 2006; FIRJAN, 2014). In general, firms seek to locate in cities with good economic and financial structures (economic), a skilled and productive labor force (sociodemographic), good infrastructure (urban), and with strong institutions and favorable fiscal policies (ZHANG, 2010, p. 94).

Another important dimension of competitiveness is innovation. Many of the new industries of the twenty first century depend increasingly on the generation of knowledge through creativity and innovation. Achieving success in those industries requires that cities support such knowledge-intensive firms, housing other knowledge-creating institutions (such as universities and research centres), in a fierce inter-urban competition game (LANDRY; BIANCHINI, 1995, p.12). Moreover, there is strong evidence that local, "territorial capital" factors, such as the innovation share of human resources working in science and technology, play an important role in explaining regional growth (CAPELLO; FRATESI, 2013).

The objective of this article is to develop a competitiveness index for the 645 municipalities of the state of São Paulo, Brazil (ICM-SP), using a Principal Components Methodology (PCA). Similar to Zhang's (2010) methodology, we constructed the ICM-SP along four dimensions (urban, sociodemographic, fiscal/institutional and economic), but we included a new, fifth dimension, innovation. Moreover, we included environmental indicators to the urban dimension (so that it became the urban-environmental dimension), and we included institutional indicators to the fiscal/institutional dimension. Using data from 2011 and 2012, we used 51 indicators spread throughout the five dimensions.

After calculating the index, we then ranked cities according to the overall competitiveness index, and by each one of the five dimensions of competitiveness. Particularly, we tested the hypothesis that today medium sized cities have in general higher competitiveness than large cities, as it has been the case recently in several countries (DIJKSTRA et. al, 2013; PARKINSON et al., 2014).

Moreover, we performed an Exploratory Spatial Data Analysis (ESDA) using the data for the Competitiveness Index for the municipalities of the state of São Paulo (ICM-SP). We tested the hypothesis that competitiveness is autocorrelated in space throughout the cities of the state of São Paulo, that is, cities in this state with similar competitiveness tend to locate near each other. We evaluated the spatial patterns of the overall competitiveness index for all cities by quintile, and for each one of the five dimensions of competitiveness. We also analyzed the trend of the data to cluster in space (local spatial autocorrelation) by looking for clusters of cities with high competitiveness and clusters of cities with low competitiveness.

The contribution of this article is twofold. First, it provides a city competitiveness index which includes an innovation dimension, as well as environmental and institutional variables, which other measures, such as the Firjan Municipal Development Index (FIRJAN, 2014) and Zhang's (2010) index, do not provide. Moreover, it provides a competitiveness index for the municipalities of the state of São Paulo, not previously available.

The paper is structured as follows. After this brief introduction, in Section 2 we review the recent literature on the determinants of competitiveness and on competitiveness indexes. In section 3 we will present the data and model designed to construct a Competitiveness Index for the 645 cities of the state of São Paulo (ICM-SP), as well as our results for that index. In section 4 we will perform an Exploratory Spatial Data Analysis (ESDA) using the data for the ICM-SP built in the previous section. Then in section 5 we present our conclusions.

2. City competitiveness

In this section we will briefly review the existing literature on city competitiveness. We will start with a discussion on the definition of city competitiveness and on the main determinants that influence city competitiveness. Then we review the indexes that have been constructed so far in order to measure competitiveness at the national, state and city levels.

2.1 Determinants of city competitiveness

Begg (1999, p. 798) states that there are different definitions of competitiveness, depending on the focus of interest. It could be defined at the firm level, for example, as the ability to meet customers' needs more efficiently and more effectively than other firms. It could also be defined for a nation, as to the degree to which it can, under free and fair market conditions, produce goods and services which meet the test of international markets, while simultaneously maintaining and expanding the real incomes of its people over the long term. It could also be defined at the urban or city level, as the capacity of a city to compete with others to attract investments and to create jobs locally, shaped by the interplay between the attributes of cities and the policy choices and institutions created by local policy makers.

The author evaluates the factors that affect urban economic competitiveness performance. The ultimate measure is the standard of living, adjusted to allow for non-pecuniary influences on the quality of life. Two other variables, the employment rate and productivity, in their turn affect the standard of living, as such variables are what generates output and thus income in a region or a city. The employment rate and productivity are affected by four categories of measures: sectoral trends, company characteristics, the business environment, and the innovation and learning environment.

All of these variables interact and will ultimately determine city performance in a multi-faceted manner, according to Begg (1999). Some determinants are mutually reinforcing, while others may be contradictory. Moreover, certain characteristics in this model may be favourable for a period, but turn sour subsequently (BEGG, 1999, pp. 801-804).

Porter (1990) noted that competitive firms in each international sector were located in a small number of countries (and regions and localities). He also pointed out that competitive advantages are often "created" and held in a highly localized process. According to him, the influence of a nation or a region in its firm's competitiveness is given by four sets of attributes that it might possess (Porter's "Diamond" model): 1) Factors Conditions, which relates to the endowment of resources (human, physical, capital, knowledge and infrastructure) that a nation or a region possess; 2) Demand Conditions, which relates to the quality of the domestic buyer market; 3) Correlated and Support Industries Conditions, which has to do with the presence of domestic suppliers and related firms to a particular industry; and 4) Strategy, Structure and Rivalry Conditions, which are related to the environment in which firms are born, how they are organized and managed, and the way in which internal rivalry occurs in the domestic industry.

Moreover, there are two set of factors that work locally and influence the other four sets of conditions: 1) Chance, which is related to the events that happen and are beyond previously forecast scenarios and come by surprise; and 2) Government (national, regional and local) Policies, which is government's deliberate action that may influence the conditions of the four sets of determinants. Porter (1990) argues that the diamond is a dynamic system, in a sense that its attributes work interconnected (one factor influences the other) and evolve over time. He also points that if companies are to compete in the global market, advantages are necessary throughout the diamond to obtain and maintain competitive advantage in their industries. Government policies that strengthen regional advantages throughout the determinants can thus influence companies in their quest for global competition.

Zhang (2010, p. 2) defines competitiveness as the set of institutions, policies, and other factors that determine the level of productivity of a city or a region. With productivity as a basic measure, competitiveness encompasses connotations that include both the level of economic growth and the potential for sustained growth. Competitive local economies not only produce higher income for their cities, but are also more likely to grow faster over the medium to long term.

The author further argues that location matters, and some cities provide better locations than others for private businesses to be more competitive. To become more competitive, businesses rely on a favorable local environment, where they can achieve

(static) cost efficiency. Moreover, cities need to continually upgrade and innovate to achieve sustained growth. In this sense, competitiveness is a dynamic concept.

Thus, for Zhang (2010), cities compete against each other, and those that can provide a better business environment are likely to have more competitive private businesses. If this is so, local policy makers need to understand the factors that private businesses regard as important, and pursue policies to improve the local business environment and promote local economic development.

For Capello and Fratesi (2013, p. 18-19), regional growth and competitiveness is largely a supply-side phenomenon, based on general rules and institutional frames and above all nourished by the internal entrepreneurial capabilities of regions and places and by the local capability of efficiently exploiting existing resources. It is influenced by endogenous factors to a region: it is the result of internal forces and endogenous capacity of a region to grow, and it is dependent on creatively exploiting its "territorial capital", enriching it in the right ways setting appropriate priorities to local and regional policies, and "taping" and mobilizing previously "untapped" assets of its territorial capital. Territorial capital is defined as the set of localised assets – natural, human, artificial, organizational, relational and cognitive – that constitute the competitive potential of a given territory. The factors that comprise endogenous territorial assets are more and more non-material factors linked to knowledge, culture, taste and creativity, and are accumulated in a highly localized matter, depending very much on local aspects.

But exogenous forces that reach a local economy from outside, such as foreign productive capital, play also an important role. Morover, national factors such as institutional, organizational and economic variables also play a role. Altogether, endogenous and exogenous factors give rise, in a cumulative self-reinforcing mechanism, to a local process of local growth. Capello and Fratesi (2013, p. 22-28) estimated empirically a multivariate regression model for European regions which included regional growth as the dependent variable. As independent variables, they included national growth and foreign direct investment flows as outside force variables, as well as territorial capital variables such as growth effects induced by the regional geographical position; degree of innovation; infrastructure endowments; regional specialisation in high-value functions; agglomeration economies; and presence of public funds. They concluded that regional territorial capital assets are fundamental for explaining the capacity of a local area to grow

more than its nation. Moreover, they showed that the national component of growth plays an important role in the explanation of regional growth, as well as the importance of the presence of foreign direct investment.

Finally, Camagni (2002) states that competitiveness at the 'territorial' level is very different than in the case of countries. In order to export, local firms have to show a higher competitiveness with respect to external firms and territories. Thus, cities and regions compete on the basis of an absolute advantage principle, and not of a comparative advantage principle. This means that there is no eficient, automatic mechanism to grant each territory some role in the international division of labour, whatever its relative performance. Therefore, weak and lagging territories (in terms of competitiveness of the economic fabric, internal/external accessibility, quality of the human and environmental factors, internal synergy and learning capability) risk exclusion and decline to a larger extent than in the past (CAMAGNI, 2002, p.2407).

On the other hand, he mentions that this competitiveness reside in dynamic elements, allowing the continuous recreation of the local advantage, through a flow of radical and incremental innovation. The sources of territorial competitiveness are increasingly of two factors: 1) increasing returns linked to cumulative development processes and the agglomeration of activities; 2) advantages strategically created by the single firms, territorial synergies and cooperation capability enhanced by an imaginative and proactive public administration, externalities provided by local and national governments and the specificities historically built by a territorial culture. Thus, those created advantages are open to the proactive, voluntary action of local communities and their governments (CAMAGNI, 2002, p.2405).

2.2 City competitiveness indexes

Competitiveness indexes have been widely used to identify and benchmark the competitive and productive potential of nations, regions and cities. In general, these indexes show the drivers of competitiveness in multiple dimensions. There is a wide variety of those indexes which have been used in different contexts. For example, the World Economic Forum compiles annually a national competitiveness ranking (WEF, 2014) among 144 participating countries. This is based on a index (Global

Competitiveness Index - CGI) which comprises 12 pillars of competitiveness, and countries have been ranked among those pillars for more than thirty years.

The Economist Intelligence Unit compiles since 2011a Business Operating Environment Index for the 27 Brazilian states (CLP, 2013), which includes eight major factors that affect business operations in the country's states: Political Environment; Economic Environment; Tax and Regulatory Regime; Policy towards Foreign Investment; Human Resources; Infrastructure; Innovation; and Sustainability.

In its turn, the Competitive Brazil Movement (MBC, 2006) created the ICE-F, a competitiveness index also for the Brazilian states. It was based on Porter's (1990) diamond model methodology including three dimensions of competitiveness: quality of the workforce; knowledge and innovation; and infrastructure. These dimensions are related to three of Porter's Factor Conditions (human; knowledge; and infrastructure, respectively).

There is also the Firjan Municipal Development Index (IFDM), built by the Federation of Industries of the state of Rio de Janeiro (FIRJAN, 2014). It ranks the current state of development of Brazilian municipalities along four dimensions: education, health, income and employment. The index ranges from zero to one, and the closer to one the better. Whenever it reaches 0.8, the city is considered a high development city, and, according to Firjan, there were 328 municipalities in Brazil in this situation in 2011.

Finally, Zhang (2010) looks at the factors that contribute to economic growth at the city level that determine competitiveness for Brazilian cities. Building on Porter's (1990) diamond model, the author evaluates Brazil's cities competitiveness using four dimensions: urban, sociodemographic, fiscal/institutional, and economic. Each dimension incorporates a series of variables using census data. Moreover, he used the principal component analysis (PCA) method to construct the index and its four dimensions. He concludes that the top-ranked cities are from the Southeast region (the country's wealthiest), and the least competitive cities are overwhelmingly from the Northeast region (the country's poorest). Note, however, that this index and the Firjan Municipal Development Index (FIRJAN, 2014) do not provide a dimension for innovation and knowledge, which is increasingly important to explain regional competitiveness (CAMAGNI, 2002, p.2397), as well as variables to measure the environmental and institutional capacities of locations.

3. Model and data

In this section we will present the data and our model designed to construct a Competitiveness Index for the 645 Municipalities of the state of São Paulo (ICM-SP), as well as our results. We use a methodology similar to the one used in Zhang (2010); note, however, that we improved upon that methodology, in that we added a fifth dimension, innovation. Moreover, we included environmental indicators to the urban dimension (so that it became the urban-environmental dimension), and we included institutional indicators to the fiscal/institutional dimension. We now have five dimensions to competitiveness: urban/environmental; sociodemographic; fiscal/institutional; economic; and innovation.

Each dimension tries to capture an important aspect of local competitiveness. The urban/environmental dimension tries to capture the urban infrastructure and the quality of the environment and of urban services. The sociodemographic dimension attempts to describe the labor market conditions (skills and productivity) of cities. The fiscal/institutional dimension tries to capture the strengths of the government and the fiscal environment. The economic dimension attempts to describe the economic and financial structure of the city. And the innovation dimension seeks to evaluate the ability to innovate and create knowledge locally.

Moreover, we chose 51 indicators, which were spread through our five dimensions. We sought to use the same variables that Zhang (2010) used, but in some cases the data were not available for many cities. Moreover, we included innovation and knowledge indicators, as well as several institutional and environmental variables that Zhang (2010) did not include. The five dimensions and their comprising variables are listed in Table 1.

Unlike Zhang's article, instead of calculating the index for all of Brazilian cities, we chose to use only the cities of the state of São Paulo as our sample. We decided to first construct the competitiveness index for the state of São Paulo, and let for a future continuation of this study to include all other Brazilian cities. Moreover, we used more recent data. Zhang (2010) used census data for the year 2000. We used instead data from the recent 2010 country census data and other sources (IBGE, 2013; SEADE, 2011; Fundação João Pinheiro/PNUD/IPEA, 2013; INPI, 2011); RAIS-MTE, 2013). We used the municipality as the level of analysis. Zhang (2010, p.94) used the minimum comparable

Table 1 – Variables Used for the Five Dimensions of the Competitiveness Index

1) Urban/Environmental	2) Sociodemographic
Urbanization rate	Per capita income
Number of people between 18 and 65 years old	Human Development Index
% of houses with garbage collection	Gini Index
% of houses with sewerage	Child mortality rate (up to 5 years old)
% of houses with piped water	Life expectancy
% of houses with lighting	% of illiteracy
Number of banks per 100,00 inhabitants	% of indigent people
Inpatient beds per thousand inhabitants	% people receiving up to 1/2 of minimum wage
Registered doctors per thousand inhabitants	Population growth 2000–2010
Nursing technicians per thousand inhabitants	% people employed in total population
Number of homicides 100,00 inhabitants	% employment in primary sector
% of houses with computers	% employment in secondary sector
% of houses with phone lines (fixed and celular)	% employment in tertiary sector
Inhabitants over Total of Vehicles	
Presence of structure for environmental management	-
Presence of local environmental fund	-
Presence of local environmental legislation	-
3) Fiscal/Institutional	**4) Economic**
City revenue over GDP	Average wage (monthly)
City revenue per capita	% GDP primary sector
City expenditure over GDP	% GDP secondary sector
City expenditure per capita	% GDP tertiary sector
Municipal Participation Fund transfer amount	City GDP per capita
City investments (excluding federal and state investment) over GDP	City tax burden
Payroll expenditure over city revenue	Per capita savings
Presence of local urban policy	Credit operations per capita
Presence of local environmental legislation	-
5) Innovation	
Patents per 100,000 inhabitants	Years of schooling of people above 25 years old
Engineers and researchers per 10,000 employees	% of population with university degree

Sources of data: IBGE (2013); Fund. SEADE (2011); Fund. J.Pinheiro/PNUD/IPEA (2013). INPI (2011); RAIS (2013).

area (MCA) as the unit of analysis in his study; the MCA takes into account the changing definition and division of municipalities throughout the years. Using the MCA as the unit of analysis lowers significantly the number of cities to account for and the complexity level of analysis: Brazil has 5,570 municipalities, but only 474 MCAs. In the case of Brazil, there had been significant changes recently in the division of municipalities. We chose the municipality as our level of analysis because in the case of São Paulo there are only 645 municipalities, and because in our time frame the definition of its cities did not change.

In order to construct our competitiveness index, we used the Principal Components Analysis (PCA) methodology. It is a simple, nonparametric method that is often used to reduce multidimensional datasets to lower dimensions for analysis. PCA is very useful for computing indexes because it has three main advantages: it does not assign weights because the method will determine whether a variable is relevant or not; it allows disaggregation of the index into subindexes to better understand the areas of improvement; and it has been extensively used to build other competitiveness indexes, such as the ones constructed by MBC (2006), WEF (2014), and Zhang (2010).

To construct the Competitiveness Index and each of its five dimensions, we transformed each one of the 51 indicators in order to belong to the interval [0,1]. The closer to 1 the value, the better the city was positioned in that variable. Therefore, we used the normalization through the cumulative distribution function of the standard normal, according to the following formula:

$$v_i = F((x_i - \bar{x}) / s)$$

, whereas v_i is the standardized value for that particular variable for the i-th city, F is cumulative distribution function (cdf) of the standard normal curve, x_i is the value for that variable for the i-th city, $\bar{x}$ is the average value for that variable among all cities, and s is the standard deviation value for that variable among all cities.

We then applied PCA to obtain each variable's weight in each of the five dimensions, so that each dimension equals the following:

$$I_i = \Sigma P_i . Z_i$$

, whereas I_i is the value for each of the five dimensions for the i-th city, P_i is the weight for that particular variable calculated by the PCA methodology for the i-th city, and Z_i is the standardized value for that particular variable for the i-th city calculated in the

previous step. The overall competitiveness index was calculated as the simple average of its five components.

Using these results, we then ranked cities according to the overall competitiveness index and according to each one of the five different dimensions of competitiveness. The results are displayed in Table 2 below for the top twenty cities of São Paulo state.

Table 2 – Competitiveness Index for the Cities in the State of São Paulo, 2012

Competitiveness		Urban/Environmental		Sociodemographic		Fiscal/Institutional		Economic		Innovation	
São Caetano do Sul	0,720	São Caetano do Sul	0,711	Vinhedo	0,751	Poá	0,741	São Paulo	0,638	São Caetano do Sul	0,938
São José dos Campos	0,677	Fernandópolis	0,711	Cerquilho	0,735	Caraguatatuba	0,737	Santana de Parnaíba	0,631	Pompéia	0,908
Jundiaí	0,673	Nhandeara	0,708	Americana	0,731	Bom Jesus dos Perdões	0,715	São Caetano do Sul	0,627	Santana de Parnaíba	0,895
Vinhedo	0,668	Duartina	0,699	Louveira	0,724	Paraibuna	0,715	Barueri	0,627	São José dos Campos	0,871
São Carlos	0,668	Barretos	0,696	Lindóia	0,719	Ilhabela	0,712	Jundiaí	0,623	São Carlos	0,841
Santana de Parnaíba	0,665	Jaú	0,693	Jaú	0,719	Guararema	0,710	Pereira Barreto	0,617	Jundiaí	0,839
São Paulo	0,663	Cajobi	0,691	Nova Odessa	0,717	Piracicaba	0,697	Borá	0,608	Indaiatuba	0,810
Indaiatuba	0,662	Americana	0,688	Valinhos	0,715	Ubatuba	0,696	Ribeirão Preto	0,607	São Bernardo do Campo	0,801
Pompéia	0,657	Neves Paulista	0,683	Jaguariúna	0,713	Águas da Prata	0,692	Osasco	0,605	Campinas	0,792
Americana	0,656	Santa Fé do Sul	0,683	Paulínia	0,708	São Roque	0,683	Cordeirópolis	0,605	Valinhos	0,773
São Bernardo do Campo	0,652	Araraquara	0,680	Tietê	0,706	Tupã	0,680	Santa Adélia	0,604	Marília	0,767
Valinhos	0,652	Ituverava	0,679	Jumirim	0,702	Itu	0,676	Castilho	0,603	Garça	0,761
Piracicaba	0,649	Lins	0,678	São Carlos	0,695	Pirassununga	0,676	Macaubal	0,603	Presidente Prudente	0,756
Araraquara	0,646	Santos	0,678	Araraquara	0,694	Ipiguá	0,675	Jaguariúna	0,602	Monções	0,755
Barueri	0,646	Adamantina	0,677	Águas de São Pedro	0,694	Ribeirão Pires	0,674	Morro Agudo	0,599	Limeira	0,752
Paulínia	0,642	São José do Rio Pardo	0,677	Amparo	0,692	Indaiatuba	0,673	Jaboticabal	0,596	São Paulo	0,747
São José do Rio Preto	0,641	Barra Bonita	0,676	Mendonça	0,690	Barueri	0,672	Águas de São Pedro	0,595	Macaubal	0,744
Águas de São Pedro	0,640	Orlândia	0,675	Monte Aprazível	0,690	Águas de Lindóia	0,668	Vinhedo	0,593	Bauru	0,742
Campinas	0,640	São José do Rio Preto	0,674	Indaiatuba	0,689	Araras	0,666	Monteiro Lobato	0,592	Santo André	0,738
Araras	0,639	Altinópolis	0,669	Lins	0,688	Jacareí	0,665	Paulínia	0,592	Santos	0,737

Source: Authors' calculations.

Our results are as follows. We noticed that the cities with the highest competitiveness indexes are, in the majority of cases, midsized cities[1], such as São Caetano do Sul (first place), Vinhedo (4th place), São Carlos (5th place), Santana de Parnaíba (6th place) and Indaiatuba (8th place). São Paulo, the capital city of the state is positioned only fifth place on the rank. Other large cities such as São José dos Campos (2nd place), Jundiaí (3rd place) and the capital city São Paulo (7th place) are also positioned in the ranking. These results show mixed evidence that the edge on competitiveness is located in midsized cities that perform well along all five dimensions of the competitiveness index.

In fact, as we proceed to analyze city performance in each of the five dimensions (results which are also presented in Table 2), we notice that in the urban and sociodemographic dimensions, medium-sized cities predominated in the ranking. In the case of the urban dimension, São Caetano do Sul first place), Fernandópolis (2nd place), Barretos (5th place), Jaú (6th place), and Americana (8th place) were in the top. Even smaller cities like Nhandeara (3rd place) and Duartina (4th place) had good urban performance. Only one large cities, Santos (14th place), performed well in the urban index. This has to do with the fact that large cities tend to have overstrained urban infrastructures.

In the case of the sociodemographic dimension, midsized cities such as Vinhedo, Americana, Jaú and Nova Odessa were among the top. Small Cerquilho was second on that ranking, and no large city was on top. This is due to the fact that large cities tend to suffer most with larger migration inflows from poorer regions of the country, deteriorating their social indicators. In the case of the fiscal/institutional index, small towns dominated in the top of that list, and only medium-sized Ubatuba, Caraguatatuba and Santana de Parnaíba performed well in this dimension. Those small cities tend to have large flows from the Municipal Participation Fund from the federal government and tend to have less expenditures on infrastructure and financial debts.

In the economic dimension both and midsized cities large cities performed well. Large industrial cities such as São Paulo, Jundiaí and Osasco had good performance, but also medium-sized Santana de Parnaíba (located in the São Paulo Metropolitan region, or RMSP), São Caetano do Sul and Barueri and also joined the top ten list. Larger cities still

[1] We classified the cities of São Paulo into three different groups: small cities (up to 50,000 inhabitants in 2013), medium cities (between 50,000 and 300,000 inhabitants) and large cities (over 300,000 inhabitants).

maintain a large industrial base, but they have being losing production capacity to cities of medium size, within the state of São Paulo and even outside the state. As far as the innovation dimension is concerned, midsized cities such as São Caetano do Sul, Santana de Parnaíba and São Carlos, and large cities such as São José dos Campos and Jundiaí, both performed well. This is consistent with the presence of research institutes and universities on those cities, as well as companies that have a tradition of high research and development investments. Small Pompéia appeared on the list as a surprise, due to its high performance on the ranking of years of schooling and of percentage of population with university degree.

Finally, an analysis of the cities that had the worst performance in the overall competitiveness index (not shown on Table 2) show that a large portion of such cities are located in the southern most part of the state, known as the Vale do Ribeira region. Moreover, there were also amongst the bottom some large and medium cities located in the periphery of the RMSP, such as Embu-Guaçu and Itaquaquecetuba. There were also, amongst worse performers, cities in the easternmost part of the state (close to the border of the Rio de Janeiro state) as well as in the westernmost part of the state (close to the border of the Mato Grosso do Sul state, in a region known as Pontal do Paranapanema).

4. Exploratory Spatial Data Analysis (ESDA) for the ICM-SP

In this section, we will perform an Exploratory Spatial Data Analysis (ESDA) using the data for the Competitiveness Index for the Municipalities of the state of São Paulo (ICM-SP) constructed in the previous section. As Almeida (2012, pp.34-35) pointed out, an exploratory spatial data analysis (ESDA) is a good tool to show evidence of spatial association and similarity in local and global patterns of cities' characteristics. In this article we look for such patterns in city competitiveness for the municipalities of the state of São Paulo.

For this we used the GeoDA software. We included a shape file for the state of São Paulo and its 645 municipalities[2]. We then joined it with data from the ICM-SP, for the overall competitiveness index and for its five dimensions of competitiveness (urban, sociodemographic, fiscal/institutional, economic and innovation) that were calculated in the previous section.

We first tested the hypothesis that spatial data are randomly distributed. That is, spatial randomness means that the values of an attribute in a region do not depend on the values of this attribute in the neighboring regions. To test the presence of global spatial autocorrelation, we will use the Moran's I statistic. This statistics has an expected value of - [1 / (n-1)], i.e. the value that would be obtained if there were no spatial pattern in the data. Values that exceed - [1 / (n-1)] indicate positive spatial autocorrelation, and values below the expected value indicate a negative autocorrelation (ALMEIDA, 2012, p.37).

This can be performed by computing univariate Moran's I test. In our case, the value of Moran's I (0.281) is higher than the expected value (minus 0.0015), providing clear indication that competitiveness is autocorrelated in space for the municipalities of the state of São Paulo. For this analysis we used the queen contiguity criteria in our weight matrix, but we also performed a sensitivity analysis test using the root contiguity criteria (ALMEIDA, 2004, p. 38). Our results show that they are invariant with respect to the contiguous convention that is used in the construction of spatial weights matrix. Thus, there is evidence of positive spatial autocorrelation, that is, cities in the state of São Paulo with above average competitiveness are neighbors to cities with high competitiveness; and

[2] The source of GIS maps and shape files is BRASIL (2014).

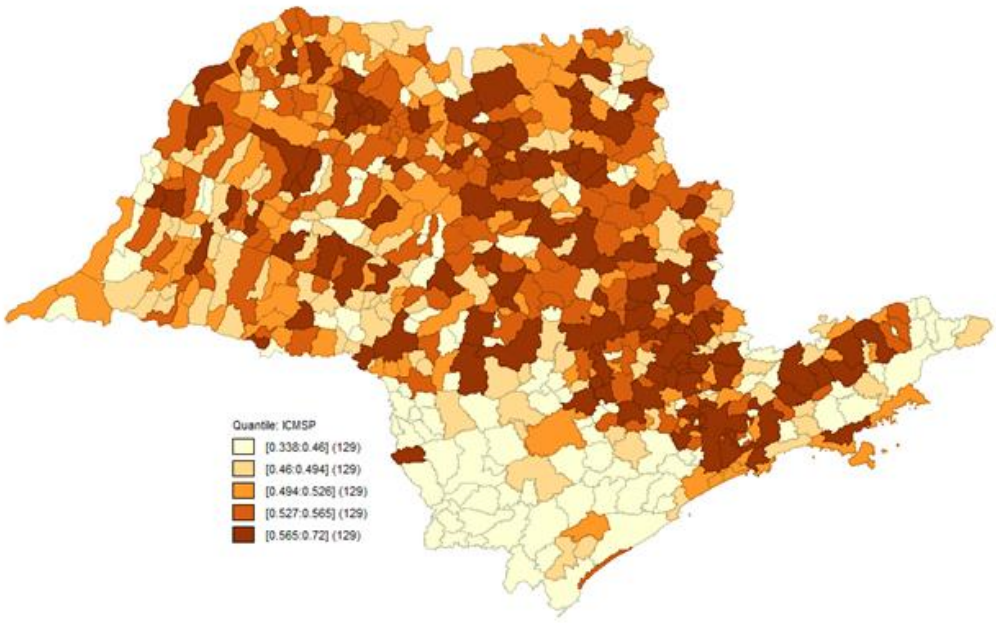
municipalities with low competitiveness index are next to municipalities with low competitiveness.

4.1 ESDA - Overall Competitiveness Index

In this subsection, we will carry out an analysis of the spatial patterns of the overall competitiveness index for São Paulo cities by showing its tendency to cluster by quintile. Next, we will show any trend of the data to cluster in space also for the overall competitiveness index using LISA cluster maps.

Initially, we evaluated the spatial patterns of the overall competitiveness index for all cities by quintile (see map in Figure 1 below). We notice that the majority of municipalities with high competitiveness (marked in brown) are located: 1) in the São Paulo Metropolitan Region (RMSP), such as Santana de Parnaíba and Jundiaí; 2) in the Campinas Metropolitan Region (RMC), such as Vinhedo, Indaiatuba and Piracicaba; 3) alongside the Anhanguera and Bandeirantes highways, in cities such as Americana, Limeira and Araras, reaching the northern part of the state, towards the Ribeirão Preto Metropolitan Region (such as São Carlos and Araraquara); 4) alongside the Washington Luis highway, in cities in the São José do Rio Preto Metropolitan Region, towards the northwestern part of the state; and 5) alongside the Dutra highway, in cities in the São José dos Campos Metropolitan Region, towards the eastern part of the state. Besides these cities there are some cities spread throughout the state with high competitiveness levels. This spatial pattern confirms most of our analysis of the previous section, which show that mostly midsized cities have high values for the overall competitiveness index. Note, however, that some important large cities are both in the top twenty ranking and have high overall competitiveness, such as São José dos Campos, Jundiaí, São Bernardo do Campo and the state capital (São Paulo).

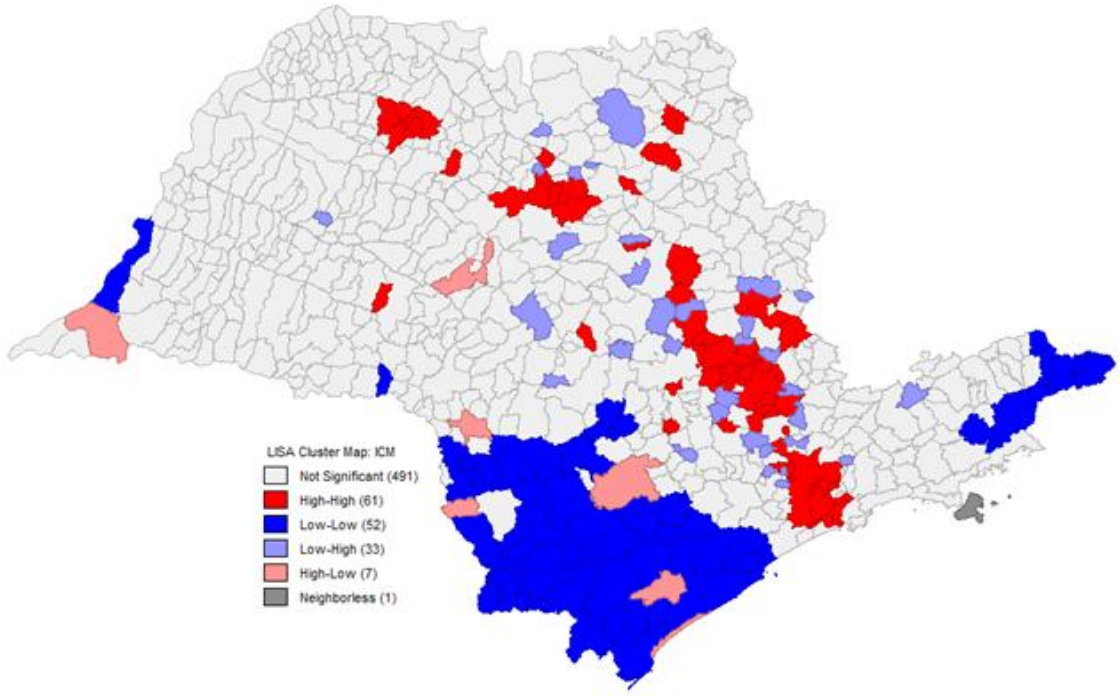
Figure 1 – Competitiveness Index for the Cities in the State of São Paulo, by quintile, 2012



Sources: Authors' calculations.

Regarding the trend of the data to cluster in space (local spatial autocorrelation), the LISA cluster maps (with the univariate local Moran's I indicators) provide groupings of data in the form of low-low, high-low, low-high and high-high statistically significant associations. In Figure 2 below, we first display the results for the overall competitiveness index for high-high clusters (marked in red). We notice that the cluster of municipalities with high competitiveness tend to concentrate in the São Paulo Metropolitan Region (RMSP), including large industrial cities of Osasco, Santo André, São Bernardo do Campo and midsized cities such as São Caetano do Sul, Barueri and Diadema; in the Campinas Metropolitan Region (RMC), including midsized cities such as Americana, Limeira and Rio Claro; and two clusters of small and medium cities in the São José do Rio Preto Metropolitan Region. Note, however, that midsized cities that are located in high-high clusters are always linked to at least one large city.

Figure 2 – Cluster Map for the Competitiveness Index for the Cities of the State of São Paulo, 2012



Sources: Authors' calculations.

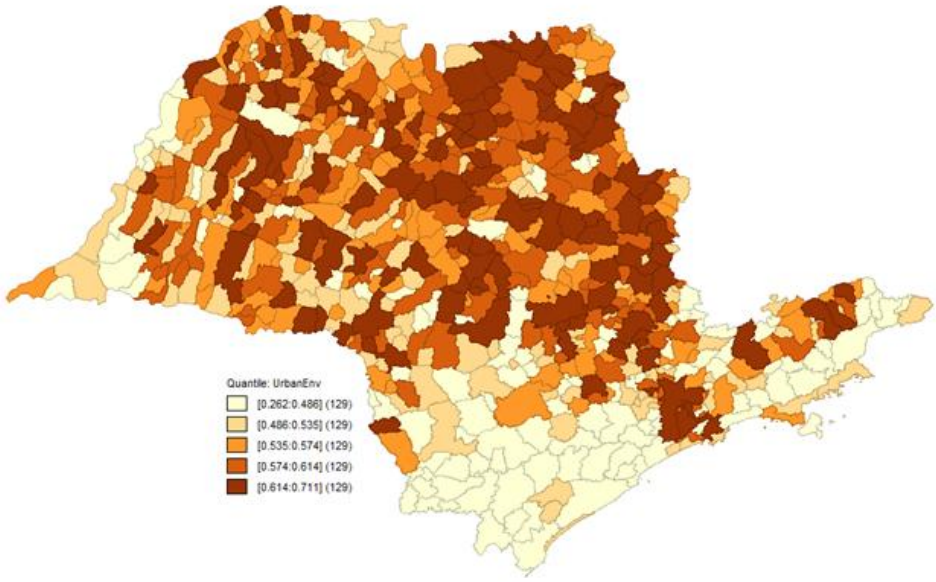
Another important analysis is for low-low clusters, that is, those which display cities of low competitiveness surrounded by other cities of low competitiveness. In Figure 3 above, we display such clusters marked in blue. We noticed three low-low clusters: 1) in the southern most part of the state, in the Vale do Ribeira region; 2) in the easternmost part of the state (close to the border of the Rio de Janeiro state); 3) in the westernmost part of the state, in the Pontal do Paranapanema region. This result is in line with what we observed above in the ICM-SP analysis. Finally, separating the high-high and low-low clusters there are cluster of cities where competitiveness is not statistically significant, cities of high competitiveness surrounded by cities of low competitiveness and cities of low competitiveness surrounded by cities of high competitiveness. In these cases we cannot point to the existence of a spatial pattern to city competitiveness.

4.2 ESDA – Five Dimensions of the Competitiveness Index

In this subsection, we will carry out an analysis of the spatial patterns of each one of the five dimensions of the competitiveness index by quintile: urban/environmental; sociodemographic; fiscal/institutional; economic; and innovation. Then we proceed to analyze the trend of the data to cluster in space also for each one of five dimensions.

Starting with the urban/environmental dimension, we displayed our results of its spatial patterns in Figure 3 below. We notice that the municipalities with high urban competitiveness are more widely spread throughout the state than the case of the overall competitiveness index. In fact, there are more municipalities colored in brown in Figure 3 with higher urban/environmental competitiveness index than in the overall index. On the other hand, the majority of the cities with low urban/environmental competitiveness (in white in Figure 4 above) are located in the westernmost, easternmost and southernmost parts of the state, just as is the case for the overall competitiveness index.

Figure 3 – Competitiveness Index for the Cities in the State of São Paulo, Urban/environmental Dimension, 2012

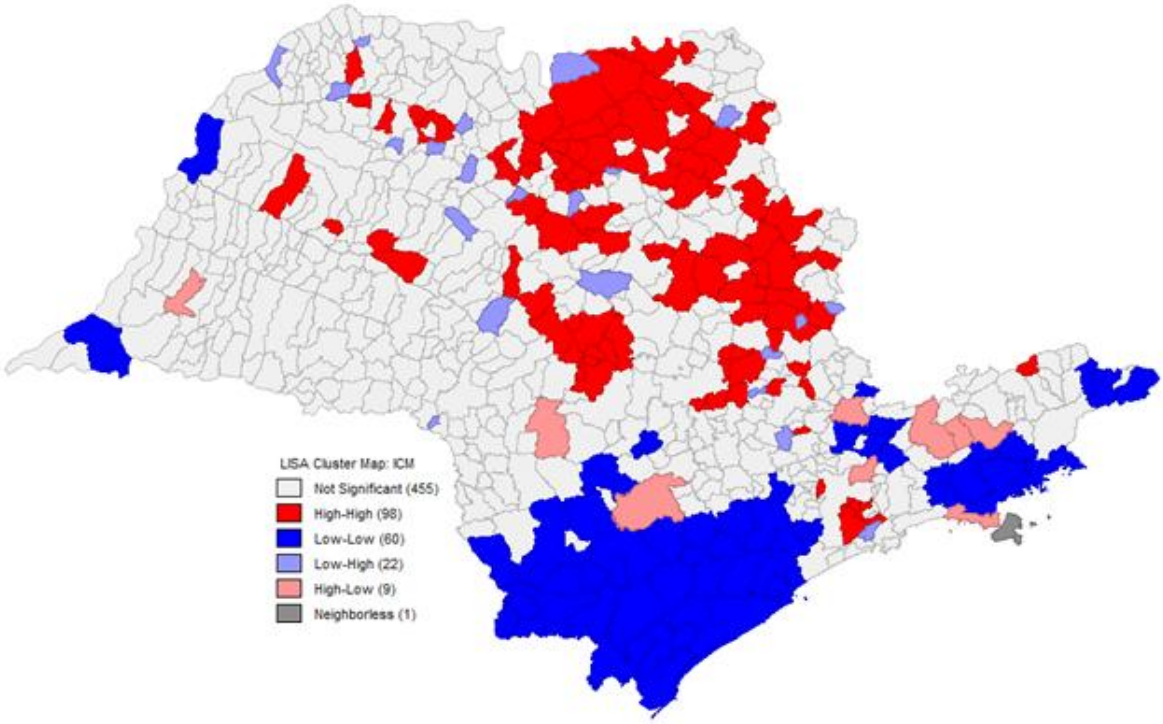


Sources: Authors' calculations.

As for the cluster analysis of the presence of local spatial autocorrelation in the urban-environmental dimension of the competitiveness index, the LISA cluster map is displayed in Figure 4. We note that the clusters of cities with high urban/environmental

competitiveness (marked in red) are composed mostly of medium sized cities located around the large cities of Campinas, Ribeirão Preto and São José do Rio Preto, and of small and medium cities around the cities of Botucatu and Matão. The cluster of cities with lower urban/environmental competitiveness (marked in blue) are also located at the Vale do Ribeira, Pontal do Paranapanema and the eastern border with Rio de Janeiro.

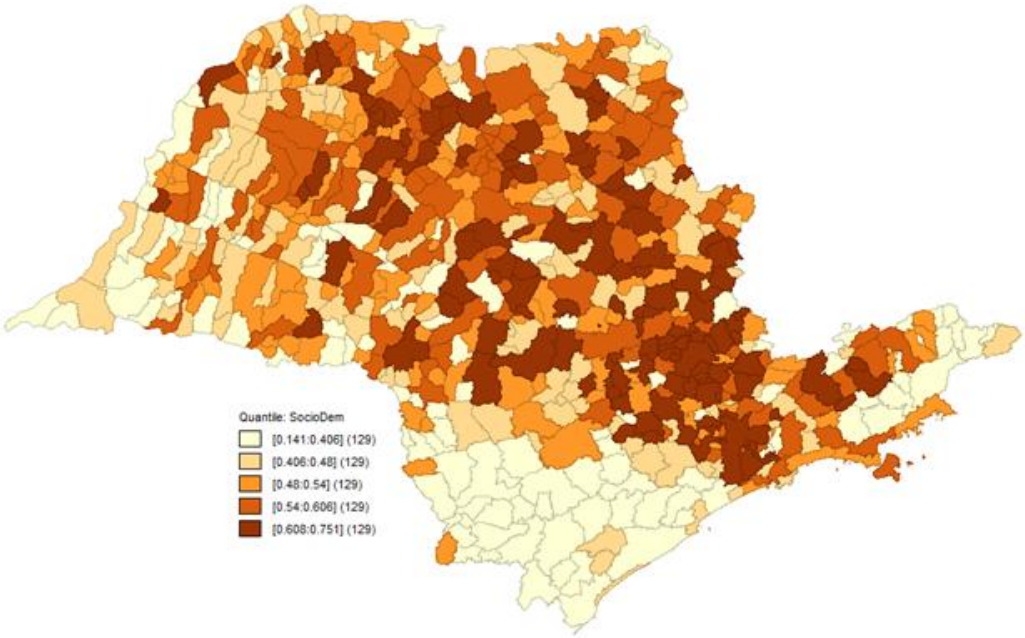
Figure 4 – Cluster Map for the Competitiveness Index for the Cities of the State of São Paulo, Urban/environmental Dimension, 2012



Sources: Authors' calculations.

For the sociodemographic dimension, we observed cities with a high sociodemographic competitiveness index located at the São Paulo, Campinas and São José dos Campos metropolitan regions, but also spread throughout the center and northern parts of the state (Figure 5). The cities with low sociodemographic competitiveness are once again concentrated in the west, east and south of the state of São Paulo.

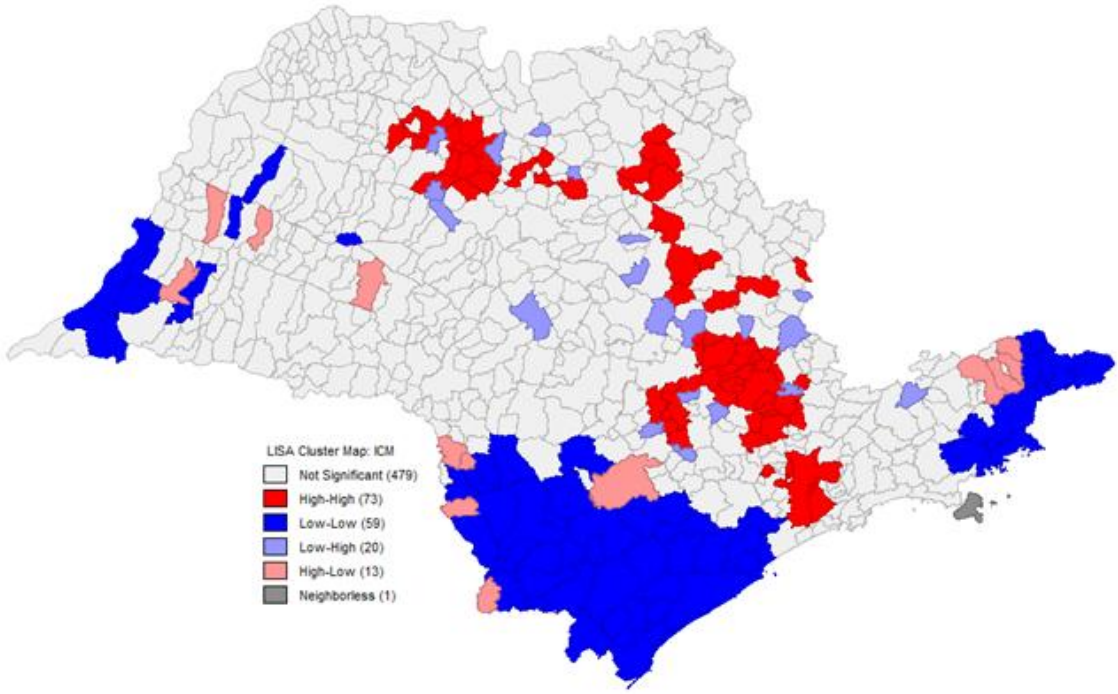
Figure 5 – Competitiveness Index for the Cities in the State of São Paulo, Sociodemographic Dimension, 2012



Sources: Authors' calculations.

The cluster analysis for the sociodemographic dimension shows a pattern of cities with with sociodemographic competitiveness clustered in the metropolitan regions of São Paulo, Campinas and São José do Rio Preto, along with some isolated cities located south of the city of Ribeirão Preto. Moreover, it also confirms that, as for other dimensions, the clusters of cities with low sociodemographic competitiveness index (colored in blue in Figure 6) are those located in the western, eastern and southern parts of the state.

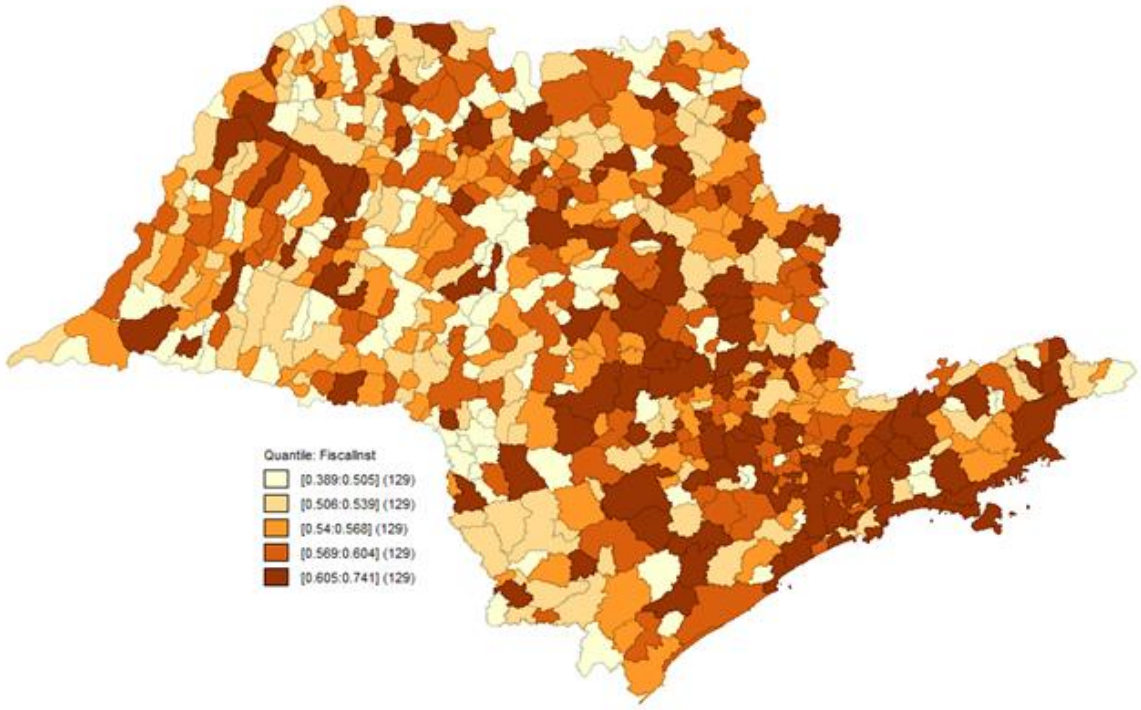
Figure 6 – Cluster Map for the Competitiveness Index for the Cities of the State of São Paulo, Sociodemographic Dimension, 2012



Sources: Authors' calculations.

In the case of the fiscal/institutional dimension, we again observed a more widespread pattern (Figure 7). Indeed, there are many small cities with high institutional/fiscal competitiveness spread throughout the state, including in the poorer regions at the far west, east and south. The large metropolitan areas of the state such as the São Paulo and the Campinas metropolitan areas did not concentrate many cities with a high position on the fiscal/institutional index. In fact, some of the large cities in São Paulo state tended to have the worse institutional-fiscal positions in the ranking. As for the cities with low fiscal/institutional competitiveness, there was no clear spatial pattern.

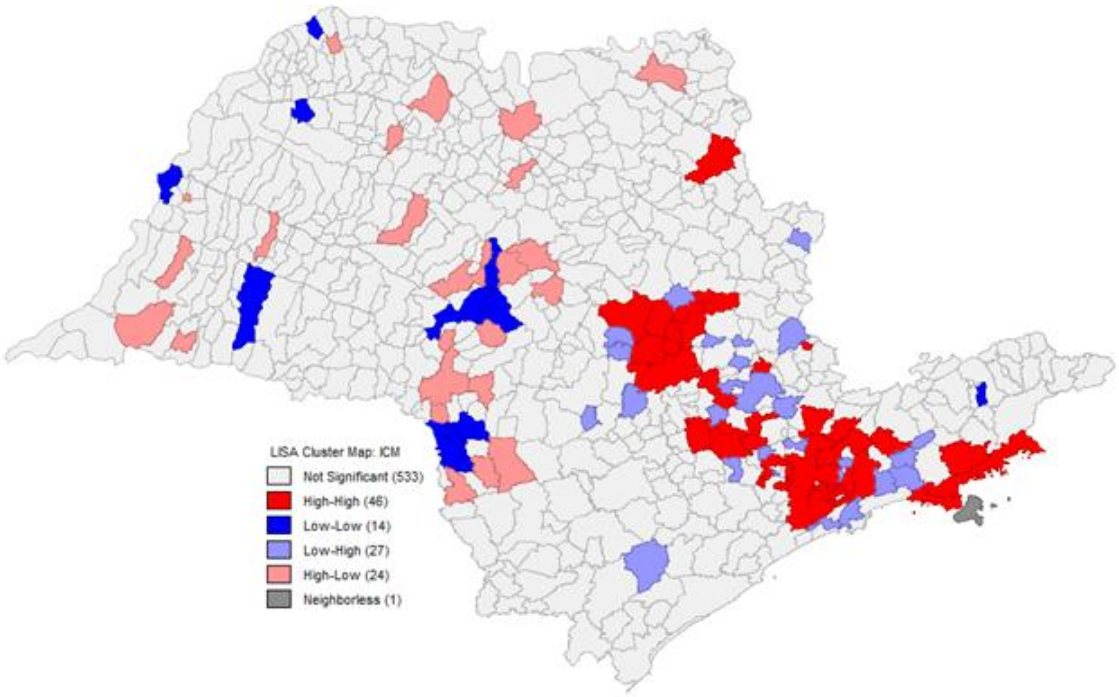
Figure 7 – Competitiveness Index for the Cities in the State of São Paulo, Fiscal /institutional Dimension, 2012



Sources: Authors' calculations.

The cluster analysis for the fiscal/institutional dimension shows that cities with high fiscal/institutional were concentraded in three regions: in the São Paulo Metropolitan area, around the city of Itú and in the northern shore of the state. There are many small cities with good fiscal (but also institutional) indicators in those areas. There were some cities with low fiscal/institutional competitiveness index (colored in blue in Figure 8) around the city of Bauru.

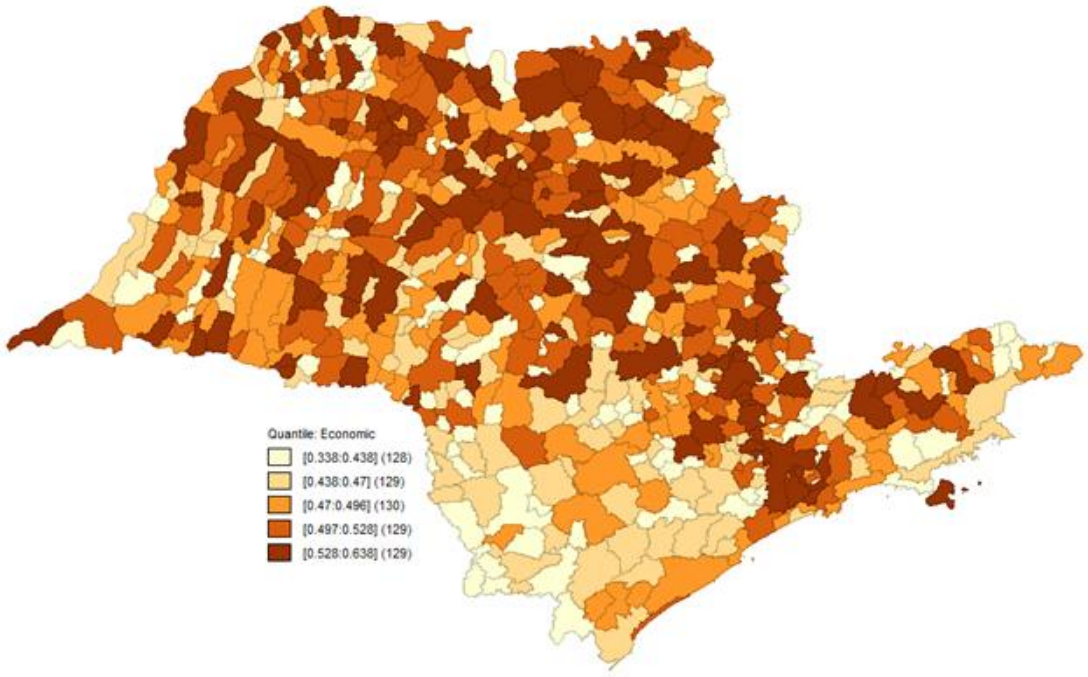
Figure 8 – Cluster Map for the Competitiveness Index for the Cities of the State of São Paulo, Fiscal/institutional Dimension, 2012



Sources: Authors' calculations.

In the case of the economic dimension (Figure 9), cities with high economic competitiveness were large and midsized cities around the São Paulo, Campinas, Ribeirão Preto and São José do Rio Preto metropolitan areas and alongside the Anhanguera and Bandeirantes, Washington Luis and Dutra highways. The majority of cities with low economic competitiveness were located in the southern part of the state.

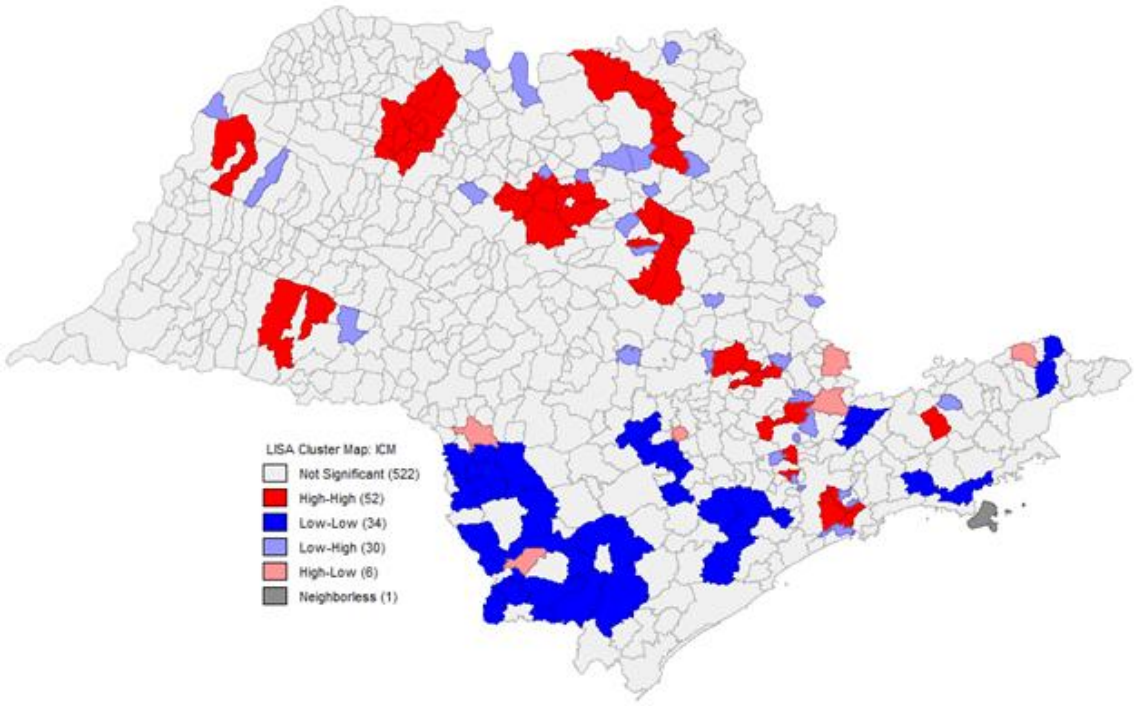
Figure 9 – Competitiveness Index for the Cities in the State of São Paulo, Economic Dimension, 2012



Sources: Authors' calculations.

The LISA maps analysis for the economic dimension (Figure 10) showed clusters in the São Paulo and Campinas metropolitan areas and in the northern parts of the state, specially around Ribeirão Preto, São José do Rio Preto and Matão. The cities with low performance in the economic dimension tended to cluster around the southern part of São Paulo state.

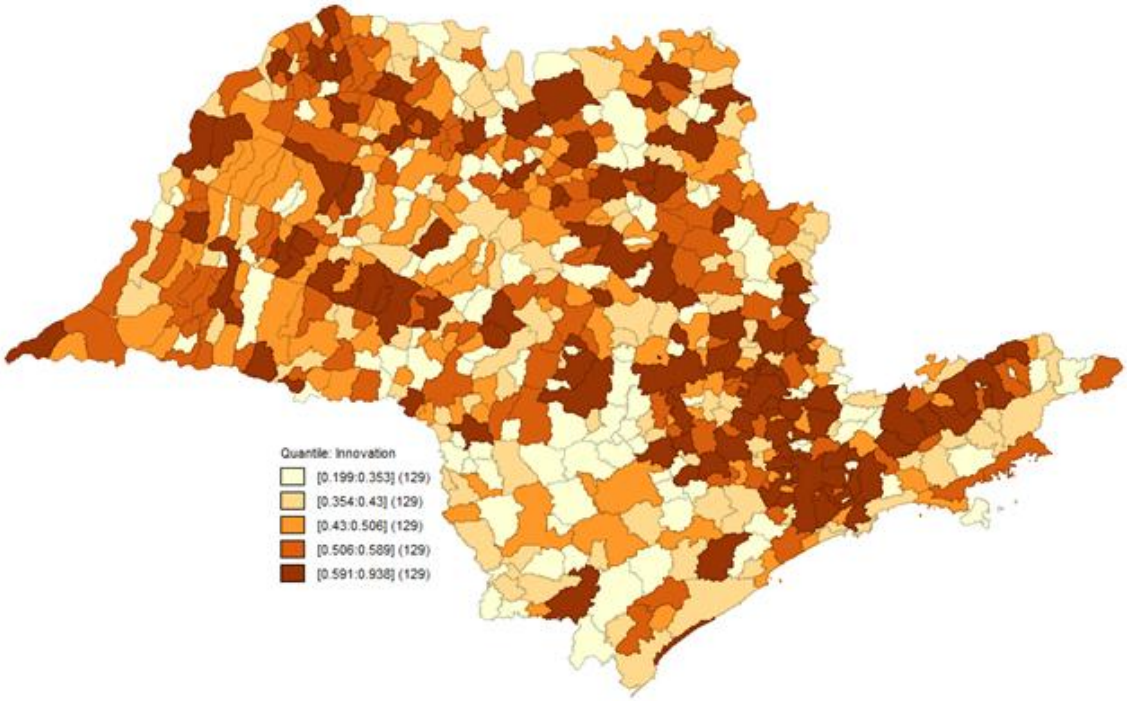
Figure 10 – Cluster Map for the Competitiveness Index for the Cities of the State of São Paulo, Economic Dimension, 2012



Sources: Authors' calculations.

Finally, in the case of the innovation dimension (Figure 11), innovative cities are spread throughout the state, as there are many cities of all sizes with good schooling indicators. However, cities with better patents and researchers indicators are located in larger urban areas. The majority of cities with low innovation competitiveness were located in the southern part of the state.

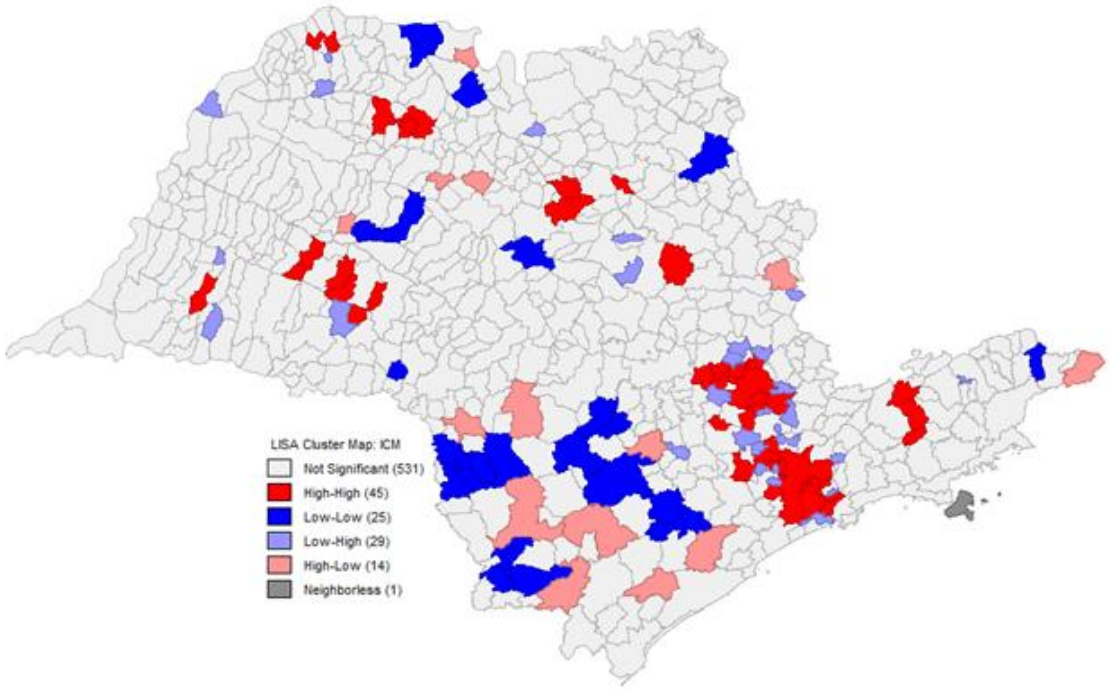
Figure 11 – Competitiveness Index for the Cities in the State of São Paulo, Innovation Dimension, 2012



Sources: Authors' calculations.

The LISA cluster map for the innovation dimension showed cities with high innovation performance in the São Paulo, Campinas and São José dos Campos metropolitan areas; in fact, those areas have companies with tradition in research and development for a long time, as well as important research institutes and universities.

Figure 11 – Cluster Map for the Competitiveness Index for the Cities of the State of São Paulo, Innovation Dimension, 2012



Sources: Authors' calculations.

5. Conclusions

Businesses are facing an ever fiercer competitive environment. If they are to compete internationally, cities and government should create more favorable conditions for the economic agents that are located there. An important question that arises is how to view and measure the potential and performance of cities. We used a methodology originally developed by Zhang (2010) to create a competitiveness index for the 645 municipalities of the state of São Paulo, Brazil (ICM-SP), using a Principal Components Analysis (PCA). We improved upon that methodology, and included a fifth dimension, innovation, as well as new indicators that were not previously included, such as institutional and environmental indicators.

Our ICM-SP includes five dimensions of competitiveness which represent the main important components of the business environment. Firms seek to locate in cities with good economic and financial structures (economic), a healthy and productive labor force (sociodemographic), good infrastructure and strong natural environment (urban/environmental), with strong institutions and favorable fiscal policies (fiscal/institutional), in a skilled and innovative place (innovation).

One important result is that we found evidence that medium sized cities (such as São Caetano do Sul) in the state of São Paulo have in general higher competitiveness than large cities, as it has been the case recently in several countries, where second-rank cities have been identified as the main driving forces in national economic performance (Europe (DIJKSTRA et al., 2013; PARKINSON et al., 2014). Agglomeration economies are called upon to explain the relatively better performance of second-rank cities, while diseconomies of scale are identified as the cause of the limited success of large ones. As to the competitiveness of the cities on the bottom of the list of the overall index, they tend to be concentrated in the southernmost, in the easternmost and in the westernmost parts of the state, as well as some specific areas in the São Paulo Metropolitan region.

We then performed an Exploratory Spatial Data Analysis (ESDA) in the data for the Competitiveness Index for the municipalities of the state of São Paulo (ICM-SP). We found that competitiveness is autocorrelated in space throughout the municipalities of the state, that is, cities with similar competitiveness tend to locate near each other. Besides, we noticed that the majority of municipalities with high overall competitiveness tend to locate along five axis: 1) in the São Paulo Metropolitan Region; 2) in the Campinas Metropolitan Region; 3) alongside the Anhanguera and Bandeirantes highways towards the northern part of the state; 4) alongside the Washington Luis highway, towards the northwestern part of the state; and 5) alongside the Dutra highway, towards the eastern part of the state.

We also analyzed the trend of the data to cluster in space (local spatial autocorrelation) by looking for clusters of cities with high competitiveness and clusters of cities with low competitiveness. First, we noticed that the cluster of municipalities with high overall competitiveness tend to concentrate along three axis: 1) in the São Paulo Metropolitan Region (RMSP); 2) in the Campinas Metropolitan Region (RMC), towards the northern part of São Paulo; and 3) alongside the Washington Luis highway, towards the northwestern part of the state.

Moreover, we noticed that the cluster of municipalities with low competitiveness tend to concentrate: 1) in the southern most part of the state, in the Vale do Ribeira region; 2) in the easternmost part of the state towards the state of Rio de Janeiro; 3) in the westernmost part of the state, in the Pontal do Paranapanema region. In these three regions of the state, competitiveness of all of its sectors is significantly lower than that of other regions. This is worrisome, as their fate could be high unemployment and even emigration. The traditional "ricardian conclusion" that each country will always be granted some specialisation is not valid for regions, and such a low competitiveness region can well be pushed "out of business". In this scenario, taking care of the regional effects of stronger global competition bears a strong economic rationale (CAPELLO; FRATESI, 2013, p. 18).

Finally, as far as the innovation dimension is concenrned, we noticed that cities with high innovation performance are clustered in the São Paulo, Campinas and São José dos Campos metropolitan areas; in fact, those areas have companies with tradition in research and development for a long time, as well as important research institutes and universities.

This study can be extended in several ways. First, as we constructed a new competitiveness index for the cities in the state of São Paulo that included an innovation dimension, such an index for the Brazilian cities could be built. Moreover, a spatial econometrics model could be built in order to explain the determinants of regional and local competitiveness. Finally, a dynamic study should also be performed, creating a panel data using data from previous years (such as the census years of 1980, 1991 and 2000).

References

ALMEIDA, E. *Econometria Espacial Aplicada*. Campinas, SP: Átomo & Alínea, 2012.

BEGG, I. Cities and competitiveness. *Urban studies*, v. 36. N. 5/6, pp 795–810, 1999.

BRASIL (2014). *Portal Brasileiro de Dados Abertos – dados.gov.br*. Available at: http://dados.gov.br/dataset/malha-geometrica-dos-municipios-brasileiros/resource/93e3e2f0-e9fd-4cc1-af06-0046af19736f. Last access: May 2015.

CAMAGNI, R.; CAPELLO, R.; CARAGLIÙ, A. The rise of second-rank cities: what role for agglomeration economies? *European Planning Studies*, v.22, n.6: pp. 1069–1089, 2014.

CAMAGNI, R. On the Concept of Territorial Competitiveness: Sound or Misleading?. *Urban Studies*, v.39, n.13: pp. 2395–2411, 2002.

CAPELLO, R.; FRATESI, U. Globalization and Endogenous Regional Growth. In CRESCENZI, R.; PERCOCO, M. (eds.), *Geography, Institutions and Regional Economic Performance - Advances in Spatial Science*. Berlin: Springer-Verlag, pp 15-37. 2013.

CENTRO DE LIDERANÇA PÚBLICA (CLP). *Brazil State-Level Business Operating Environment*. Economist Intelligence Unit (EIU), 2013.

DIJKSTRA L.; GARCILAZO E.; McCANN P. The economic performance of European cities and city regions: myths and realities. *European Planning Studies*, v.21, n.3: pp. 334–354, 2013.

FEDERAÇÃO DAS INDÚSTRIAS DO RIO DE JANEIRO (FIRJAN). *Índice FIRJAN de Desenvolvimento Municipal* (IFDM), 2014.

FUNDAÇÃO JOÃO PINHEIRO/PNUD/IPEA. *Atlas do Desenvolvimento Humano no Brasil*. 2013. Available at: http://atlasbrasil.org.br/2013/pt/consulta/. Last access: May 2015.

FUNDAÇÃO SEADE. *Informações dos Municípios Paulistas (IMP) – 2011*. Available at: http://produtos.seade.gov.br/produtos/imp/. Last access: May 2015.

INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA (IBGE). *Perfil dos Municípios Brasileiros – 2013*. Available at: http://www.ibge.gov.br/home/estatistica/economia/perfilmunic/2013/default.shtm . Last access: May 2015.

INSTITUTO NACIONAL DA PROPRIEDADE INDUSTRIAL (INPI). *Números de Patentes por Município*, 2011. Available at: http://www.inpi.gov.br/estatisticas. Last access: May 2015.

KOURTIT, K.; NIJKAMP, P.; SUZUKI, S. The rat race between world cities: In search of Exceptional Places by means of super-efficient data development analysis. *Computers, Environment and Urban Systems*. v. 38, pp. 67–77, 2013.

LANDRY, C.; BIANCHINI, F. *The Creative City*. London: Demos, 1995

MOVIMENTO BRASIL COMPETITIVO (MBC). *Índice de Competitividade Estadual – Fatores (ICE-F)*. Brasília: MBC, 2006.

PARKINSON, M.; MEEGAN, R.; KARECHA, J. City size and economic performance: Is bigger better, small more beautiful or middling marvellous? *European Planning Studies*, v. 23, n.6, pp. 1054–1068, 2014.

PORTER, M. E. *The Competitive Advantage of Nations*. New York: Macmillan, 1990.

RELAÇÃO ANNUAL DE INFORMAÇÕES SOCIAIS (RAIS). *Estatísticas – RAIS*. Ministério do Trabalho e Emprego (MTE), 2013. Available at: http://portal.mte.gov.br/geral/estatisticas.htm. Last access: May 2015.

SINGHAL, S.; McGREAL, S.; BERRY, J. An evaluative model for city competitiveness: Application to UK cities. *Land Use Policy*, v. 30., pp. 214–222, 2013.

WORLD ECONOMIC FORUM (WEF). *The Global Competitiveness Report 2014 – 2015*. Geneva: WEF, 2014.

ZHANG, M. *Competitiveness and Growth in Brazilian Cities*. Washington: World Bank, 2010.