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Benchmarking of world cities through Self-Organizing Maps

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ABSTRACT

This paper argues that there is a global trend towards the highest possible performance among functionally specialized and heterogeneous world cities in different parts of our world. It aims to map out the relative disparities in competitive performance among a preselected set of major global cities by offering a hierarchical benchmark analysis of these cities on the basis of a recently completed comparative study on their socio-economic 'power', as exerted and/or perceived by various groups of relevant urban stakeholders. The analytical tool employed to highlight and better understand the relative (hierarchical) position of these cities from a topological perspective is based on Self-Organizing Maps (SOMs), which depict in a multidimensional space the similarities among the cities under consideration. The empirical results are presented and interpreted from the perspective of a benchmark ranking of the various cities involved, while finally also an actor-oriented analysis of the distinct performance components of these cities is provided.

Introduction

Cities in the developed world are powerhouses[1] of creative thinking, development of new technologies, entrepreneurial spirit, socio-economic progress and ecologically sustainable transformation. In this way, these powerhouses can act as the engines of the world's economic growth and vitality. A wealth of challenges and opportunities is found in urban environments, not only in the urban production and consumption domain, but also in the resource and infrastructure potential of these cities (see e.g. Black & Henderson, 2003; Duranton, 2007; Pumain & Moriconi-Ebrard, 1997). Modern cities are diverse and distinctive in their history and cultural heritage as well as in their ways in coping with economic, social and environmental challenges in a globally networked economy. A focus on the high potential of urban areas from a global perspective is necessary when facing long-run great challenges. The implementation of effective strategies and actions in an urban setting will ensure that these cities are not only aware of their own strengths and weaknesses, but are also fit and able to adapt and prosper in a competitive global setting. Clearly, global competition among cities or urban agglomerations is not a goal in itself, but mainly the outcome of a self-organizing process induced by the openness and interdependence of our world.

In the past two centuries, the urban landscape in our world has completely changed. Many current cities in Europe (Madrid, Lyon, Vienna, Paris, Torino, Stockholm, Frankfurt, Brussels of Amsterdam) were until the mid 1850s still relatively small. They turned into urban agglomerations with the rise of the Industrial Revolution, and continued to grow on a structural basis (despite various ups and downs). Clearly, urban sprawl meant at first glance a disruption of existing urbanization trends, but in the long run the central position of cities was even reinforced (Tellier, 2009). Metropolitan development nowadays increasingly turns into mega-cities development, and it appears to be hard to find a conclusive answer to Alonso's (1964) challenging question "*How big is big enough?*" and "*How big is too big?*". It seems plausible that ongoing urban dynamics will remain a landmark in a modern open society in the future.

It is noteworthy that modern urbanization does not only mean a shift from rurality to urbanity, but implies also the emergence of large-scale urban agglomerations which turn into mega-cities (see Nijkamp, 2010). Socio-demographic changes (e.g., ageing), migration and mobility, entrepreneurial dynamics, sustainability and efficiency of transport and energy systems, ICT (and other advanced technologies), and increasing returns to scale in urban agglomerations are the driving forces for new settlement patterns in our modern society. Cities have turned into force fields with both centripetal and centrifugal movements in an open world, an observation made already more than two decades ago by Dema-

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[1] In this paper, various concepts such as cities, urban areas, and agglomerations are used in a rather loose way. For a precise definition of all such concepts we refer to Gregory et al. (2009).

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tteis (1988). Especially the seminal work of Friedman (1986) on world city developments – leading to an urban system as an inter-connected global system with a specific hierarchical functional structure – has inspired much research on globalization and urban development (see also Beaverstock, Smith, & Taylor, 1999; Knox & McCarthy, 2005; Kourtit, Nijkamp, Lowik, van Vught, & Vulto, 2011; McCann, 2008; Sassen, 2006). It is noteworthy that there is an increasing interest in the performance of cities from a global perspective.

Cities – and increasingly, metropolitan areas – operate indeed more and more on a world scale, in which monopolistic competition and product variety play a central role (see e.g. Abdel-Rahman & Fujita, 1990; Becker & Henderson, 2000; Duranton & Puga, 2000; Glaeser, Kallal, Scheinkman, & Shleifer, 1992; Quigley, 1998). These agglomerations act often as economic growth engines and mirror the fact that in an open global space-economy scale advantages are essential, an observation also made in the New Economic Geography.[2] A prominent question is now: which agglomeration has the highest socio-economic performance? It has become fashionable to design rankings of cities, often from different angles (e.g., accessibility, wealth, business climate, etc.). There are nowadays numerous attempts to rank the relative performance of cities in our world. The present study aims to test the relevance of a recently developed tool in computational neural network analysis, viz. Self-organizing Maps (SOMs), for ordering and ranking the relative positions of different world cities so as to better understand their performance in a global perspective.

The paper is organized as follows. The next section will exemplify some attempts to arrive at a relative comparative ranking of various cities world-wide. Then, the following section will be based on a concise description of the database used in the present study, which originates from the Japanese Institute for Urban Strategies (2010). In a subsequent section, we will concisely outline the mechanism and analytical power of SOMs, while the next sections, will offer the empirical findings followed by an interpretation. The concluding section will offer some retrospective and prospective remarks.

Urban benchmarking

Cities and metropolitan areas in our world are to some extent operating like business firms in an open globalizing world. They may wish to enhance their international image, their socio-economic or cultural profile or their share in international resources or revenues in order to reinforce their relative position. There have been many attempts to create a ranking system for major cities in our world in order to offer a systematic performance assessment of these cities. Such a ranking system has normally two objectives: (i) it provides to local stakeholders a comparative insight into the strong and weak points – relative to competitors – of the city at hand, and (ii) it offers evidence-based information for a tailor-made marketing policy of a given city (see also Cerreta, Concilio, & Monno, 2010). Such benchmarking exercises provide decision makers with focused handles on how to improve their relative position.

From the numerous attempts to map out the relative strengths and weaknesses of a set of relevant cities we will only concisely address here a few empirical investigations. A major attempt can be found in comparative studies related to the concept of world cities (see Friedman, 1986; Sassen, 1991; Taylor, 2004; Taylor & Csomós, 2011; Taylor et al., 2011). In these studies the focus is on the position of cities from a global network perspective, in which proximity and connectivity play a central role in identifying urban hierarchies on the basis of the links that advanced producer services share with the rest of the world. In this approach, the cities' position is not based on their nodal structure in a broader network, but on their contribution to shape the world city network. Especially advanced firms (e.g., excellent firms in the high-tech sector, consultancy, accountancy, advertising) act as main agents for world city formation (see also GaWC, 2008). In later stages of the world city network, also linkage data from multinational firms were included in the statistical analysis. The resulting urban hierarchy in these studies is thus mainly dependent on the composition of the industrial sector, with a particular view on the advanced service sector.

Another original, comparative study on leading cities of the world and their competitive advantages was undertaken by Grosveld (2002). His statistical analysis of the strong and weak points of cities all over the world has been inspired by Porter's seminal book on 'The Competitive Advantages of Nations' (1990). This research aims to map out the key local factors that determine the international competitive position of cities in a globalizing world with the aim to arrive at a global ranking of cities. The data for the statistical review of these cities stem mainly from perceptions of decision-makers and experts in these cities. These perceptions are subdivided into integral and functional perceptions and are based on survey questionnaires. Based on an extensive statistical database, the author was able to offer a ranking of leading cities in the world.

Another, more recent study on the comparative performance of cities can be found in Caragliu, Del Bo, and Nijkamp (2011). The authors aim to analyse urban performance from the perspective of infrastructural, human and social capital. They address in particular the class of so-called 'smart cities'. The statistical analysis of these cities is based on an extensive database from the EU Urban Audit data source, which comprises much information on demography, social aspects, economic impacts, training and education, environmental, culture and recreation. The authors aim to offer an exploratory underpinning for city rankings on the basis of a broad set of underlying city attributes (e.g., accessibility, public transport, etc.). The authors combined also the city profiles with various functional urban criteria and were able to confirm various positive correlations between urban growth and underlying parameters.

An interesting study on the urban world, by mapping the economic power of cities, can also be found in a research publication of McKinsey Global Institute (2011). This research gives a ranking of the economic performance of 600 cities all over the world, based on their contribution to global economic wealth. It goes without saying that major metropolitan areas such as New York, London, Shanghai, Tokyo, Paris or Chicago assume top positions on this rank list.

Finally, we mention here the Global Power City Index (GPCI), created by the Japanese Institute for Urban Strategies (2010). This study is based on a collection of actually observed data, complemented with information on perceptions of various classes of stakeholders. The GPCI index does not only map out the strengths and weaknesses of many global cities, but also evaluates and ranks these major cities of the world in a broadly-composed comparative analysis, according to their comprehensive socio-economic potential ('power') to attract creative people and excellent companies from around the world amidst an environment of increasingly strong world-wide competition among agglomerations. This index comprises a multiplicity of important attributes and offers therefore a rather balanced picture of the economic performance and

[2] The New Economic Geography emerges through dynamic processes in the spatial economy. It shows the interplay and linkages (in an interactive chain) between graphically and historically influenced forces (e.g., economic, cultural, social and institutional factors), each of critical importance and balanced against each other (see Kourtit & Nijkamp, 2013), in the spatial economy. This may lead to unstable behaviour (and more divergence) in urban development, and even to multiple equilibria (see e.g., Krugman, 1991).

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