Habitat International xxx (2016) 1–14

Contents lists available at ScienceDirect

Habitat International

journal homepage: www.elsevier.com/locate/habitatint

# Spatial representations and policy implications of industrial co-agglomerations, a case study of Beijing

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ARTICLE INFO

*Article history:*
Received 20 July 2015
Received in revised form
12 January 2016
Accepted 20 February 2016
Available online xxx

*Keywords:*
Industrial co-agglomerations
Regional growth
Urban planning
Spatial structure
Exploratory spatial data analysis
Input–output method
China

ABSTRACT

Industrial parks have been tested in various regions around the world, in attempt to foster innovation and fuel economic growth. Despite the importance of industry co-agglomerations in regional growth, few studies examine them in regional geographic space. This paper combines exploratory spatial data analysis and input–output method to explore the spatial pattern of key industrial co-agglomerations in Beijing, which is illustrated by location, function, frequency, spatial hierarchy and spacing. The results contribute to linking abstract economic and actual geographical spaces in urban and regional growth, enabling urban and regional planners to judge and evaluate planning initiatives before and after implementation. The failure of sub-center plans and risks of industrial parks schemes in Beijing are addressed. By considering industrial input–output relations including environmental and human resources, urban planners can optimize the development of such co-agglomerations to foster sustainable urban development.



## 1. Introduction

In the fields of urban and regional planning, a primary focus has been given to identify and understand co-agglomerations of industries. Applications of this field of study include monitoring disequilibrium and domination during economic development, cultivating chances of cooperation and rivalry, creating milieu for shaping industrial competitiveness, and stimulating technological innovation (Belussi & Caldari, 2009; Funderburg & Boarnet, 2008; Mota & de Castro, 2004; Porter, 1998a; Rigby and Essletzbichler, 2002; Steinle and Schiele, 2002). While it is has been acknowledged that a group of related industries are co-located or geographically proximate (LaFountain, 2005), few studies have examined the spatial pattern of the co-agglomeration of industries to inform the above applications (Arbia, Espa, Giuliani, & Mazzitelli, 2010; Arbia, Espa, & Quah, 2008). As urban and regional economies grow, the spatial distribution and geographical co-agglomeration of industries may not necessarily follow the same patterns. To date, planning efforts to match the geographic and economic clustering of industries have been limited, although there are various industrial park schemes. To improve the evaluation of urban planning implications and inform future policy-making, an analysis of the spatial co-agglomeration of industries as it relates to economic patterns is required. Such an analysis will inform the understanding and optimization of such schemes and other planning options, including how to optimize industrial input–output relations governing environmental and human resources.

The spatial pattern of the co-agglomeration of industries is of great importance to regional studies and urban planning practices (Isard, 1956; Rigby and Essletzbichler, 2002). It is the projection of the economic structure onto the geographical space, as a spatial response to the economic attempts or endeavors associated with the co-agglomerated industries. In practice, this effort can help subjective planning measures more closely reflect market reality. It is not a new but rather an ongoing criticism that planning or policy decisions do not adequately respond to market forces, and that is the main reason of many failed and prematurely abandoned planning strategies (Friedmann, 2005; Souza and Silva, 2011). Co-agglomerated industries in economic space can translate into a variety of structures in geographical space, and vice versa. In their own right the two structures of economic and geographical spaces

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http://dx.doi.org/10.1016/j.habitatint.2016.02.007
0197-3975/

may differ, and this may lead to loss of efficiency in operation (Neuman & Hull, 2009). Capturing these differences is critical in planning making process.

Among various constructs of industrial relationships, horizontal and complementary relations seem a more important co-agglomeration type to economic development and their spatial representation is more meaningful for policy analysis. Compared to the traditional argument for supply chains or vertical linkages from suppliers to producers and consumers as their basic input data (McDonald, Huang, Tsagdis, & Tuselmann, 2007; Oosterhaven, Eding, & Stelder, 2001), a growing number of studies have claimed that horizontal and complementary relations are more important at a city and regional level, for facilitating and stimulating competition, cooperation and innovation, as a main source of regional economic growth (Li, 2012).

Porter (1998b, p. 199) points out that in the current knowledge-driven economic development, there is large potential in a group of industries with commonalities or complementariness. The industries with horizontal and complementary relations share similar demand or supply patterns, competing on market and resources or mutual attraction among suppliers of complementary products and/or among users of jointly supplied products (Hoover & Giarratani, 1999). By stimulating competition on market and resources, horizontal and complementary relationships facilitate knowledge innovation and positive spillover effects, and such a role is perhaps no less than the specialisation process via supply chains (Hertog, Bergman, & Remoe, 2001). Industries with horizontal and complementary relations also stimulate chances for new industries (Jacobs' externalities) and recently (Frenken, Oort, & Verburg., 2007) used 'related variety' to show that a region specializing in a particular composition of complementary sectors will experience higher growth rates than a region specializing in non-complementary sectors. However, these findings have yet to be incorporated into mainstream urban and regional planning efforts in a data driven manner.

This paper is interested in applying spatial data analysis to examine the urban spatial economy by decomposing the horizontal and complementary relations of industries, using empirical data from Beijing, a large city region with diversified economic activity (Xie, 2013; Yang, Cai, Ottens, & Sliuzas, 2013). With the establishment of the free market and subsequent globalization, the government policymaking has shifted to promote regional growth with introducing sub-centers and industrial parks. Meanwhile, the industrial relationship has been dramatically re-shaped under free market economy under the global industrial value chain, and arguing that industry parks are a new production space in China (Li, Bathelt, & Wang, 2012, Wang and Wang, 1998; Yang et al., 2013). However, there is a big challenge for planners and policy makers to align these parks with market forces. Therefore, Beijing is a suitable case to study the co-agglomeration of industries, their spatial manifestations and how they inform regional economic planning against proposed planning measures.

We begin with a literature review to formulate a conceptual framework of the spatial representation of co-agglomeration of industries. Section 3 presents a methodology for examining the co-agglomeration of industries in regional economic-spatial space, and Section 4 introduces the case of Beijing. We describe the results of the spatial manifestation of the key industrial co-agglomeration patterns in Section 5. A discussion of the understanding of this spatial manifestation and its policy implications follows in Section 6. Section 7 concludes with an evaluation of the value and limitations of this research.

## 2. Industrial co-agglomerations and spatial representations

Co-agglomerations of industries, the tendency of related industries to locate near to each other (Ellison & Glaeser, 1997), share an important status in city and regional analyses and practices (Isard, 1956). They are often used to identify key groups of sectors for growth, sources of innovation and decomposing economic structure, widely appearing in regional and development theories, such as agglomeration economies, growth poles and industry clusters (Duranton & Storper, 2006; Funderburg & Boarnet, 2008; Giarratani, Gruver, & Jackson, 2007).

Recent progress of spatial statistics and analysis makes it possible to revisit these classic urban and regional development theories. For instance, K-densities (Duranton & Overman, 2005) and Ellison and Glaeser's index (Ellison & Glaeser, 1997) are used to test geographic concentration and localization and of industries. There is also an attempt to examine the tendency of industries to be co-agglomerated and co-localised (Duranton & Overman, 2008; Ellison, Glaeser, & Kerr, 2007; Feser, Sweeney, & Renski, 2005). However, most studies are applied at the national level, without pre-defined functional relationship that force the colocation of firms and industries.

The application of spatial statistics at city or regional scale, directed by functional relationships, is critical to understand in depth the key urban development concepts. Such an application could well inform urban planning policy. For example, Industry co-agglomeration played an essential role in the concept of industrial clusters, which permeate worldwide, theorizing the practice of various special economic or industrial parks, which is usually taken as a main strive of cities and regions to empower their economy (Baissac, 2011; Cheng, van Oort, Geertman, & Hooimeijer, 2013; Yang, Hao, & Cai, 2015). However, this practice is not always successful, mainly due to failing in developing key industrial relationships (Rainer and Chen, 2006). The inconsistent economic and spatial initiatives hinder the aims of integrated economic and spatial development in the city. A mismatch between city sub-centers and employment creation can waste a large amount of public resources and cause economic-spatial tensions (Song, Wang, Zhang, & Peng, 2007).

A criticism also occurs in academic field. Although it is widely accepted that functional linkages and geographical proximity are essential for industrial growth, they have not been well linked, which is a thorny issue in current urban and regional analysis (Martin & Sunley, 2003). The spatial dimension of industrial co-agglomerations is quite often arbitrarily decided (Bergman & Feser, 1999; Martin & Sunley, 2003), and geographical proximity is not substantiated for understanding industrial organization.

Given the importance of co-agglomeration of industries to urban and regional development, this paper is interested in examining its spatial representation. That is addressed by the following concepts:

**Function:** represented by a group of interrelated industries (industry co-agglomeration) dedicated to particular economic activities;

**Frequency**: a limited number of locations are expected to be observed significantly at a regional scale because of different industrial attributes, uneven space, limited investment, and different favorable conditions for different economic activities.

**Location:** the place where an industry co-agglomeration is, as defined by the polarization on the geographical space of the economic poles formulated by the industry co-agglomeration.

**Size and spacing:** the land area/boundary of the spatial manifestation of the functionally interrelated industries and the distance of each location if not just one observed.

**Spatial hierarchy:** the place where the industry co-

Please cite this article in press as: Yang, Z., et al., Spatial representations and policy implications of industrial co-agglomerations, a case study of Beijing, *Habitat International* (2016), http://dx.doi.org/10.1016/j.habitatint.2016.02.007