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Spatiotemporal analysis of land development in transitional China

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ABSTRACT

This study investigates three types of land development in China, land for cities and towns, stand-alone industrial sites, and space devoted to transportation. Relying on shift-share analysis, spatial filtering and geographically weighted regressions, we find that the spatial patterns and underlying determinants of China's construction boom vary across subcategories and periods. City and town land development follows the administrative hierarchy, as it is especially pronounced in provincial capitals and centrally administrated municipalities, and is largely dependent on urbanization, passenger transport, and fixed assets investment. The proliferation of stand-alone industrial areas is mainly driven by the expansion of foreign direct investment, industrial adjustment, and the capacity of freight transport. Transportation land development is determined by the development of railway and highway systems as well as local economic development. Temporally, our results suggest that land development and its agglomeration accelerated from 1998 to 2002 to 2003–2008. Also, globalization had more influence during 1998–2002, whereas the role of decentralization and marketization became more significant in the period of 2003–2008.

1. Introduction

China is undergoing the greatest urbanization process in world history, accompanied by an unprecedented development of land (Wei & Ye, 2014; Wei, 2012). Indeed, one of the most significant structural changes in China's urbanization is the rapid increase of developed land and the shrinkage of agriculture land (He, Huang, & Wang, 2013). According to the official data from Ministry of Land and Resources (MLR), from 2004 to 2008, China's developed land increased by 12,600 km^2, while the arable land declined by 7,510 km^2. As an important dimension of China's urbanization, land development and its detailed patterns and determinants deserve more attention from scholars (Li, Wei, Liao, & Huang, 2015; Wei & Ye, 2014).

The increase in built-up areas is central to the process of urban expansion in China (Li et al., 2015; Wei & Ye, 2014). Seeking to explain the process, scholars have used such concepts as development state, entrepreneurship state, transitional institutions, growth machine, as well as economic transition to conceptualize the underlying mechanisms of demographic and landscape urbanization in China (Li, Wei, & Huang, 2014; Lin & Ho, 2005; Lin, 2007; Wei, 2012; Yang & Wang, 2008). Under the framework of economic transition, China's physical urbanization is conceptualized in terms of multiple mechanisms based on globalization, decentralization, and marketization (Gao et al., 2014; Huang, Wei, He, & Li, 2015; Li et al., 2015; Wei, Li, & Yue, 2017).

Land has multiple uses, and land use types matter in urban expansion and land use planning (He et al., 2013). Limited by the data sources, studies largely rely on the applications of geographic information science (GIS) and remote sensing, which can hardly distinguish the subcategories of land development precisely (Mertes, Schneider, Sulla-Menashe, Tatem, & Tan, 2015). As a consequence, the spatial patterns and underlying determinants of land development subcategories have rarely been compared and carefully studied. Similarly, measurements of urban expansion are also limited to assessing physical growth. The spatial effects, along with local/regional advantages, structural influences, and the effects of national development have not been thoroughly examined (Seto & Kaufman, 2003; Deng, Huang, Rozelle, & Uchida, 2008; He et al., 2013; Li et al., 2015).

Relying on the official data on land use change from MLR in

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China, this study investigates the regional disparities among the growth patterns and dynamics of three subcategories of development space: land for cities and designated towns, which consists of the residential, public service, commercial, industrial, and transportation land within a city area; stand-alone industrial land, which represents the industrial and mining sites located outside of residential settlements; and transportation space which comprises highways, railways, civil airports, and other transport facilities (MLR, 2011). By highlighting the spatially and temporally varying effects of different land use types in the context of China's economic transition, this paper seeks to answer the following questions: How can we identify types of regional land development that are more associated with unique regional competitive advantages? Do globalization, decentralization, marketization, and urbanization result in accelerated regional land development in China? Are such relationships sensitive to land use types and are they changing over time?

2. Literature review

2.1. Land use change and urban expansion in China

Land use patterns and the distribution of different functional zones in urban areas were the major topics in research on the evolution of space and urban structure in earlier urban studies (Anas, Arnott, & Small, 1998). Examples include the concentric zone model, the sector model, and the multiple nuclei model. With the intensification of globalization and urbanization in the late 1980s and the development of the technologies of GIS and remote sensing, urban geographers have turned their attention from urban form toward the large-scale expansions of construction land and built-up area (Deng et al., 2008; Li et al., 2015; Seto & Kaufman, 2003; Turner, Lambin, & Reenberg, 2007). Since then, scholars have de-emphasized land use types, and have been keen to focus on the expansion of developed land in developing countries (Ho & Lin, 2004; Deng, Huang, Rozelle, & Uchida, 2006, 2010; 2008; He et al., 2013; Wang, Chen, Shao, Zhang, & Cao, 2012; Li et al., 2015, 2017).

Urban expansion in China, also referred as land or landscape urbanization, has drawn plenty of scholarly attention (Bai, Chen, & Shi, 2011; Wei et al., 2017). Based on the absolute change of construction land and built-up area, these studies cover almost all the research dimensions, from temporal and spatial patterns to the underlying dynamics. They find that the extent of China's land urbanization declines from the coastal to the inland area, from higher-level rank cities to prefectural cities, and from metropolitan areas to small towns (Li et al., 2015; Schneider & Mertes, 2014; Zhang, Zhou, Chen, & Ma, 2011).

In addition to studying the expansion patterns, scholars have employed urban growth models and econometric methods to identify the major driving forces of urban land development. In general, these are urbanization at an unprecedented pace, economic transition, and economic growth, structural adjustments. The specific mix of determinants of urban expansion differs across space and scales (Tan, Li, Xie, & Lu, 2005; Deng et al., 2006; 2008; Wang et al., 2012). Nationally, based on the classification results of large-scale remote sensing data, Deng et al. (2006 & 2008) conclude that urbanization and the shifts from reliance on manufacturing to more emphasis on service industries drive urban expansion in China today. Others, such as Lin and Ho (2005) and Wang et al. (2012) find that the industrialization process in rural areas and the large numbers of rural-urban migrants are the primary factors influencing landscape urbanization in China. Other research finds that the growth of tertiary industry and the consequent rise in average salary are important impetuses after urban growth in China (Ding & Lichtenberg, 2011). Regionally, Tian and Ma (2009) point out that economic growth is the most significant driving force of urban expansion in the Yangtze River Delta, while the research about the Pearl River Delta shows other detailed factors of construction land expansion, such as foreign direct investment (FDI), fixed asset investment, and cheap arable land value. Tan et al. (2005) specify that there are some additional factors such as the household registration system and land use planning, which lead the rapid growth of built-up areas in the Greater Beijing mega-region.

At the city level, geographers have found that the income gap between rural and urban residents is an extra driving force of urban sprawl in Beijing (Deng & Huang, 2004; Xie, Fang, Lin, Gong, & Qiao, 2007). The income gap between the residential area and the rural area, as well as a special relationship between the rural hinterland and the urban area, are the unique factors for Shanghai (Han, Hayashi, & Cao, 2009; Li & Wu, 2006; Li et al., 2014). Regarding Guangzhou, the development of the transportation system has been recognized as the primary determinant (Fan, Wang, Qiu, & Wang, 2009; Ma & Xu, 2010). Although plenty of empirical findings have been obtained in previous studies, comparisons between determinants affecting the different categories of land development have rarely been conducted.

2.2. Categories of land development in China

Geographers have recently begun to examine the categories of development space, such as city and town land, industrial sites, as well as transportation space. According to MLR (2011), city and town land in China is mainly occupied by residential, public service, inner city transportation facilities and commercial uses. Studies have proved that the expansion of these types of land is propelled by urban population growth, urbanization, urban hierarchy effects, globalization, and economic growth (Ding & Lichtenberg, 2011; He, Huang, & Wang, 2012; Kuang, Liu, Dong, Chi, & Zhang, 2016; Li et al., 2015). With respect to urban hierarchy effects, the proliferation of public schools and hospitals, university towns, new central business districts (CBDs), as well as other types of urban infrastructure are major contributors to the conversion of agriculture land to land for cities and towns (Ding & Zhao, 2011). In China, public services, including public education and healthcare, are arranged in accordance with the urban hierarchy (Li et al., 2015; Pan & Shallcross, 2016). The centrally administrated municipalities and provincial capitals always have better education, healthcare, and other public services. These advantages add to the attractions cities at or near the top of the urban hierarchy have for migrants from rural areas and under-developed cities. Consequently, disproportionately large flows of migrants to major cities fuel their expansion and reinforce their position at the top of the urban hierarchy. The increasing number of urban residents contributes a growing demand for urban infrastructure, as well as the expansion of residential and commercial land use.

In addition to the urban administrative system, globalization has been recognized as a significant impetus for China's city land development, specifically by means of investment in the new CBDs and the realization of globally oriented mega-projects, such as the Olympics Games and Expo (Universal Exposition) (Wei, 2015). However, although some detailed mechanisms and factors have been identified in existing literature, most studies still focus on built-up areas to represent the expansion of cities and towns in China (He et al., 2013; Li et al., 2015). A quantitative analysis under an integrated framework to specify city and town land use is still needed.

According to China's *Yearbook of Land Resources*, from 2004 to 2010, the Chinese government provided 1070 km^2 of land for industrial usage. Scholars have found that the expansion of industrial