



## Analysis on coupling relationship of urban scale and intensive use of land in China



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### ABSTRACT

The relationship between metropolitan scale expansion and land use intensity has been a hot research topic in Mainland China in the recent years. Even though many scholars have already discussed this topic from a theoretical standpoint, unfortunately, empirical research in this regard has been woefully lacking. In light of this, this study proffers an empirical investigation of 120 major Chinese cities in 2009, by first establishing an urban land use intensity index by means of a principal component analysis, followed by the application of the structural equation model (SEM) to verify said relationship. The findings show that urban land use intensity has both positive and negative effects on urban scale. In particular, while the agglomerate effect of land and capital is positive, the substitution effect between them is negative. The findings of this study particularly address the coupling relationship of urban scale and land use intensity in Mainland China. The results imply that when the levels of non-land factors rise, urban land use intensity will improve. In other words, following the implementation of the new urbanization policy in China, and the ever-growing significance of the dynamic agglomeration effect, there is a positive coupling relationship between urban scale and land use intensity.

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### Introduction

Since the 21st century, with the advancement of industrialization and urbanization, urban expansion in China has become increasingly prominent, with big cities or even megacities being developed (Ding, 2013; Wu, Zhang, & Shen, 2011). China has a large population with a relatively small urban land mass. This crowdedness drives most of the cities to expand their urban sizes rapidly, leading to lower inner land utilization inside cities. In the meantime, big cities' per capita built-up area was on the rise: for example, from 77 km<sup>2</sup>/million in 2008 to 92 km<sup>2</sup>/million in 2009. Faced with a fast growing population with relatively little land in China, it is thus urgent to speed up the transformation from extensive land use to intensive land use, especially for urban land. Urban expansion has always been an important issue in academic research and government decision-making. In China, the expansion of the city has two forms, namely, "endogenous form" and "exogenous form". The "exogenous form" means expanding laterally on urban scale, while "endogenous form" means intensifying urban land use. From a land use perspective, lateral urban spreading

and intensified land use are two ways to satisfy land demand, which are complementary. However, in the situation of increasing land supply, both ways are significantly different in location, land prices, land quantity and so on. Thus, there exists certain competition between them. Furthermore, there must be some kind of relationship between urban scale and land use intensity. An investigation into the coupling relationship between city size and land use intensity reveals the action mechanism between them, and provides implications for reasonable urban growth, which yields important theoretical and practical value.

Since the 1980s, many domestic and foreign scholars have carried out a wide range of studies on topics related to urban scale. According to Alonso's (1964) early single center city model, the rent boundary of a product is decided by price and cost in the market, and the city boundary depends on population, family income, transport cost, and rent for farmland. At issue had been, for example, intensive use of urban land, land intensive use connotation, land intensive use evaluation and the driving force analysis. Since the 1990s, some researchers have continuously promoted notions such as "Smart Growth" (Gabriel, Faria, & Moglen, 2006; Miller & Hoel, 2002), "Compact Development" (Burchell & Shad, 1998), and "Infill Development" (Wong, Boon, Chia, & Chong, 1997).

Since 2008, the Chinese government has been well aware of the fact that the existing urbanization policy had to be overhauled. Thus,

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a new ‘increasing vs. decreasing balance’ land-use policy has been promulgated (Long, Li, Liu, Woods, & Zou, 2012). Under the new general land use regulation, the amount of urban and rural developed areas within an administrative region is strictly controlled by a quota system. The urban–rural policy stipulates that a balance between increasing urban and decreasing rural land use patterns be maintained, so that rural villagers can become urban citizens (Zhang, Hu, Skitmore, & Leung, 2013). That is also the target of China’s new urbanization policy (Wu, 2013; Wu, Zhang, Skitmore, Song, & Hui, 2014). By 2009, this new policy was implemented in 19 of 31 Chinese provinces. This research paper chooses the year 2009 to study because China implemented the ‘increasing vs. decreasing balance’ land-use policy right at the time as the transition period.

Although many scholars have evaluated urban land use intensity, there has neither been a widely recognized evaluation index system nor evaluation method for studying this issue. This paper is organized as follows: The next section reviews the relevant literature with regard to the static and dynamic coupling relationships between urban scale and land use intensity. Using principal component analysis, an evaluation index system for urban land use intensity is to be constructed. In Section ‘The SEM for the coupling relationship between urban scale and land use intensity’, a structural equation modeling approach is to be employed to investigate the coupling relationship between urban scale and urban land use intensity, and Section ‘Conclusions’ concludes the study and provides suggestions for further research.

### Theoretical analysis of coupling relationship

As early as 80 years ago, Hotelling (1929) pointed out that “our cities become uneconomically large and the business districts within them are too concentrated”. Then Henderson (1974) proposed a conceptual model for the determination of the optimal size of the city. As shown in Fig. 1, point J is the optimal size of the city. However, the relationship between city size and land intensive use is uncertain.

Many studies have found that factors such as intensity contained economic development, and that urban location advantages, policy guidance, economy, nature and policy are the main driving factors to promote urban land use. From the land use perspective, the intensive use of urban land refers to the exploitation potential of internal urban land, while urban expansion refers to the horizontal development of land for urban use. They are in a complementary relationship to meet the overall demand for land. However, with the same driving force stimulation, there exists certain competition on location, utilization modes and quantity between the two ways. It follows that there must be some kind of relationship between urban scale and land use intensity. The following sections of this

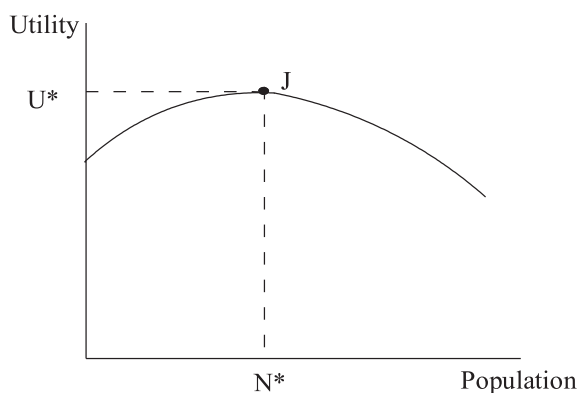


Fig. 1. Conceptual model of optimal city size.

paper are to analyze both the static and dynamic states, and to establish the research hypotheses based upon the results obtained from previous studies.

#### Factor substitution effect under static state

As we all know, land has the function of “carrier” while being an important element in human activities. From a macro-perspective, the “carrier” function can be considered as “internalization.” Therefore, land can be taken as a production factor such as capital and technology. According to resource economics, factor inputs of a city can be divided into two types, namely the land factor and non-land factors such as capital, labor, and technology. Different combinations of these two types of factors are the basis for the development of cities. To produce economic output, land factors and non-land factors need to maintain at a certain proportion. Under the substitution effect, when one type of factor input decreases, then the input of another type of factors increases in order to maintain the same level of output. Under normal circumstances, the higher the price of one factor is, the less the demand/input of it will be.

In a static state, according to the theory of land rent-seeking, there is a trend forming a competitive and alternative relationship between land and non-land factors. Taking the city as a whole, when the relative price of land is lower, less non-land factors are required, for they are replaced by land factors. The greater the input of the land is, the larger the city will be, then the less the input of non-land on unit area of land is; when the relative price of land is higher, people tend to use non-land factors to replace the land factor, causing land input being in small quantities. The less the input of the land is, the smaller the size of a city is, then the more the input of non-land on unit area of land is. In accordance with neoclassical economics, the capital can substitute for land (Chen, Yan, Wu, & Li, 2011; Wu, Qu, & Zhou, 2009). At the same time, technical progress can offset the fixed land constraints to economic growth. The process of land use intensity actually is the process of replacement of the land factor by non-land factors such as capital and labor. Intensifying urban land use caused by non-land factors replacing the land factor reduces the speed of urban expansion and the demand for newly increased land. It means that the process of urban land intensive utilization has a negative impact on urban expansion through the factor substitution effect. Therefore, it is assumed in this study that urban land use intensity has a direct and negative impact on urban scale.

#### Urban agglomeration effect under dynamic state

From a dynamic perspective, urban expansion, especially in big cities, is driven by urban agglomeration effect. This effect is embodied in three levels, namely, plots, districts, and the whole city. On a plot level, agglomeration effect refers to more input. The investment of more factors in production increases productivity and land revenue of a particular area, resulting in higher land prices. On the district level, plots with high returns attract new investors. With the process of accumulation and connection, the district gradually becomes an idiomatic industrial agglomeration district. This agglomeration can bring lower unit costs and higher labor productivity, and encourage the improvement of the hardware infrastructure and software production services to form localization economies. Then the cost advantages brought by localization economies promote the clustering of labor, capital and technology in cities and the formation of highly-intensive land utilization. This kind of land utilization has many advantages, such as providing jobs for the labor force, offering diversified products for the public, and establishing better investment channels for funds. At the same time, it attracts more production factors, which accelerate

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