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Building height restrictions,land development and economic costs☆

Chengri Ding*

Urban Studies and Planning Program & National Center for Smart Growth, University of Maryland, College Park, MD 20742, United States

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ABSTRACT

Beijing has a unique spatial pattern that is characterized by an inverted U-shape building height curve and geometrically developed transportation network (rings of highways and axial roads). The inverted U-shape curve of building heights is mainly the outcome of building height restrictions in inner city for historical preservation. This paper estimates the economic costs of the building height restrictions by using land development data. Through comparing land development without building height restrictions and simulations, we show that the economic costs are substantial. The impacts of the building height restrictions include land price decrease by up to 60%, housing output decrease by up to 70%, and land investment decrease by 85%. To accommodate the loss of housing output, the city edge has to expand, causing urban sprawl (given all other things equal). In order to offset building space reduction, housing prices rise by 20% and the city edge expands by 12%. Finally, induced travel costs resulting from urban sprawl and low density caused by building height restrictions may not be trivial.

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Introduction

Urbanization and technological innovation in building construction have dramatically transformed urban landscape through the world. As both city size and number of mega cities continue to rise, issues concerning the supply of land to accommodate urbanization become increasingly challenging. The notion of the "vertical city" begin to spread out, as evidenced in many modern cities such as New York, Las Angeles, Tokyo, Chicago, Hong Kong, Singapore, Kuala Lumpur, Shanghai, Taipei, just name a few.

The emerging of ever-rising skyscrapers in central areas of cities creates a symbolic value in revealing a city's supreme identity and the success of owners and occupants (Chau et al., 2007; Bertaud and Bruckner, 2005).[1] Skyscrapers increase the status for businessmen who place their offices on top floors or wealthy individuals living in penthouse apartments who enjoy the fantastic views of the skylines as well as the better air quality (Barr, 2008; Chau et al., 2007; Gaubatz, 1999). Skyscrapers might bring substantial economic and environmental benefits. The economic benefits include high employment and population densities that (1) facilitate interactions among people in a limited and compacted geographic areas; (2) are key factors in agglomerative economies; and (3) provide easy access to various urban amenities services such as employment opportunities, entertainment, shopping, and healthcare facilities (Kornblatt et al., 2008; Rosenthal and Strange, 2003, 2005; Kohlhase and Ju, 2007). High densities are important to boost ridership of mass transit because congested central areas discourage mobile usages (Kornblatt et al., 2008). Environmental benefits brought by skyscrapers are improved energy efficiency as well as reduced carbon dioxide emission (Ellis and Torcellini, 2005; Smith, 2008; Leung and Weismantle, 2008).[2]

Partly because of perception and partly because of lack of empirical evidence, these positive benefits, however, may neither be fully appreciated nor considered to be sufficiently large enough to offset negative impacts or dis-amenities of skyscrapers. A skyscraper's dis-amenities include: (1) destroying of historical characters of central city; (2) high pressure on urban infrastructure and congested urban traffic resulted from high job and employment densities; and (3) loss of environmental quality such as blocking of sunlight, trapping of air pollution near the streets; creating urban heat islands; and blocking of natural breezes (Tatsuo, 2005).

Building height restrictions become a common planning tool to mitigate these negative impacts or dis-amenities; to preserve historical characters of central cities; to minimize the impact of structure on the landscape in increasing the compatibility of new

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* Tel.: +1 301 405 6626; fax: +1 301 514 5639.
E-mail address: cding@umd.edu

[1] For instance, many buildings in New York Manhattan such as the Chrysler (1929) and the Empire State (1930), the Bank of Manhattan (now 40 Wall Street) (1929) in New York City were constructed by developers with explicit intention for the world record holder (Tauranac, 1995; Gluckman, 2003; Barr, 2008).

[2] It is extremely difficult, if not impossible to accurately measure and gauge true and full benefits of building height restrictions on economic development, aesthetic and historical preservation, and urban amenities particularly in monetary term, although hedonic models can be used to reflect price premium of these benefits.

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structures with the surrounding neighborhood; and to control population density.[3] Although building height restrictions are widely practiced, there are few empirical studies on their costs. Some empirical studies are found in the planning literature but none specifically on China.[4] Using Bangalore data, Bertaud and Bruckner (2005) show that the FAR (Floor Area Ratio) restrictions cause cities to further expand into rural areas, which in turn raise commuting costs in the range of 1.5–4.5% of household consumption. They also suggest that the cost saving from lower infrastructure demands due to building height restrictions in central locations may not be able to offset the cost increases of a wide infrastructure network needed to accommodate consequent urban spatial sprawl/expansion. Sridhar (2010) concludes that FAR restrictions positively contribute to suburbanization in India cities. Montgomery (2003) shows that the New York's building height restrictions on residential development passed in 1885 were responsible for the severe housing problems in the early decades of the 20th century. Finally, Koster et al. (2011) show that firms are willing to pay 4% for a 10% increase in building height and conclude that tall buildings are still undersupplied in the Netherlands.

The objective of this paper is twofold: to estimate the economic costs of building height restrictions using Beijing's case in which the building skyline is strictly regulated and planned; and to contribute to our general understandings concerning the effects of land use regulation on the price of housing and urban spatial development patterns. Given renewed interests in the impacts of land use regulation and numerous empirical studies, the literature produces mixed results about the effects of land use regulation on urban spatial development (Quigley and Rosenthal, 2005; Ihlandfeldt, 2007; Levine, 1999). This may be resulted from the combination of the complexity of regulatory behavior, various forms of regulations (density control, limitation on developable land supplies, lot restriction, and design standards etc.), and estimation issues such as measurement error and endogeneity of land use regulation (Deakin, 1989; Downs, 1991; Quigley and Rosenthal, 2005; Ihlandfeldt, 2007).

Unlike the majority of empirical studies that use a comparative approach or hedonic models, this paper first develops a theoretical model in which housing services are estimated by inputs from land and capital in the form of constant elasticity of substitution; then calibrates the CES housing production function using land development data from Beijing; and finally estimates the economic costs of building height restriction by comparing simulated land and housing prices and land development intensity (capital density) with and without restrictions. The economic costs are captured in four difference aspects. First, building height restrictions cause underinvestment in land improvement and a reduction in land use intensity. Second, they reduce social welfare defined by aggregated land rent. Third, the city edge has to expand outward to accommodate housing output reduction caused by building height restrictions in the inner city, causing urban sprawl and inducing higher transportation costs.[5] Fourth, building height restrictions may interfere with market principles in which resource allocation and input usage are determined by prices. In land development, capital and land can be substituted for each other and the profit from land development is maximized by choosing optimal capital and land inputs with reference to their relative prices. Thus fixed building height limitations take away the freedom of capital-land substitution in land development and results in not only inefficiency in both capital and land resources but also social welfare loss. As Bertaud (2007) points out, substitution of capital for land is thus highly limited in China and the impact of this limitation on urban form may not be trivial. In a sum, economic impacts of building height restrictions are measured by losses in land development intensity, reduced capital usage, and affected housing prices.

The paper is organized as the follows. The next section describes urban planning and planning driven urban spatial development pattern. The third section presents the model. The fourth section discusses data, empirical estimates of land development such as land price gradient, housing price gradient, and housing production function, as well as the simulated results on economic impacts of building height restrictions. The final section draws conclusions and final remarks.

Urban land use regulations and urban spatial development

Building height restrictions and zoning

Chinese cities such as Beijing adopted land use regulations that are quite similar to ones used in many other cities throughout the world in terms of its planning contents. For instance, urban land use regulations include designation of land use types, determinations of maximum floor area ratio and building coverage, requirement of minimum open/green space, and maximum allowed building heights.

Because of a long and rich history and cultural tradition, Beijing adopts very rigid building height restrictions, particularly in central areas (Li, 1996).[6] For instance, building height is restricted to a maximum of 9 m for three stories in Huangcheng, an area of 6.8 km^2. Huangcheng areas contain the Forbidden City and Zhongnanhai that houses the office and residential buildings for the central government and officials. Maximum building height increases to 45 m for 15 stories around the second ring located about 3.5 km from Tiananmen Square, which is defined as the city center. It further increases to 60 m for 20 stories around the third ring of 7.5 km, and 80 m for 25 stories between the third and four rings. Also, there are locational variations of maximum building height to facilitate urban air circulation. Maximum building height is 45 m in the northwest, 60 m in the south, and 80 m in the east of Beijing, respectively.[7]

Li (1996) illustrates that the planned building height increases away from the city center – Tiananmen Square (Fig. 1). Prior to massive urban development in the first decade of the 21st century, the tall buildings are mostly concentrated in the third ring especially the east side of Beijing. Due to the building height restrictions, Beijing is one of very few cities around the world that have an inverse density curve in the central city (rising density with distance) and an inverted U-shape curve of urban density as a

[3] An example of building height restrictions is Washington, DC in which no building can be taller than the U.S. Capital. Other cities like Paris, Tokyo, Beijing, just name a few, have also adopted explicit building height restrictions.

[4] Arnott and MacKinnon (1977) use a general equilibrium model to estimate costs of residential building height restrictions and conclude that the costs are quite modest. Helsley and Strange (2008) argue that tall buildings facilitate both internal and external returns to scale and induce reputation effects.

[5] The reduced housing outputs in restricted areas are compensated by "extra land development at city edge so that there is not unmet housing demand". This is ensured by the condition specified in footnote 17.

[6] Chinese urban planners view high population density is associated with urban dis-amenities such as congestion, low living quality, and overloaded infrastructure. So they use building height restrictions to control population density and encourage development in suburbs. The positive aspects associated with high density are either overlooked or underappreciated. This is also reflected in the national urbanization strategy of "strictly controlling big cities, moderately developing medium-size cities, and actively promoting the development of small cities and towns" in 1980s and 1990s.

[7] Sources: http://news.xinhuanet.com/house/2006-11/06/content_5294623.htm, http://www.xinhuanet.com/chinanews/2005-12/15/content_5825054.htm, http://www.china.com.cn/chinese/2002/Nov/226892.htm.