



Disintegration of metro and land development in transition China: A dynamic analysis in Beijing

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ABSTRACT

The spatial disintegration of transit systems and land development is a vital challenge to the effectiveness of transit-oriented development policies. While transit land use integration and disintegration has received much research interest, conclusions remain mixed. This paper aims to clarify this area, using the large city of Beijing, China, as a case study. It evaluates whether and how Beijing's land and metro developments have disintegrated according to the basic principles of the Alonso-Muth-Mills model. A before-and-after approach is applied during a period of rapid transit development: 2008–2015. The results show that metro development, generally, was not clearly integrated with land use. Although newly transferred land parcels were geographically concentrated around metro stations, land use types and the degree of land intensification were unrelated to metro development; rather, the road system had a greater influence on these aspects. In addition, metro development led to more fragmented land use in the core areas (< 1.5 km) of metro stations than in the fringe areas (1.5–3 km away). This situation was mainly caused by institutional barriers to land-metro integration, such as revenue-oriented land development, the remaining centrally planned system of infrastructure investment, improper urban planning, and the fragmentation of development management that has occurred following China's political decentralization and marketization. Improving the integration of transit and land development will be difficult unless further reforms and institutional capacity-building are achieved.

1. Introduction

Transit development seems to be one of the driving forces of land development in urban areas (Cervero and Landis, 1997; Calvo et al., 2013; Cervero and Kang, 2011; Pan and Zhang, 2008). Transit development manifests its influence on land development through increases in land value, land use changes, land use intensification, etc. By improving an area's accessibility and bringing in more people, transit development increases and redistributes local land values. Good examples of this can be found in Buffalo, Seoul, Montreal and Beijing (Hess and Almeida, 2007; Cervero and Kang, 2011; Dubé et al., 2013; Zhang and Wang, 2013). Therefore, transit development often results in different levels of land use change and intensification towards more capital-intensive purposes (Bhattacharjee and Goetz, 2016; Cervero and Landis, 1997; Cervero and Kang, 2011; Ratner and Goetz, 2013).

The relationships between transit and land development can be classified according to their degree of integration. Some categories include transit-oriented development, joint development, adjacent development and separation development (Cervero et al., 2002). According to the classic rent-bid theory developed by Alonso (1964), Muth (1969) and Mills (1972), integration between

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transport and land use refers to the match between a location's transport accessibility and the land use at the location, including land use type and density. Greater transport accessibility results in higher land rents. Therefore, land at a location with good transit accessibility can be used for high-rent-producing purposes, for example, commercial and business use, and it can also have a high degree of land intensification. Contrarily, disintegration of transport and land use refers to the separation between transport and land use development.

A high level of integration of transit and land development is important for local urban development. Well-integrated transport land use makes transit-oriented development possible (Cervero and Duncan, 2002). Incremental increases in land value due to proximity to transit services is often captured by governments, developers or other stakeholders. The captured value is usually used for public revenue or further investment in public services, including the maintenance and improvement of existing transit services. For example, in Hong Kong, about 50% of day-to-day public transit operating costs is supported by revenue from property that is adjacent to the transit line (Hui et al., 2004). An appropriate level of transport land use integration creates more efficient land use patterns by attracting more capital-intensive, customer flow-requiring and traffic-dependent uses close to transit lines—such as retail, finance and consulting—due to land value increase. These businesses will attract people and promote other local services such as restaurants, cafes, hotels and property. In this way, transit can play a role in keeping residents and businesses in the urban centre and preventing urban sprawl (Cervero and Landis, 1997; Calvo et al., 2013). In addition, if combined with favourable environmental factors, transport land use integration can play a part in reducing car dependence and promote more efficient and environmentally friendly travel modes while increasing local customer patronage (Nasri and Zhang, 2014; Langlois et al., 2015; Ratner and Goetz, 2013). In other words, disintegration of transit development and land use can hinder sustainable urban growth (Cervero and Landis, 1997; Gu and Ye, 2007; Atkinson-Palombo and Kuby, 2011).

This paper aims to fill these research gaps using the city of Beijing, China, as a case study. It evaluates if and how metro development has fragmented from land development during the period 2008–2015, and it analyses what factors affected the degree of integration. Three important features of land use are examined in this study. They are the spatial distribution or location of the land parcels that were traded for development, the use or category of land, and land intensification. Land intensification is measured by floor-area ratio (FAR), which is the ratio of a building's total floor area to the area of the land on which it is built.

China's cities have been undergoing a process of rapid urbanization and transition since the 1990s. The populations in cities have increased by about 10 million per year. Both land use and transit development have changed at a rapid pace. These changes have occurred not only to the physical development of land use and transit systems, but also to the economic and institutional systems, on which the spatial relationships between land use and transit systems rely. Since the 1980s, China's cities have transitioned from a centrally planned system to a market system. Market factors have become the new forces determining urban development (Zhao, 2011; Zhao et al., 2009b) and transportation (Zhao, 2013a). Urban development management has become fragmented due to political decentralization and marketization. The separation in administration and responsibility between different government departments and agents has been increasing. This brings new challenges to the integration of transit development and land development in China's cities. Cases from China's cities are good examples with which to demonstrate clear and obvious changes in land use and transit systems, and the interactions between them. Therefore, this study can potentially enhance our understanding of the drivers of land-transit development and integration.

The rest of the article is organised as follows: Section 2 provides a literature review of the spatial relationships between transit development and land use and their influences; Section 3 introduces the methods—the city context, survey and data. Sections 4–6 present the analysis and results. Section 7 provides a discussion and policy implications, and Section 8 concludes the paper.

2. Literature review

The existing literature about land-transit disintegration can be classified into three categories: (1) studies of the effects of transit development on land use, (2) studies of the effects of land use on transit development, and (3) studies of the relationships between transit systems and land use.

What does disintegration between transit and land use mean? It can be understood theoretically by bid-rent theory. Classic bid-rent theory was developed by Alonso (1964), Muth (1969) and Mills (1972), and it is referred to as the Alonso-Muth-Mills (AMM) model. According to this model, transit systems increase the accessibility of a given location. Individuals or firms are more likely to make higher bids for accessible land, forming a bid-rent surface that peaks around transit stations and decreases with distance from them. It is only economical to use expensive land for capital-intensive uses, such as commercial and retail. Less capital-intensive uses, such as manufacturing and residential, tend to be located further away from stations. Land that is near a transit station should be developed at a relatively high density to cover the high rent. The closer to the station, the higher the density of land use becomes. The AMM model gives the basic principles for the integration between transit systems and land use: greater transit accessibility is associated with land use that has higher rent production and intensification. However, if greater transit accessibility is associated with land use that has less rent production and intensification, there is a disintegration between transit systems and land use.

Many studies have confirmed the influence of transit development on land use change. For example, Cervero and Landis (1997) found that a rail transit system accounted for the most growth in square footage near its stations, and that it was the greatest influence on the city of San Francisco being able to keep its businesses and shops in central areas. Generally, land parcels located close to metro stations have a high potential for development and commercial or other high-rent production uses. In a study of land use before and after Seoul's Bus Rapid Transit (BRT) system was built, researchers found that BRT improvements prompted property owners to convert single-family residences into multi-family units or apartments, or into residential and retail mixed use (Cervero and Kang, 2011). In a study of the Minneapolis Metro Blue line, Hurst and West (2014) found that after the metro went into operation, land

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