Transport Policy 51 (2016) 93–102

Contents lists available at ScienceDirect

Transport Policy

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

Density-oriented versus development-oriented transit investment: Decoding metro station location selection in Shenzhen

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ARTICLE INFO

Article history:
Received 1 July 2015
Received in revised form
5 April 2016
Accepted 8 April 2016
Available online 28 April 2016

Keywords:
Metro investment
Station location
Transit-oriented development
Shenzhen

ABSTRACT

The transit-oriented development literature has focused on the built environment around stations in operation, largely neglecting how the station location was selected. We hypothesize that city governments in China are likely to put stations outside established suburban centers. By putting metro stations at relatively underdeveloped places, city governments can lower right-of-way cost and gain more revenue from future land transactions. Using Shenzhen as a case study, we test this hypothesis with metro planning examples and land transaction data from 2000 to 2014. We found that metro alignment and station placement has bypassed the core of established communities. This planning practice is supported by a strong real estate market that appreciates transit accessibility, despite the high transit operation subsidy.

1. Introduction

The enormous cost involved in the establishment of a metro system (above and below ground rail guided urban transit network) justifies detailed planning, which includes route alignment and location of metro stations (Samanta and Jha, 2008). Many researchers have pointed to the relatively high density land use or high-priced properties that surround metro stations as positive impact of metro operation on land development (Dorantes et al., 2011; Hess and Almeida, 2007). Most literature on transit investment and transit-oriented development (TOD), however, has focused on describing the built environment surrounding stations, but not the potential siting that planners have considered. The existence of high-density development around metro stations could result from two different paths: either the station is built to serve pre-existing high-density areas or the station has attracted high-density (re)development. A better conception of these alternative development paths can help us to understand the characteristics of planning, design and operation associated with metro systems in different parts of the world, including those in China.

When stations are placed to serve pre-existing high density areas, the advantage is relatively high ridership, which helps to boost fare box revenue and reduce operational subsidy. One particular example is the American federal government's New Start program. In evaluating grant proposals from various locations, the Federal Transit Administration uses cost-effectiveness measures, such as the expenditure to produce one-hour travel time saving, as major project ranking criteria (FTA, 2012). Since fixed guide-way projects placed in relatively high density corridors can produce relatively robust ridership and thus more travel time savings, density-oriented transit planning is typically prioritized to receive federal grants. In contrast, places like Hong Kong have emphasized a development-oriented approach. New metro stations are placed at places where new town development is expected to happen (Lee and Leung, 1994). One particular concern underlying Hong Kong's approach is to support metro investment and operation with revenue from the real estate sector.

From the perspective of municipal finance, the choice between the density-oriented approach and the development-oriented approach is a tradeoff between land-sector revenue and fare-box revenue, which is strongly affected by the fiscal environment for metro investment. The American federal government which does not receive any direct revenue from land development around stations, has elected to prefer fare-box revenue to land-sector revenue. In contrast, the Hong Kong government, which owns the land and collects revenue from land development activities, has emphasized land development revenue. These two approaches can, of course, co-exist. For example, the US Federal Transit Administration's New Start program also examines land development

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http://dx.doi.org/10.1016/j.tranpol.2016.04.004
0967-070X/

potential around planned stations when ranking projects, albeit with a weight lower than the factor of ridership and time-saving. The development-oriented approach in Hong Kong also targets future high ridership, expecting that development around stations should catch up quickly, so that the subsidy required for metro operation will soon be reduced.

Observing how China's city governments fund metro projects, we hypothesize that the fiscal environment shapes the choice of Chinese local governments and the development-oriented approach is more likely to be emphasized.. First, unlike the US metro systems which are heavily subsidized by the federal government, metro construction and operation in China in general receives no funding from the central or provincial governments. City governments fund metro projects with general revenue sources or with bank loan guarantees for metro corporations. In addition, in contrast to USs private land ownership, China's city governments represent the national state in each city and claims significant benefit stemming from urban land development. A typical practice for city governments to raise revenue has been to transfer multi-decade land use rights to the private sector (Yang, 2006; Yang et al., 2007). Placing transit stations in undeveloped parcels is likely to raise significant revenue for the city government as property developers tend to bid higher prices for parcels closer to stations.

Furthermore, placing stations in a pre-existing high-density area not only implies high right-of-way-costs, but also a loss of opportunity to boost land-sector revenue (Yang, 2006). In developed areas, property value appreciation stemming from metro operations benefits the private sector more than the city government because China does not have an American-style property tax. Property value appreciation does not lead to an increase in property tax revenue. The lack of an annual property tax, therefore, discourages China's city governments from placing stations in pre-existing high-density areas.

This hypothesis is tested with a case study of metro planning, particularly metro station placement, in Shenzhen, the fifth city in mainland China to operate a metro system. By examining planned metro lines and those in operation, we will review how concern about land-sector revenue has affected project ranking, route design and station placement. By examining the price of transacted land parcels in relation to their distance to the nearest metro stations, we aim to find out whether station placement in general has bypassed community centers.

2. Funding metro in Shenzhen

Shenzhen is located on a southern tip of China's Guangdong Province and on the east bank of the Pearl River, neighboring Hong Kong. Occupying 1991 square kilometers, the city had a total registered population of 10.8 million in 2014. As China's first and one of the most successful special economic zones, Shenzhen has grown from a tiny border town into a modern metropolis with a gross foreign export value that ranks first among all Chinese cities. In 2014, Shenzhen's GDP had reached 1600 billion RMB (US$ 258.06 billion), fourth among all cities in China, making it one of the most developed cities in China and one of the fastest-growing cities in the world (SZGOV, 2014).

Similar to other megacities, traffic congestion raises the need for high capacity rapid transit systems. Following Beijing, Tianjin, Shanghai and Guangzhou, Shenzhen is the fifth mainland China's city to operate a metro system. Shenzhen's metro system was developed in three phrases (Fig. 1), with different funding arrangements for each phase (Table 1). In the first phase, the *Luobao Line* and the first part of the *Longhua Line* were planned in 1998 and began operation in 2004, with a length of 22 km and an investment of 11.5 billion RMB (US$ 1.85 billion). The city government funded 70% of the construction cost in cash and the remaining 30% through bank loans.

In the second phase, the network added three new lines (*Shekou Line, Longgang Line* and *Huanzhong Line*) and extended the existing *Luobao* and *Longhua Lines*. These lines were completed in 2011, with a total length of 142 km and a total investment of 68.8 billion RMB (US$ 11.10 billion). The proportion of the construction cost covered by Shenzhen government's general revenue shrunk from 70% to 50%. The remaining 50% was funded by Shenzhen

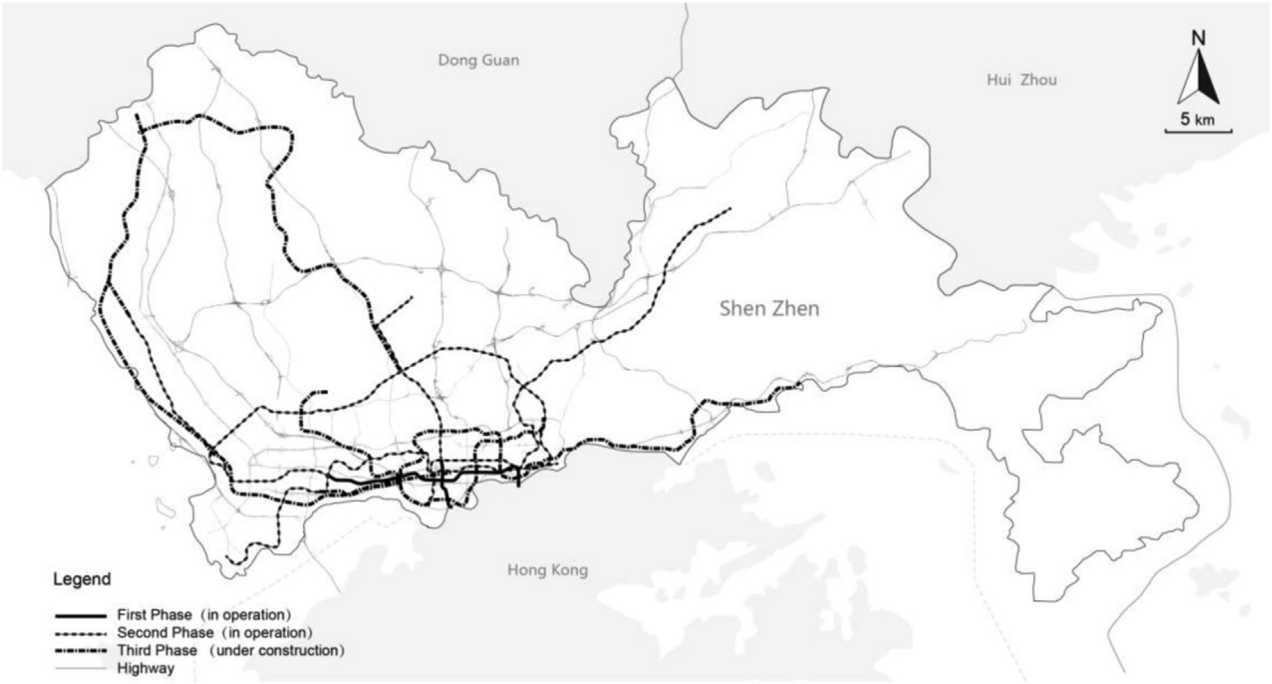

Fig. 1. Three Phases of Shenzhen Metro System.