

Developing Metro-based Accessibility:

Three Aspects of China's Rail+Property Practice

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ABSTRACT

Populous Chinese cities have invested heavily in metro systems and planned proactively for transit-oriented development. Rail plus property (R+P) programs, where metro corporations engage in, and even lead real estate development in or around rail station areas, have been recurrently reported among these cities. However, careful assessment of these programs is still rare in the existing literature. Built upon multiple R+P programs led by Shenzhen Metro Cooperation and/or Hong Kong Mass Transit Cooperation, this article fathoms the rationale for R+P programs in Mainland China, the obstacles for the private sector participation and the balance between profit making and social goods supply. It finds that R+P programs serve as alternative funding sources for expensive metro projects. It decreases municipal governments' cash flow contribution to those projects, which is mandated by the central government. In addition, local business environment for R+P projects has disadvantaged private sector participation. Furthermore, public subsidy to local metro corporations is likely to persist as R+P programs have not been designed for economic value maximization; rather, they are in place because (1) they reduce the cash flow burden of the municipal government; (2) they are tasked by the municipal government to produce a considerable number of affordable public housing.

KEYWORDS

Rail plus property, TOD, metro investment, China

1. Introduction

Metro investment and transit-oriented development (TOD) are key transport and land components for sustainable mobility in high-density cities around the world (Renne, 2016). East Asian cities such as Tokyo and Hong Kong have even encouraged direct participation of railway or metro corporations in real estate development, with an aim that real estate sector revenue, which is boosted by convenient access to metro services, can feed the funding needs for expensive metro capital projects and operational subsidy (Cervero and Murakami, 2009; Chang and Phang, 2017).

More than 30 cities in Mainland China have metro systems in operation, and the media have frequently reported rail plus property (R+P) efforts in those cities. Why are the R+P programs created in Chinese cities? Are those programs open to the private sector participation? Would those programs eliminate municipal subsidy for metro operation? Answers to those questions not only help us understand China's efforts towards metro-based accessible and greener cities but also provide valuable insights to other high-density cities whose ambition for metro systems is often compromised by their high price tag.

The above questions are intriguing for three reasons. First, Urban China may or may not need to have R+P programs for simple value capture purpose. Urban land in Chinese cities, which is legally owned by the state, is typically controlled by each municipal government. Local governments also manage land-use planning and the timing that they wish to release land to the market. This kind of local control gives Chinese municipal governments a "built in" value-capture mechanism that delivers huge amounts of revenue (Lin, 2007; Yang et al., 2007; Chang and Murakami, 2019). The municipal government could always garner a huge amount of up-front land lease revenue to fund the metro projects by placing a station in relatively under-developed land parcels (Yang et al., 2016a). We collected information on R+P programs in all Chinese cities with metro operation. We found that about two thirds of metro corporations in these cities have participated in real estate market. What is the rationale for those metro corporations to initiate the R+P programs given that they can potentially be funded by the government's huge amount of revenue from unprecedented land lease in recent years?

Second, the emergence of R+P programs in Mainland China is quite relevant to its counterparts in Hong Kong. It was firstly introduced in Shenzhen in 2011, Shenzhen Municipal Government viewed Hong Kong MTRC as a role model in R+P programs. The Chinese central government and Shenzhen Municipal Government have worked collaboratively to enable Hong Kong MTRC's direct business investment in Mainland China (Luan et al., 2014). However, since its first R+P project in Shenzhen, Hong Kong's MTRC's second project has not been reported, either in Shenzhen or in other Chinese cities. Is it because Mainland China's business environment of R+P projects too hostile for a private corporation like Hong Kong MTRC?

Third, despite the widespread of R+P programs in two thirds of Chinese cities with at least one metro line, none of the local metro operators, except for Shenzhen Metro, has claimed to be able to make profits. They still receive various funding and subsidy from the municipal government. By contrast, the Hong Kong MTRC is widely known for its operational efficiency and its profit-making capacity. Is it because metro corporations in Mainland China follow a business model that constrains their ability to make profit?

To answer the above questions, we examine in detail two sets of cases: 1) the P+R programs by Shenzhen Metro in Shenzhen, and 2) the P+R efforts by Hong Kong MTRC in Mainland China. Hong Kong MTRC is selected because it has been viewed as a role model in metro operation and R+P practice in China and beyond (Chang and Phang, 2017). It has successfully won contracts in quite a few Chinese cities to operate their respective metro line(s). It has successful and unsuccessful R+P experience in a couple of Chinese cities. Its performance in Mainland China serves as the reference for the business environment for the private sector participation in R+P projects (Question 1). Shenzhen Metro is selected as a representative of R+P leader in Mainland China. Its huge metro

investment and R+P project portfolio can help us understand the rationale for R+P programs in China (Question 2) and their various operational characteristics (Question 3).

2. Metro investment, TOD and R+P Model

Urban rail transit investment can increase land value by reducing residents' commuting costs, increasing accessibility and enhancing agglomeration benefits (Chatman and Noland, 2011). Several empirical studies in developed and developing countries have shown that metro investment has led to higher property values near stations, and real estate markets indeed capitalize the improved access to metro services (Cervero and Landis, 1993; Sharma and Newman, 2018; Yang et al., 2016b). Of course, this capitalization should be conditioned on some financial instruments that enable the expensive metro projects; otherwise, metro development would not happen (Wang et al., 2019). Transit oriented development (TOD), joint development and rail plus property programs not only help activities cluster around stations, but also serve as land value capture tools, which foster integration between land development and rail transit at the station level (Keefer, 1984; Renne, 2009; Geurs et al., 2010).

TOD is an integrated strategy for compact, mixed-use and pedestrian-friendly development connected to transit stations (Cervero, 2007; Hesse and Knowles, 2012; Lane, 2017). TOD generally contains multiple city blocks in a station area. Density and street layout within these blocks should have a station orientation, so that metro access benefit can be better utilized, which also naturally helps to sustain transit ridership (Lin et al., 2018; Wang et al., 2019).

Development projects within station areas may be carried out jointly by transit corporation, real estate developers and other relevant participants (Cervero et al., 2002). While TOD is typically planned by public agencies, many development projects have been carried out by public-private partnerships, which helps to create "win-win" outcomes for both private and public sectors (Mathur and Smith, 2013; Cervero, 1994). TOD implementation follows different procedures in different countries and regions. In Singapore, for example, the government has reserved land parcels for commercial purposes when rail transit was built. When market is mature enough for the development project, the land will be released for development by the private developers. The government can obtain the value increment out of the increased land transfer fee (Sharma and Newman, 2017; Sun et al., 2017). However, in this case, rail transit is built and financed with resources pooled by the government from various sources and no direct feedback exists between land value capture and rail transit investment.

The corresponding practice in Japan is titled "land readjustment". The rail company firstly obtains surrounding land parcels. It either purchases those parcels with a pre-rail-construction price from existing land owners or creates a partnership with those owners. The company then plans and integrates rail transit and land development (Suzuki et al., 2015). Under Japan's private ownership system of land, development is market-oriented. The private sector is usually highly proactive in promoting TOD, which can maximize profits.

Partially inspired by the Japanese experience, Hong Kong has created its own version of TOD and joint development, named as rail plus property (R+P) model (Murakami, 2012; Xue and Fang,

2015). R+P model places a financing arrangement on top of TOD planning (Xue and Fang, 2015). While TOD emphasizes clustered development around transit stations, the R+P model further expects a joint development of transit infrastructure and real estate led by the metro operator. The R+P model typically features an integration of financing, construction and operations. Hong Kong MTRC acquires the right to develop land around or above the stations at the pre-rail-construction market price. Then it sells or leases the completed development projects with the post-rail-construction market price (Cervero and Murakami, 2009; Suzuki et al., 2015). Due to accessibility and agglomeration benefits brought by railway projects, Hong Kong MTRC can capture the land value increment (Chang and Phang, 2017). And this increment and its derivatives are used to pay for the costs of metro construction and operation (Lin et al., 2008).

R+P programs produce various benefits for the metro corporation and the city it serves. They increase ridership and property prices. An R+P station with transit-oriented design on average attracts 35,000 additional weekday passengers. It has housing price premiums in the range of 5 to 30 percent (Cervero and Murakami, 2009). Apart from the tangible economic benefits for the corporation, R+P programs bring about urban benefits such as compact urban form, high population density and efficient transport (Sharma and Newman, 2017). R+P programs effectively shape the urban structure through high-density development along metro corridors, which in turn contribute to the sustainable development of the city in question. In Hong Kong, accessibility provided by metro services has attracted people to live close to metro stations. As of 2002, 41% of the Hong Kong population lived in the catchment area (500 meters) of metro stations (Tang et al., 2004).

Factors that make R+P programs successful are place/context specific. In Hong Kong, the R+P model's success lies in Hong Kong's unique conditions, which are characterized by four main elements: a large ridership, a regime of public ownership of land, a booming real estate market and Hong Kong MTRC's mature experience in urban planning and integration of rail and property development (Aveline-Dubach and Blandeau, 2019). Hong Kong's MTRC excels in aligning its institutional role with its objectives, tasks, requirements and decision-making environment (Tang et al., 2004). In Shenzhen, the successful implementation of R+P depends not only on the booming local/national real estate markets but also on strong political will of aggressive and powerful government leaders, relatively mature capital markets and the ability of the active private sector—but there was still the need for legal, regulatory and institutional reforms to achieve more effective R+P programs at the national and municipal levels (Xue and Fang, 2015).

The R+P practice has been promoted in developing countries to pursue sustainable urbanization (Bon, 2015; De Jong et al., 2010). Cervero contends that R+P is well suited for financing rail infrastructure and advancing TOD in the rapidly growing cities in Mainland China (Cervero and Murakami, 2009). Most of the existing literature on the R+P model, however, has focused on cases in Hong Kong. R+P cases outside Hong Kong have rarely been studied. In fact, Hong Kong MTRC has tried to implement R+P projects with several local governments in Mainland China but most of the efforts did not prevail. So far, there is only one completed R+P project entitled “Tiran” developed by Hong Kong MTRC in Mainland China. Aveline-Dubach and Blandeau (2019) argued that it remained to be seen whether the R+P model implemented by Hong Kong MTRC can

be duplicated in Mainland China. Nevertheless, metro companies in Shenzhen, Guangzhou and other Chinese cities were frequently reported to initiate their own version of R+P projects. Why were these projects initiated in Mainland China? Why was it difficult for Hong Kong MTRC to expand its R+P model there? What are the differences between the Hong Kong MTRC's R+P model and those adapted by Mainland China cities? To answer these questions, we assess multiple R+P programs led by Shenzhen Metro Cooperation and/or Hong Kong Mass Transit Cooperation.

3. Case selection

Shenzhen is located at Guangdong Province and is one of the four first-tier cities in China that is known for innovation and related R&D activities. Being a neighbor of Hong Kong, Shenzhen was chosen to become a Special Economic Zones (SEZ) in the late 1970s. Hong Kong is a Special Administrative Region (SAR) of China since 1997 and was once a colony of the Great Britain. Hong Kong is one of the most internationalized and developed cities in Asia and one of the most densely populated places in the world. Nowadays, both Shenzhen and Hong Kong face severe land supply constraints and are highly dense. Their vitality and sustainability depend on a strong metro system.

Shenzhen Metro was established by Shenzhen Municipal Government on July 31, 1998. In Hong Kong, railway lines are built and operated by the Mass Transit Railway Corporation Limited (Hong Kong MTRC). Both Shenzhen Metro and Hong Kong MTRC implement R+P programs in China. They are selected for two major reasons.

First, both Hong Kong MTRC and Shenzhen Metro are among the top metro operators in China and their R+P project experience can be used as a reference for other metro companies. Shenzhen Metro has established a system of rail construction, rail operation, property development and asset management. In 2018, its annual operating income was RMB 11.1 billion and the net profit was 7 billion yuan. As an R+P practitioner, Shenzhen Metro in 2018 was the second largest real estate developer in Shenzhen in terms of development capability. It was also recognized as “Shenzhen Real Estate Social Responsibility Benchmarking Enterprise” for its involvement in social housing and related activities (Shenzhen Metro, 2019).

Hong Kong MTRC is one of the few profitable rail transit companies year after year in the world. Its annual passenger volume reached 2.04 billion in December 2018. As a metro operator, Hong Kong MTRC has achieved a punctuality rate of 99.9% for 10 consecutive years. Hong Kong MTRC has implemented the R+P model extensively in Hong Kong and has exported this model in several other foreign cities. As of 2016, Hong Kong MTRC owned buildings over about half of the system's 87 stations, amounting to 13 million square meters of floor area (Leong, 2016). In the past ten years, Hong Kong MTRC has actively expanded its international and Mainland China businesses. It has obtained railway operation franchises in Mainland China, the UK, Sweden, Australia and Macau (Hong Kong MTRC, 2019).

Second, the experience in Shenzhen Metro and Hong Kong MTRC can help understand the business environment for R+P projects from different angles. Shenzhen Metro is a state-owned enterprise funded by Shenzhen Municipal Government. Shenzhen's experience can help understand the rationale of the municipal government in Mainland China to promote R+P projects. Hong Kong MTRC is an oversea private enterprise from the perspective of the municipal government in Mainland China. Its experience in different cities in Mainland China can help understand the

business environment for the private sector's participation in urban metro development, which has been promoted by the Chinese central government.

Our review of R+P cases led by Shenzhen Metro and Hong Kong MTRC suggests the following: (1) R+P programs were initiated and replicated to relieve fiscal pressure of the municipal government across Chinese cities; (2) state-owned enterprises have overwhelming advantage over the private sector in those programs; (3) subsidy for metro corporations from the municipal government will be likely to continue as the purpose of R+P projects in Mainland China is not to eliminate operational subsidy.

4. Three aspects of China's practice in R+P programs

4.1. Rationale for R+P programs in Shenzhen

The introduction of R+P programs in Shenzhen appears to be motivated by a desire to mobilize more resources for metro investment. As of 2019, Shenzhen Metro had 14 R+P Projects. Upon completion, those projects will add up to a total floor area of 4.5 million square meters. The floor area under construction was 3.3 million square meters. They were located on top of train depots or around metro stations. Shenzhen Metro has partnered with real estate developers to work on those projects. Those projects were in general of mixed development, including retail, office and housing. Housing units in five of those projects mainly serve the municipal government's public housing programs.

R+P programs did not exist from the beginning in Shenzhen. When Shenzhen began to make plans for a metro system in 1996, it wished to have nine metro lines. The alignment and siting of the metro lines and stations were mainly based on the criteria such as engineering feasibility and cost control. Metro development was not closely coordinated with land development. When the first 22 km track was constructed, Shenzhen Metro received a cash grant from the municipal government's general revenue, which is 70% of the total investment. The remaining 30% came from a bank loan, which Shenzhen Municipal Government was the guarantor of credit.

In 2005, the Chinese central government announced a transit-priority strategy to be adopted by all Mainland China cities. Consequently, TOD emerged as a popular concept in the country's urban development and was expected to produce more than just transport benefits. In practice, TOD has also been used as a value capture tool by different municipal governments in Mainland China. With land parcels around metro stations owned by municipal governments, the greater the value appreciation from metro investment, the higher the land lease revenue for the municipal government. Metro planning practice in Mainland China tends to place a number of stations in under-developed land parcels (Yang et al., 2016a). Since the metro system is funded by the municipal government, a value capture mechanism therefore is embedded in the public land ownership.

This value capture mechanism not only has its impacts on station placement, but also on development density in station areas. In Shenzhen and many other Chinese cities, the same land parcel can receive a higher amount of land sale proceeds if the maximum allowable floor area is higher. As a result, development density bonuses have been typically granted to land parcels in or

around station areas. In Shenzhen, land parcels in a station area can receive a density bonus ranging from 20%-80% of the baseline density specified in the existing land use planning. Land lease revenue received by the municipal government, however, is not guaranteed for metro investment and operation. It is subject to the competition from other sectors such as education and social services. In addition, a significant time gap exists between the expenditure for metro construction and the collection of land lease revenue for land parcels in or around station area. There is no guarantee that land lease revenue becomes instantly available for metro projects when metro construction begins. Furthermore, the Chinese central government mandates an upper limit of 60% debt ratio for metro capital projects, which imposes significant fiscal pressure on the municipal government.

R+P programs were thus passively introduced by the municipal government as a remedy to meet the mandate. It enables the municipal government to replace cash contribution with land contribution and also makes the funding available before the engineering work begins. Hong Kong MTRC's involvement in Shenzhen's Line 4 was a pilot project (Luan et al., 2014). The sale of land development right to Hong Kong MTRC enabled the city government to lower down its cash contribution. Following that, in the third and fourth phases of Shenzhen's metro development, the municipal government has eliminated cash contribution need completely by transferring land development right to Shenzhen Metro, who in turn used the development right to leverage bank loan and to carry forward capital projects.

Table 1

Phases of Metro Development in Shenzhen

Phase	First	Second	Third	Fourth
Track length	22 km	157 km	255km	148.9km
Investment amount (RMB)	12.04 billion	78.37 billion	160.56 billion	134.53 billion
Government financing model	Government contribution:70% (Cash)	Government contribution: 50% (Cash)	Government contribution: 50% (Land)	Government contribution: 50% (Land)
	Enterprise finance:30%	Enterprises finance: 50%	Enterprises finance: 50%	Enterprises finance: 50%
Integration with land development	Rail separated from land	Transit-oriented development	Practice of R+P	Practice of R+P

1 USD = 7.1709 RMB in September 2019

Note that R+P is not encouraged by the municipal government alone. Shenzhen Metro also like this approach as it is eager to get involved in the booming real estate market. R+P programs enable the metro corporation to work as the developer for real estate projects on top of the stations, over the train depot, or in proximity to a station exit. As those projects are well designed and integrated

with the metro infrastructure, the revenue from property sales is quite attractive. It raises the possibility for the metro corporation to get rid of its reliance on governmental subsidy and even become a profit-making entity¹.

Other cities in China and Shenzhen share the similar institutional and fiscal environment. The central government requires that the municipal government's monetary contribution in metro capital projects should be higher than 40% of the total costs and by no means should use any debt to finance that contribution. In 2018, following central government's above requirement, a few metro projects that did not meet this debt ratio requirement have been suspended (General Office of the State Council, 2018). With successful R+P projects, the municipal government can potentially fulfill this requirement by replacing this 40% cash contribution with land parcels of equivalent or higher amount of value.

This arrangement of R+P as an alternative financing venue for public transport has also been observed in cities other than Shenzhen, with varying implementation characteristics (Li et al., 2013; Tian, 2006; Zhang and Wang, 2013). For example, Shanghai and Dongguan have different approaches when transferring land development right to the metro corporations (Yang et al., 2019). When this approach is used to fund inter-city rail network in Guangdong Province, it involves not only municipal governments, but also a partnership between the province government and relevant city governments (Li et al., 2013). Regardless of these differences, they appear to share the same motivation, i.e., to fund expensive metro projects and operation by enhancing the connection between transit accessibility and land development, which can maximize revenues from land/property sales or lease.

4.2. Environment for private sector participation in Mainland China

The fiscal pressure stemming from expensive metro projects can be relieved if metro projects are funded under a public-private partnership. As an incentive for the private sector participation, the requirement of 60% as the upper limit for debt ratio can be waived if a metro project is funded by non-government entities, which include domestic private corporations and overseas corporations like Hong Kong MTRC. Hong Kong MTRC's involvement in Beijing, Shenzhen and Hangzhou should have to some extent benefited from this policy. So far, metro lines operated by Hong Kong MTRC or its joint ventures with the local metro corporations include altogether 6 metro lines in Shenzhen (1), Hangzhou (1), and Beijing (4).

¹ The possibility of reducing operational subsidy should also be desired by the municipal government, even though it may not be the initial purpose to introduce the R+P projects. Except for a few metro lines, such as Line 4 in Beijing, few metro lines in Mainland China can claim to have earned operational profit. Most municipal governments must cover the big amount of annual operational deficit. The fiscal capacity of the municipal government, therefore, has been used by the central government as a major criterion for approval a metro project at the municipal level. The newest central government's related regulations, which were published in 2018, require that the municipal government which want to build a brand new metro system should have an annual revenue of at least 30 billion RMB.

Hong Kong MTRC has tried to add real estate components on top of metro projects, but with limited success. In Table 2, we compiled Hong Kong MTRC's R+P attempts in Mainland China according to our best knowledge. Within Shenzhen, Hong Kong MTRC has successfully worked with the Shenzhen Municipal Government on metro Line 4 and associated Tiara project, which is a real estate project on top of the train depot for Line 4 (Luan et al., 2014). This project follows a BOT model. Hong Kong MTRC built the metro line and received a 30 years' franchise to operate it. Following that, Hong Kong MTRC has tried to replicate the Line 4 project in the development of metro Line 6. A memo of understanding was signed, with an intention that Hong Kong MTRC would collaborate with Shenzhen Metro on Line 6 and associated R+P components. But Hong Kong MTRC eventually withdrew from this memo. Shenzhen Metro carried forward the whole project afterwards. Hong Kong MTRC has also explored R+P opportunities in Shenyang, Tianjin, Beijing, Chengdu, and Hangzhou. None of them prevailed.

Another R+P project of Hong Kong MTRC in Tianjin reached a formal contract, which was eventually foregone and discontinued by both signees: Hong Kong MTRC and Tianjin Municipal Government. The Tianjin case to a large extent illustrates how Hong Kong MTRC had actively explored R+P programs beyond Shenzhen. In August 2013, Hong Kong MTRC and Tianjin Railway, a state-owned enterprise of Tianjin Municipal Government, set up a Special Purpose Venture (SPV) "Tianjin City Railway Port Construction Co., Ltd", which obtained the land development right at North Canal Station, which is one of Tianjin's Metro Line 6's stations. The SPV paid land lease fee in November 2013. The total land area is about 66,900 square meters. In March 2017, MTRC however sold its share in this SPV (49%) to Shouchuang Real Estate Co., Ltd, a big land developer in China. About one year later, Hong Kong MTRC signed an agreement to operate a new shopping mall developed by the SPV at the North Canal Station on January 26, 2018. In this case of Tianjin, therefore, Hong Kong MTRC began its role as a potential R+P developer, but ended up as a property manager only.

The Tianjin case should not be interpreted as Hong Kong MTRC's preference of property management over property development, even though Hong Kong MTRC has indeed reduced land development activities in Hong Kong and began to undertake more tasks of property management there (Aveline-Dubach and Blandeau, 2019). Instead, the decision was mainly driven by a concern on overall profitability of R+P projects. Hong Kong MTRC's internal estimation showed that the forecasted future of the real estate market in Tianjin/Mainland China was not strong enough to guarantee profit (Hong Kong MTRC, 2017). The new arrangement could reduce financial risks and increase profit margins when it was only involved in managing new properties in station areas.

The Tianjin case is not unique. Earlier than that, in 2009, Hong Kong MTRC signed a franchise agreement with Shenyang Municipal Government on the construction and operation of Shenyang's Metro Lines 1 and 2. This agreement has a real estate component, which is a property development project in Shenyang's Golden Gallery area. But this agreement was not materialized for a similar concern on R+P projects' profitability. The government leaders in Shenyang changed, and the new leaders were unwilling to provide the amount of subsidy required by Hong Kong MTRC in the agreement (Chi, 2013).

Table 2
Hong Kong MTRC R+P efforts in Chinese Cities

Year	Nature of contract	Real estate component	Floor area (m ²)	Current status
2009	Development agreement	Along Shenyang Metro Lines 1 and 2	-	Discontinued
2011	Formal contract	Tiara project on the depot of metro Line 4	About 206,167	Completed
2013	Formal contract	Development around North Canal Station of Tianjin Line 6	About 60,000	Discontinued
2017	Letter of Intent	Development along Beijing's Daxing Line North Extension and Nanzhao Depot	-	No progress
2018	Memorandum of understanding	Development along Chengdu Metro	-	No progress
2018	Memorandum of understanding	Development at Hangzhou West Station	-	No progress

Note that, all those projects forgone by Hong Kong MTRC were eventually carried forward by the local metro corporations. Why were those financially infeasible projects deemed by Hong Kong MTRC acceptable to respective local metro corporations? One may guess that SOEs might have higher performance than the private sector. However, this is unlikely to be the case. In Shenzhen, for example, it was analyzed that Hong Kong MTRC's performance in operating Metro Line 4 is much more cost-effective than other metro lines operated by Shenzhen Metro (Yang, et al, 2014). Metro Line 4 in Beijing, which is also operated by Hong Kong MTRC, is one of the few examples of metro lines in Mainland China with operational profit.

When Hong Kong MTRC's negotiation regarding an R+P project with a municipal government proceeds smoothly, the corresponding local metro corporation should be a potential business partner for Hong Kong MTRC in the eyes of the municipal government. However, this corporation becomes an alternative to Hong Kong MTRC when the government leader worries that Hong Kong MTRC has asked for too much. Unfortunately, Hong Kong MTRC more often than not tends to ask for too much according to the local government leader, who often mentioned that Hong Kong MTRC was unwilling to take necessary risk in exchange of higher profitability² (Based on conversation with a chairman of Shenzhen Metro Vanke Investment Development Co., Ltd.). Then why was the local metro corporation always willing to take the risk?

To Hong Kong MTRC, the key question for an R+P project's feasibility in Mainland China lies in how much land it will receive from a municipal government. This is a perfect example of imperfect information. While the cost of the engineering part is difficult to estimate, it can still be

² The expected rate of return could be another variable. However, R+P projects are similar to public infrastructure projects and the developers are expected to earn a return similar to a typical infrastructure project. When the rate of return is expected to be fixed, how different risks, i.e., perceived costs and benefits and associated uncertainties, is managed become the key variable.

done with a certain mutually acceptable benchmark. The profit margin from the real estate market is much more difficult to estimate. Combining these two items together add another layer of complicacy to an R+P project. Hong Kong MTRC, listed in the Hong Kong Stock and Security Market (HKSSM), has to be more conservative in risk control as compared to a local metro cooperation in Mainland China. The latter is not subject to any HKSSM regulations and scrutiny like the former and can even seek financial assistance from the local municipal government if needed. Not having the same advantage as a local metro cooperation in Mainland China, therefore, Hong Kong MTRC tends to ask for a higher amount of land than the former to reduce the odds of business loss. The municipal government leader is very sensitive about this request of Hong Kong MTRC: too much land for Hong Kong MTRC might incur question on rent seeking and endangers their career. By contrast, negotiating and adjusting an R+P project deal with a local metro corporation is much more flexible. Such a cooperation is owned by the municipal government and is willing to carry forward the project even if its internal estimates point to insolvency. In the middle of the project, the corporation also has the opportunity and avenue to renegotiate the deal with the municipal government should up to date information on project cost and revenue becomes available. Other SOEs like the corporation, which engage in urban infrastructure projects, have similar flexibility.

In case the real estate price increase faster than expectation and the real estate component of the metro corporation becomes too profitable, the city government can classify and take back a portion of the developed housing units as public housing, and thus reduce the profit margin of the real estate component. This practice will be detailed in section 4.3. This flexibility would hardly be possible if Hong Kong MTRC carries an R+P project. Of course, such situations may also engender issues of accountability and transparency (Wang et al., 2017; De Jong et al., 2010). They had also more or less put Hong Kong MTRC or any other non-SOE entities to a disadvantaged position when competing for an R+P project in Mainland China.

The aforementioned risk faced by Hong Kong MTRC can also be observed in Shenzhen, where exists Hong Kong MTRC's only successful P+R project in Mainland China. In 2005, its initial agreement with Shenzhen Municipal Government includes 80 hectares of land along Line 4. When the project was finally approved by the Chinese central government in 2009, the real estate component has been downsized to the Tiara project, which has a land area of 89,400 sq meters only, 28% of what was initially asked by Hong Kong MTRC. When the negotiation on Line 6 began, Shenzhen Municipal Government has favored its own SOE—Shenzhen Metro. Among the 35 Mainland cities with metro in operation as of 2019, over 20 of them have reportedly implemented R+P projects or their variants, all with the local SOE as the sole developer.

The above-mentioned possibility of contract renegotiation, which has been initiated by the municipal government, has also happened to Hong Kong MTRC in Beijing. Metro Line 4 in Beijing is operated by a joint venture, 49% of which is owned by Hong Kong MTRC and 51% by two SOEs in Beijing. The operational subsidy specified in the contract was renegotiated when the ridership increases faster than the expectation (Change 2013). While this is a metro operation only contract, any renegotiation of an R+P contract would involve more efforts and introduce more uncertainties, as the contract covers not only metro operation but also real estate businesses.

One may guess that SOEs might have higher performance than the private sector. However, this is unlikely to be the case. In Shenzhen, for example, Hong Kong MTRC's performance in

operating Metro Line 4 is much more cost-effective than other metro lines operated by Shenzhen Metro (Yang, et al, 2014). Metro Line 4 in Beijing, which is also operated by Hong Kong MTRC, is one of the few examples of metro lines in Mainland China with operational profits.

Note that Shenzhen is among the first four cities open to foreign direct investment. It is among the most business-friendly Chinese cities, if it were not the top one. This helps to explain why Hong Kong MTRC has its only R+P projects in Shenzhen, not in other cities. If Shenzhen has difficulties in working with the private sector and oversea investors, the other cities in China are likely to have the similar amount of and even more difficulties.

4.3. Profitability and Public Housing

Metro investment in Chinese cities is expected to help increase transit ridership and lower congestion and emissions. Metro/Transit fares are purposefully set low to attract riders. Subsequently, municipal governments then have to subsidize the deficit in metro/transit operation. In contrast to the public interest carried by transit services, real estate development in general is profit oriented. The rapid economic development and household income growth in the past two decades have cultivated lucrative real estate businesses in Chinese cities. In theory, it is likely that R+P programs can generate at least some revenue to cross-subsidize transit/metro operation. In practice, is the cross-subsidization big enough to make the metro corporation financially viable? Would the lucrative real estate business help metro corporations make a big profit?

So far, among all metro corporations in Mainland China, Shenzhen Metro is the only one claiming to make a profit, partially due to its successful R+P programs. This makes it an exemplar for those who want to use R+P programs to generate revenue to cross-subsidize transit operation. In 2016, Shenzhen Metro's total gross revenue reached RMB 12.5 billion, and its profit reached RMB 40 million. In 2017, its total gross revenue exceeded RMB 14 billion and its net profit reached 6.6 billion (Shenzhen Metro, 2018). In terms of net profit and total gross revenue, Shenzhen Metro has a very impressive growth rate. In terms of revenue composition, transport operation accounts for 25% and about 65% is revenue from property development³. The profit margin of rail operation for Shenzhen Metro is -35% and property development is 63%. Rail operation is obviously money losing and is subsidized. The reported profit for Shenzhen Metro indeed relies on a strong real estate sector.

Metro corporations in other Chinese cities still rely on municipal subsidy for metro operation. While they could make a profit in the future, the Shenzhen case suggests that the profit is unlikely to be big. As mentioned in section 4.1, R+P programs in Mainland China were introduced to reduce municipal cash contribution, which was mandated by the Chinese central government. A further examination of several real-world R+P programs suggests that they were not designed for profit

³ As a comparison, Hong Kong MTRC's revenue composition is significantly different. Transport operation accounts for 30% and property development accounts for about 50%. The contribution from the real estate sector is lower than that in Shenzhen. The profit margin is 9.1% for transit operation and 80% for property development, suggesting that Shenzhen Metro is less effective in generating profit.

maximization. In Shenzhen, public housing was added to ensure that Shenzhen Metro would only make limited profits. Table 3 lists all real estate projects carried out by Shenzhen Metro.

Table 3

Real estate projects by Shenzhen Metro (until 2019)

Plot	Land area (hectare)	Floor area (thousand sq meters)	Land value (billion yuan)	With public housing	Project name
Tanglang Depot	4.36	261.5	2.10	Yes	Langlu home
Tanglang Depot	4.3	200	-	Yes	Nanhua Cuifu
Qianhai Depot	33.72	807.9	0.77	Yes	Qianhai era
Shekou West Depot	6.37	110.3	0.77	Yes	Longrui Home
Shenzhen university Station	0.98	97.8	0.72	No	Technology Building
Qianhai hub	20.01	1,330.1	14.56	Yes	Qianhai hub
Henggang Depot	14.62	322	1.18	Yes	Jingshang Garden
Hongshu wan Station	6.83	452	6.72	No	Shenzhen wan Huiyun center
Chegong miao Depot	-	1530	-	No	Shenzhen Metro Real Estate Building
Chegong miao Hub	0.66	115.8	2.09	No	Huitong Building
Shenzhen North Station	3.96	315.9	3.02	No	Huilong Business Center Huide Building Project
Anto Hill Parking Lot	13.55	533.4	9.19	No	Shenzhen Metro Yi House
Tanglang F Block	4.28	127.7	1.87	No	Tanglang City

Among the 13 projects, six of them include public housing. Those housing units were built on top of train depots or in station areas. Shenzhen Metro was required to build those housing units on behalf of the Shenzhen Municipal Government, which only paid Shenzhen Metro for the engineering cost of metro construction. The latter had to use its revenue from real-estate businesses to cover the remaining costs of R+P projects. So far, Shenzhen Metro has built more than 22,000 units of municipally owned apartments, with a total floor area of 1.85 million square meters

(Shenzhen Metro, 2019). The municipal government then rent those apartments to the working-class households who met certain criteria. For those projects with public housing, the exact percentage of the total floor area for public housing varies among different projects. Langlu Home, which is on top of the train depot of Metro Line 4, was entirely devoted to public housing. Longrui Home, which is on top of the train depot of Metro Line 2, was mixed with public housing, offices, retail space and market-priced housing. While all items except for public housing are money-making, the whole project has an estimated margin of only 6% (Zhang and Yang, 2009).

For a given project, that percentage could even change over the course of project development. For example, Langlu Home includes a few mid-rise buildings and three high-rise buildings. While the mid-rise buildings were classified as public housing in the beginning. The three high-rise buildings were not clearly classified then. They could be sold on the market. As the engineering work approached to the end, the government eventually decided to make Langlu Home 100% public housing. Changes of this kind not only help the municipal government to provide more public housing, but also helps it adjust the profit margin of Shenzhen Metro.

With a significant percentage of developable floor area devoted to public housing, metro corporations' odds of making a profit depends heavily on high profitability of the real estate market. Shenzhen Metro appears to be luckier than its counterparts in other cities in this regards. The reported profit of Shenzhen Metro is highly correlated to the local real estate market's higher profit margin than elsewhere. From 2015 to 2018, the median housing price per sq meter has more than doubled in Shenzhen. It increased much faster in Shenzhen than in Guangzhou, Shanghai and Beijing, the other three first-tier cities in Mainland China. Without such rapid price spike, Shenzhen Metro might also be money-losing.

Of course, it is questionable to expect metro corporations to make a profit in the Chinese context. Metro corporations should carry the public interests in urban passenger mobility and are not expected to make big profit in the real estate market. If the pressure for public housing is moderate, the city government may be more conservative when transferring land development right to the metro corporation.

Besides the social goods such as increased supply of public housing and reduced traffic congestion mentioned above, environment benefits of metro investment are also not well captured in the balance sheet of metro corporations. The traffic problems in China's big cities are still deteriorating. Automobile emissions account for an increased proportion of total air pollutants and carbon emissions in these cities. The Copenhagen Climate Conference clearly calls for reduction in urban carbon emissions, green transportation concepts and low-carbon travel policies. Chinese municipal governments' promotion of metro investment and R+P are aligned with those concepts and policies. They spend substantially on building/upgrading transit/metro systems, promoting public transit ridership by low fares, and placing high density commercial, residential, office, and various activity nodes around metro/transit stations. To most people, such accessibility-based urban development patterns always warrant governments' policy support and even fiscal subsidy.

5. Conclusions

To combat increased automobile ownership and traffic congestion, many Chinese cities have adopted a "transit metropolis" strategy, which pools resources and expertise across different

governmental units to systematically promotes transit services and TOD (Zhou, 2016). As a value-capture strategy, R+P model introduces a feedback mechanism, enabling a direct linkage between rail transit expenditure and value increment brought by accessibility improvement stemming from transit services. The rise of R+P programs in populous Chinese cities reflects the need for a value capture mechanism to fund metro development, which has become increasingly costly.

Shenzhen's experience with R+P programs shows how the infrastructure development, land/housing development and finance sectors can work together to create more social goods. While the transport and environment impacts of metro investment are already well understood, the relevant financing approach requires a bit more investigation. From the government perspective, it is a tradeoff between land contribution and cash contribution. The Chinese central government and province governments seldom directly fund metro projects. In most cases, municipal governments must find sources of funding for those projects. By default, municipal governments should fund at least 40% of metro project cost with cash flows from its general revenue according to the mandate of the Chinese central government. The expensive metro projects therefore pose serious fiscal challenges for most municipal governments. However, the public land ownership in China enables municipal governments to replace that cash contribution with leases of land development right. The same right can then be used by buyers (usually the local metro cooperation and its business partners) to leverage bank loans, which fund the capital cost of metro construction and the associated real estate projects.

Thanks to the Chinese central government's encouragement for the private sector participation in metro construction and operation, Hong Kong MTRC, as arguably the only oversea metro company active in Mainland China, has engaged in quite a few Chinese cities' metro construction and operation. Its capacity and efforts to promote R+P, however, appear much less appreciated by corresponding municipal governments. We find that state-owned metro companies have overwhelming advantages over this competitor. This situation, according to our investigation, is largely due to Hong Kong MTRC's approach to risk management, which differs significantly from that of SOEs, including local metro corporations like Shenzhen Metro. Having local governments as their backup, SOEs are always ready to take bigger risk at the beginning and renegotiate with municipal government amid of R+P projects. As subordinates of the local government, they also have more internal contacts and avenues to reach local government's leaders. All the above are hardly available to Hong Kong MTRC.

Equally important, local metro corporations are not under the market pressure to gain profits, at least for the initial construction of the local metro network. This has enabled Shenzhen Metro to assume a new role assigned by the Shenzhen Municipal Government: a provider of public housing. Operational subsidies for China's metro companies therefore are likely to persist for the foreseeable future. At least in Shenzhen, R+P projects are not designed to maximize profits. Metro corporations' R+R projects, nevertheless, could still make "windfall" profits when local real estate market experience unexpected growth.

The R+P model in China still deals with real estate market uncertainties and political risks (Xue and Fang, 2015). One would not expect the R+P model to be a panacea for all the efficiency and subsidy issues faced by local metro corporations, which have been widely discussed (e.g., see Yang et al., 2018). The model's significance for the urban society should be assessed not only on or

against various criteria or benchmarks concerning infrastructure/metro finance, but also on its contributions to environment sustainability and social (in)equity stemming from metro-based accessibility.

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