Funding Sustainable Cities in China

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DOI
10.4233/uuid:b6eebef5-f519-4921-9d55-54c85aff3992

Publication date
2018

Document Version
Final published version

Citation (APA)
Zhan, C. (2018). *Funding Sustainable Cities in China*. [Dissertation (TU Delft), Delft University of Technology]. https://doi.org/10.4233/uuid:b6eebef5-f519-4921-9d55-54c85aff3992

Funding Sustainable Cities in China

FUNDING SUSTAINABLE CITIES IN CHINA

Proefschrift

ter verkrijging van de graad van doctor
aan de Technische Universiteit Delft,
op gezag van de Rector Magnificus Prof.dr.ir. T.H.J.J. van der Hagen;
voorzitter van het College voor Promoties,
in het openbaar te verdedigen op
donderdag 22 februari 2018 om 12:30 uur
door

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ISBN 978-94-6186-897-8

This research was funded by the China Scholarship Council and Delft University of Technology.

Delft, the Netherlands

Cover picture designed by Y. Wei

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Acknowledgements

It is a much-awaited moment for me to write this part because it means that I am going to arrive the destination of my Ph.D. journey and will start a new adventure soon. I would like to take this opportunity to thank my supervisors, friends, and family.

My heartfelt gratitude first goes to Professor Martin de Jong for his dedicated effort and patience in guiding my dissertation. His vast knowledge in developing sustainable cities significantly contributed to improving the quality of this work. He is such a kind and easy-going person that we forged our solid relationship, as a professor-Ph.D. candidate relationship and as a friendship.

I appreciate Professor Hans de Bruijn very much for his constructive comments on how to improve my dissertation. It was so enjoyable to discuss with him. His holistic view contributed to a more transparent dissertation structure, and his thoughts helped me sharpen the ideas in this research.

I would also like to thank all my friends in the Netherlands. Their company made my life here become more colourful and left me with unforgettable memories.

Additionally, thank China Scholarship Council for its financing the development of my academic career in the Netherlands and Urban Knowledge Network Asia (UKNA) for funding my field research in China.

My family members have been giving me much freedom to do whatever I like. It is my luck to grow and live in the family. Thank you for having been standing by my side as always.

Changjie Zhan

Delft, the Netherlands

September 2017

Acronyms

BOT	Build-Own-Transfer
BOOT	Build-Own-Operate-Transfer
CCICED	China Council for International Cooperation on Environment and Development
CDG	Shenzhen Special Zone Construction and Development Group
CEUPSU	China-EU Partnership on Sustainable Urbanization
DUCI	Longgang District Urban Construction and Investment Co., Ltd.
ESI	Euro Sino Invest
G20GFSG	G20 Green Finance Study Group
GHG	Greenhouse Gas
GDP	Gross Domestic Product
ILCC	Shenzhen International Low Carbon City
IE Singapore	International Enterprise Singapore
JVs	Joint Ventures
MOF	Ministry of Finance
NDRC	National Development and Reform Commission
OECD	The Organization for Economic Co-operation and Development
P.R.C	People's Republic of China
PPP	Public-Private Partnerships
PFIs	Public-Finance Initiatives
PVAW	Planning the Village Area as a Whole
ROI	Return on Investment
RIFS	Research Institute for Fiscal Science Ministry of Finance P. R. China
RCCEF	Research Center for Climate and Energy Finance
SPVs	Special Purpose Vehicles
SSTEC	Sino-Singapore Tianjin Eco-city
SSTECAC	Sino-Singapore Tianjin Eco-city Administrative Committee
TBL	Triple bottom line
TEID	Tianjin Eco-city Investment and Development Co., Ltd.
KBUD	Knowledge-based Urban Development

UDICs	Urban Development and Investment Corporations
UIFP	Urban Investment and Financing Platform
UNCTAD	United Nations Conference on Trade and Development
WCED	World Commission on Environment and Development

1 Introduction

1.1 Research Background

Under the United Nations Climate Framework Convention, developed countries are committed to providing developing countries with US $ 100 billion each year to facilitate them to cope with environmental issues by 2020 (WRI, 2016). The start-up capital is US $ 10 billion. The United States, Japan, the United Kingdom, France, and Germany were committed to contributing to the start-up capital, yet the actual injected funds were about half of the amount they promised (Gu & Wang, 2017). However, the US decided to withdraw from the Paris agreement after President Trump Donald took office, challenging the goal of Paris agreement to raise US $ 100 billion each year by 2020. This is because the US committed to investing US $ 3 billion (Green Climate Fund, 2018), accounting for 30% of the total of the start-up fund.

Additionally, it is projected that the total investment to projects responding to climate change may amount to US $ 220 billion each year during the period from 2010 to 2020 and about US $ 1 trillion each year between 2020 and 2030 (International Energy Agency, 2010). Buchner et al. (2015) presented in their report that global climate financing reached at least 391 billion in 2014, with 38% and 62% coming from public and private investment, respectively. Climate Bonds Initiative (2017) estimated that about US $ 1 trillion should be raised through issuing green bonds by 2020 to build infrastructure adapted to the climate change.

On April 22 2016, China signed the Paris Agreement at the United Nations Headquarters in New York and formally promised that carbon dioxide emissions in China would reach the peak at around 2030 and strive for reaching the peak as soon as possible. China, as a

developing country pursuing high-carbon economic growth path in previous decades, is an essential force in response to the global climate change. Hodson and Marvin (2010) argue that rapid urbanization, massive industrialization and high dependence on resources make China an excellent place to carry out low carbon cities. In 2010, China launched a pilot project for the development of low-carbon cities. Eight cities and five provinces were taken as pilot cities in the first batch, and 28 cities and one province were added in the second batch launched in 2012. Currently, the project covers 36 cities and six provinces (NDRC, 2010, 2012). The pilot projects in the first batch are Guangdong Province, Liaoning Province, Hubei Province, Shaanxi Province, Yunnan Province, Tianjin, Chongqing, Shenzhen, Xiamen, Hangzhou, Nanchang, Guiyang, and Baoding. The pilot projects in the second batch include Hainan Province, Beijing, Shanghai, Shijiazhuang, Qinhuangdao, Jincheng, Hulunbei'er, Jilin, Daxing'anling, Suzhou, Huai'an, Zhenjiang, Ningbo, Wenzhou, Chizhou, Nanping, Jingdezhen, Ganzhou, Qingdao, Jiyuan, Wuhan, Guangzhou, Guilin, Guangyuan, Zunyi, Kunming, Yan'an, Jinchang, and Wulumuqi. The pilot projects are illustrated in Figure 1-1. The expansion of low-carbon cities also challenges local governments at different levels in terms of the transition of urban construction and filling financial gaps caused by developing low-carbon projects. CCICED (2015) projected capital needs in three different scenarios in China during 2014 and 2030 (see Table 1-1).

Table 1-1 Projected capital needs in China during 2014 and 2030

Unit: in trillion CNY

	low	**medium**	**high**
2014-2020	14.6	24.3	29.9
2021-2030	26.49	47.79	95.45

Source: CCICED (2015)

Note: the projection did not consider the expenses for eco-system protection, adaption to climate change, marine conservation and protection and so on.

According to CCICED (2015), the three scenarios are projected based on the following data. The low scenario is projected on the basis of the green development goals, the level of environmental protection, and levels of investment as of 2013; the middle scenario is projected on the basis of the investment needs to achieve the environmental standards set in 2013 and the green development goals in 2015; the high scenario is based on the environmental standards and the green development goals set in 2015.

In the low scenario, China needs 14.6 trillion CNY (about US $ 2.22 trillion) from 2014 to 2020, while the amount would be 26.49 trillion CNY (roughly US $ 4.03 trillion) from 2021 to 2030. In the medium scenario, China needs 24.3 trillion CNY (about US $ 3.7 trillion) from 2014 to 2020, while the amount would be 47.79 trillion CNY (roughly US $ 7.27 trillion) from 2021 to 2030. In the high scenario, China needs 29.9 trillion CNY (about US $ 4.55 trillion) from 2014 to 2020, while the amount would be 95.45 trillion CNY (roughly US $ 14.53 trillion) from 2021 to 2030. Also, some researchers estimated that the total investment in urbanization would be about 40 trillion CNY (roughly US $ 6.09 trillion) in ten years. Put otherwise, investment in urbanization need 4 trillion CNY each year, which puts forward higher requirements for 'green banks' (Ding, 2016; Wang, 2016).

Figure 1-1 Pilot low-carbon cities launched by NDRC

Source: NDRC (2010) and NDRC (2012)

Note: The green marks stand for the pilot provinces of the first batch; the purple mark is the pilot province of the second batch; the red marks are pilot cities of the first batch; the blue marks are pilot cities of the second batch.

1.2 Problem Statement

Currently, more and more people live in cities, and this leads to an enormous increase in global GHG emissions (Chavez & Ramaswami, 2011), as well as a vast impact on the environment. This issue has evoked serious concern among local authorities in China. Against this backdrop, Chinese governments have launched various urban development programs, including low-carbon cities, eco-cities, smart cities, knowledge cities, and sustainable cities. In practice, policy makers, planners, and developers often use these terms interchangeably (de Jong et al., 2015) albeit they are sometimes approached differently in the academic field. Therefore, to avoid confusion, we start by clarifying the definition of each term and delimit their scope (see section 2.1).

These initiatives offer hope to the Chinese government in tackling potential environmental risks. However, they also bring new challenges such as raising funds since local authorities usually depend on public sector financing to support such initiatives, and it is not sufficient due to the scaling-up need of investments in green projects (OECD, 2014).

The vast financial gap between the scaling-up investment needs and the available public finance for climate finance cannot be alleviated in the short run for the following reasons.

First, the existing policy settings and institutional arrangements have become barriers for large-scale private capital to enter the construction of sustainable cities (Adams et al., 2006). Second, the application of low-carbon technology to infrastructure means an enormous investment, higher risks, and a longer payback period, preventing investors from investing money in construction. Third, it is difficult to evaluate the economic benefits of investing money in activities related to climate change, which further becomes a barrier to attracting more funds for the construction. Therefore, local governments have to take responsibility for the development of infrastructure that may not generate revenues. However, local governments were and are under enormous pressure to raise money for constructing infrastructure for the following two reasons. On the one hand, the decentralized governance structure shifted many functional and fiscal responsibilities from the central government to local governments. On the other side, the adoption of the Tax Sharing System in 1994 separated the central and local government power in tax-collection over certain categories of taxes. With the confluence of these two factors, local governments were in a situation where fiscal revenue was not commensurate with the rapidly increasing expenditure in developing sustainable cities (Ba & Yang, 2014). Currently, two funding instruments are used to fill the gap, depending on the local economic status. One is budget revenue transfers from the central government, which can be further divided into two categories according to the purpose of the funds, namely, general purpose funds and specific purpose funds. General purpose funds include revenue-sharing transfers and tax rebates (Shah & Shen, 2006), while specific purpose funds are predominantly provided to a limited number of designated poor and rural localities (Liu & Salzberg, 2012). These transfers from the central government coupled with other local revenues still cannot cover the capital expenditure required for the development of sustainable cities. So local governments resort to another financing vehicle to bridge the gap, known as off-budget funds, including revenues from land concessions, borrowing through municipal government-owned urban investment and financing platforms (UIFPs), municipality collected surcharges, and public-private partnerships (PPP) (Wedeman, 2000; Xu, 2011; Zhan, 2013).

Off-budget funds, especially funds raised through land concessions and UIFPs, played an instrumental role in city development in the past years so that local governments excessively relied on it, resulting in a wide range of problems. For the central government, raising money from off-budget sources can be risky (Zhan, 2013). Because these liabilities are not reflected in the balance sheet and hence are hard to notice even when the gearing ratio (the proportion of a company's debt to its equity) is over the acceptable level (usually this ratio should not be over 100%). For local governments, off-budget funds such as land concessions are not sustainable in that the urban expansion speed will slow down with the maturity of the urban market and land is a scarce commodity (Ba & Yang, 2014). Therefore, it is significant to explore financial toolkits to expand financial sources for the development of sustainable cities in China.

1.3 Research Questions

The main question of this research is "what financial toolkits can be employed to facilitate the development of sustainable cities in China?" It is broken down into the following four sub-questions to achieve the research goals.

(1) How have Chinese governments traditionally arranged finance for the extensive investments in infrastructure, how has the emphasis on funding sources shifted over time and what is the new trend in funding?

(2) How is Sino-Singapore Tianjin Eco-city (SSTEC) funded?; how do involved actors balance their interests in participating in the construction, and which lessons can be drawn for other eco-cities in China and globally?

(3) Which financial vehicles are utilized in Shenzhen International Low-carbon City (ILCC), in what way do these contribute to sustainability and which lessons can be drawn from it for other eco and low carbon cities in China and elsewhere?

(4) Based on previous case studies, what are the similarities and differences in financing vehicles between Shenzhen International Low Carbon city and Sino-Singapore Tianjin Eco-city, and is there a financial model can be applied to future sustainable cities in China and globally?

1.4 Methodology

For the investigation of different models of financing sustainable cities in China', desk research and interviews were drawn upon to collect data.

Desk research was employed to review the literature regarding various city terms and theories for the development of sustainable finance. Multiple data sources were used to retrieve information, including journals, the websites of Sino-Singapore Tianjin Eco-City (SSTEC) and Shenzhen International Low-carbon City (ILCC), auditing reports of SSTEC in the past few years (retrieved from the website of the Shanghai Stock Exchange), and other web-based reports (e.g., the World Bank, the United Nations Environmental Program, the National Development and Reform Commission (NDRC) Report, and the national audit report issued by Chinese National Audit Office).

Interviews were used to investigate what financing vehicles were adopted to raise money as well as to map the roles of various stakeholders in the construction of ILCC. Two series of interviews were conducted in 2015 and 2016. The first series of interviews was carried out between April and July 2015 in Tianjin, China while the second was conducted between February and March 2016 in Tianjin and Shenzhen, China. For the Tianjin case, 11 people working in or with SSTEC were interviewed in the period April–July 2015, including officials, developers, financial staff and project managers. In February 2016, the researcher visited SSTEC again and stayed there for one week to collect additional information. For the Shenzhen case, nine interviews were conducted between February and March 2016.

1.5 Dissertation Structure

This research centers on the exploration of financial toolkits for the development of sustainable cities in China. To answer the central question, the financial vehicles the Chinese government employs for the construction of infrastructure and other large-scale projects were first studied from a historical perspective to gain insights into the evolutionary path of the financial vehicles in China. To have a concrete picture, two sustainable cities, Sino-Singapore Tianjin Eco-city (SSTEC) and Shenzhen International Low-carbon City (ILCC), were selected as the cases to investigate how sustainable cities are financed. One of the reasons for choosing SSTEC lies in its popularity both in China and globally. Additionally, it is currently the closest to completion and arguably the most successful large-scale sustainable new town development in China (Chang et al., 2016; de Jong et al., 2016; Rapoport, 2014). Similarly, Shenzhen, as one of the earliest cities implementing the reform and open-up policy, has made significant success in economic development. Many forward-thinking projects have been put into practice there. ILCC, as one of the demonstration projects of the China-EU Partnership on Sustainable Urbanization (CEUPSU), has attracted more and more attention from all over the world and is under proper development currently. The two cases are intriguing examples for understanding innovative forms of funding with the specific aim to do this in environmentally, socially, and economically sustainable ways. Therefore, following the research on path dependence in funding urban infrastructure development in China, case studies were carried out to investigate financial toolkits that SSTEC and ILCC employ for financing their construction. Based on the results of each case study, a comparative study was further conducted to find out the similarities and differences in funding sustainable projects in China, aimed at providing references for financing sustainable cities in future.

Figure 1-2 presents the structure of the dissertation. The dissertation consists of three parts, namely, part I background information and theories, part II case studies, and part III synthesis. Part I includes chapters 1 2, and 3, demonstrating the background information on the topic, problem statement, research questions, theories, and the historical evolution of financing urban infrastructure development in China. Part II includes chapter 3, chapter 4, and chapter 5, which are the case studies. Part III synthesizes the research findings and presents what needs to be done in future. The main contents of each chapter are demonstrated below.

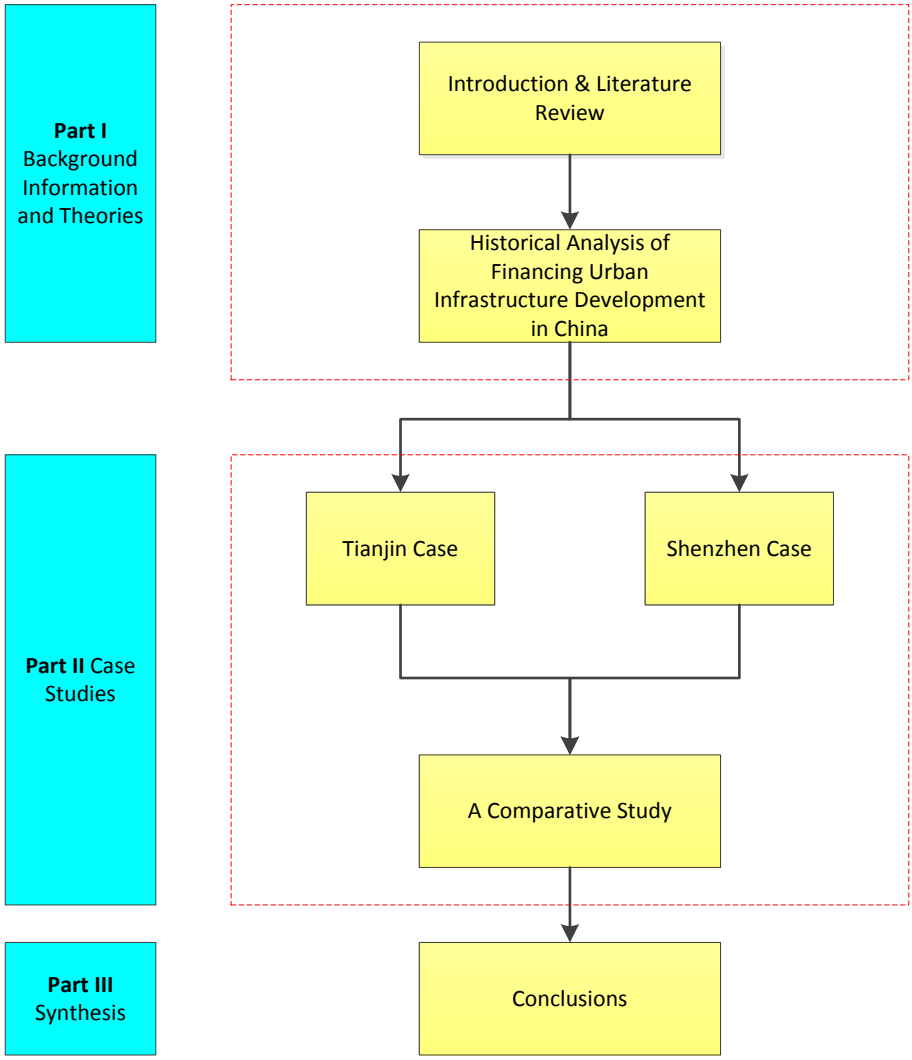


Figure 1-2 Dissertation structure

Chapter 2 reviews the literature on the research topic, including key concepts, sustainable finance, financing instruments, and theoretical foundations for financing sustainable cities.

Chapter 3 presents the historical evolution of financial arrangements for urban infrastructure development during 1949 and 2016. We reviewed the financial vehicles have been used in different stages and explored the reasons behind these options. We established that PPP and municipal bonds have recently grown popular in China to supplement public funding, yet this does not occur in a void but should be understood as the path-dependent consequence of historical evolution of funding arrangements for urban development. Additionally, our analysis demonstrates how weaknesses in earlier phases present challenges which new solutions in later phases are aimed to address.

Chapter 4 comes to the specific case and focuses on a thus far relatively understudied aspect of SSTEC, the financial vehicles used to fund SSTEC, which presents how eco cities finance their development in China. We investigate what financial vehicles have been used in SSTEC, which players are involved in the construction, how these players balance their interests, and what lessons can be drawn from the cases.

Chapter 5 examines which financial vehicles are utilized in ILCC, in what way these contribute to sustainability and which implications the lessons drawn from it have for other eco and low carbon cities in China and elsewhere.

Chapter 6 investigates what financing toolkits can be employed to fund the construction of sustainable cities through a comparative study of Tianjin and Shenzhen cases. We present a generic model to help future projects cope with financing issues for the development of sustainable cities after carrying out the comparative study of Tianjin and Shenzhen cases.

Chapter 7 draws conclusions, reflects the limitations of the dissertation and presents what can be done in future.

2 Literature Review

Section 2.1 is mainly based on the contribution the author made to the following peer-reviewed article. However, only parts are used where this author did the major share of the work.

- de Jong Martin, Joss Simon, Schraven Daan, Zhan Changjie, Weijnen Margot. (2015), 'Sustainable-Smart-Resilient-Low Carbon-Eco-Knowledge Cities; Making sense of a multitude of concepts promoting sustainable urbanization' *Journal of Cleaner Production*, 109: 25-38.

This chapter reviews the literature in terms of key concepts, financial instruments, and theories about sustainable finance. The literature regarding various terms clarifies the definition and delimits the scope. The overview of financial instruments provides an overall picture of the financing sources for urban development. The last section is theories including triple bottom line, impact investing, and stakeholder analysis, which provide theoretical foundations for the development of sustainable finance.

2.1 Concepts of Various Terms

Recently, people more and more concern about the harmony between their living environment and nature. Therefore, a plethora of urban development initiatives are launched to echo the trend, including 'sustainable cities', 'green cities', 'digital cities', 'smart cities', 'intelligent cities', 'information cities', 'knowledge cities', 'resilient cities', 'eco cities', 'low carbon cities', 'liveable cities', and 'ubiquitous cities'. De Jong et al. (2015) investigate how these

city terms are defined individually and linked to each other in the literature. With the aid of bibliometric analysis, ‘sustainable cities,’ ‘smart cities,’ ‘resilient cities,’ ‘low carbon cities,’ ‘eco cities,’ and ‘knowledge cities’ are singled out based on their frequency and conceptual distinctiveness (de Jong et al., 2015). The other terms are incorporated into ‘sustainable city’ and ‘smart city’ respectively. Of these, ‘green city’ and ‘liveable city’ are under ‘sustainable city’ while ‘digital city,’ ‘intelligent city,’ ‘ubiquitous city’ and ‘information city’ are under ‘smart city.’ Therefore, this section reviews the above six terms in accordance with de Jong et al. (2015) which the author also contributed to the work.

2.1.1 Low-carbon City

The government of UK issued the ‘UK Energy White Paper: Our Energy Future--Creating a Low Carbon Economy' in 2003, first defining the low carbon economy (Liu et al., 2009). The low carbon economy emphasizes the economy development should be able to balance human activities with nature by consuming less natural resources and causing less environmental pollution (Department of Trade and Industry, 2003). Since then, many countries try to take the ‘low-carbon’ concept into consideration when developing their economy (Tan et al., 2017). Many scholars define the low-carbon city by referring to the UK’s definition of the low-carbon economy (de Jong et al., 2015). For example, Zhou et al. (2012) and Khanna et al. (2014) conceptualize the low-carbon city based on the UK Energy White Paper.

Till now, no consensus concept has been given. Liu et al. (2009) hold the view that low carbon cities could be understood as city construction models, which help cities realize the goal of reducing carbon emissions by changing the economy development mode, people’s attitudes towards consumption as well as their lifestyle, yet such change should be on the premise of ensuring the continuous improvement of the life quality. Chen and Zhu (2013) interpret low-carbon cities both from macro and micro perspectives. From a macro aspect, low-carbon cities should be able to decouple economic development and energy consumption. From a micro perspective, low-carbon cities should cover the following fields, widely using renewable energy, increasing energy efficiency, and taking measures to absorb carbon dioxide emissions. Chavez and Ramaswami (2011) argue that low-carbon cities should be able to improve the energy efficiency within their boundary. Yung and Chan (2012) believe that low carbon cities are closely connected to sustainable development, and the development of low carbon cities is one of the most challenging tasks the world faces in recent decades. Other researchers such as Skea and Nishioka (2008) and Wei (2011) also stress the importance to develop low-carbon cities in parallel with the concept of sustainable development, requiring citizens to change their lifestyle to respond to the goal of reducing greenhouse gas (GHG) emissions. From the perspective of resources, Hodson and Marvin (2010) envision low carbon cities as cities aimed at making better use of resources to improve their efficiency and effectiveness. Similarly, the concept of low-carbon towns has been put forward in China. A low-carbon town is conceptualized as a town planned with concrete actions, aiming to reduce CO2 emissions in the short run and transit to a low-carbon economy and society in the long run (Li et al., 2012).

2.1.2 Eco-city

'The eco-city is an umbrella metaphor that encompasses a wide range of urban-ecological proposals that aim to achieve urban sustainability' (Jabareen, 2006, p.46). The development of eco-cities has different meanings in different eras. Therefore, Joss (2011) divides the history of eco-city developments into three stages, namely, stage I from the 1980s to early 1990s, stage II from 1992 to early 2000s, and stage III from 2000s to present. Stage I is also known as grassroots movement or visions. The concept of eco-city was still a normative term in the first phase. Register (1987) officially describes an eco-city as the ecological supporting capacity of the city's bioregion, aiming at reconstructing cities to be in the balance with nature. Stage II is regarded as local and national experimentation. Roseland (1997) points out that eco-cities or sustainable communities represent a goal or a direction for community development – not simply a marketing slogan. At this stage, the concept of 'eco-city' was translated into practice, further promoting the development of eco-city. Stage III is the global expansion or policy mainstreaming stage. The development of eco-city at this stage is largely driven by the policies. A host of eco-cities have been emerging around the world.

The eco-city has been developing for several decades, yet no consensus has been reached in defining the term (Joss, 2011; Yu, 2014). They are designed to handle the risks and problems in the economic-environmental sustainability (Caprotti, 2014). Hald (2009) defines an eco-city as a city that improves the citizen's living standards yet without damaging the environment they are living in. Similarly, Cugurullo (2013) describes an eco-city as a city that is planned in such ways so that all citizens can meet their own demands and can improve their fortune by doing no harm to their nature or putting other people into a dangerous living condition both at present and in the future. However, they also state that it is hardly possible to translate the eco-city concept into the reality unless inhabitants of the eco-cities are willing to cooperate with practitioners because the construction of an eco-city involves a host of local citizen's interests. Citizens should get ready to comply with the restrictions on resource consumption and should make sacrifices to change their traditional consumption habits. Therefore, eco-cities should be able to sustain itself without being highly dependent on natural resources yet use renewable energy to support its development, which thus leaves little or no ecological footprint (Premalatha et al., 2013; Wong & Yuen, 2011).

Currently, eco-cities have been given special meanings in coping with climate change and other risks endangering our environment, requiring the government over the world to adapt their sustainability policies to urban development (Caprotti, 2011). As such, many studies focus on emphasizing the instrumental role of institutional and policy tools playing in eco-city development. For example, Rohracher and Späth (2014) take Graz (Austria) and Freiburg (Germany) as two cases investigating the roles of urban energy policies and socio-technology plays in the transition of a city to an eco-city. Lehmann (2010) summarizes that the literature on eco-cities pays more attention to stressing the significance of combining the urban planning concept with the next generation infrastructure provision and the environmentally friendly buildings, coupled with the policies to guarantee the vitality of the social economy. Additionally, Ghorab and Shalaby (2016), from the technology perspective, stress the pivotal role of technology playing in developing eco-cities.

Regarding how to develop an eco-city, it seems that the eco-systems approach is one of the most appropriate methods to cope with the problems regarding sustainable urban development (van Bueren et al., 2012). Integrated approaches, system perspectives, long-term horizons, engagement of all relevant stakeholders, and transparency through information sharing while respecting the specificity of the natural and social context of the cities involved invariably characterize valid points of departure for the development of viable eco-cities (de Jong et al., 2013). The development of eco-cities is based on the combination of ecological requirements and socio-economic conditions (Hald, 2009). The development of eco-cities is a process of incorporating social, economic, and environmental aspects into the urban development (Ghorab & Shalaby, 2016; Song, 2011; Yu, 2009). In line with such views, Kline (2000) summarizes four characteristics of an eco-city, including ecological integrity, economic security, quality of life, and social responsibility. Quality of life and social responsibility, economic security, and ecological integrity are in line with social, economic, and environmental aspects respectively. From those reviewed, it can be found that the environment for constructing an eco-city is complex, so we should not view the eco-city in a single and simple way but understand it in a complex context.

2.1.3 Smart City

The concept of 'smart city' as such is also relatively new in origin, although it stems from, or can at least be seen as a more advanced successor to, the older 'information city,' 'digital city' and the 'intelligent city' categories. In recent years, however, the 'smart city' has completely eclipsed its associates and predecessors in popularity, even to the extent of surpassing the sustainable city in the frequency of academic use in 2013 (see Figure 2-1). A city can be defined as 'smart', according to Caragliu et al. (2011), when investment in human and social capital, coupled with investment in traditional (transport) and modern information and telecommunication infrastructure, generate sustainable economic development and a high quality of life while promoting prudent management of natural resources. In essence, elaborate and sophisticated ICT-facilities are provided all around the urban territory, which allow companies to collaborate and innovate, to provide better services to citizens and, thereby, empowering citizens with access to information to the extent that they can debate, influence and even make policy (Lee et al., 2013). An early stage smart city can be conceptualized as one that provides combined services via the integration of the IT and construction industries (Korea Land Corporation, 2005), although it has been argued that the validity of any claim to be smart ought to be cantered upon something more than the use of information and communication technologies (ICTs) alone (Hollands, 2008).

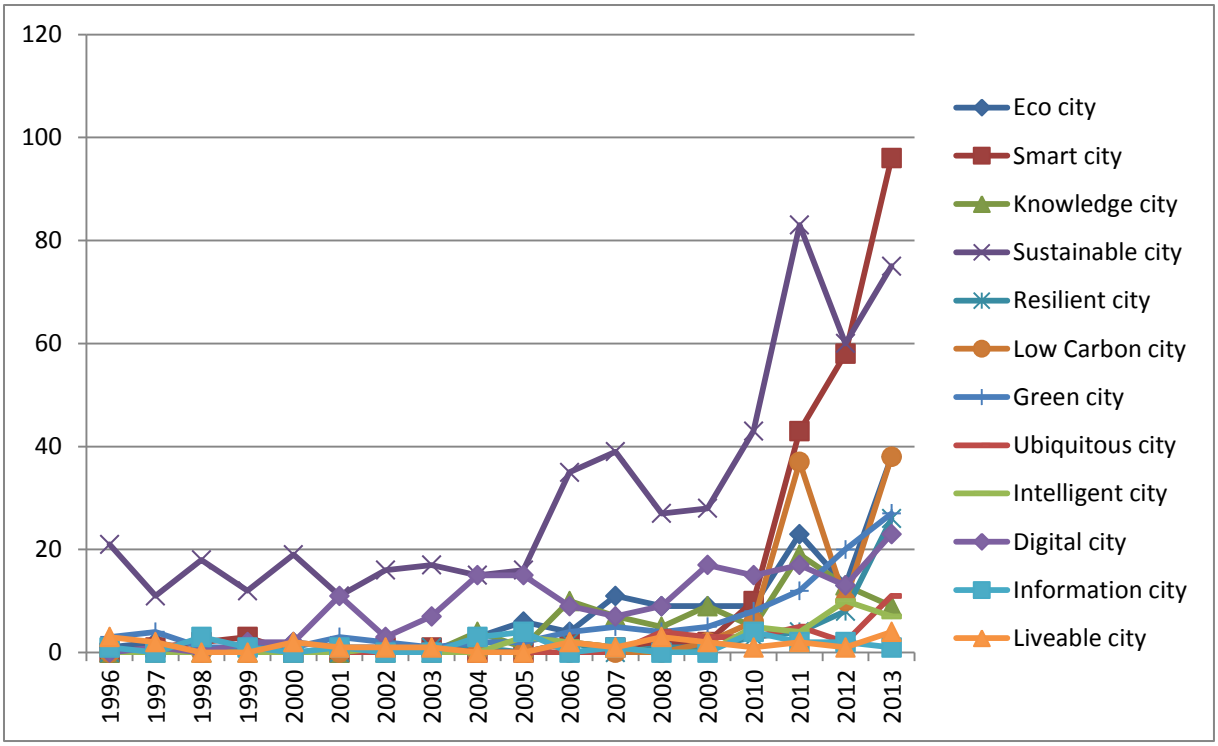


Figure 2-1 Evolution of the twelve categories over time

Source: de Jong et al. (2015)

Based on a thorough review of the smart city literature, Caragliu et al. (2011) conceptualize the smart city by summing up six characteristic features: (1) improving administrative and economic efficiency and enabling the development of culture and society by utilizing networked infrastructures; (2) an underlying emphasis on business oriented urban development; (3) a strong focus on the goal of realizing the social inclusion of different kinds of urban residents in public services; (4) emphasizing the significant role of high-tech and creative industries in long-term growth; (5) paying ample attention to the function of social and relational capital in city development; and (6) taking social and environmental sustainability as an important aspect of smart city development. Likewise, Giffinger and Gudrun (2010) and Lee et al. (2013) argue that the smart city consists of the following six ingredients – noting here the arguably rather tautological definition - namely: a smart economy, smart mobility, a smart environment, smart people, smart living and smart governance. In that sense, most recent academic literature emphasizes that smart(er) cities go way beyond 'information cities', 'digital cities' and 'intelligent cities' in that they take into consideration that information technology does not stand on its own, but should effectively be contextualized and embedded in wider physical and social systems, thus allowing it to be at the service of people, business and government (Allwinkle & Cruikshank, 2011; Deakin & Al Waer, 2012; Leydesdorf & Deakin, 2011). The category 'smart city' has proven particularly popular not only among adopting cities but also among large engineering firms, because it offers concrete innovation and investment opportunities for physical urban and infrastructure development. It promotes engineering system solutions to urban problems and consequently has somewhat shifted attention away from environmental conceptions of the city to ones oriented towards infrastructure and information use. The terms 'eco' and 'green' are added

mainly to indicate the inclusion of green spaces and parks for recreation. Consequently, its net contribution to the environmental cause remains disputed, according to some (Salvati et al., 2013; Viitanen & Kingston, 2014). At the same time, its fast increase in the frequency of occurrence suggests that a new, intensely linked node is in the making, which constitutes a new collection of keywords and related concepts, and which is distinctly different from the 'sustainable city.' While the present analysis pictures the 'smart city' as a satellite, it may well continue to grow in mass and, in time, move to the center stage of the academic debate on urban development.

2.1.4 Knowledge City

The category 'knowledge city' has an apparent resemblance with aspects of the 'smart city' in that what is seen to be the desirable direction for urban development is similar: information- and knowledge-intensive production without high environmental impact. However, its theoretical origins are quite different and associated more with the economics of innovation. It is effectively interchangeable with conceptions of 'knowledge-based urban development' (KBUD) (Arbonies & Moso, 2002; Yigitcanlar & Loennqvist, 2013). Yigitcanlar et al. (2008) point out that the first references to 'knowledge cities' can be traced back about three decades. Knight (1995) may have been the first author officially to introduce the concept of KBUD, describing it as the conversion of knowledge ingredients into local development to offer a platform for the city to develop sustainably, coupled with a social learning process to help citizens to realize urban change. More recently, 'knowledge cities' have been defined as integrated cities that physically and institutionally combine the functions of a science park with civic and residential functions (Yigitcanlar et al., 2008). However, they lack the emphasis on the central role of ICTs in triggering this development. Hence, this category's conceptual evolution in the past decade has been separate from 'smart city.' Modern urban planning began to embrace KBUD because of the vital impact of knowledge cities on enhancing a region's competitiveness in globalization (del Rosario González Ovalle et al., 2004; OECD, 2008). In its widest interpretation, the concept of 'knowledge city' not only focuses on the knowledge economy and industrial structure, but also stresses enriched human capital, a vibrant and diverse socio-cultural environment, conservation of the natural environment, a high-quality built environment, accessibility, tolerance and acceptance of multiculturalism, and social equity (Florida, 2005; van Winden et al., 2007; Yigitcanlar et al., 2008). Peer and Stoeglehner (2013) additionally argue that knowledge cities require a strong organizing capacity to establish such foundations, with an essential partnership between public and private actors, the academic world and the wider community, in order to negotiate and determine jointly the knowledge demand, knowledge transfer, and knowledge learning. Thus, the planning of a 'knowledge city' can foster the conditions for learning networks which help sustainable development at the regional level through a collective innovation process (Valkering et al., 2013). Fernandez-Maldonado and Romein (2010) hold the view that KBUD should balance economic quality, socio-spatial quality, and organizational quality to develop sustainably. Taken together, the realization of 'knowledge cities' may have a positive impact on environmental sustainability, although it is essentially only instrumental for achieving other, economic innovation-related goals; as such, the 'knowledge city' does not centrally promote ecological sustainability or even regenerative development. Nevertheless, a

much-praised city such as Melbourne has been the winner of the Knowledge City Award in 2013, while equally priding itself in being 'green' as well as the home of the Melbourne Principles for sustainable city development, which essentially stress the community participation aspect of sustainable urban development. As shown in Figure 2-1 and 2-2, the 'knowledge city' is a relatively long-standing conceptual category, but one which has not significantly grown across the time frame analyzed. It has a conceptually distinctive identity, quite separate from 'smart city,' and paradoxically keyword associations suggest a closer interconnectedness with 'sustainable city,' 'eco-city' and 'low carbon city' than with the other categories, in spite of its largely economic innovation-oriented connotations.

2.1.5 Resilient City

Holling (1973, p. 17) may have been the first to use the term resilience. As he and Gunderson went on developing it, they did so from an ecological perspective as "the persistence of relationships within a system", "the ability of these systems to absorb changes of state variables, driving variables, and parameters, and persist" and "the capacity of a system to undergo disturbance and maintain its functions and controls" (Gunderson and Holling 2001, quoted in Jabareen 2013: 220). Since then, the concept has seen the widespread application to a variety of other academic fields in addition to ecology, including economic geography, natural and man-made disaster management, terrorism, and flood control (Barnett, 2001; Davic & Welsh, 2004; Jabareen, 2013). The recent and most complete definition covering the application in the greater variety of academic disciplines was given by UNISDR (2010: 13): "resilience means the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including the preservation and restoration of its essential basic structures and functions".

According to recent literature, the study on the 'resilient city' illustrates the various perspectives implied in resilience research: (1) reacting to ecological problems; (2) handling hazards and disasters; (3) coping with shocks in the development of urban and regional economies; and (4) promoting resilience through urban governance and institutions (Leichenko, 2011). Some claim that researchers focusing on a small number of factors may draw inaccurate conclusions, because the 'resilient city' is a complex and multidisciplinary system requiring an integrated approach to allow analysts to deal with many uncertainties and vulnerabilities which are not always easy to predict (Folke et al., 2010; Jabareen, 2013; Little, 2004). Jabareen (2013) includes (1) adaptation, (2) spatial planning and (3) sustainable urban form (consisting of compactness, density, mixed land use, diversity, passive solar design, greening, and renewal and utilization) as the three interrelated components of uncertainty orientation which analysts have to deal with to build good predictive models of urban systems as a foundation for developing measures to promote the 'resilient city'. Academic use of the category 'resilient city' has seen a steady increase since 2008 and has by 2013 become significant. Figure 2-2 demonstrates that the resilient city has established a theoretical branch of its own which has steadily been gaining in academic popularity since 2006. Its connections with hurricane Katrina (New Orleans, USA) and emergency management (reflective of its adaptation aspect) as well as with sustainability (reflective of its mitigation effect) seem significant. However, it remains to be seen whether related keywords will evolve into

substantial components of the 'resilient city' conceptual identity in the literature, assuming a further consolidation of this category in years to come. It also appears that although the 'resilient city' has been used in various academic disciplines, most recently it has become most conspicuous in safety science, environmental science and governance. Whether this conception will eventually contribute positively to sustainable urban development will depend primarily on its interpretation as being at least partly mitigation, i.e., spatial planning and sustainable urban form, oriented (although in the short run urban survival as such may also depend heavily on effective climate adaptation). The effects of policy measures for the benefit of the 'resilient city' can only be assessed if unambiguous quantification approaches have been adopted. This does not appear to have happened to date, judging from the available literature.

2.1.6 Sustainable City

Sustainability has become more and more popular nowadays, which has been defined as 'development that meets the needs of the present without compromising the ability of future generations to meet their needs (WCED, 1987, p. 8).' Since the adoption of Local Agenda 21 strategies after 1992, the term has extended from the environmental sphere to economic, social and even cultural spheres. The concept of sustainable development is often characterized by issues such as the proper use of resources to guarantee generational equity, protection of the natural environment, minimal use of non-renewable resources, economic vitality and diversity, community self-reliance, individual well-being, and satisfaction of basic human needs (Choguill, 1996; Hardoy et al., 1992).

Ecologists have long argued for equilibrium with basic ecological support systems, and since the 1987 Brundtland Commission, the notion of sustainable development has taken on renewed and urgent currency (Daly 1991, United Nations 1987, Silvers 1976). The notion of sustainable development enjoins current generations to take a systems approach to urban growth, and to manage resources – economic, social and environmental – in a responsible manner for their own and future generation's enjoyment in line with the Earth's carrying capacity. Over the years, various writers from a range of disciplines have expounded the concept and suggested ways to measure, monitor and implement sustainability (see, for example, Aguirre 2002, Kates et al. 2005, Hasna 2007, Boulanger 2008). In the main, the objectives have been to direct urban development towards minimizing the use of land, energy, and materials, and impairment of the natural environment while maximizing human well-being and quality of life. The implication is that settlement patterns need to be liveable, attractive while sustainable, and this can be achieved through ecological planning.

As shown in Figure 2-2, the term 'sustainable city' links to 'smart city,' 'eco-city,' 'low carbon city,' 'resilient city,' 'knowledge city,' 'liveable city,' 'green city,' and 'intelligent city,' suggesting that 'sustainable city' has substantial overlap with the other seven terms. However, 'liveable city,' 'green city,' and 'intelligent city' are left out in this discussion as stated at the beginning of the chapter. Additionally, Figure 2-2 shows that the 'sustainable city' has the largest interconnected node, indicating that it is the most frequently occurring term. Based on the above reasons, this dissertation uses sustainable cities as the umbrella term to represent and include the other five terms.

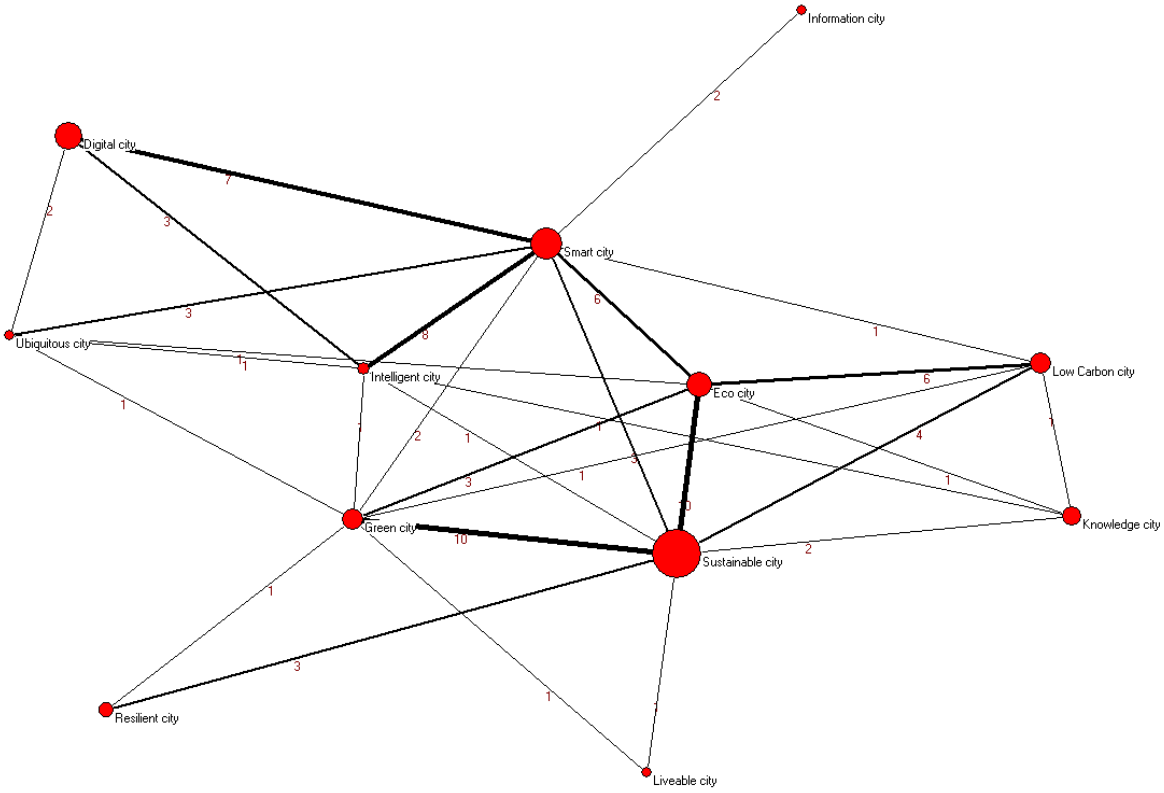


Figure 2-2 Co-occurrence of the twelve categories in titles, abstracts, and keywords

Source: de Jong et al. (2015)

2.2 The Transition of the Traditional Finance to Sustainable Finance

The traditional financial theory takes the assumptions about values and investment outcomes as the basis, which is confined to financial returns and risk management (Fullwiler, 2015). The thoughts of the traditional financial theory are conducive to shareholders. However, with the rapid change in social value, the traditional finance is regarded as unsustainable since it is based on 'private property rights, growth and expansion, competition, maximizing consumption of non-essentials, maximizing returns on shareholders and directors and so on (Gray & Milne, 2004, p. 73).' Fatemi and Fooladi (2013) posit that the traditional way to shareholder wealth maximization is not appropriate to help create sustainable wealth since corporations tend to pursue short-term profits under the guidance of this concept and thus bring negative impact to the society and environment without paying costs, which could undermine economic growth and development. Additionally, the financial structures and arrangements under the traditional finance could not deliver some of the contemporary issues such as poverty and climate change (Sandberg, 2015) since financial markets do not allocate capital efficiently which results in financial resources flowing to unsustainable sectors (Richardson, 2005). Therefore, researchers start to rethink the role of finance in addressing these challenges. For example, Baker and Nofsinger (2012) have studied socially responsible finance from the view of the corporate and investment world. However, the concept of sustainable finance has not been fully explored yet, particularly when it comes to social aspects of capital markets (Salzmann, 2013). Roberts (2007) argues that companies are set up

to serve human beings, which requires them to recognize and consider other stakeholder's interests not just limit to shareholder's. Therefore, Kramer and Porter (2011) reckon that the concept of 'shared value' should be applied to the contemporary world so that both corporations and society can benefit from the corporation's business activities. Similarly, Sandberg (2015) points out the flaws in the dominant view of finance, focusing merely on profits, and then proposes a two-level model (a model considering both the dominant view of finance and social responsibility) by taking into account sustainability to approach the problems the dominant view of finance faces.

Against this backdrop, other factors such as non-financial information are taken into consideration aiming to finance the world's development sustainably. As defined by Fullwiler (2015), sustainable finance should concern not only financial aspects such as financial gains/losses and risks but also non-financial issues such as altruism for current and future generations, ecological reservation, and corporate social responsibilities. The emphasis on incorporating non-financial factors into finance leads to the transition of the traditional finance to sustainable finance.

2.3 Literature regarding Financial Instruments

With the ever-developing world economy, countries have begun to take environmental issues more and more seriously and seek to transit their economy to sustainable development. This trend requires countries to invest a large sum of money in infrastructures and other fields such as renewable energy, imposing funding challenges on local authorities. Therefore, both researchers and practitioners have tried hard to explore new financial instruments that can be employed to scale-up funds for sustainable development. Merk et al. (2012) argue that the main financial instruments adopted by major green urban sectors include taxes, user fees, grants, Public-private Partnerships (PPP), land-based income, loans, bonds, and carbon finance. Inman (2005) holds the view that public services can be funded through user fees, resident-based taxation, and business-based land value taxes. Of these, user fees can be applied to both residential and business services, and resident-based taxation is adopted to finance residential services while business-based land value taxes are applicable for business services. Slack (2010) presents some financial instruments for large cities, including user charges, tax, intergovernmental transfers, borrowing, PPP and development charges. Bahl and Linn (2014) divide financial instruments into own-source financing and external sources of financing on the basis of financial sources. Own-source financing includes user changes and betterment levies, property taxation, and non-property taxes while external sources of financing encompass intergovernmental transfers, borrowing, PPP, and international aid. Z/YenGroup (2015) systematically explores financial instruments for financing sustainable infrastructures in cities. The research group identifies three instruments, namely, public finance, debt finance, and equity finance instruments (see Table 2-1). To be specific, public finance instruments include land sales, land or infrastructure asset leaseholds, PPP & Private-finance initiatives (PFIs), taxes, land value capture mechanisms, user charges & fees, grants and subsidies, building rights and planning permits. Debt finance instruments encompass loans and bonds, de-risking & credit enhancement instruments, and debt refinancing instruments while equity finance instruments consist of infrastructure equities listed, equity

funds listed/unlisted, and equity-funded direct investments (e.g., special purpose vehicles (SPVs) and joint ventures (JVs)) in infrastructure. Instead of directly exploring financial instruments, Meltzer (2016) discusses how to use concessional climate finance to facilitate the development of low-carbon resilient infrastructure projects, including (1) developing an enabling environment and co-financing packages; (2) supporting local banks, the development of financial instruments, and low-carbon technology; (3) strengthening monitoring of outcomes; and (4) improving cooperation between climate funds.

Although researchers explore instruments that can be employed to finance the development of sustainable cities, it does not mean that all these financial vehicles play equal roles in raising money. Bahl and Linn (2014) concluded that debt finance, PPP, and land-based levies are effective instruments to finance city construction; intergovernmental transfers and grant finance are of paramount importance, and user charges and property taxes are critical yet underused. In general, the financial instruments large cities adopt should be in line with their responsibilities in providing infrastructure and services (Slack, 2010). Researchers such as Slack (2010) and Zhan et al. (2017) shed light on mobilizing private capital in that the involvement of private sectors can alleviate local authorities' financial pressure. Therefore, researchers suggest employing PPP and bonds to finance climate-related projects since they are regarded as two effective ways to get private sectors on board (Reichelt, 2010; Sullivan et al., 2013).

Table 2-1 Overview of financial instruments

Instruments	Potential to be	Explanation
Public finance		
Land sales	Low	One-off source of finance, limited impact. Difficult to incentivize sustainable infrastructure development once land is sold.
Land or infrastructure asset leaseholds	Low	Would depend on government policies and targets. Contracts could stipulate sustainability performance objectives. Difficult to monitor.
PPP & PFIs	Medium	Depends on the type of project and government policies and targets. Could include sustainability targets
Taxes	Medium to high	Depends on tax design and scope, e.g. tax to favor density over urban sprawl or low-carbon energy over fossil fuel sources. Requires coordination across departments and tax incentives
Land value capture mechanisms	Medium to high	Depends on the design and government policies and targets. Could mandate the achievement of sustainability objective (e.g., energy efficiency targets)
User charges & fees	Medium to high	Depends on the integration of externalities and incentives encouraging sustainable usage of infrastructure (e.g., public transport) or resource conservation.
Grants and subsidies	Medium to high	Depends on design given limited public resources, these instruments should be targeted at projects that have significant potential of leveraging additional sources of finance while delivering sustainable benefits.
Building rights and planning permits	Medium to high	Depends on if planning processes and permit allocation is tied to sustainability requirements.
Debt finance		
Loans	Medium	Depends on instruments
- Concessional or flexible loans	Medium to high	Depends on design and scope. Terms and conditions should stipulate specific sustainability objective when possible, e.g. energy efficient mortgages
- Syndicated loans	Low to	Depends on sustainability being integrated into lending criteria
Bonds	Medium	Depends on scope and purpose. Can be combined with tax efficiency measures
- Infrastructure bonds	Medium	Depends on sustainability being integrated into design and scope and on disclosure
- Green bonds	High	Depends on standards and disclosure. Project selection criteria should be specified upfront and monitored throughout.
Debt funds	Medium	In theory possible, depends on the scope of the fund and integration of sustainability criteria.
De-risking & credit enhancement instruments	Medium	Depends on whether they are targeted at sustainable infrastructure projects that need credit status enhancement.
Debt refinancing instruments	Medium to high	Could provide refinancing for long-term sustainable infrastructure projects, e.g. renewable energy. Further development of 'green securitization' market required.
Equity finance		
Infrastructure equities-listed	Medium to high	Own significant amount of infrastructure assets. Depends on companies 'capital expenditure strategy towards low-carbon infrastructure and policy requirements
Equity funds-listed/unlisted	Low to medium	Depends on stock selection strategy, scope of the fund and disclosure
Equity-funded direct investments in infrastructure	Medium	Depends on type of infrastructure, investment strategy and government policy. Future potential depends less on the instrument and more on the suitability of sustainable infrastructure projects being financed through this type of vehicles
- SPVs	Medium	Commonly used for renewable energy projects. Depends on type of infrastructure and government involvement.
- JVs	Medium	Depends on type of infrastructure and JV scope.

Sources: compilation based on Z/YenGroup (2015)

2.4 Theories

The literature presented in section 2.4 discussed the necessitate to transit traditional finance to sustainable finance and the key concept of sustainable finance while the literature concerning financial instruments displays the possible financial sources for urban developers. However, not all financial instruments are available and suitable for funding sustainable development. Therefore, this section demonstrates theories to guide what financial instruments can be employed to finance sustainable development.

2.4.1 Triple Bottom Line

The triple bottom line (TBL) was first coined by Elkington (1994), including profit, people, and the planet. It aims at gauging company performance on the financial, social, and environmental aspects. The concept of TBL indicates that corporations should not only be responsible for their shareholders but also for a broader span of stakeholders, including environmental protection agencies (Sitnikov, 2013). Although financial, social, and environmental aspects are critical to sustainable finance, this does not imply that the roles various stakeholders play in the decision-making process should be equal (Donaldson & Preston, 1995). Especially for projects involving the public interests, they need to take into account natural, social, and economic systems (Brown et al., 2006). Gimenez et al. (2012) argue that the TBL concept requires companies to responsibly participate in social and environmental activities since positive financial returns can be obtained in the process of performing social and environmental responsibilities. Mostly the TBL is used to report the social, environmental, and economic performance of corporations (Gray & Milne, 2004; Rogers & Ryan, 2001). Hawken et al. (1999) regard the term as human or social capital, which becomes one of four major 'types' of capital, namely, natural, manufactured, financial, and human capital. Cheney (2004) holds the view that TBL is a means to present a corporate's performance in environmental and social activities. Later, some researchers applied the TBL principle to the development of sustainable communities, arguing that sustainable communities need '(1) to take stock of the human, environmental and economic resources available to them, (2) to develop a shared vision about the way in which these resources are utilised and (3) to develop a means to evaluate toward identified goals (Rogers & Ryan, 2001, p. 281).'

Emerson (2003) coins the term 'blended value,' arguing that all investment or finance activities should be understood as carrying out concurrent tasks in the social, economic and environmental realms. Bonini and Emerson (2005) believe that corporations not only can 'do well' but also can 'do good,' which means that it is possible for corporations to achieve social and environmental goals when they pursue economic value. Emerson et al. (2006) point out that traditional investing philosophy aims to a trade-off between risks and financial returns while blended value offers new insights into the investment philosophy which views investment from multiple dimensions by taking into account economic, social, and environmental factors. Aguilera et al. (2007) argue that mixed motives should form the basis of corporate social initiatives. Corporations start taking into account social and environmental value in that more and more researchers, and practitioners realize that the true business operating costs should also cover the social and environmental costs (Freundlich, 2005). As

stated by Fullwiler (2015), the theory of sustainable finance is based on the idea that (1) investors have blended values and that (2) each investment activity has blended results, covering both financial and non-financial returns. The concept of blended value requires program initiators to consider the benefits of various stakeholders from financial, social, and environmental points of view (Fergus & Rowney, 2005; Soppe, 2008, 2009), much in line with the concept of the 'triple bottom line.' However, it should be noted that blended value is not simply the sum of the components of the triple-bottom-line analysis, all three requirements should be met separately (Bugg-Levine & Emerson, 2011).

It has been questioned if TBL can facilitate the reporting of actor performance in economic, environmental, and social aspects. However, the concept of TBL is critical to sustainable development. Some analysts stress financial stability more by considering the financial sources. When it comes to sustainable finance, it requires investors to follow TBL precept so that money flows to environmentally friendly fields. With the growing need for funding to develop sustainable infrastructures, it is of pivotal importance to diversify the sources, which requires solid collaboration among the various involved public and private stakeholders (Z/YenGroup, 2015; Zhan & de Jong, 2017b).

2.4.2 Impact Investing

The UNEP Inquiry (2015) argues that the development of the financial system will deeply influence environmental and social outcomes. Therefore, urban developers should incorporate the environmental impact of infrastructure investments to make cities more resilient (Basiago, 1999). The growing public awareness and political involvement in addressing sustainability issues have led to growth in capital committed to more sustainable financial practices (The UNEP Inquiry, 2015), just as it is evident that good scores on sustainability indicators can positively affect financial performance (WBCSD/UNEPFI, 2010). The shift of the investment goal from financial returns to social and environmental issues when generating financial returns brings in a new financing option, known as impact investing, for projects with social and environmental impacts. Impact investing was coined in 2007 (Höchstädter & Scheck, 2015), arguing that the financial return is not the only goal of investment but combines philanthropic objectives with financial goals (Louche et al., 2012). More and more investors set up long-term and responsible investment strategies through managing the issues related to environmental, social and governance standards (G20GFSG, 2016). Many researchers present their understanding of the term 'impact investing' yet no consensus definition has been achieved. However, even the definition of 'impact investing' varies, it is generally conceptualized based on the two key aspects, financial return and non-financial impacts (Höchstädter & Scheck, 2015). Impact investing refers to companies pursuing social and environmental impact while generating financial returns (Bugg-Levine & Emerson, 2011; GIIN, 2016), which 'involves the placement of capital in enterprises or projects intended to produce social or environmental as well as financial returns (Jackson, 2013, p. 609).'

The emphasis on social and environmental impact distinguishes impact investing from traditional investment (Wong, 2013). The emergence of impact investing is a reflection of the blending of financial, social, and environmental values (Austin et al., 2006).

Impact investing is an efficient method to mobilize both private and public funds to involve in the social projects in the ever-changing global economy (Gates, 2011). It is not exclusive to developed economies but applies to emerging economies too (O' Donohoe et al., 2010). Impact investing also stresses its non-financial attributes such as social and environmental impacts. Therefore, it has attracted many investors' attention such as faith-based investors, pension funds, insurance companies, banks, high net worth individuals, and hybrid organizations (Bugg-Levine & Goldstein, 2009), making it a viable option to support large-scale projects with social and environmental challenges (Glänzel & Scheuerle, 2016). Although impact investing emphasizes the importance of philanthropy, it is not pure philanthropy. The return of the invested principal is a prerequisite for impact investments (Höchstädter & Scheck, 2015). The debate of impact investing centers on the level of return on investment (ROI) yet researchers and practitioners have not clearly defined the level of ROI (Louche et al., 2012). In general, there is no boundary regarding the level of ROI, whether if it must be below, at, or above the market rate (Höchstädter & Scheck, 2015). However, the financial return on impact investment should be adequate, competitive, or reasonable (Chua et al., 2011). After all, impact investing is still commercial behavior.

2.4.3 Stakeholder Theory

The stakeholder concept was first introduced in 1963 in a Stanford Research Institute Memorandum (Freeman, 2010). Later, the stakeholder theory has been well developed and applied to various fields such as corporate social responsibility (Roberts, 1992), business ethics (Freeman et al., 2004), environmental marketing (Cronin et al., 2011; Polonsky,1995), and finance (Zingales, 2000). Stakeholder theory argues that different stakeholders have different claims in organizations, for example, owners expect obtaining certain level profits while the public may be interested in how organizations contribute to the nation's economic development (Polonsky, 1995). The various expectations may lead to conflicts between companies and their stakeholders if their interests have not been addressed. Marcoux (2000) holds the view that the primary concern of stakeholder theory is the distribution of economic gains. However, Freeman et al. (2004) argue that distribution is only a part of the theory, and the stakeholders' discourse power is also very critical. In addition to economic gains, they believe that information sharing should be covered by the distribution. In the view of Parmar et al. (2010), stakeholder theory is an instrument to better respond to complex scenarios in the world. Sustainable finance aiming to achieve social, environmental and financial sustainability involves various stakeholders, requires taking into account balancing the interests of different stakeholders.

Therefore, this research employs stakeholder theory to examine which actors are involved in financing the construction and how they balance their interests to make sure the construction is indeed financed in a sustainable manner.

2.5 Theoretical Framework

Figure 2-3 is the theoretical framework of the dissertation, demonstrating how each chapter relates to the other ones. Chapter 3 presents the evolution of urban development finance in China, providing an overall picture of how Chinese authorities have arranged funding over time and why some financial instruments currently in use are unsustainable. It is conducive to

the comparison of the practices in Tianjin and Shenzhen in following chapters and know what innovative practices are. The study of Shenzhen and Tianjin cases tests the theories reviewed in chapter 2, namely, stakeholder theory, impact investing and triple bottom line. Of these, stakeholder theory is employed to support stakeholder analysis in the following chapters while the other two are used to test if Tianjin and Shenzhen programs can finance sustainably from social, environmental and financial perspectives. Then a comparative study will be carried out based on the research in previous chapters, concluding with innovative practices that can be replicated to other projects.

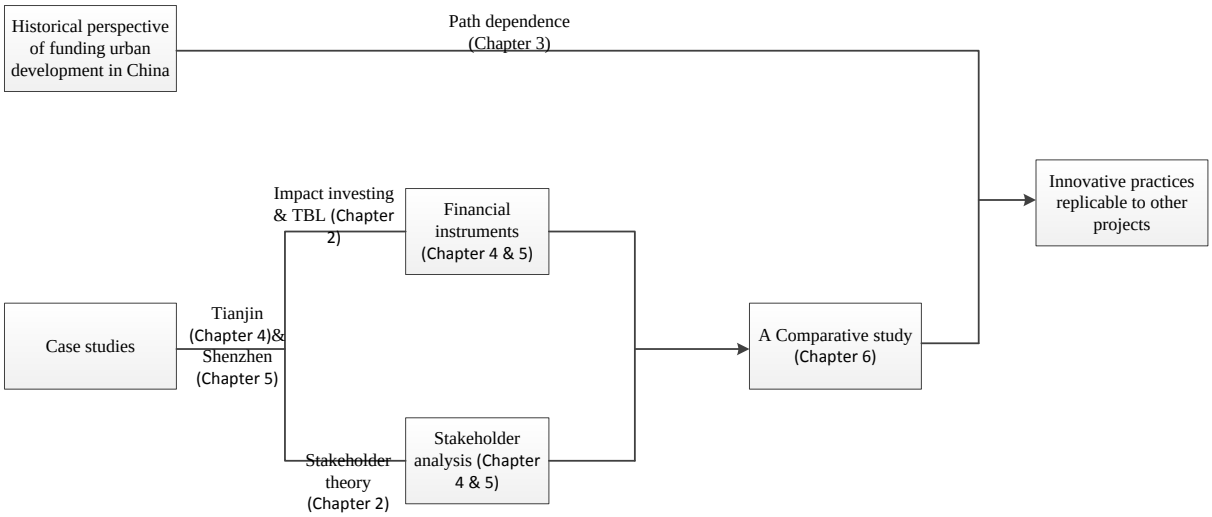


Figure 2-3 Theoretical framework

2.6 Summary

This chapter first clarifies various city categories, concluding that sustainable cities are used as the umbrella term to represent other terms in this dissertation. Then the transition from the traditional finance to sustainable finance is introduced to explain why the development of sustainable finance matters. Later, various financial instruments are presented to show the possible financing sources for developers. In the last section, the theoretical foundations for sustainable finance are demonstrated, including triple bottom line, impact investing and stakeholder analysis. Of these, stakeholder theory is employed to investigate how the interests of actors are balanced in the investigated cases so that conflicts will be avoided and thus actors would continue participating in the construction, while the theories triple bottom line and impact investing are used to test if financial arrangements in the two investigated cases are sustainable from social, environmental, and economic perspectives.

3 Path Dependence in Financing Urban Infrastructure Development in China: 1949-2016

This chapter is mainly based on the following peer-reviewed article:

- Zhan, C., de Jong, M., & de Bruijn, H. (2017). Path Dependence in Financing Urban Infrastructure Development in China: 1949-2016. *Journal of Urban Technology*, 24(4), 73-93.

3.1 Introduction

Since the foundation of the People's Republic of China (PRC), China has more than 60 years of experience in financing urban construction, evolving all the way from a simple financial model characterized as unified fiscal allocation in the era of the planned economy into the various financing models in the socialist market economy. These changes are closely linked to the governmental policies and legislation in each stage. Previous studies (Ba & Yang, 2014; Cao & Zhao, 2011) divided up the financing system for urban construction into three stages in accordance with the changes in China's fiscal system, namely the planned economy stage (1949-1977), the reform and pilot stage (1978-1993) and the market economy stage (1994 to present). Accordingly, the path dependence in urban development financing through time can also be divided into three stages, namely, the first stage is constituted by the first 19 years after the foundation of PRC which is known as the planned economy (1949-1977); the second stage is the early stage of implementing the reform and opening-up policy (1978-1993); and the third stage is called the socialist market economy (1994 to present).

Theoretically speaking, the path urban finance and investment has followed in China has not been purely rational target-driven or tool-innovation-based. It is, in fact, a combination of selecting targets and tools and reacting to specific historical situations. After the foundation of PRC, China imitated the Soviet Union to build a centralized socialist political and economic system (Chung, 2003). It centralized the state power in terms of politics and accordingly implemented the command economy. This political and economic system established the dominant role of Chinese governments in urban development (Lv, 2003). With the further development of China's economy, the government-led model no longer meets the requirements. To bridge the gap between finance and urban infrastructure needs, the Chinese governments began to transform their functions (e.g., weakening their own role in urban development finance) and emphasized developing the market economy (e.g., introducing more parties to finance urban development). The public-private interface became increasingly important, and the influence of public or private players on urban development become either stronger or weaker depending on their control of various resources. Change in the roles of governments and market players mold the evolution in urban development finance in China. In other words, we can best look at this evolution as a path-dependent process, defined as 'how the set of decisions one faces for any circumstance is limited by the decisions one has made in the past, even though past circumstances may no longer be relevant' (Praeger, 2007).

In this paper, we adopted mainly qualitative research methods to demonstrate this path dependence in urban development financing in China. We also gathered relevant quantitative data to help understand the changes in funding vehicles. Data related to fixed asset investment, fiscal revenues and expenditures, and land concession revenues were collected from the websites of the National Bureau of Statistics and the China Land & Resources Almanac, while data related to PPP were gathered from the website of the Ministry of Finance. Various policies, notices, and local practices were obtained from scattered sources including academic publications, government web sites, public media, and other web-based reports (e.g., the World Bank Technical Assistance Report). With the help of these data, we reviewed the three stages of financial arrangements for urban construction and particularly focused on the third stage, which offered new insights into the emergence of bonds and PPP. Currently, bonds and PPP are two financial vehicles academics and practitioners hail particularly in China. The new rise of PPP since 2014 has not been fully explored, which encouraged us to dwell more on this new trend. Furthermore, we combined path dependence with the evolution of the financial arrangements for urban construction, enriching the existing literature on the topic.

The rest of this paper is organized as follows. It first reviews the existing academic literature on institutional path dependence (section 2) then dives into the evolution of financing vehicles for urban construction on the basis of the aforementioned developmental phases and further analyses the usefulness and robustness of these financing vehicles at each stage (section 3). Focusing on the advent of the new budget law and the national promotion of PPP, section 4 describes the latest trends. Section 5 presents the conclusions.

3.2 Institutional Path Dependence

North (1990) holds the view that the technical path dependence proposed by Arthur (1988) which explains the dominance of VHS video recorders over Betamax and QWERTY's

keyboards over those manufactured by Dvorak, can also be applied to the evolution of institutions. Institutional change is constrained by four kinds of increasing revenue: (1) the set-up costs for a new institution; (2) the learning effect related to the existing institutional framework, the web externalities and institutional matrix; (3) the coordination effect in complementary activities resulting from contracts with other organizations and political groups; and (4) the adaptive expectations. North argues that path dependence shows how institutional frameworks shape processes of mutation and selection and constrain future developmental options because of artificial lock-ins into particular existing institutional pathways. David (1994) notices the difference between technology and institution, but he believes that the three causes of path dependence (correlation of technology, economies of scale and irreversibility of investment) can be used to explain both. According to him, path dependence leads institutions to evolve gradually and due to constraints they do not normally provide effective solutions to the problem of resource allocation. Stark (1992) points out that institutional change is essentially evolutionary. He argues it should be seen as recombination and rearrangement of elements due to the emergence of new methods that are selectively absorbed.

As for the Chinese context, Lv (2003) analyses path dependence of institutional change in China in detail. He distinguishes three types. The first type of path dependence is influenced by the traditional culture. The second type is the path dependence influenced by the socialist system after the foundation of the PRC. The third type is the path dependence influenced by the gradual reform of China's economy. Wu (1995) holds the view that reform is one of the most significant institutional changes in contemporary China and the path dependence in this process is self-evident. He further states that the selection of institutions at the beginning reinforces the inertia of current institutions because it is more convenient to go along with the original institution than explore a new one. Moreover, vested interest groups would put pressure on new institutions. They try to consolidate current institutions and impede reform even if new institutions are more efficient. Mu et al. (2011) use path dependence theory to study the rise and fall of PPP in China. They argue that the adoption of PPP in China is a path-dependent process rather than aims at the optimal economic effects advocated by various multinational organizations.

Many researchers studied the evolution of China's economy from the perspective of path dependence. But few if any used path dependence to explain the evolution of urban development finance in China. This is our goal here. We apply path dependence to the evolution of urban development finance to grasp the possibilities and limitations of newly adopted financial arrangements currently in vogue.

3.3 Financial Arrangements for Urban Construction in Three Stages

3.3.1 The Stage of the Planned Economy (1949-1977)

In the period 1949-1977, China implemented its urban development policies with unified central allocation, which meant that money for local economic activities was determined by budgetary choices made by the central government. Consequently, fiscal appropriations were the only funding source for urban construction and it was impossible to invest any other type

of capital in the field of urban construction. At this stage, the central government played a planning role in the process of urban construction. Local governments were not the responsible parties for urban construction but rather the executors of the central government's economic plans. Public utilities were considered government investments and classified as urban fixed assets, listed under the item 'capital construction projects'. The money for the construction of public utilities was disbursed as national fiscal expenditure, and local governments carried out the construction as per the original plans made by the central government (Liu, 2011). Therefore, investments in infrastructure not only depended on the country's and city's fiscal status but also on their investment policies and plans.

At this stage, central government appropriations were the only source meeting the demand for China's urban infrastructure construction. Expenditure at this stage was very limited. During the period of the first five-year (1953-1957) and the second five-year plans (1958-1962), under the guidance of the thought of "manufacturing first, life second," the central government gave priority to developing basic manufacturing facilities over urban infrastructures. The ratio of investment in urban infrastructure to total investment in fixed assets dropped from 2.13% in the first five-year to 1.96% in the second five-year (Ba & Yang, 2014). Moreover, during the cultural revolution (1966-1976), the development of urban infrastructure even completely stagnated. However, afterward, China's economy began to recover, and most educated youth (zhi qing) headed back to cities followed by a growing share of the rural population in cities, which placed more strain on urban infrastructure again.

In this period, the whole society was operating under the relationship of superiors (the governments) and subordinates (citizens), which influenced the evolution of the urban development system. Against the backdrop of an almost pure command economy, the finance and investment of urban infrastructure was subordinate to and serving the state's heavy industry. The governments were responsible for all the arrangements in urban development. The main characteristics of this stage were 'administrative enforcement, plan-based arrangement, and market exclusion.' Investment choices were a natural outcome of the conflicts between the good vision of quickly recovering the domestic economy and the reality of a weak economic foundation, which proved to have a positive meaning in that period. However, with the change of China's socio-economic status, following this road any further would not have allowed urban development finance to make any adjustments because appropriations from the central government were too limited to meet the high need for urban construction.

3.3.2 The Reform and Pilot Stage (1978-1993)

The period 1978-1993 is known as the reform exploration and pilot stage. Before the implementation of the reform and opening-up policy in 1978, China has experienced two waves of decentralization. One was the Great Leap Forward started in the late 1950s, and the other is the cultural revolution happened in the late 1960s. By the end of the cultural revolution, many financial resources had been decentralized and were under the control of local governments (Xu, 2011). After 1978, the central government began to improve roads, bridges and public utilities, which required enormous investments. Appropriations from the state treasury could no longer meet the growing needs for urban infrastructures. Therefore,

both the central government and local governments explored options to diversify funding sources for urban construction. At this stage, investments in urban development had undergone profound changes: the central government was not the only funding party anymore, but local governments, state-owned enterprises, collective enterprises, urban and rural residents, and foreign investors also became significant investors. Accordingly, a new funding pattern with multiple investment channels (e.g., fiscal revenue, self-raised money, domestic bank loans, project finance, build-own-transfer (BOT) and foreign capital) was established, which enhanced the marketization of funds for urban construction and mobilized a greater variety of parties.

In terms of fiscal revenue, the central government introduced new taxes and raised tax rates to increase local government's fiscal revenues and implemented special purpose taxes (e.g., urban maintenance and construction tax[1]) to ensure the funding sufficiency for special projects. Meanwhile, some cities began to raise money for the construction of bridges, roads, and energy through charging fees (e.g., tolls and capacity-bulking costs) from infrastructure users. Some cities even tried to charge higher fees from public utilities and service users, such as raising bus fares, water rates, electricity rates, etc. However, the scope of these sources and their impact on urban infrastructure investment were still limited. Table 3-1 lists the impact of various national and local policies and practices on the funding sources for urban construction.

In addition, in this period, cities made use of foreign and domestic private capital for urban construction for the very first time. In 1984, Guangdong province explored 'BOT' (Build-Operate-Transfer) by cooperating with Hongkong Hopewell Holdings Limited Company and other private Chinese companies. In 1986, Shanghai carried out a 'nine four special project' program (jiu si zhuan xiang), which became known as 'self-borrow, self-repay' (zi jie zi huan), with Shanghai municipality itself becoming responsible for loans and their repayment. With the aid of this program, Shanghai municipality directly raised $3.2 billion from other countries, of which 40% was used for urban infrastructure construction. In 1995, the Guangxi Laibin Power Plant (B) was the first BOT pilot project that was approved at the national level. Since then, the Ministry of Foreign Economic Relations and Trade[2] took measures to standardize the utilization of BOT.

[1] In 1985, the state council issued 'Interim Regulations for Urban Maintenance and Construction Tax of the People's Republic of China' to strengthen urban maintenance and construction and to expand and stabilize financial sources for urban maintenance and construction.

[2] It was incorporated into the Ministry of Commerce of the People's Republic of China in 2003.

Table 3-1 National and local policies and practices

Year	Policies/Practices	Effects
1979	Investment in infrastructure changed from fiscal appropriation to debt finance.	Treasuries have been readopted as a financial vehicle for raising money, broadening the funding sources for infrastructure construction.
1980	Central government began implementing the fiscal system reform, namely, 'dividing revenues and expenditures between the central government and local governments, implementing responsibility contracts at various government levels' (hua fen shou zhi, fen ji bao gan)[3].	It decreased the central government's revenues and weakened its macro-control ability, but also enabled local governments to arrange their financial affairs more freely than before.
1982	Shenzhen first started to collect land use fees.	Land use fees were used for urban infrastructure construction.
1983	Financial decentralization (jin rong fen quan)	It provided a favorable marketing context for exploring multiple ways to finance.
1985	Central government began to collect taxes instead of profits, canceled business taxes and surcharges, maintenance fees and 5% tax on industrial and commercial profits and collected urban maintenance and construction tax.	Urban maintenance and construction tax provided earmarked funds for urban construction.
1987	Shenzhen took the lead in carrying out land use right concession policies.	Transferring land use rights in profitable ways became one of the most important financial sources for urban infrastructure development.
1988	The 'multi-type responsibility system' (duo zhong bao gan zhi du) was introduced.	It led to a widening gap between regions in terms of fiscal revenues, influencing the balance in economic development among regions.

[3] Since 1980, the Ministry of Finance adopted a new mechanism, known as 'dividing revenues and expenditures between the central government and local governments, implementing responsibility contracts at various government levels'. This mechanism clearly defines the scope for revenue and expenditure between the central government and local governments. It ratifies the base quota of local governments' responsibilities on the basis of each local government's fiscal revenues and expenditures in 1979. Cities whose revenues exceeded their expenditures needed to turn over a certain percentage of revenues to the central government. Contrarily, for cities whose revenues were below their expenditure, the central government left a certain percentage of the business taxes to local governments as an adjustment in their revenues. The central government supplied quota subsidies to those cities that were still unable to cover their expenditures when they retained all their business tax. The revenue-sharing ratio or subsidy quota was kept unchanged for 5 years after it was approved. Local governments could spend more if their revenues were high and spend less if their revenues were low. The central government would not offer subsidies to local governments within 5 years; they themselves had to keep a balance between their revenues and expenditures.

Since the 1980s, the construction of urban infrastructure in China has attracted attention from local governments and other parties, leading to an increase of the investment in fixed assets year by year. In 1993, the total investment in fixed assets was 1307.23 billion CNY, 13.6 times as much as the investment in 1981 (see Table 3-2). According to a document compiled by the National Bureau of Statistics, there are five sources for investment in fixed assets: state budget, domestic loans, foreign investment, self-raising funds and other sources[4]. From the table, it can be learned that the ratio of the state budget to total investments in fixed assets decreased from 28.1% in 1981 to 3.7% in 1993. Conversely, the ratio of self-raising funds and other sources grew steadily from 55.4% in 1981 to 65.5% in 1993. The growth of self-raising funds and other sources was mainly invested in profitable industries. Yet the investment in quasi-operational and non-operational projects[5] came still mainly from government sources. In addition, domestic loans were one of the main funding sources for investments in fixed assets, which increased from 12.7% in 1981 to 23.5% in 1993. In 1993, fiscal decentralization also reached its peak (Xu, 2011), the proportion of local fiscal revenue to national revenue was 78% (NationalBureauofStatistics, 2016).

Table 3-2 Investment amount and financial sources of fixed assets from1978 to 1993[6]

Unit: in billion CNY

	State Budget (appropriation)		Domestic Loans		Foreign Investment		Self-raising Funds and Others		
Year	Amount	Ratio (%)	Amount	Ratio (%)	Amount	Ratio (%)	Amount	Ratio (%)	Total
1981	26.98	28.07	12.20	12.69	3.64	3.78	53.29	55.45	96.10
1982	27.93	22.70	17.61	14.31	6.05	4.92	71.45	58.07	123.04
1983	33.97	23.75	17.55	12.27	6.66	4.65	84.83	59.32	143.01
1984	42.10	22.97	25.85	14.10	7.07	3.86	108.27	59.07	183.29
1985	40.78	16.03	51.03	20.06	9.15	3.60	153.36	60.30	254.32
1986	45.56	14.60	65.85	21.10	13.73	4.40	186.92	59.90	312.06
1987	49.66	13.10	87.20	23.00	18.20	4.80	224.11	59.11	379.17
1988	43.20	9.28	97.78	21.01	27.53	5.92	296.87	63.79	465.38
1989	36.61	8.30	76.30	17.30	29.11	6.60	299.03	67.80	441.04
1990	39.30	8.70	88.55	19.60	28.46	6.30	295.44	65.40	451.75
1991	38.04	6.80	131.47	23.50	31.89	5.70	358.04	64.00	559.45
1992	34.75	4.30	221.40	27.40	46.87	5.80	505.00	62.50	808.01
1993	48.37	3.70	307.20	23.50	95.43	7.30	856.24	65.50	1307.23

Source: National Bureau of Statistics of China (1981-1993)

[4] Self-raising funds refer to as fixed assets companies receive funds which raised by enterprises and public institutions for fixed assets investment in the reporting period, including enterprises and public institutions' self-owned funds and funds raised from other companies but excluding various fiscal funds, foreign capital and money borrowed from various financial institution.

Others refers to as funds receive in the reporting period used for fixed assets investment except for the aforementioned funds, including raising funds from public, individual funds, donation funds and funds transferred from other companies.

[5] A quasi-operational project refers to a project has both profitable and non-profitable characteristics. As for the profitable part, it can be operated by a private company, while the non-profitable part, it can only be operated by the government.

A non-operational project is a project can only be operated by government due to its non-profitable characteristics.

[6] No recorded data exist for the period 1978-1980

The change in China's financial system and practices mentioned above broadened the funding horizon for urban development. Although this was typical of the marketization in the funding sources for urban construction, economic development in this period was still quite strongly plan-based (Laperrouza, 2008). The growth of the central government's fiscal revenue under the mechanism characterized with 'responsibility contracts at various government levels' (fen ji bao gan) dramatically decreased since its revenues depended on tax transfers from local governments. This weakened the central government's ability to control macroeconomic developments, widening the gap between the rich and the poor provinces and cities. To redress the imbalance, the central government began to implement the so-called tax sharing system reform, which opened a new financial era for urban development in China.

3.3.3 The Stage of the Socialist Market Economy (1994 to present)

The period from 1994 to the present is referred to as the era of the socialist market economy. In this period, the central government put more emphasis on research to improve investment and financing structures for infrastructure projects, which accelerated reforms in the system. Since 1996, the central government has issued a series of regulations to standardize investment practices in urban infrastructure construction. In December 2001, the State Planning Commission issued the 'Opinions of the State Planning Commission on Promoting and Guiding Private Investment,' which called on local governments to create an environment for fair competition for private investors and to promote the development of private investments in general. It also encouraged and supported the participation of private capital in the construction of infrastructures and public welfare projects in the form of sole proprietorship, cooperation, joint ventures, equity participation, and franchising. For example, megacities like Beijing, Shanghai, and Shenzhen explored new financial arrangements for infrastructure construction by employing the 'government guidance, social participation, and marketing operation' [7] mode. Since then, diversification of financing channels for infrastructure construction has been firmly established.

As shown in Table 3-3, the total investments in fixed assets have skyrocketed since 1994. The proportion of domestic loans and foreign investments to the total investments were decreasing, while the ratio of self-raising funds and others to the total investments were increasing the most from 64.68% in 1994 to 83.77% in 2015. This was partly because some Chinese companies active in urban infrastructure development (often public utilities) went public and became listed on stock exchanges (including the Shanghai and Shenzhen stock exchanges) in this period. In the beginning, listed companies were mainly in the taxi business, e.g., Shanghai Pudong Dazhong Taxi Co., Ltd.[8], and Shanghai Dazhong Taxi Co., Ltd.[9] Later on, other public utility companies in the fields of energy, water supply, heat supply, power supply and

[7] Government guidance refers to governments being responsible for planning and decision-making at the macro-level. Social participation requires various social parties to invest in infrastructure construction.
Marketing operation aims at optimizing resource allocation on the basis of considering the balance between supply and demand and the elasticity of demand.

[8] Now it is known as Shanghai Dazhong Public Utilities (Group) Co., Ltd.

[9] Now it is known as Dazhong Transportation (Group) Co., Ltd.

public transportation were also listed on stock exchanges. In this period, asset-backed security[10] also became a funding source for urban construction.

Table 3-3 Investment amount and financial sources of fixed assets since 1994

Unit: in billion CNY

Year	State Budget (appropriation)		Domestic Loans		Foreign Investment		Self-raising Funds and Others		Total
	Amount	Ratio	Amount	Ratio	Amount	Ratio	Amount	Ratio	
1994	52.96	2.97	399.76	22.42	176.90	9.92	1153.10	64.68	1782.72
1995	62.11	3.03	419.87	20.46	229.59	11.19	1340.92	65.33	2052.49
1996	62.59	2.68	457.37	19.58	274.66	11.76	1541.24	65.98	2335.86
1997	69.67	2.76	478.26	18.93	268.39	10.63	1709.65	67.68	2525.97
1998	119.74	4.17	554.29	19.30	261.70	9.11	1935.98	67.42	2871.71
1999	185.21	6.22	572.59	19.24	200.68	6.74	2016.97	67.79	2975.46
2000	210.95	6.37	672.73	20.32	169.63	5.12	2257.74	68.19	3311.04
2001	254.64	6.70	723.98	19.06	173.07	4.56	2647.01	69.68	3798.70
2002	316.10	7.02	885.91	19.67	208.50	4.63	3094.19	68.69	4504.69
2003	268.78	4.59	1204.44	20.55	259.94	4.43	4128.47	70.43	5861.62
2004	325.49	4.37	1378.80	18.49	328.57	4.41	5423.63	72.74	7456.49
2005	415.43	4.39	1631.90	17.25	397.88	4.21	7013.88	74.15	9459.09
2006	467.20	3.93	1959.05	16.47	433.43	3.64	9036.02	75.96	11895.70
2007	585.71	3.88	2304.42	15.28	513.27	3.40	11676.97	77.43	15080.36
2008	795.48	4.35	2644.37	14.46	531.19	2.90	14320.49	78.29	18291.53
2009	1268.57	5.07	3930.28	15.71	462.37	1.85	19361.74	77.38	25022.97
2010	1301.28	4.55	4402.08	15.40	470.36	1.65	22404.20	78.40	28577.92
2011	1484.33	4.29	4634.45	13.39	506.20	1.46	27973.44	80.85	34598.42
2012	1895.87	4.63	5159.35	12.59	446.88	1.09	33465.47	81.69	40967.57
2013	2230.53	4.54	5944.20	12.09	431.94	0.88	40554.58	82.49	49161.25
2014	2674.54	4.92	6522.10	12.00	405.29	0.75	44746.12	82.33	54348.06
2015	3092.43	5.29	6105.40	10.45	285.45	0.49	48936.60	83.77	58419.88

Source: National Bureau of Statistics of China (1994-2015)

However, the most influential financial events include the (1) tax sharing system reform; (2) land concessions; and (3) urban development and investment corporations (UDICs).

The tax sharing system reform

The tax sharing system is a fiscal management system, which separates central and local revenue sources in accordance with certain tax categories (Ba & Yang, 2014). The tax sharing system reform was introduced as a top-down tax reform promoted by the central government in order effectively to deal with the allocation of financial rights and responsibilities between the central government and local governments. Under the tax sharing system, the tax was divided into central taxes, local taxes, and taxes shared by the central and local governments. This reform, on the one hand, increased the central government's fiscal revenues and

[10] According to the definition given by wikipeida, an asset-backed security is a security whose income payments and hence value is derived from and collateralized (or "backed") by a specified pool of underlying assets.

improved its macro control capacity and the transfer payment system. On the other hand, the local government's tax revenues decreased while the responsibilities they had to shoulder were not reduced, which widened the gap between the local government's fiscal revenues and their expenditures (Ba & Yang, 2014; Bird, 2005).

Figure 3-1 lists the effects brought about by the 1994 tax sharing system reform on the central and local fiscal revenues. Before the reform, namely, during the period between 1989 and 1993, the proportion of local fiscal revenues to national fiscal revenues took up around 70% in 1989, and it even reached 78% in 1993. After the reform, with the transfer of the tax collection rights from local governments to the central government, the central government's fiscal revenues increased year by year while the local government's fiscal revenues began to decrease, which was especially notable in 1994. Local fiscal revenues declined from 78% in 1993 to 44% in 1994, while the central fiscal revenues jumped from 22% in 1993 to 56% in 1994. This change made local governments run short of fiscal resources to spend on local affairs, especially urban construction projects.

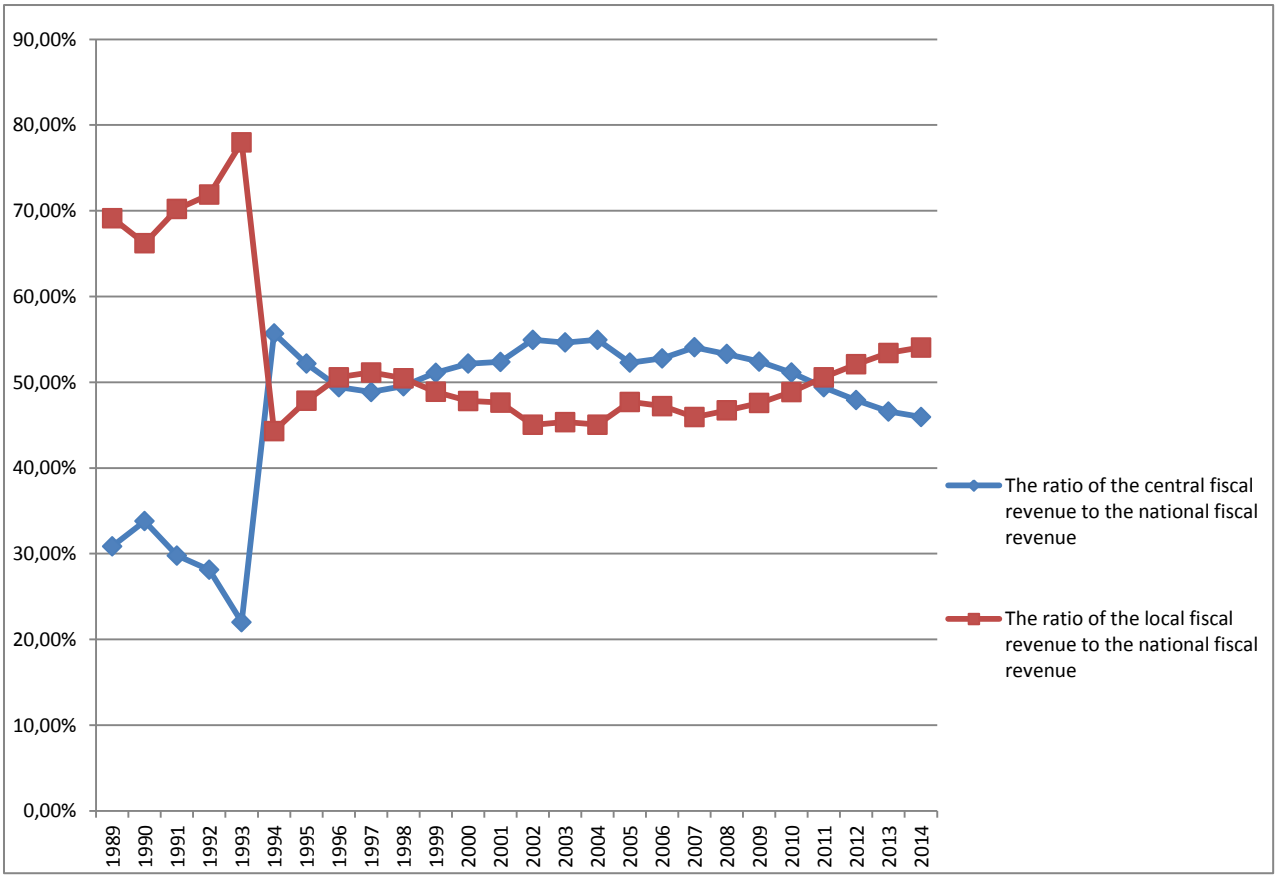


Figure 3-1 Changes in the ratio of central fiscal revenues to local fiscal revenues before and after 1994

Source: National Bureau of Statistics of China (1989-2014)

Table 3-4 shows the change in the difference between the local fiscal revenues and expenditures before and after the tax sharing system reform. Before the reform, the gap between local revenues and expenditures was not significant, varying from minus 10 billion to plus 10 billion CNY. After the reform, the gap began to increase year by year; the deficit

amounts increased from 172.66 billion CNY in 1994 to 5.32 trillion CNY in 2014. Rapid urbanization made this widening gap painfully visible (Ba & Yang, 2014; Wu, 1999). These contradictory tendencies led local governments to face a huge challenge in meeting their financial needs. Therefore, local governments turned their eyes to local taxes since they are the key sources of local revenues (see Figure 3-2). Yet many local taxes are related to land, which mobilized local government's enthusiasm to implement land concessions.

Table 3-4 Evolution of local fiscal revenues and expenditures before and after 1994

Unit: in billion CNY

Year	Local fiscal revenues	Local fiscal expenses	Differences
1989	184.24	193.50	-9.26
1990	194.47	207.91	-13.44
1991	221.12	229.58	-8.46
1992	250.39	257.18	-6.79
1993	339.14	333.02	6.12
1994	231.16	403.82	-172.66
1995	298.56	482.83	-184.28
1996	374.69	578.63	-203.94
1997	442.42	670.11	-227.68
1998	498.40	767.26	-268.86
1999	559.49	903.53	-344.05
2000	640.61	1036.67	-396.06
2001	780.33	1313.46	-533.13
2002	851.50	1528.15	-676.65
2003	985.00	1722.99	-737.99
2004	1189.34	2059.28	-869.94
2005	1510.08	2515.43	-1005.36
2006	1830.36	3043.13	-1212.78
2007	2357.26	3833.93	-1476.67
2008	2864.98	4924.85	-2059.87
2009	3260.26	6104.41	-2844.16
2010	4061.30	7388.44	-3327.14
2011	5254.71	9273.37	-4018.66
2012	6107.83	10718.83	-4611.01
2013	6901.12	11974.03	-5072.92
2014	7585.96	12921.55	-5323.19
2015	8300.20	15033.56	-6733.36

Source: National Bureau of Statistics of China (1989-2015)

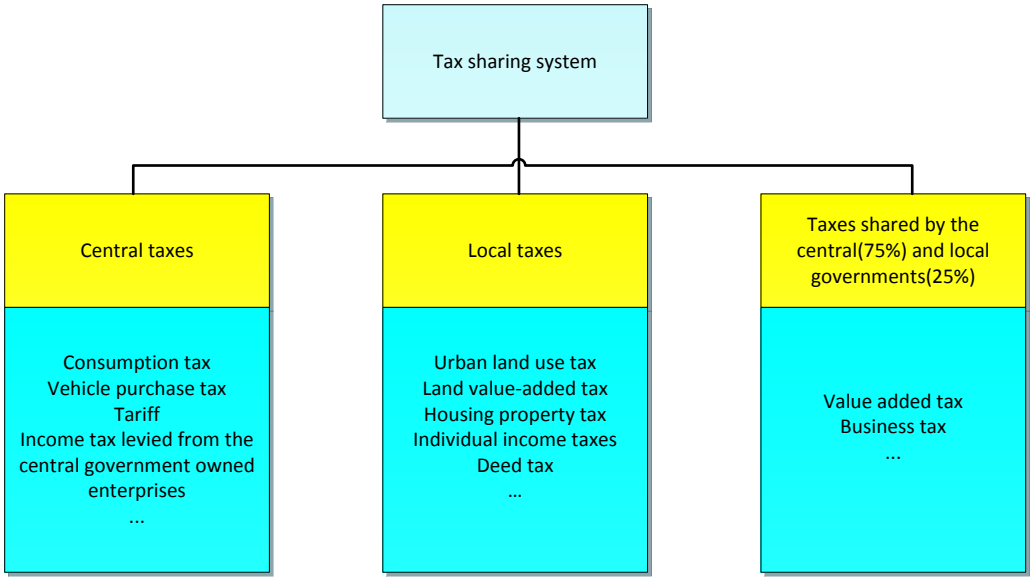


Figure 3-2 The tax sharing system

Land concessions

Local governments directly or indirectly control the vast majority of urban infrastructure projects. However, under the conditions of the current tax sharing system and the absence of inheritance tax and gift tax, the traditional fiscal distribution system taking the budget revenues as the local governments' core funding source no longer meets local governments' financial needs for urban construction. In response to this new scarcity, local governments have begun to raise money through land concessions. In addition, after the implementation of the tax sharing system, many local taxes exclusive to local governments are related to land concessions (e.g., land value-added tax), which provides stimuli for local governments to promote land finance.

In the early 1990s, with the further reform of the urban land use system, the real estate industry became increasingly prosperous. In this context, cities urgently needed urban infrastructures to match the development of their real estate. Due to their financial limitations, many local governments allowed real estate developers to construct auxiliary facilities. The return for the developer's investment in auxiliary facilities was obtaining the concession to use land, an arrangement known as 'land finance.'

In this century, especially since 2003, with the establishment of the 'bidding-auction-listing'[11] transfer system for profit-oriented land and the heating up of the urban housing and land market in most cities (Su & Zhao, 2007), land, as the local government's greatest resource, became more and more valuable and brought enormous land dividends for local governments. On the one hand, as the direct reflection of these land dividends, local governments' revenues from land concessions kept growing with the rise in land prices and reached new records year on year. In fact, they evolved into the most significant component of off-budget revenues for

[11] The bidding-auction-listing transfer system refers to the four methods to transfer land use rights in China, i.e. bidding, auction, listing and agreement transfer. The provision on transferring state-owned land use rights through bidding-auction-listing issued by the ministry of land and resources stipulated that profit-oriented land should be transferred to the public through bidding, auction, listing or agreement transfer.

local governments. In 2001, local fiscal revenues were at 780.33 billion CNY, of which 129.7 billion CNY were from land concessions. The proportion of land concession revenues to the local government's fiscal revenues was 16.62% in 2001 and reached 40.55% in 2015 (see Figure 3-3). Although overall, the proportion of land concession revenues increased in this period, it went through peaks and troughs. The trough in 2008 resulted from the financial crisis. In 2010, land concession revenues reached their peak, being influenced by a significant increase in the scale of land supply, the ratio of 'bidding-auction-listing land,' and the land prices around the country. Since 2013, the land concession revenues increased slowly and even started to decrease. Slower economic growth was the main reason. Furthermore, real estate developers were more cautious when purchasing land because of possible oversupply. The government began to adopt regulatory policies to curb this oversupply. On the other hand, as an indirect reflection of land dividends, local governments increased their debt financing ability with the increase of land prices (Anderson, 2009; Cao, Feng, & Tao, 2008). The combination of 'land concession revenue' and 'land mortgage loan' became an important financing model for local governments to raise money for urban construction. Meanwhile, the investment in infrastructure stimulated the growth of local economies and improved the quality of urban life, which further promoted the rise in land prices. It created conditions for local governments to raise more money from banks (Pu & Wang, 2014). The positive feedback loops between land finance and infrastructure investment are the core of the finance and investment model for urban construction in recent years. However, this model has various drawbacks. Land concessions generate higher revenues for local governments and help them solve the financial deficiency problem, so local officials tend to sell land for political reasons. This behavior actually overdrafts future land revenues since the following 70 years land concession fees are one-off collected in advance by local governments and spent during their tenure, which improves current official's political performance but impairs their successors' benefits. Meanwhile, local governments expropriate land from farmers at a low price but sell them at a high price, which not only harms farmers' interests but also pushes up housing prices and hence creates more social conflicts. This new system is unlikely to change in the short term. Due to the various stakes at play, Wu (1995) sketches how the presence of specific institutions at the beginning reinforces inertia. This is because it is more convenient for local governments to go along with the original path than to explore a new path. Therefore, officials do not have strong incentives to change the land finance mechanism since the institutional change costs are high, and the results are uncertain (e.g., if the change fails, the result would affect the official's performance and thus influence their promotion possibilities).

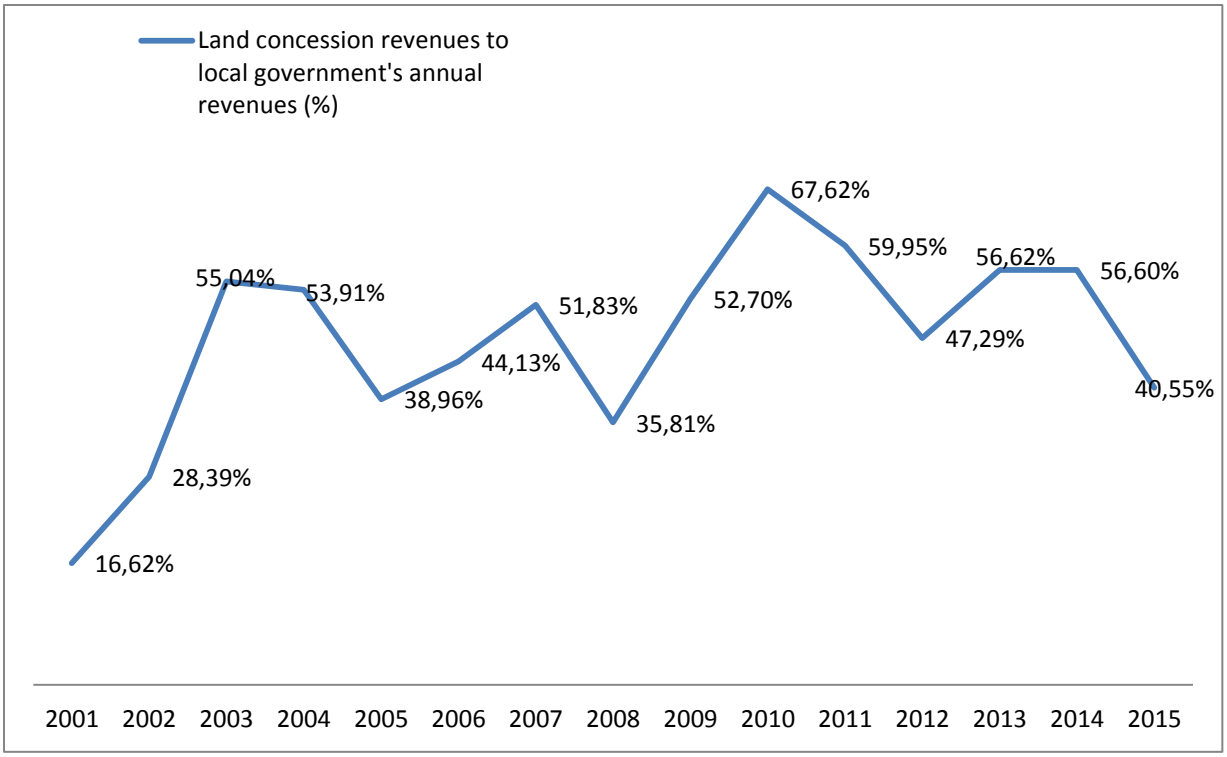


Figure 3-3 Land concession revenues to local government's total annual revenues (%) between 2001 and 2015

Sources: National Bureau of Statistics of China and China Land & Resources Almanac (2001-2015)

UDICs

According to the Budget Law of the People's Republic of China issued in 1994, local governments are not allowed to issue local government bonds, except as otherwise stipulated by law or the State Council. The legal restriction and poor financial status of local governments have led to a lack of investments in urban construction. Therefore, to bypass these legal constraints, UDICs have been founded to help local governments borrow money from the market and quickly develop public facilities (TheWorldBank, 2010b). Local governments usually use public resources (e.g., land use rights) or pack the best quality assets of state-owned companies as initial capital to set up UDICs. Some provide services such as water and gas supply as well as road and bridge construction to generate cash flows; some do not have revenues (e.g., helping build streets); and even some are just "empty-shell" corporations helping local governments to borrow money from banks (Liu & Salzberg, 2012). Therefore, different levels of UDICs (e.g., municipality- and county-level) are set up for different purposes. These companies are founded under the Company Law of the P. R. C., but the law does not define the relationship between UDICs and local governments (TheWorldBank, 2010b), which raises serious concerns about the potential risks caused by the extensive use of UDICs to borrow extra-budgetary loans for infrastructure (NationalAuditOfficeofPRC, 2013). With the land use right as well as financial subsidies, UDICs were easily able to obtain loans from banks since it is commonly believed that government-backed loans are creditworthy (Ba & Yang, 2014). The appearance of UDICs made the article 'not to allow local governments to be indebted' a mere scrap of paper. Instead, it is now common to see the existence of many highly (indirectly) indebted local

governments. This has also given rise to distorted views of liability among many local officials; they are not concerned about these loans since these will often have to be repaid by their successors well after they themselves have been promoted elsewhere. The mismatch between local officials' debt liability and their personal interests encourages local governments blindly to borrow money. For local officials, the more money they borrow, the more likely they are to be promoted because they have more money to help them speed up urban construction and boost local GDP (Wu et al., 2015). This mechanism can at least partly explain why local officials have strong incentives to borrow even if this is forbidden by the budget law.

In addition, after the 2008 financial crisis, the central government introduced policies to support local governments to enlarge the number of financing channels and encourage them to provide matching resources to support a 4 trillion CNY investment plan. This led to a rapid increase in the number of UDICs and their debt amounts. There were more than 10,000 UDICs in total throughout the nation by the end of 2010, 25% more than the number at the end of 2008 (People'sBankofChina, 2011). The increase in UDICs helped local governments raise money for urban construction but also created new problems. For example, the debt balance UDICs were responsible for increased to 4.08 trillion CNY by the end of June 2013 (NationalAuditOfficeofPRC, 2013), which was equal to one-twelfth of China's GDP (51.9 trillion CNY) in 2012. A part of the debts was not completely covered by collaterals (NationalAuditOfficeofPRC, 2013). Since the money borrowed through UDICs is mentioned on local governments' off-balance-sheet, it is obviously difficult to spot due to the near-complete absence of the information on loans (Feng, 2013; Wong, 2013; Xu, 2015). No supervisory agency was assigned to monitor UDICs' financial status and activities (Feng, 2013; Wong, 2013), increasing the repayment risks. Furthermore, local governments heavily rely on land concession revenues or new loans to repay their debts (NationalAuditOfficeofPRC, 2013). This is not sustainable because land resources are limited and the growing financial burden causes a snowball effect on interests. Therefore, controlling the debt and reducing the chance of occurring a debt crisis are crucially important issues for the central government, paving the way for the introduction of municipal bonds and PPP.

Overall, the investment and financing model for urban construction in China has gradually shifted from an early stage characterized as completely controlled by the central government to a market-based financing model that makes use of both fiscal funds and private capital. Yet governments are still playing a dominant role in infrastructure investment. Accordingly, a fully diversified investment model which involves various capital sources has not yet been established.

Local governments have changed their role from command to guidance, and hence the market has grown increasingly important. Urban development finance at this stage is characterized as a combination of 'government guided and market-driven operation,' which had both positive and negative influence on urban development. On the one hand, it spurs the development of urban infrastructure. On the other hand, it has activated a lock-in effect where private sector enthusiasm to invest in infrastructure cannot be fully mobilized. It also generated many side effects, such as high indebtedness and unsustainable land finance.

3.4 New Trends in Financing Urban Construction

PPP is an arrangement to incorporate the private sector into develop infrastructure or deliver public services for the public sector (Delmon, 2011). With the new 'Budget Law' enacted in 2014 and the nation-wide promotion of PPP by the central government, a new trend in financing urban development has emerged. With the new 'Budget Law' enacted in 2014 and the nation-wide promotion of PPP by the central government, a new trend in financing urban development has emerged.

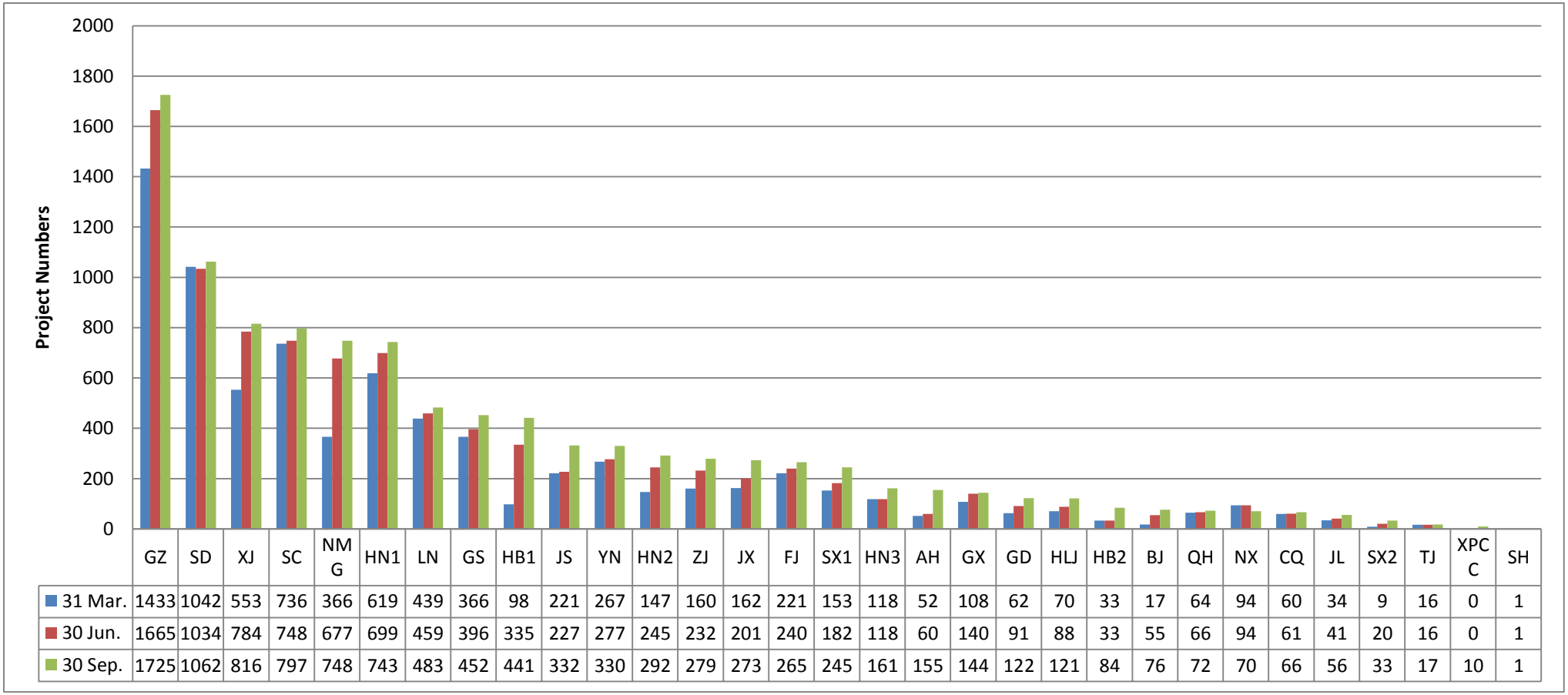
The old budget law stipulated in article 28: "local governments at various levels shall prepare their budget in accordance with their revenues, and the balance of revenues and expenditures shall not have deficits. Local governments are not allowed to issue local government bonds, except as otherwise stipulated by law or the State Council." This clause constrained local governments in getting loans from banks. In the second half of 2011, the State Council chose four financially strong authorities (Shanghai, Zhejiang province, Guangdong province, and Shenzhen) as pilots to start issuing bonds by themselves, which was viewed as the starting point for issuing local government bonds. In 2014, the new budget law was issued. Article 35 of the new budget law, for which article 28 of the old budget law was taken as a point of departure, stated: 'the local governments at various levels shall prepare their budget in accordance with their revenues and the principle of balance of revenues and expenditures and shall not have deficits, except as otherwise stipulated by law'. This new article replaced the phrase 'local governments are not allowed to issue bonds': local governments could from then on raise money by issuing bonds without breaking the law. The new budget law provides a new solution for Chinese governments in arranging money for urban construction since issuing bonds under the legal framework makes the risks local governments face transparent to the central government and thus keeps debts at controllable levels (Bellier & Zhou, 2003; Krumm & Wong, 2002; Tang, Shen, & Cheng, 2010) .

In addition, PPP has begun to attract the Chinese central government's attention again. PPP is not a new financing vehicle in China, but it offers new hope for Chinese governments when it comes to handling debt crises (Thieriot & Dominguez, 2015). Looking at PPP's timeline in China, it has gone through a rise-fall-rise evolution since 1993. From 1993 to 2007 PPP was on the rise, mainly due to growing demand for transport services and limited infrastructure capacity along with a global trend to apply privatization and liberalization philosophies to infrastructures; however, PPP in China began to fall from 2007 onwards, because many private contractors appeared unable to deliver a final product at reasonable conditions (de Jong et al., 2010; Mu et al., 2011). PPP has begun to see a new rise since 2014. Many notices/guides/opinions were first issued at the national level to advocate and regulate the implementation of PPP across the country (see table 3-5). Later, Fujian province, Anhui province, Jiangxi province, Henan province, Shandong province, Jiangsu province, Hebei province, Hunan province, Sichuan province, and Zhejiang province in succession issued provincial PPP documents based on the national documents issued by the Ministry of Finance (MoF) and the National Development and Reform Commission (NDRC). To echo the central government's policies, PPP projects were launched. Figure 3-4 shows the PPP projects each province launched in March, June, and September 2016, in an upward trend. At the end of

September 2016, 10471 projects were registered at the Ministry of Finance (MOF, 2016a). PPP offers more opportunities for private capital to get access to urban construction, which diversifies local governments' funding sources and reduces their financial burden. Second, PPP is conducive to the integration of social resources and the revitalization of the stock of social capital, which further increases economic growth dynamics and the transformation and upgrading of local economies. PPP could also promote the reform of the fiscal and taxation system, making local governments pay more attention to long-term financial planning. Yet there are problems local governments should pay attention to. It should be noted that private finance should be repaid at some future point. There are three repayment forms, including user-based, government-based, and government-and-user-based repayments. Figure 3-5 is the numbers of PPP classified based on the repayment forms launched in March, June, and September 2016. PPP arranged through user-based repayment indicates that the initial investments should be repaid by users, expanding the funding sources for local governments. Government-based repayment does not provide extra money for local governments in that they have to repay the money at some future point. However, this form alleviates local government's financial burden in the short run and enables them to repay on an annual basis. Government-and-user-based repayment is a combination of user-based and government-based repayment, requiring local governments to pay back when the money collected from users is insufficient to meet the amount mentioned in the agreement. Government-and-user-based and user-based repayment forms together account for 76% of the total amount of registered PPP projects (see figure 3-6), indicating PPP certainly helps the Chinese governments expand their funding sources. However, one common problem with PPP in China is that the government promotes the use of private capital to boost the modernization of infrastructures, but fails to create conditions for improving market conditions (Beh, 2010).

Table 3-5 PPP documents issued by MOF and NDRC

Issue date	Notices/Guides/Opinions	Issued by	Highlights
23 Sept. 2014	Notice of related issues regarding the promotion and application of Public-Private Partnership	MOF	MOF advocates carrying out PPP nationally and requires parties to actively promote PPP pilot projects and form an institutional framework as soon as possible. It is a framing and agenda-setting document.
29 Nov. 2014	Notice of operation guidance (trial) for Public-Private Partnership	MOF	This notice drafts specific guidelines for PPP operation from five angles: project identification, project preparation, project procurement, project implementation and project transfer.
30 Nov. 2014	Notice of related issues regarding the implementation of pilot public-private partnership projects	MOF	The notice issues the first batch of PPP demonstration projects, including 30 projects in 15 provinces and cities covering the field of urban rail transportation, sewage treatment, water and heating supply, environmental governance and so on.
2 Dec. 2014	Opinions on Carrying out Public-Private Partnership	NDRC	NDRC advocates carrying out PPP nationally and requires parties to actively promote PPP pilot projects and clearly state project scope, operations, working mechanisms and policy guarantees. It is a framing and agenda-setting document.
2 Dec. 2014	General Contract Guidelines for Public-Private Partnership Projects (2014)	NDRC	This is a contract manual for PPP projects, including contact subject, contract relationship, project preliminary work, revenue and return, force majeure and law modification, contract termination, default management, dispute settlement and other terms.
30 Dec. 2014	Notice regarding standardized management of public-private partnership contracts	MOF	This document provides guidelines and clues for standardization of PPP contracts.
31 Dec. 2014	Notice on government procurement measures on public-private partnership contracts	MOF	This document aims to generalize PPP models and standardize government procurement practices, stipulating the government's procurement process, dispute settlement, supervision, and inspection.
13 Feb. 2015	Notice regarding the introduction of public-private partnerships into the field of municipal public utilities	MOF	This is a framing document, mainly stipulating the goal, principles, requirements, implementation, and guarantees for the introduction of PPP projects in the fields of urban water supply, sewage treatment, garbage treatment, public transportation infrastructure, public parking lots, utility tunnel and other municipal public utilities.
10 Mar. 2015	Notice of related work regarding the promotion of development finance to support for Public-Private Partnerships	NDRC	This document provides opinions and guidelines for promoting developmental financial support for PPP projects.
7 Apr. 2015	Notice regarding guidelines for the proofing of financial capacity in public-private partnership projects.	MOF	This is a framing document, aiming to promote the implementation of PPP projects, to ensure contract enforcement and to prevent and control fiscal risks. It clarifies and standardizes the process for proofing financial capacity of PPP projects.



	GZ	SD	XJ	SC	NMG	HN1	LN	GS	HB1	JS	YN	HN2	ZJ	JX	FJ	SX1	HN3	AH	GX	GD	HLJ	HB2	BJ	QH	NX	CQ	JL	SX2	TJ	XPCC	SH
31 Mar.	1433	1042	553	736	366	619	439	366	98	221	267	147	160	162	221	153	118	52	108	62	70	33	17	64	94	60	34	9	16	0	1
30 Jun.	1665	1034	784	748	677	699	459	396	335	227	277	245	232	201	240	182	118	60	140	91	88	33	55	66	94	61	41	20	16	0	1
30 Sep.	1725	1062	816	797	748	743	483	452	441	332	330	292	279	273	265	245	161	155	144	122	121	84	76	72	70	66	56	33	17	10	1

Figure 3-4 Number of PPP projects each province launched in March, June, and September 2016

Source: MOF (2016a) and MOF (2016b)

Note: GZ-Guizhou, SD-Shandong, XJ-Xinjiang, SC-Sichuan, NMG-Neimenggu, HN1-Henan, LN-Liaoning, GS-Gansu, HB1-Hebei,JS-Jiangsu, YN-Yunnan, HN2-Hunan, ZJ-Zhejiang, JX-Jiangxi, FJ-Fujian, SX1-Shanxi (陕西), HN3-Hainan, AH-Anhui, GX-Guangxi, GD-Guangdong, HLJ-Heilongjiang, HB2-Hubei, BJ-Beijing, QH-Qinghai, NX-Ningxia, CQ-Chongqing, JL-Jilin, SX2-Shanxi(山西), TJ-Tianjin, XPCC-The Xinjiang Production and Construction Corps, SH-Shanghai

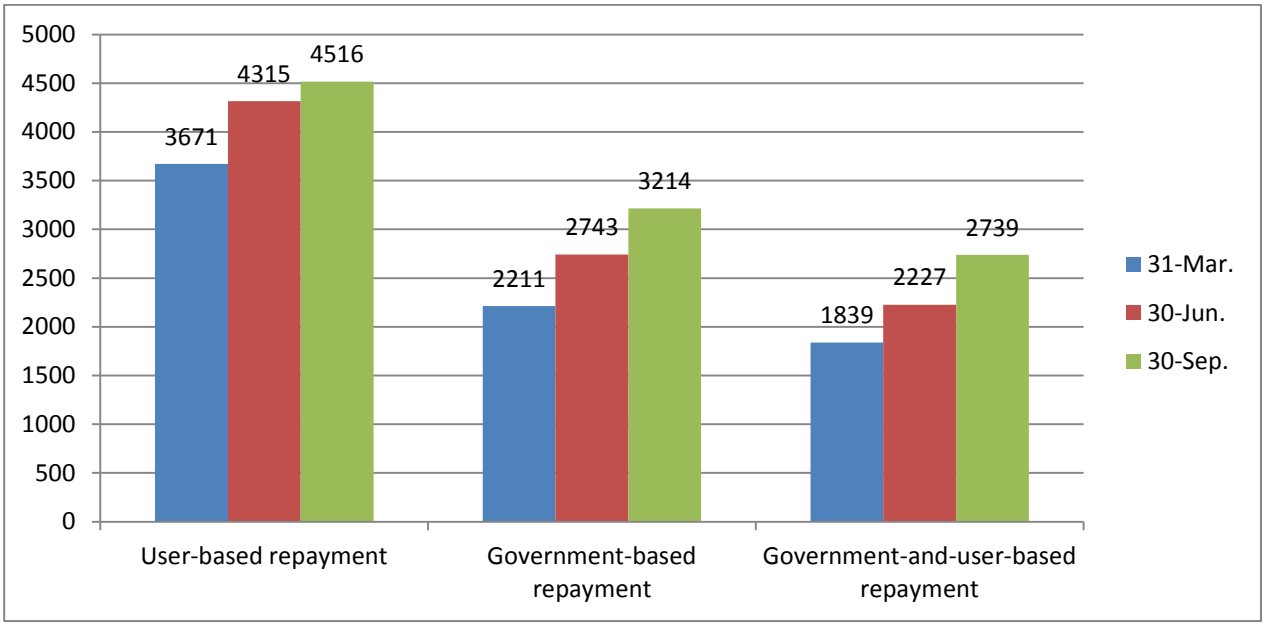


Figure 3-5 The number of each PPP type launched in March, June, and September 2016

Source: MOF (2016a) and MOF (2016b)

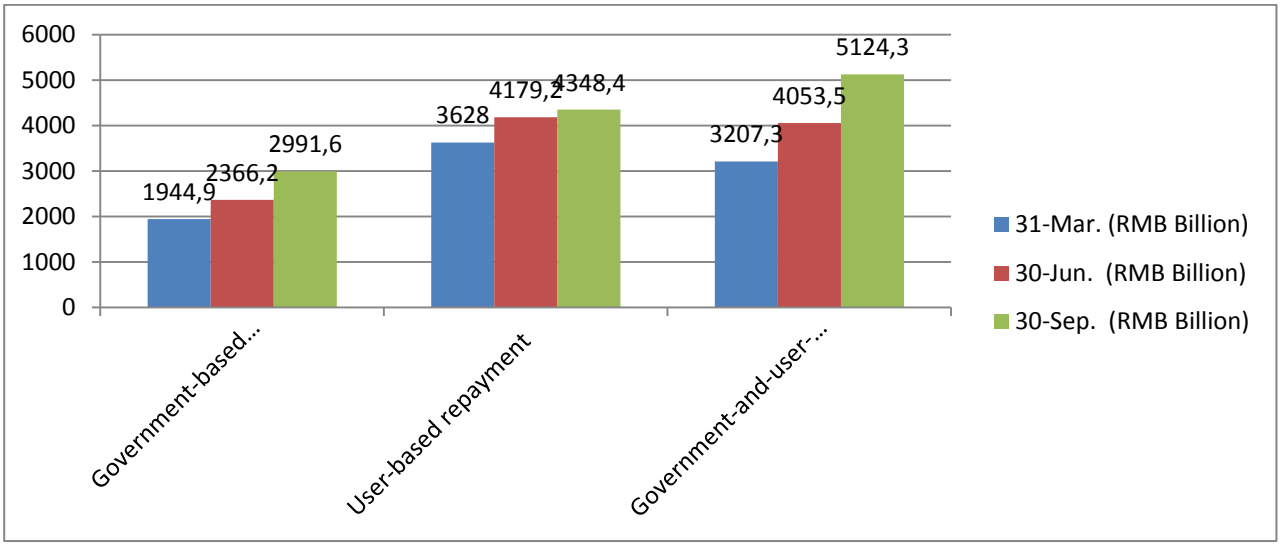


Figure 3-6 Investment amounts of each PPP type in March, June, and September 2016

Source: MOF (2016a) and MOF (2016b)

3.5 Conclusions and Implications

We have described the evolution of the financial arrangements in China for urban construction over time as a path-dependent process. Every new stage could be understood from increasingly poignant funding problems in a previous stage, institutional reforms in the fiscal system to deal with them and historical institutional lock-ins that led to workable

but suboptimal and only temporarily effective solutions. At each transition from stage to stage, a rebalancing act between Chinese governments and market players was performed. The selection of new paths for urban development finance and investment was a dynamic process, which reallocated and restructured factors of production (e.g., human resources, land, and capital) with the system growing increasingly complex and hard to control. Old financial gaps were filled, and new ones emerged. Path-dependent evolution steers urban finance in new directions each time, but these directions are influenced by historically inherited institutions that operate the system reform and thus take the shape of a new lock-in rather than an optimal solution (Xu, 2011).

At the end of the 1970s, the urban population increased dramatically due to the liberation of the rural labor force, which put forward new needs and wishes for urban infrastructure. All these factors challenged the central government and local governments in terms of their financial arrangements. Gradually, Chinese governments began to explore new financial vehicles for urban development. They levied new taxes, raised tax rates, made use of foreign capital and implemented responsibility contracts at various government levels to broaden fiscal revenues. Although implementing responsibility contracts at various government levels brought a variety of merits, it also created many headaches, including a slow-down in the constitution of an integrated market and a weakening of the central government's ability to control macroeconomic developments.

The above drawbacks along with the development of China's economy drove Chinese governments to adopt the tax sharing system, which dramatically reduced local governments' revenues and hence funds for urban construction. Land concessions and UDICs were adopted to cope with financial deficiencies in this period. These two financial vehicles gave an enormous boost to the development of China's urban infrastructure. Yet they can now also be viewed as unsustainable vehicles. First, land prices are more likely to fluctuate cyclically, which challenges the funding capacity of local governments. System risks will increase significantly if local authorities depend heavily on land revenues as a guarantee for bank loans. In addition, in the future, less and less land will be available for exploitation due to growing scarcity of land resources, an additional challenge to the robustness of the land finance formula. Second, borrowing money through UDICs has made local governments' debts opaque to the central government, which only adds to the unwieldiness of these debts. The central government cannot avoid having to find an answer to the very substantial indebtedness that local governments face. Moreover, repayment terms of bank loans are always shorter than those for bonds, as a consequence of which financial risks will increase if repayments are due in the same period. Cities would thus face a shortage of local fiscal revenue. Issuing local bonds can reduce local governments' installment amounts by dividing the total debts into longer repayment periods. However, local bonds are still in their infancy in China; many additional guidelines and regulations are still to be issued to support the new budget law in regulating the application of municipal bonds.

Limitations in the use of land concessions and UDICs will drive PPP to reach a new zenith in helping Chinese governments solve their indebtedness while continuing infrastructure expansion. Since 2014, MOF and NDRC have issued a host of guidelines to standardize local governments' procurement practices through PPP, thus creating a favorable policy environment for their application by local governments. By introducing private parties to urban construction, local governments can relieve their financial burden, at least in the short term. In addition, supporting measures (e.g., tax incentives) were taken to facilitate the implementation of PPP. Institutional change has the characteristics of a new lock-in constrained by pre-existing arrangements. The interests of the PPP stakeholders may be harmed due to the existence of an imperfect market, while isolated information feedback and high transaction cost cast a dark shadow over PPP being the answer to funding difficulties. Path-dependent evolution will steer the finance of urban infrastructure development in new directions once actors perceive the drawbacks of existing institutional arrangements as unsustainable and in need of further reform. Analyzing the evolution of financial arrangements for urban infrastructures as a path-dependent institutional process can help analysts and decision-makers spot and anticipate strengths and weaknesses in newly emerging arrangements and make realistic assessments of their viability and desirability.

4 Financing Sino-Singapore Tianjin Eco-city: What Lessons Can be Drawn for Other Large-scale Sustainable City-projects?

This chapter is mainly based on the following peer-reviewed article:

- Zhan, C., & de Jong, M. (2017b). Financing Sino-Singapore Tianjin Eco-City: What Lessons Can Be Drawn for Other Large-scale Sustainable City-projects? *Sustainability*, 9(2), 201

4.1 Introduction

Environmental degradation is widely considered one of the most serious challenges facing China today (Li et al., 2012a; Sek and Chu, 2017). The Chinese government has launched a variety of initiatives to promote the emergence of an 'eco-civilization,' one of which is the development of eco-cities. Ecocities have been defined as cities aimed at minimizing the need for energy, water, and other resources as well as the output of waste and pollution by applying green standards in transportation, buildings, and waste disposal equipment (Register, 2006; Roseland, 1997). Fleshing out this relatively abstract goal can take a variety of shapes, such as reducing the emission of GHGs, the greening of urban space, rationalizing the use of resources, and promoting alterations in the energy mix towards renewables (Perrone, 2014). China has put tremendous effort into developing green or sustainable cities in response to this global trend by embracing high numbers of nationally endorsed eco-cities, low carbon cities, and low carbon eco-cities (de Jong et al., 2013). Among these, Sino-Singapore Tianjin Eco-City (SSTEC) has attracted by far the most attention, both domestically and internationally, due to the extensive involvement of the

Singaporean government and its being embraced as a national flagship initiative in China (Caprotti et al., 2015; Low et al., 2009; UNEP, 2013). Moreover, Sino-Singapore Tianjin Eco-City is currently closest to completion (Rapoport, 2014), and tends to be regarded as a comparatively successful project when compared to other Chinese initiatives (Chang et al., 2016; de Jong et al., 2016). It is, therefore, all the more intriguing that so little is known about the funding sources and financial arrangements applied in SSTEC, since these may hold part of the key to making similarly massive sustainable urbanization projects financially viable. The literature on eco-city development covers a variety of aspects. Elements of policy-making, technology and technocracy, environmental and social impact, green buildings and incorporation of the next generation of urban infrastructures in the planning practice have all been dealt with (Caprotti, 2014; Lehmann, 2010; Rapoport, 2014). Technology-push in eco-city development is a common topic in the literature. It has been taken as a means to achieve sustainability goals in eco-cities because it attracts companies and inhabitants to locate in eco-cities (Geels, 2002; Joss & Molella, 2013). However, under the banner of green technology (e.g., smart utility grids and concentrated solar power), inhabitants are forced to pay higher costs for their use of facilities in eco-cities (Cugurullo, 2013; Joss & Molella, 2013), because green technology usually implies high initial investment costs. Without the input of inhabitants themselves, financial and other, follow-up operations in eco-cities face tremendous challenges (Gunawansa, 2011). Gunawansa (2011) has explored contract and policy challenges to developing eco-cities and found that the competing interests of sustainability, public acceptance, applicability of existing policy and legal architecture, and high development costs tend to be the key challenges. Many scholars argue that the main obstacles to the development of sustainable projects include governance (Dale & Naylor, 2005; Sabel, 2001) and the disconnect between different tiers of government (Bradford, 2003). van Bueren et al. (2012) suggest that an approach in terms of eco-systems is one of the most appropriate ones when dealing with problems regarding sustainable urban development. De Jong et al. (2013) argue that viable eco-cities need to consider factors like integrated approaches, system perspectives, long-term horizons, engagement of all relevant stakeholders, and transparency through information sharing. Miao and Lang (2015) find that strong international input of expertise and funds, as well as crucial support from the central government, are the main factors contributing to a better performance of SSTEC in comparison with Shanghai Dongtan eco-city. Various scholars also stress the importance of supporting policies, both legal, organizational and financial, in China (Miao & Lang, 2015; Pow & Neo, 2013), but also in Japan and India (van Berkel et al., 2009).

On the social front, the reporting on eco-city development generally and even SSTEC is more mixed. Caprotti (2014) argues that Tianjin Eco-city is not really an eco-city since it does not differ significantly from any other contemporary Chinese city. He also regards it as an empty city since the city consists of completed but not yet occupied residential blocks. Caprotti et al. (2015) state that the development of eco-cities is eco only for inhabitants but not for the landscape. The high-level political involvement promoting the development of Tianjin Eco-City brings criticism with it as well (Keeton, 2011) in that it is a key aim of the Tianjin Eco-City initiative to further collaboration between China and

Singapore in economic development. All in all, the literature on eco-city development in China and more specifically on SSTEC has become sizeable, but the aspect of finance is remarkably absent from it.

This does not mean, however, that the land for analyzing financial management of large urban development projects eco-city is completely barren. Sustainable urban development projects, especially those in China that revolve around the establishment of large new towns with green features, can well be considered mega-projects. Altshuler and Luberoff (2003) view urban development projects as mega-projects. SSTEC, a city built on saline and alkaline land, is definitely a mega-project in that sense, which covers transportation, housing, and infrastructures like hospitals and schools. A great number of studies have been conducted on funding mega-projects, covering wind technology (Corsatea et al., 2014; Olmos et al., 2012), eco-systems and communities (Luzadis et al., 2001; van Dijk et al., 2014) and new electric generation projects (Caplan, 2012). In line with Flyvbjerg's extensive research program on the finance of mega-projects, in many cases, it appears that time and cost overruns tend to be the rule rather than the exception. This is not only due to technological complexity, analytical limitations, and efficient project management skills, but systematic over-optimism among and biased information provided by project initiators (Flyvbjerg et al., 2003; Leijten et al., 2010). Is it conceivable that the same mechanisms loom behind the financial arrangements of eco-cities? Currently, national mega-projects in China, including SSTEC, rely heavily on capital brought in by the initiator (Hult, 2015), with governments usually acting as such initiators. Governmental budgets alone can rarely if ever guarantee continuous innovation even if it should suffice for completion of the entire project (Perrone, 2014). Among well-known eco-city projects in China, financial failure is not uncommon, as reported for the cases of Caofeidian Eco-City (Hult, 2015) and Shanghai Dongtan Eco-City (Miao & Lang, 2015). It seems, therefore, critical to strive for an ingenious balance of financing tools and initiatives (Baeumler & Mehndiratta, 2012) and expansion in the variety of sources to raise money to secure the overall financial viability of eco-city projects (Gunawansa, 2011; Zhan et al., 2017a). Funding mega-projects involved more than merely looking at the construction phase: projects go through construction, operation, and maintenance phases (Novick, 1990) and different phases require different financing mixes and arrangements. Taking the entire life-cycle into consideration tends to help in reducing the total investment of a project (Rahim et al., 2014), but in this contribution on SSTEC we only focus on the construction phase, because its investments account for by far the largest proportion of the total investment. Moreover, Tianjin Eco-City is quite clearly still in the construction phase, making it unfeasible to say anything firm in subsequent phases.

The significance of financial arrangements to the construction of eco-cities is obvious, but relatively little is known about the topic as of yet. This contribution aims to shed light on the question how SSTEC has arranged its financial issues. We will address the following questions: (1) How is SSTEC funded?; (2) Which policy actors are involved in SSTEC?; (3) Which of these actors account for which funding sources and how do these relate to each other?; and (4) Which lessons can be drawn for other eco-cities in China and globally?

To address these questions, we leaned on a few different information sources. Desk research was first employed to review the academic literature as well as to collect empirical data from SSTEC's websites, its auditing reports in the past few years (retrieved from the website of the Shanghai Stock Exchange and audited by independent auditing companies), and other web-based reports (from the World Bank and the United Nations Environmental Program). We subsequently interviewed 11 people working in or with SSTEC in the period April–July 2015, including officials, developers, financial staff and project managers. We then also repeatedly visited the SSTEC site. In February 2016, we visited the site again and stayed there for one week to collect additional information. Interviews were conducted in Chinese by the first author. Since our respondents requested anonymity, they are not listed by name. The rest of this paper is organized as follows. We identify the funding instruments used in SSTEC (Section 2) and then distinguish the stakeholders involved in SSTEC and what the roles they play in finance (Section 3). Section 4 summarizes the lessons learned from the Tianjin case. Finally, we present our conclusions in Section 5.

4.2 Financial Vehicles Used in SSTEC

Tianjin eco-city has been under construction for eight years. The initial start-up area in the southern district has been completed, including roads, buildings, landscaping and greenery, national animation industrial park, and ecological business park. The construction of other areas is still underway. Numerous financial resources have been invested in the construction, yet the total costs are difficult to estimate. The World Bank stated that reliable estimates of the total project costs are impossible (Baeumler et al., 2009), while DAC&Cities (2014) estimated that total project costs would reach CNY 50 billion (approximately US $7.61 billion) (According to DAC & Cities (2014), the investment amount in US $ is approximately 9.7 billion, which means the exchange rate of US $ to CNY is 1:5.15 in 2014. This is inconsistent with the exchange rate in 2014. Therefore, we convert CNY into US $ at the January 2016 exchange rate, namely, US $ to CNY is approximately 1:6.57. The exchange rate will also be applied to the currency conversion hereafter.). Such a large investment obviously challenges the initiators' capacity in raising funds for the construction of SSTEC. On 31 December 2015, the total assets of Tianjin Eco-City Investment and Development Co., Ltd. (TEID) amounted to CNY 17.88 billion (approximately US $2.72 billion), which is 4.47 times as much as its initial investment (CNY 4 billion, approximately US $608.82 million). This begs the question how TEID arranges its finance to meet SSTEC's phenomenal construction costs. With the aid of the company's financial information (Table 4-1), we present the financial tools TEID utilizes to raise money.

Table 4-1 The overview of consolidated financial data of SSTEC from 2013 to 2015

Unit: in million CNY

Consolidated Balance Sheet	**31 December 2015**	**31 December 2014**	**31 December 2013**
Inventory	7541.11	8338.98	7868.58
Original value of fixed assets	2370.34	2095.07	1621.42
Total assets	17,881.17	17,251.06	16,803.63
Short-term loan	468	459.28	313.5
Non-current liabilities due within one year	1461.03	1025.67	1773.82
Long-term loan	5169.44	6403.57	5552.98
Bonds payable	1938.38	1186.90	1182.35
Consolidated Income Statement	**2015**	**2014**	**2013**
Government grants	61.54	119.17	119.01
Profit after tax	46.99	45.57	39.69
Consolidated Cash Flow Statement	**2015**	**2014**	**2013**
Cash received from bank loans	2615.50	2799.17	3596.85
Cash received from issuing bonds	-	-	-

Sources: financial statements of SSTEC from 2013 to 2015 (TEID, 2014, 2015, 2016a).

4.2.1 Bank Loans

The financial statement shows that bank loans and corporate bonds are the two key capital sources for SSTEC. Bank loans are both short-term and long-term. TEID has good financing capacity since it collaborates with 12 banks (TEID, 2016a). As of 31 December 2015, TEID had a total credit of CNY 10.24 billion from those 12 banks and the loans TEID acquired from them were at CNY 8.54 billion, of which the short-term loans, non-current liabilities due in one year, and long-term loans TEID and its subsidiaries acquired from them were about CNY 7.1 billion. Table 4-1 also shows that short-term loans were significantly lower than long-term loans at the end of each year. This structure is in line with the nature of the company's business.

Bank loans are one of the most common financing vehicles since they are flexible and can be used to support the company's operations. However, the disadvantages are obvious, such as high costs, complicated procedures to obtain approval from banks, and limited credit amounts.

4.2.2 Corporate Bonds

As for corporate bonds, TEID issued a 7-year bond in 2012 with a total amount of CNY 1.2 billion at a coupon rate of 6.76%. As of 31 December 2015, the balance of bonds payable was CNY 1.94 billion, which increased by 63.31% in 2015 from the previous year. This is because TEID issued a 3-year bond in 2015 with a total amount of CNY 1 billion at a coupon rate of 4.65%.

On 29 October 2015, TEID successfully issued a 3-year bond with a total amount of CNY 1 billion at a coupon rate of 4.65% in Singapore. The 'Tianjin

Eco-city Investment and Development' bond is of more than symbolic importance. It is the first bond directly issued by a China-based non-financial company in an international market. Besides, the money raised will be used for SSTEC's construction, which matches the financing activities for eco-city development well. The experience of issuing bonds for the development of sustainable cities in the international market is intended to serve as a model for other eco-cities in China (Financial staff 2 (TEID Tianjin China), 23 February 2016).

TEID issued its first short-term financing bonds (referred to as '16 Eco-city Investment CP001') at an amount of CNY 600 million on 28 January 2016 (TEID, 2016c). The term was 366 days. The short-term financing bonds were underwritten by CITIC Securities and the China Construction Bank. The corporate credit rating was AA+, and the debt rating was A-1. The registered credit amount of the bonds is CNY 1.5 billion and is issued in two phases. The short-term financing bonds finally raised 1 billion with a coupon rate of 3.37% (0.33% lower than the market price), which was 400 million more than the original plan. The raised money was used to repay the bank loans.

TEID also issued CNY 400 million medium-term notes with a period of three years on 16 March 2016 (TEID, 2016b). The medium-term notes were underwritten by CITIC Security and China Construction Bank. The corporate credit rating was AA+, and the debt rating was A-1. The medium-term notes were in high demand among investors and finally raised CNY 1.98 billion, which was CNY 1.58 billion more than the original plan. The coupon rate was 3.5%, 1.3% lower than the original price and 26% lower than the same period standard bank interest. All the raised money is used to repay the bank loans.

The issue of short-term bonds is a good sign for TEID in financing since it offers TEID a new channel to finance at a lower interest. Similarly, the issue of the medium-term notes lowered the company's financing costs and improved its brand recognition in the capital market, which has a positive impact on the company's future capacity to finance. The medium-term notes lock TEID in a funding source with lower interest in the medium term, which not only expands the company's financing sources but also reduces its costs. However, corporate bonds also have some disadvantages. For example, TEID may be under high financial risks if it cannot repay the bonds on the maturity date. Besides, the money raised through bonds is earmarked and can only be used for a limited set of projects.

4.2.3 International Assistance Programs

The World Bank offered a Global Environmental Facility grant with an amount of US $6.16 million to facilitate Sino-Singapore Tianjin Eco-city Administrative Committee (SSTECAC) in planning and managing the construction of Tianjin Eco-city, including (1) technical assistance, software, and equipment; (2) a public transport system; and (3) green building pilot investments and technical assistance (TheWorldBank, 2010a).

4.2.4 Government Grants and Tax Refund

From 2013 to 2015, the grants TEID acquired from governments were CNY 119.01 million, CNY 119.17 million, and CNY 61.54 million respectively (TEID, 2014, 2015, 2016a).

Besides, local governments refund a part of their taxes created within the SSTEC to TEID (Tianjin Municipal People's Government, 2008). Local governments also allocate land sales that belong to them to TEID to support construction (Civil servant (SSTECAC Tianjin China), 15 May 2015; Financial staff 1 (TEID Tianjin China), 21 July 2015)

4.2.5 Private Capital

Foreign investors (Singaporean companies), public listed companies, and other private companies contributed to the construction of SSTEC through investing money into professional companies, which efficiently buffers the financial pressure local governments face and facilitates the construction of mega-projects such as SSTEC.

International Enterprise (IE) Singapore provided financial assistance to Singapore-based companies to help them gain a foothold in Northern China. Although this program was not specifically aimed at helping the development of SSTEC, it encouraged Singapore-based companies to invest and start their business in SSTEC, which indirectly contributed to its development.

The involvement of private capital can help relieve local government's financial burden but also introduces advanced technology and management experience to the construction. On the other hand, it also adds some risks. For example, it will be difficult to find a successor if the cooperation between the public and private sectors breaks down. Besides, it may lead to higher living costs for inhabitants when they use facilities provided by private players since most of them are profit-oriented.

In March 2012, International Enterprise Singapore (IE Singapore) launched an assistance program to facilitate Singapore-based companies to enter into the market of North China through SSTEC. It is a 5-year program with a total investment of S$ 9.5 million (approximately US $ 6.7 million (SG$ is converted to US $ at the exchange rate in January 2016. Namely, US $ to SG$ is approximately 1:1.24.) (IESingapore, 2016).

In short, the financial vehicles adopted by SSTEC to support the construction of the eco-city include bank loans, corporate bonds, government funds and tax refunds, private capital and international assistance programs (Figure 4-1). The pros and cons of these financing vehicles are shown in Table 4-2.

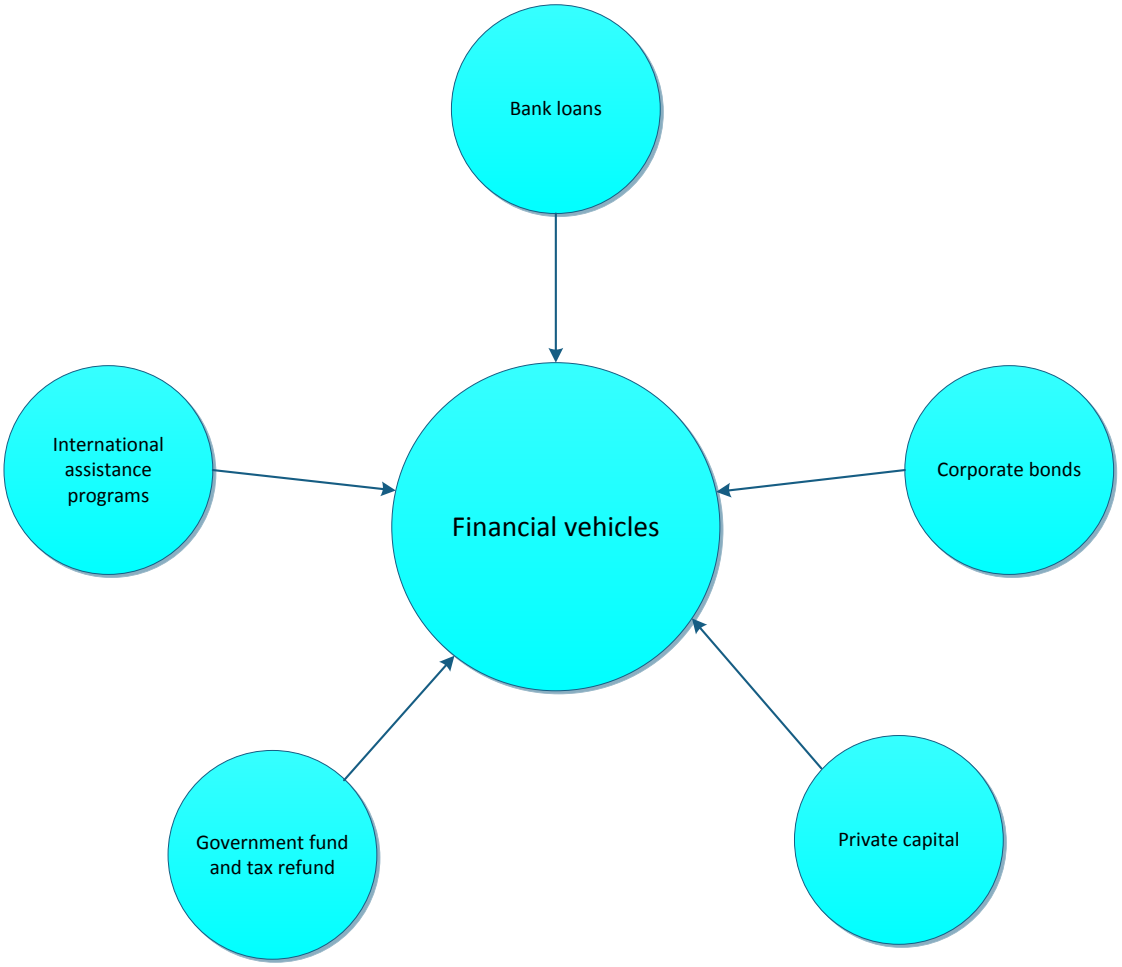


Figure 4-1 Financial vehicles used for the construction of SSTEC

Table 4-2 Advantages and disadvantages of the financing vehicles

Items	Pros	Cons
Bank loans	Flexible, with many options in loan terms and loan types	High costs, complicated procedures, and limited credit amounts
Corporate bonds	Lower costs; possibility to raise large amounts of money and mobilize social resources	High financial risks; strict restriction terms
Private capital	Flexible; financing responsibility transferred to the private sector, which relieves the financial burden on governments.	Difficult to find successor if public-private partnership breaks down; higher living costs for inhabitants
Government funds and tax refund	No need to repay	Heavy dependence on government policies
International assistance programs	No need to repay	Aimed at particular projects and not available for all projects.

4.3 Stakeholder Analysis

4.3.1 Players Involved in SSTEC

SSTEC is built with 'strong national government support, paired with structured foreign involvement,' indicating that it is not only a demonstration project but also receives policy and funding support from the Chinese and Singaporean governments (de Jong et al., 2016). An elaborate organizational structure has been set to allow for professional supervision of

the project (de Jong et al., 2013). This support from the very highest level gives an enormous boost to the confidence other players have in the likelihood that it will become a success. The project is simply too big and prestigious to fail. However, the active involvement of two national governments alone cannot guarantee SSTEC's current status and future development. This obviously also requires extensive involvement of and resources from various stakeholders, including state-owned, private, and multinational enterprises, banks, local residents and the broader public. The financial emphasis of each of these stakeholders is different, yet all are indispensable to SSTEC. It is crucial to balance the interests of these different stakeholders when it comes to maintaining the sustainability of financing and investment activities in the process of eco-city construction. This section identifies stakeholder interests, thus paves the way for an analysis what roles these stakeholders play in the financial arrangements.

Table 4-3 lists the interests of the identified stakeholders and their impact on the construction and operations of SSTEC. The stakeholders have been classified into three categories: direct primary, indirect primary, and secondary stakeholders.

Local governments, SSTECAC, Sino-Singapore Tianjin Eco-city Investment and Development Co. Ltd. (SSTEID), and TEID and its subsidiaries are of high importance and have a lot of influence on SSTEC since they are directly engaged in making guidelines, arranging finance, and developing the eco-city. SSTECAC is the representative of the local governments, so the interests of SSTECAC and local governments tend to coincide, that is to develop the local economy and preserve the environment. SSTEID receives its investments from both a Chinese and a Singaporean consortium, acting on behalf of Chinese and Singaporean parties respectively and aiming to earn profits through their involvement in the eco-city. TEID acts like a municipal government-owned urban development and investment corporation (UDIC) and as a master developer. However, it distinguishes itself from other UDICs in that it has diversified ownership, which indicates that TEID cannot be simply regarded as the financial vehicle of local governments although it is in charge of the financing and investment activities for the construction of the eco-city. The principal interest of TEID is to represent its shareholders and maximize their value. Similarly, TEID's subsidiaries also have diversified ownership (both Chinese and Singaporean corporations participating in the investment). Subsidiaries aim to earn profits by participating in the construction and providing professional services (e.g., waste management and water treatment).

Both the Chinese and the Singaporean central governments have a lot of influence on SSTEC at the macro level, which is significant since they stipulate the overall planning but will not directly participate in the decision-making on specific designs and implementation and will not substantially change the way in which these are carried out. Therefore, they can be classified as indirect primary stakeholders. The Chinese central government wishes to collaborate with Singaporean government by introducing Singaporean experience in environmental protection while the Singaporean government's goals are to find more opportunities to export its capital, technology, and knowledge.

The remaining parties are either important but with low influence or less important and with low influence, the reason to qualify them as secondary stakeholders. This includes banks, private parties involved in the eco-city construction, other companies in the eco-city, and local residents. Their interests need to be mentioned since they are still of paramount importance for SSTEC's development. Banks provide funds for the eco-city. In addition to money, private parties also provide knowledge in specific fields (e.g., energy, waste). Local residents represent a key component of SSTEC after its completion since they act as a source of revenue for real estate companies and other service providers.

Table 4-3 Stakeholder analysis

Stakeholder	Key Interests	Importance to the Eco-City	Influence on the Eco-City Construction	Role
A. Primary direct				
Local government	• Develop the local economy • Pilot new practices in eco-city construction • Meet national requirements	High. Will provide overall leadership and local business support	High. Will have influence on all aspects of local policy	Responsible for all functions and under scrutiny of the central government
Sino-Singapore Tianjin Eco-City Administrative Committee	• Represent local governments • Change mode of economic development	High. Will make guidelines and administrate the construction of SSTEC	High. Will have influence on all aspects of local policy	Responsible for all functions and under close scrutiny of both central and local government
Tianjin Eco-City Investment and Development company and subsidiaries	• Earn profits	High. Will integrate lessons learned across all projects and carry out construction	High. Will have influence on input into each sub-project, including finance and physical development	Master developer and implementer, responsible for developing real estate and public facilities
Sino-Singapore Tianjin Eco-City Investment and Development Company	• Earn profits	High. Will introduce advanced know-how from Singapore and help design	High. Will have influence on design	Engaged in long-term investment, design, development, and promotion of sustainable lifestyles
B. Primary indirect				
Chinese central government	• Balance economic development and environmental protection	High. Will provide overall leadership and political support	High. Will have influence on all policy aspects	Responsible for overseeing project progress
Singaporean central government	• Political cooperation; • Look for niche markets in China	High. Will provide overall leadership and political support	High. Will have influence on policies where Singaporean players are concerned	Responsible for overseeing project progress
C. Secondary				
Banks	• Gain income from interest	High. Will provide financial support	Low. Cannot intervene	Creditors
Private companies (including Singaporean) involved in eco-city construction	• Earn profits • Look for additional opportunities	High. Will provide financial and technical support	Low. Cannot intervene	Investors and consultants
Other companies in the eco-city	• Enjoy tax rebates, preferential policies • Develop propitiously with the aid of SSTEC	Low. Key component in eco-city after completion	Low. Not involved in construction	Beneficiaries of successful construction
Public in China and Singapore	• Gain income from bond interest	High. Will provide financial support	Low. Not involved in construction	Buying bonds issued by SSTEC
Local residents	• Improve life quality	Low. Key component in eco-city after completion	High. Not involved in construction	Beneficiaries of successful construction

Note: A. Direct primary stakeholders: parties directly participating in the construction of the eco-city; B. Indirect primary stakeholders: parties indirectly participating in the construction of the eco-city but important and having high influence on the construction; C. Secondary stakeholders: remaining players, including parties important but with low influence, less important and with low influence.

4.3.2 The Role of Involved Actors Playing in Financial Arrangements

After identifying the stakeholders, we now proceed to analyze their role in SSTEC's financial arrangements. Figure 4-2 displays SSTEC's financial arrangements paired with involved stakeholders, which shows how various resources to construct and operate SSTEC are mobilized and what the role of each stakeholder is in the financial arrangements. The light blue boxes refer to the involved actors in the construction while the green boxes represent the various resources mobilized by TEID and SSTECAC.

The SSTEC model is based on Table 4-3 and Figure 4-2. The first layer is that of government involvement. Local governments (e.g., SSTECAC) jointly with the central government finance SSTEC's development by providing government funds and tax refunds. Besides, political support from the central government indirectly influences SSTEC's financial arrangements by adding to its credibility and reputation. TEID as the key construction party is the beneficiary of government funds and tax refunds. Meanwhile, it is responsible for raising money through various other channels. TEID is a bridge connecting the governments of China and Singapore, banks, the World Bank, and the public. For example, banks provide loans to TEID, which is one of the most common and stable sources of money for the eco-city. The World Bank provides international assistance to SSTECAC, indirectly contributing to SSTEC's construction and adding to its status as well. The public in China and Singapore are the purchasers of corporate bonds. In addition to the players above, private parties from China and other countries (e.g., Singapore and Japan) contribute funds by investing in various companies (e.g., green transportation and energy companies).

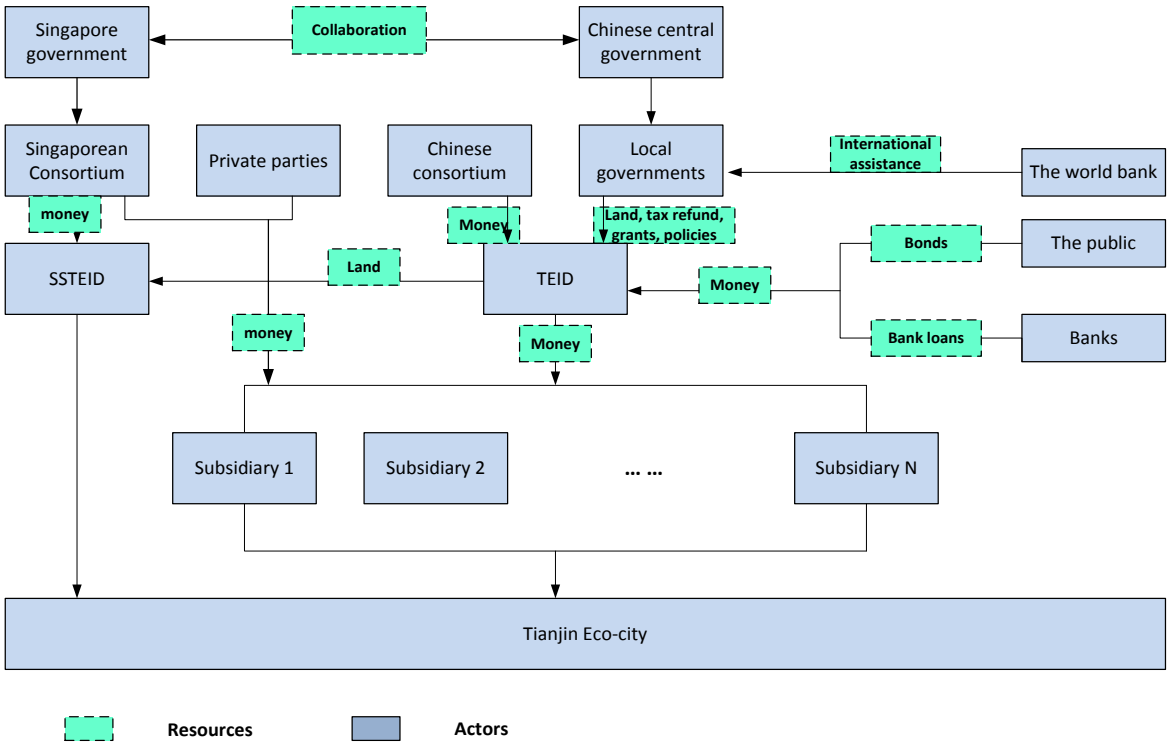


Figure 4-2 The role of involved actors in SSTEC's financial arrangements (authors' own compilation)

4.4 Lessons Learned from SSTEC

As mentioned above, the funding sources of SSTEC include bank loans, corporate bonds, international assistance programs, government funds and tax refunds, and private capital. Of these, bank loans, corporate bonds, and private capital have thus far been the most vital funding sources. However, the feasibility of issuing corporate bonds in Singapore and the extensive involvement of private capital are closely related to the following three aspects: a diversified ownership structure, supporting policies, and a market-based operation mode.

4.4.1 Diversified Ownership Structure

SSTEC is developed as a cooperative initiative between Chinese and Singaporean enterprises, upon the active invitation of the Chinese and Singaporean governments. TEID and SSTEID are its key developers. TEID obtains its investments from a Chinese consortium (led by TEDA Investment Holding Co. Ltd.), which is responsible for land acquisition and preparation, investment, construction, operation and maintenance of infrastructure (TEID, 2012). SSTEID receives its financial input from both a Chinese and a Singaporean consortium (led by the Keppel Group) with a total investment of CNY 4 billion, each party taking up 50% of the total investment, aiming to catalyze large-scale urban solutions (SSTEID). The Chinese consortium used the land use rights as its initial investment while its Singaporean counterpart injected cash.

To bypass the legal constraints (According to the Budget Law of the People's Republic of China issued in 1994, local governments are not allowed to issue local government bonds, except as otherwise stipulated by law or the State Council.) of China's 'Budget Law' on local governments, local governments usually founded special purpose vehicles to help them raise money for the construction of industrial parks, software parks or large-scale infrastructure in the past few decades (Zhan et al., 2017a). This practice makes local governments accountable for the debts and hence increases the financial pressure on them. The foundation of TEID has generated enormous change in both the ownership structure and company operations, adjusting the 'government-invested and government-dominant' financing model into something more complex. In terms of the ownership structure, TEID obtains investments from six Chinese enterprises led by TEDA Investment Holding Co., Ltd. with a registered capital of CNY 3 billion. In terms of shareholder structure, the Chinese consortium, as shown in Figure 4-3, consists of six shareholders, including TEDA Investment Holding Co., Ltd. (35%), China Development Bank (On 18 December 2009, TEID held its 8th shareholder's meeting. The shareholders meeting passed the resolution to transfer all 20% shares held by China Development Bank to China Development Bank Capital Co., Ltd. TEID completed the alteration of the registration particulars in Tianjin Administration for Industry and Commerce in 2010.) (20%), Tianjin Real Estate Development Management Group Co., Ltd. (15%), Tianjin Tanggu City Construction & Investment Company (10%), Tianjin Hanbin Investment Co., Ltd. (10%), and Tsinlien Group (Tianjin) Assets Management Co., Ltd. (10%). On the one hand, this form disperses the company's ownership, which prevents it from being a financing vehicle for local government. On the other, although all six companies are state-owned, they are strongly interwoven with each other. This ownership structure separates local

governmental from enterprise functions, which is helpful for the marketization of enterprises and expected to improve economic and decision-making efficiency.

The contributions from the Singaporean consortium expand the spectrum of financial sources for SSTEC's construction. TEID introduced Keppel Integrated Engineering Ltd. to its operations. They co-founded an environmental protection company, an energy company, and a water treatment company. TEID also introduced SSTEID to invest in the fields of transport and information park development. In addition to making use of foreign capital, TEID also made use of domestic private capital to set up subsidiaries for the construction of public utilities. For example, TEID in pair with the public listed company (TEDA) co-founded a municipal engineering and landscape company and environmental protection company. TEID set up eleven subsidiaries, of which only four were 100% TEID-owned. All others had mixed ownership structures (see Table 4-4). State-owned, multinational, and public listed companies were involved in the construction of SSTEC, diversifying its funding sources. With this ownership arrangement, SSTEC not only undertakes the tasks to construct SSTEC but also takes into account the broader goal of the company (i.e., the maximization of shareholder value).

Table 4-4 Registration capital, shareholding ratio, and the role of TEID's subsidiaries

Subsidiary	Sector	Registration Capital (CNY 10 Thousand)	Shareholding Ratio (%)	Role
Tianjin Eco-city Energy Investment and Construction Co., Ltd. (EID)	Engineering design	23,529.42	TEID 51 Others: 49	Responsible for construction, development, and utilization of renewable energy; design, construction, management, operation, maintenance and consulting of the public energy facilities in Tianjin eco-city, including heating, water supply, and gas.
Tianjin Eco-city Municipal Engineering and Landscape Architecture Co., Ltd. (MELA)	Engineering	10,000.00	TEID: 65 Others: 35	Responsible for construction and management of municipal engineering
Tianjin Eco-city Construction and Investment Co., Ltd. (CI)	Real estate development	30,000.00	TEID: 90 Others: 10	Responsible for investment, construction, and maintenance of public facilities Tianjin Eco-city
Tianjin Eco-city Industrial Park Operation and Management Co., Ltd. (IPOM)	Real estate development	27,500.00	TEID: 100	Responsible for development and management of real estate
Tianjin Eco-city Public House Construction Co., Ltd. (PHC)	Real estate development	31,950.93	TEID: 100	Responsible for investment, construction, and maintenance of public housing in Tianjin Eco-city
Tianjin Eco-city Urban Resources Operation Co., Ltd. (URO)	Advertisement and consultant	1000.00	TEID: 100	Responsible for outdoor advertisements, municipal facilities and the naming of commercial facilities
Tianjin Eco-city Water Investment and Construction Co., Ltd. (WIC)	Hydraulic engineering	10,000.00	TEID: 60 Others: 40	Responsible for water treatment; wholesale, retail, import and export of water treatment equipment as well as operation and management of water management facilities
Tianjin Eco-city Information Park Investment and Development Co., Ltd. (IPID)	Information development	26,483.00	TEID: 61.15 Others: 38.85	Responsible for development, operation, transfer and consultancy of information technology; development of real estate; lease and management of self-owned housing and property services
Tianjin Eco-city Green Transportation Co., Ltd. (GT)	Transport operation	10,000	TEID: 85 Others: 15	Operation and management of public transport and school buses; construction, operation and maintenance of railway as well as technical consulting, technical service and technical collaboration in the field of railway and new energy automobiles
Tianjin Eco-city Environmental Technology Consulting Co., Ltd. (ETC)	Technical advisory	1086	TEID: 70 Others: 30	Responsible for environmental impact assessment of construction projects and planning, environmental-social and health impact assessment
Tianjin Eco-city Environmental Protection Co., Ltd. (EP)	Garbage disposal	10,000	TEID: 80 Others: 20	Responsible for the treatment of environmental contamination, ecological restoration and conservation, and investment, construction, operation and maintenance of water and other systems related to environmental hygiene

Source: 2015 annual report (TEID, 2016a).

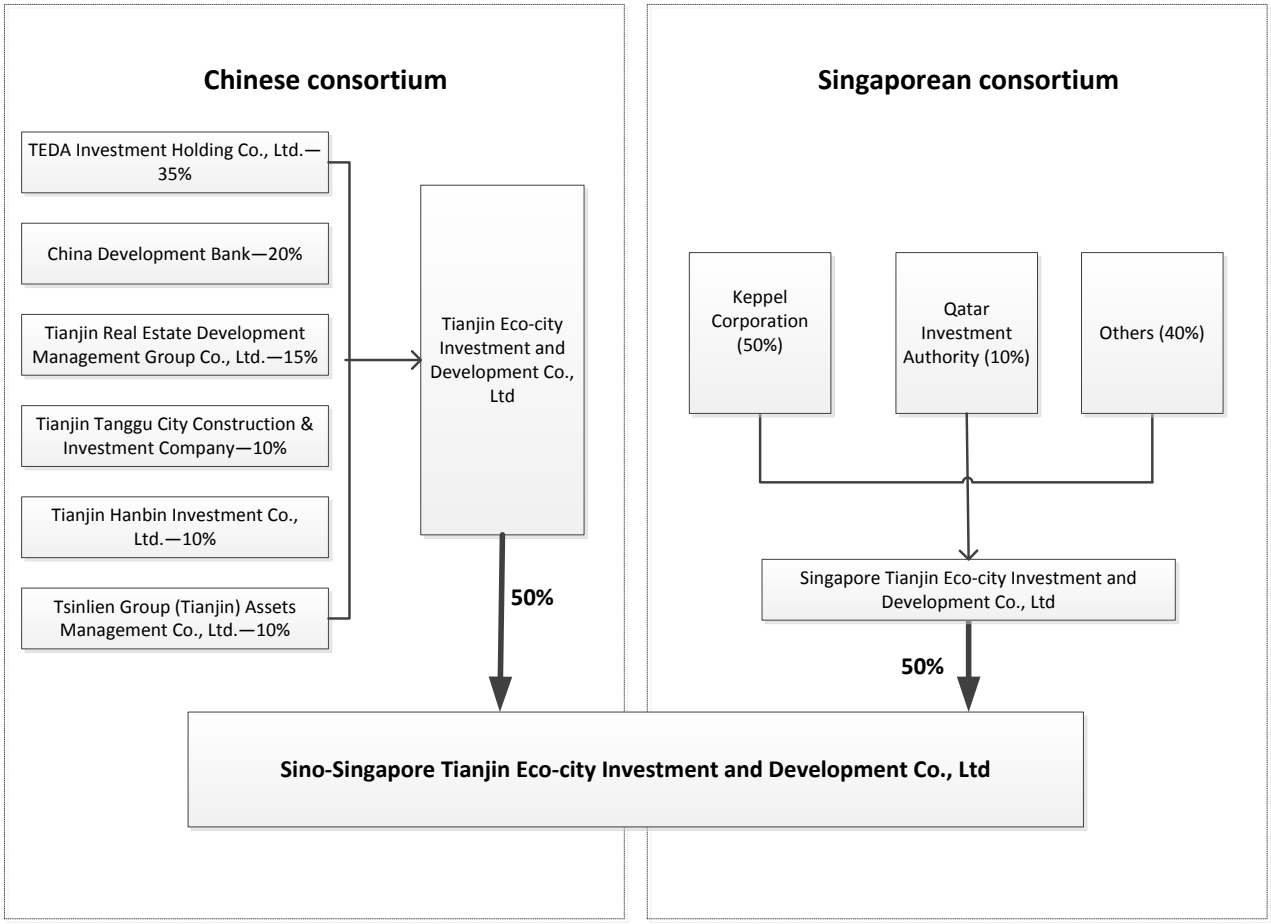


Figure 4-3 SSTID's ownership structure

Source: TEID (2014).

4.4.2 Supporting Policies

As per the *Framework Agreement between the Government of the People's Republic of China and the Government of the Republic of Singapore on the Development of an Eco-city in the People's Republic of China* and supplementary agreements, TEID is the beneficiary of tax refunds and the refund of land sales belonging to the local government within SSTEC (Tianjin Municipal People's Government, 2008). The taxes and the land sales belonging to local governments created within SSTEC should be refunded to TEID, allowing TEID at least to break even in its regional investments.

Apart from the high prestige, visibility and credibility derived from its status as a national-level investment project directly under the State Council (the de facto Chinese national government body), various other supporting policies for SSTEC are issued at the national level by central ministries and commissions. For instance, the National Development and Reform Commission has given priority to Sino-Singapore Tianjin Eco-City by immediately approving its application for issuing CNY 1.2 billion corporate bonds (Financial staff 1 (TEID Tianjin China), 21 July 2015). Besides, the grid power generated in the eco-city can be sold to the State Grid Corporation of China at market prices if there is a surplus after meeting the usage requirements within the eco-city (Interview with staff in SSTECAC, 2015). The Ministry of Housing and Urban-Rural Development rewarded SSTEC with CNY 5 0 million

because all the buildings SSTEC is in charge of in the eco-city are constructed according to green building standards. We can, therefore, claim that national level government support generates a sort of multiplier effect through which various other sources from other players are also released because they believe SSTEC is too big and beautiful to fail.

4.4.3 Market-Based Operation Mode

As shown in Table 4-5, roads, bridges, and other non-operational public utilities and infrastructure are funded and constructed by TEID and its subsidiaries first, after which the government repurchases them from those construction companies. The governments grant concessions to TEID and its subsidiaries for supplying water and gas and constructing other profitable projects. For those projects, TEID and its subsidiaries can collect fees from users by providing water, gas and other comprehensive services based on the concession agreements. Under these concession agreements, companies are responsible for investment, construction, operation, and maintenance while the governments provide subsidies for companies on the basis of cost estimation to ease the companies' pressure in financing in the early stages of construction and to mobilize their enthusiasm for investments. SSTECAC returns the 'supporting fees for municipal public utilities' and the government's net profit from land concessions to TEID for further infrastructure construction through purchasing public services and subsidies. Concession agreements with governments are guarantees for TEID and its subsidiaries to get sustainable operation assets and stable cash flow expectations, further broadening TEID's funding sources.

Table 4-5 Methods for constructing projects on a market basis

	Fields	**Methods**
Non-operational public utilities and infrastructure	Environmental protection, roads, bridges, cleaning, municipal administration, green maintenance, etc.	Local governments sign contracts with TEID and buy public services from it, while TEID provides products and services for local governments.
Operational and quasi-operational projects	Energy utilization, environmental governance, public utilities, outdoor advertisement, network construction, land consolidation, etc.	These will realize through signing concession agreement between local governments and TEID.

In sum, one can claim that the shared responsibility of the Chinese and Singaporean governments has created a strong impetus from public and private enterprises in both countries to be involved in and contribute to SSTEC's development. This mobilized a greater variety of players than would usually be the case with megaprojects of this kind and all were willing to lay in substantial resources with a strong belief that SSTEC's would be a success and contributed money be a safe investment and repaid in due course. This allowed for both diversified ownership structures, a variety of supporting policies from public organizations and a market-based mode of operation, even if many of the enterprises are formally public.

4.5 Conclusions

SSTEC enjoys a great variety of funding sources. Bank loans, corporate bonds, international assistance programs, government grants and tax refunds, and private capital are the main ones. A great many players are involved, including the governments of both China and

Singapore, state-owned, private, and multinational enterprises, banks, and the public. We established that the key factor contributing to progress in the project is the extensive and highly structured collaboration between the two national governments. It is their strong backing that gives a host of other, 'lower' yet essential players the confidence that this is a 'no fail mega-project,' one they can safely invest in. The stakes the Chinese national and Singaporean governments put in it are so high that they will do everything to make it a success. The wholehearted public sector support is clearly favorable for master developers when they apply for loans from banks since it is commonly believed that government-backed projects are more creditworthy (Ba & Yang, 2014). As a consequence, other government bodies in China offer various preferential policies, public and private enterprises from both countries feel free to contribute with substantial investments, 12 banks lend money, bonds are issued internationally by a Tianjin-based non-financial company for the first time and the mode of operation is decidedly more market-oriented than has been the case with other urban development projects in China. Put otherwise, SSTEC's being a bi-national flagship project has been a catalyst in generating and securing the plugging in of significant resources from a great many other public and private players. This made it too big to fail, and the fact that follow-up decisions were all made to guarantee it becoming a success reduced the likelihood of this mega-project evolving into a planning disaster. That said, the lack of full transparency does generate concerns that high yet invisible amounts of especially public funds are spent on it. It has been possible neither in previous studies nor in this one to provide clarity at this point.

Replicability of the lessons drawn from the SSTEC experience to other similar projects in China and globally was one of the Chinese national government's goals of the project. As a large demonstration project, its main lessons were to be mainstreamed around the nation (Chang et al., 2016). However, since even large countries like China can only have limited numbers of national flagship projects and subsequently pay the same attention and throw in the same amount of public funds to other eco-city projects as they do to this one, this replicability is likely to remain limited in practice. However, we still found two innovative financial practices not restricted to national flagship projects that we believe do offer lessons to other urban development projects.

First, a significant innovation in SSTEC's financial arrangement is that TEID's functions have been altered. TEID is responsible for land acquisition and preparation, investment, construction, operation and maintenance of infrastructure in the eco-city. It is the beneficiary of tax refunds and the refund of land sales belonging to the local government within SSTEC. Additionally, the municipality follows the principle 'neither taking nor giving anything to TEID so that it can achieve breakeven itself,' meaning that TEID is no longer a financing tool for the Chinese government. Instead, TEID delegates tasks to differently specialized subsidiaries, which makes its operations resemble more those of businesses in a market. Moreover, the knowledge and technologies TEID gains from SSTEC's construction expand its business scope and thus create more revenue, facilitating it to achieve the market-based operation. The market-based operation encounters fewer administrative barriers to introducing private players to the project. Against this backdrop, foreign investors (Singapore-based companies), state-owned companies, public listed companies, and other private companies all

contributed to the project by providing either money or knowledge. The involvement of these parties in providing funds buffered the financial pressure on local governments and facilitated the construction of this mega-project.

Second, the corporate bonds issued in Singapore were the first directly issued by a Tianjin-based non-financial company in the international market. This event has ignited more than the hoped for interest and its success bodes well. The issue of these bonds in Singapore is significant since it may set the standard for other urban development projects in issuing bonds internationally as well as broadening the variety of funding sources. This practice is, therefore, replicable to other urban mega-projects as it makes the financial structure more diversified and robust. However, corporations should pay attention to potential risks of issuing corporate bonds in the international capital market, including the change in the exchange rate and bond rating (Hu, 2017). Issuing corporate bonds in non-Chinese currencies may lead to the increase in financial costs when CNY depreciates against other currencies (Fang, 2017). Additionally, bond rating plays an instrumental role in raising money through issuing bonds. The lower the bond rating, the higher financial costs for issuing corporate bonds in the international capital market (Fang, 2017; Hu, 2017).

SSTEC's construction is well underway, but not yet completed. Although it is still too early to assess its success, preliminary assessments of the project have been mixed. Chang et al. (2016) have drawn attention to the importance of SSTEC as a symbol of China's new style of ecological governance which practical, engineering-oriented, aimed at economic self-sufficiency and with Asian rather than European partners more conversant with the Chinese context. In comparison with previous Sino-foreign eco-city projects, it has indeed been more stable, more financially viable and more geared towards all societal classes rather than just the rich. On the other hand, they have also pointed to significant problems of implementation such as delayed construction, slower sales than anticipated and low occupancy rates of buildings where also many buy real estate for speculation or multiple home ownership. These setbacks qualify the success story since they forced SSTECAC to sell land parcels in the eco-city's residential area at below market prices, to target high-income groups more than planned and allow them to develop gated communities advertised through images of luxury urban living. In the view of Chang et al. (2016), these decisions make it uncertain whether SSTEC can still be named a proper eco-city where economic, social and ecological sustainability are truly in balance with each other. In our view, it is rather a sign of strength that flexible choices are made in decision-making processes since very few if any mega-projects do not suffer from disappointments and difficult situations. In fact, this article has aimed to demonstrate that the chosen financial arrangements are intricate and sophisticated and deserve closer attention in future eco-city projects. What remains, however, is the doubt whether the cost and time overruns incurred in SSTEC would eventually still make it a mega-project in the negative sense as described by Flyvbjerg et al. (2003). Only a very thorough ex-post assessment with fully open books in a few years time will allow us to get a nuanced answer to this question.

5 Financing Low Carbon Cities: The Case of Shenzhen International Low Carbon City

This chapter is mainly based on the following peer-reviewed article:

- Zhan, C., & De Jong, M. (2018). Financing Low Carbon Cities: The Case of Shenzhen International Low Carbon City. *Journal of Cleaner Production*, 180,116-125

5.1 Introduction

Shenzhen International Low Carbon City (ILCC) was launched in 2012 with the support of China's National Development and Reform Commission (NDRC). Although ILCC was only initiated five years ago, it has attracted attention from all over the world because of its role as a critical example and potential international model in the development of eco and low carbon cities. A great deal of research has already been conducted on ILCC in the domain of its conceptual underpinnings and governance (de Jong et al., 2015; de Jong et al., 2013), its use of sustainable energy (Ye et al., 2015; Zhang et al., 2016), and its planning (Cales, 2014; Wu et al., 2014). However, little research has been done on eco and low carbon city development from a financial perspective. The construction of sustainable cities involves large investment sums, an enormous challenge for local governments. It is estimated that the investments in green projects (e.g. eco and low carbon cities and renewable energy projects) in China amount to about CNY 2900 billion (roughly US $ 460 billion by using the exchange rate of US $:CNY at 1:6.3, hereinafter) each year from 2015 to 2020 (RIFSMF, 2015). Considering fiscal limitations and the need for priority expenditure in other policy areas, it is estimated that two-thirds of this amount (approximately US $ 300 billion) need to be covered by funds from the domestic and international capital markets (RIFSMF, 2015). Traditionally, the

financial vehicles China employs to finance infrastructure includes public funding (including the annual budget, treasury bonds, and other financial capital), debt financing (funds raised through banks and other financial institutions and bonds), inner accumulation (undistributed profits), Foreign Direct Investment and private capital (NationalBureauofStatistics, 2016). Zhan et al. (2017a) have presented a financial history of urban infrastructure development in China and find that domestic loans and self-raising funds are playing an increasingly important role. Liu and Salzberg (2012) explore the influence of local governance, municipal finance, and land-use planning on the development of low carbon cities in China. These three factors come together in the development of eco and low carbon cities in China. Liu and Salzberg (2012) argue that local authorities predominantly employ Public Private Partnerships (PPP), land concessions, and urban development and investment corporations (UDICs) to fill the gap between fiscal revenue and expenditure. However, they show that the current municipal financing practices complicate efforts to promote low carbon development, requiring researchers and practitioners to seek more appropriate financing mechanisms. Since 1994, land concessions and UDICs have been used by local governments to support infrastructure development (Cao et al., 2008; Xu, 2011; Zhan et al., 2017a), which has also been applied to the development of eco and low carbon cities. However, they are generally regarded as unsustainable since they tend to lead to high indebtedness (NationalAuditOfficeofPRC, 2013) and limited availability of land concessions due to growing scarcity of land (Zhan et al., 2017). In most cases, local governments opt for cheap solutions and lease out land to earn income thus wasting valuable space, which is far from sustainable. Zhan and de Jong (2017b) point out that sometimes significant foreign sources for financing green projects are provided, as in Sino-Singapore Tianjin Eco-city, offering new insights into how funding sustainable city projects can be arranged. Yet this solution cannot always be chosen since the central government does not help other urban development projects in the same way as it does for Tianjin. After experiencing a rise (1993-2007) and then a fall (2007-2010) in the application of Public-Private Partnerships (PPP) in China (Mu et al., 2011), local authorities have regained their faith in the application of PPP since they believe that these can help relieve their financial burden. Kameyama et al. (2016) also argue that private-sector investment plays an instrumental role in meeting the long-term investment needs for low-carbon development in Asia. However, using PPP is not entirely unproblematic. Sullivan et al. (2013) focus on the risks and opportunities for funding low carbon cities. They argue that the low carbon agenda is disconnected from the needs and interests of private-sector investors, which has made it hard to carry out PPP in urban development projects in the UK. In addition, the long-term cost recovery periods make it difficult to find private investors for low-carbon cities (Kościelniaka & Górkab, 2016). In the long-term, it is inevitable that local authorities come to understand the view of the private sector on finance-related risks (Sullivan et al., 2013). The experience from the UK offers important lessons for China on how to develop low carbon cities through PPP, requiring Chinese authorities consciously to balance the risks and interests between public and private parties and create beneficial conditions for implementation.

ILCC is taken as an example to examine how financial arrangements for urban development can be made sustainable more than just in name and which lessons can be drawn from the

financial arrangements selected in ILCC for the practice of financing other eco and low carbon cities. A thorough investigation of the funding practice in ILCC, coupled with the application of stakeholder involvement to explain the logic behind financing low carbon cities, contributes to the existing literature on the theory and practice of sustainable finance. In addition, the study echoes the topical theme regarding the role of finance playing in coping with climate change.

To carry out the study, data were collected from sources such as academic publications, ILCC's websites, other web-based reports (e.g., the NDRC Report, the national audit report issued by Chinese National Audit Office), and nine interviews with officials, developers, and project managers. Content analysis of existing literature, research reports, and various reports issued by ILCC and the Shenzhen municipality is employed to extract relevant information. Interviews were used to investigate what financing vehicles were adopted to raise money as well as to map the roles of various stakeholders in the construction of ILCC.

This paper proceeds as follows. Section 2 presents the literature regarding funding sustainable development along with the theoretical foundations underlying financing eco and low carbon cities. Then section 3 introduces the Shenzhen case, including the current status of ILCC and the players involved. Section 4 deals with the financial vehicles ILCC employs and the role of involved stakeholders in it. Section 5 presents the lessons learned from the Shenzhen case and puts them in a broader context.

5.2 Financing Sustainable Cities

The failure of existing financial structures and arrangements to address contemporary sustainability challenges, such as poverty and climate change (Sandberg, 2015), has drawn attention to the topic of rethinking the role of finance in addressing these challenges. Baker and Nofsinger (2012) have studied socially responsible finance from the view of the corporate and investment world. However, the concept of sustainable finance has not been fully explored yet, particularly when it comes to social aspects of capital markets (Salzmann, 2013). Sandberg (2015) points out the flaws in the dominant view of finance, focusing merely on profits, and then proposes a two-level model (a model considering both the dominant view of finance and social responsibility) by taking sustainability into account to approach the problems the dominant view of finance faces. Emerson (2003) coins the term 'blended value,' arguing that all investment or finance activities should be understood as carrying out concurrent tasks in the social, economic and environmental realms. Similarly, Aguilera et al. (2007) argue that mixed motives should form the basis of corporate social initiatives. Both the two-level model and the blended value proposition emphasize the combination of financing activities with social sustainability, thus becoming the theoretical foundation of sustainable finance. As stated by Fullwiler (2015), the theory of sustainable finance is based on the idea that (1) investors have blended values and that (2) each investment activity has blended results, covering both financial and non-financial returns. It requires program initiators to consider the benefits of various stakeholders from financial, social, and environmental points of view (Fergus & Rowney, 2005; Soppe, 2008, 2009), much in line with the concept of the 'triple bottom line.' The triple bottom line was first coined by Elkington (1994), including profit, people, and the planet. It aims at gauging company performance on the financial, social,

and environmental aspects. However, it should be noted that blended value is not simply the sum of the components of the triple-bottom-line analysis, all three requirements should be met separately (Bugg-Levine & Emerson, 2011). Although financial, social, and environmental aspects are critical to sustainable finance, this does not imply that the roles various stakeholders play in the decision-making process should be equal (Donaldson & Preston, 1995). Some analysts stress financial stability more by considering the financial sources. With the growing need for funding to develop sustainable infrastructures, it is significant to diversify the sources, which requires solid collaboration among the various involved public and private stakeholders (Z/YenGroup, 2015; Zhan & de Jong, 2017b). Z/YenGroup (2015) argues that financing sustainable infrastructure, on the one hand, depends on the financial sources; on the other hand, it relies on the combination of sustainability and lending and investment strategies. Also, Meltzer (2016) reports that funding from private sectors should be aligned with climate and other sustainability objectives.

Other authors study sustainable finance from environmental and social points of view. The UNEP Inquiry (2015) argues that the development of the financial system will deeply influence environmental and social outcomes. Therefore, urban developers should incorporate the environmental impact of infrastructure investments to make cities more resilient (Basiago, 1999). The growing public awareness and political involvement in addressing sustainability issues have led to growth in capital committed to more sustainable financial practices (The UNEP Inquiry, 2015), just as it is evident that good scores on sustainability indicators can positively affect financial performance (WBCSD/UNEPFI, 2010). The shift of the investment goal from financial returns to social and environmental issues when generating financial returns brings in a new financing option, impact investing, for projects with social and environmental impacts. Impact investing refers to companies pursuing the social and environmental impacts while generating financial returns (Bugg-Levine & Emerson, 2011; GIIN, 2016). Impact investing is not exclusive to developed economies but applies to emerging economies too (O' Donohoe et al., 2010). Impact investing has attracted many investors' attention such as faith-based investors, pension funds, insurance companies, banks, high net worth individuals, and hybrid organizations (Bugg-Levine & Goldstein, 2009), making it a viable option to support large-scale projects with social and environmental challenges (Glänzel & Scheuerle, 2016). In the rest of this contribution, we will examine whether the financial vehicles ILCC employs are sustainable in financial, social, and environmental terms.

5.3 Shenzhen International Low Carbon City

5.3.1 Brief Introduction to Shenzhen's International Low Carbon City

ILCC is a demonstration program in the collaboration between China and the EU on sustainable urbanization, aimed at displaying China's achievements in low carbon technology. It is located in Longgang District, Shenzhen, China, at the border with Dongguan and Huizhou in Guangdong province. ILCC was launched in 2012 and covers a planned area of 53 km2. Currently, the economy in Pingdi is still underdeveloped while carbon emission levels are high. As a flagship project of the China-EU Partnership on Sustainable Urbanization, Shenzhen municipality is trying its best to develop ILCC into a pilot area to realize a great-

leap-forward in urban development planning under the concept of integrating industry with the city, green urban management and benefit sharing under the constraints of carbon indicators to eventually provide replicable pathways for low carbon development in future urbanization (Interviewee 1, 2 March 2016). Figure 5-1 presents the planned area of ILCC. The green area is the total area of ILCC covering 53 km2. The yellow area is the expansion zone with an area of 5 km2. The red area is the start-up zone covering an area of 1 km2, which is currently under construction. The start-up zone includes both the renovation projects and new-build projects. Figure 5-2 demonstrates the historical evolution of ILCC as well as the major events that have thus far happened in the startup zone.

Figure 5-1 The start-up zone, expansion zone, and total area of ILCC

Source: ilcc.com.cn

ILCC has seen considerable progress since 2012. ILCC has held the annual ILCC Forum from the very beginning. It completed the renovation projects C-Hotel and C-Plaza, where low-quality housing and factories were retrofitted and upgraded. In addition, 70% of the first stage road construction and 10% of the second stage road construction had been completed in the startup area by the end of 2016. The German Town, a high-tech industrial area in collaboration with German players, held a ceremony in June 2016, indicating the beginning of its construction. In November 2016, ILCC also started the construction of the eastern extension of subway line 3. In March, a ceremony was held to celebrate the establishment of a joint administration committee of GZUCM-RMIT (standing for Guangzhou University of Chinese Medicine and Royal Melbourne Institute of Technology) Life Science & Bioengineering (Shenzhen).

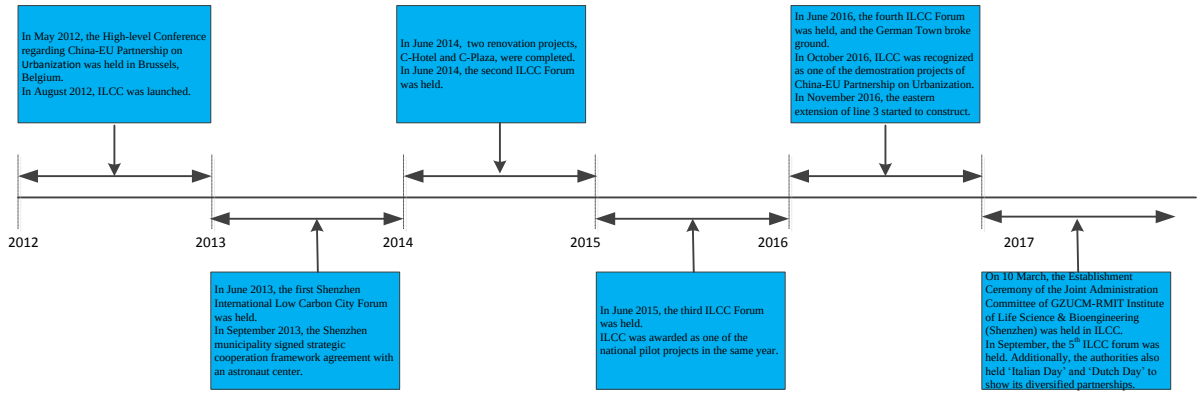


Figure 5-2 Timeline of major events in ILCC

Source: ILCC (2017a)

From an economic perspective, a lot has happened as well. For example, Pingdi Sub-district, an office representing the municipal government in Pingdi, reports a steady improvement in its economic performance and an industrial transformation which is well underway (Interviewee 4, 16 March 2016). According to the statistics provided by Pingdi Sub-district, its GDP increased from CNY 6.55 billion (about US $ 1.04 billion) in 2013 to CNY 8.05 billion (about US $ 1.28 billion) in 2015 with an average annual increase of 11%. Gross industrial output value increased from CNY 18.24 billion (about US $ 2.9 billion) in 2013 to CNY 22.703 billion (about US $ 3.6 billion) in 2015 with an average annual growth of 12%. At least equally importantly, carbon emission per GDP fell by 4% in 2015. In 2015, Pingdi Sub-district's total income reached CNY 480 million (about US $ 76.19 million), an increase of 41% over the previous year. The average dividend of each shareholder was CNY 20,618 (US $ 3273), an increase of 22% compared with the previous year. Total retail sales of social consumer goods were CNY 1.85 billion (roughly US $ 293.65 million), an increase of 8.6% over the previous year.

Although ILCC has been in existence for five years and seen significant progress, it still has a long way to go since the start-up zone covers 1 km^2 while the total area occupies 53 km^2.

5.3.2 Players Involved in Shenzhen International Low Carbon City

Shenzhen has managed to diversify ILCC's funding sources by integrating development, construction, operation, and management. It established a management system known as 'A+1+2+N', linking all participants and balancing their interests (see figure 5-3). There are four levels in the management system, in which Shenzhen Municipality, its Low Carbon office on site, the Shenzhen Special Zone Construction and Development Group Co., Ltd. (CDG) and the Longgang district government play a dominant role in the construction, while private parties contribute to ILCC by investing various resources.

The "A + 1 + 2 + N" management system entails that Shenzhen's overall master plan guides ILCC's development and Longgang district and CDG are taken as the base to construct a comprehensive service platform to serve for ILCC's further deployment. A is the "Steering Committee of Shenzhen International Low Carbon City," a body established at the national level. The National Development and Reform Commission chairs the committee, while relevant ministries, commissions, and the Shenzhen Municipality are members. "1" refers to

the development and construction leading group of the low carbon city and its offices in ILCC. "2" stands for (A) the government of Longgang district, the relevant departments (e.g., Pingdi Sub-district) and companies (e.g., Longgang District Urban Construction and Investment Group (DUCI)); and (B) CDG. "N" is ILCC-based corporations, universities or colleges, R&D institutes, intermediary organizations, and NGOs.

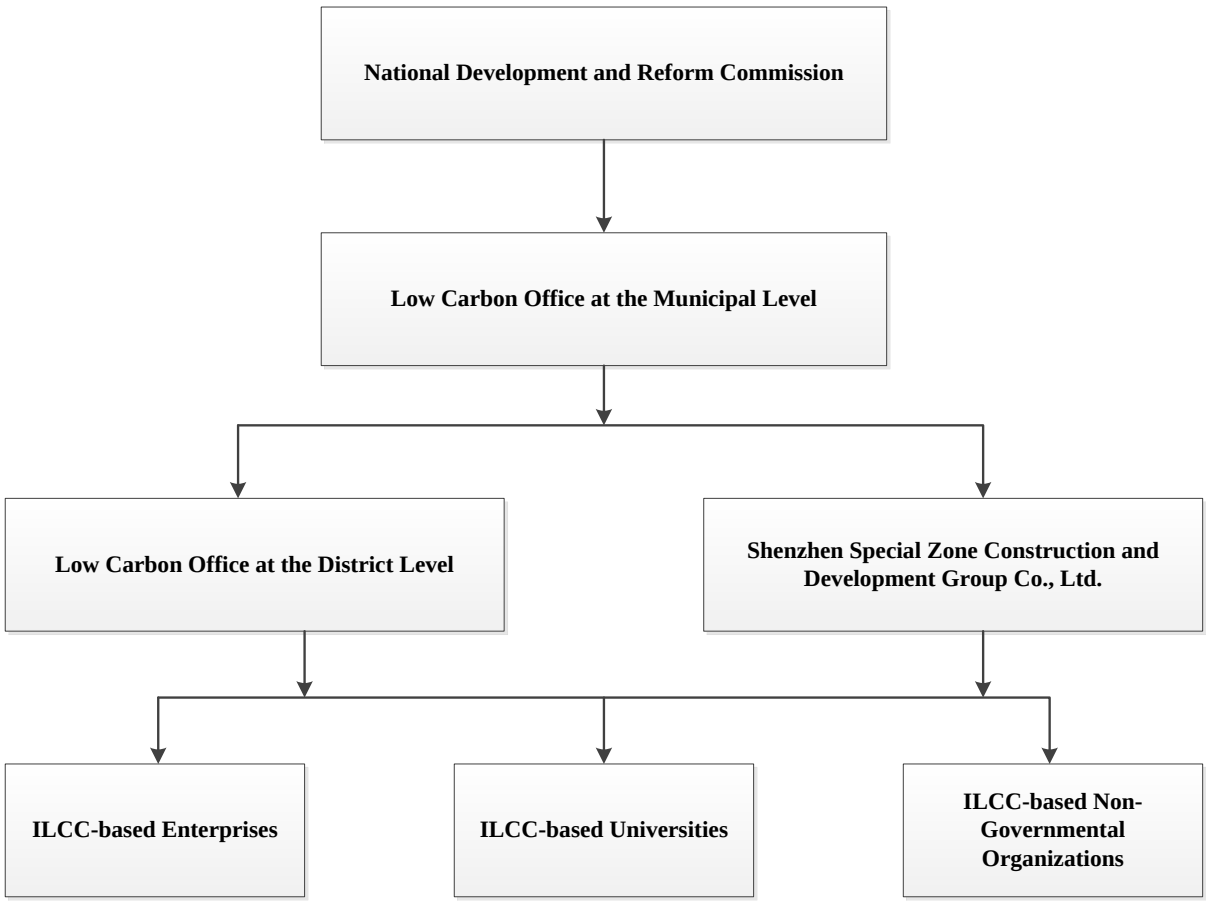


Figure 5-3 The A+1+2+N model

Although all these players contribute to the construction of the low carbon city, their significance and influence vary greatly. Table 5-1 demonstrates the importance, influence, and roles of each stakeholder involved. Following their relative importance and influence, they are divided into three categories: direct primary, indirect primary, and secondary.

(1) Direct primary stakeholders

Local governments and local construction and development corporations can be regarded as direct primary stakeholders, being of vital importance to and with high influence on the low carbon city. Local governments include both the municipal and district governments, namely Shenzhen Municipality, the low carbon office of Shenzhen Municipality, the low carbon office of Longgang District, and Pingdi Sub-district. For the municipal government, the development and construction leading group of the low carbon city and its offices are the resident agencies accountable for making the overall development plan, developing

innovative management mechanisms, and drafting standards for the construction and admittance of newly entering industry.

Governments at the district level consist of the Longgang district government and the relevant departments (e.g., the low carbon office of Longgang district and Pingdi Sub-district), which are responsible for overall planning, land acquisition, investment promotion, dealing with the relationship with ILCC-based enterprises and defending the interests of residents.

The construction and development corporations consist of municipal and district level construction and development companies, i.e., CDG and DUCI. They are responsible for financing and investment, infrastructure development, investment promotion, operation, and management.

(2) Indirect primary stakeholders

ILCC's steering committee is the representative of the National Development and Reform Committee, consisting of relevant national ministries and commissions and Shenzhen Municipality. It plays a role in overseeing the progress of the low-carbon city, which is of vital impact on ILCC, yet it is exerted at a distance.

(3) Secondary stakeholders

The remaining actors are viewed as secondary parties since they are either important but with low influence or less important with low influence, covering banks, private companies, the public, and local residents.

Although banks cannot intervene in the construction of ILCC, they play an instrumental role in supplying money to relevant stakeholders. At first sight, the debtors appear as local construction and development corporations, yet in fact, local governments are the real debtors since these corporations are their representatives in raising money in the capital market.

Private companies include both Chinese and foreign companies (e.g., ESI, Dutch Power Company, Japanese and American companies). They not only invest money in ILCC, but also technology, human resources, and other high-quality resources.

The public buys bonds at the capital market, becoming a critical funding source for ILCC's development. They have no real influence.

Residents also play a role in ILCC by contributing their land use rights to the planning and redevelopment of the whole area and become players and stakeholders in it. Under this arrangement, the original residents enjoy the benefits of ILCC's development along with other parties involved in the low carbon city and are not required to leave.

Table 5-1 Stakeholder analysis

Stakeholders	Key interests	Importance to the low-carbon city	Influence on the low-carbon city	Roles
A. Primary direct				
Local governments (e.g., Shenzhen Municipality, Longgang district government)	• Develop the local economy • Pilot new practices in the low carbon city • Meet national requirements	High. Will provide overall leadership and local business support	High. Will have influence on all aspects	Responsible for planning the overall blueprint of ILCC
Local construction and development corporations (e.g., CDG, DUCI)	• Increase the value of state-owned assets • Earn profit	High. Will provide financial support as well as experience in construction	High. Will have influence on the construction of ILCC	Responsible for financing and investing in ILCC, as well as carrying out parts of the construction
B. Primary indirect				
Steering Committee of ILCC	• Balance economic development and environmental protection	High. Will provide policy and political support	High. Will have influence ILCC at the macro level	Responsible for overseeing the progress of the low carbon city
C. Secondary				
Banks	• Interests	High. Will provide financial supports	Low. Cannot intervene	Creditors
Private parties (including German and Dutch companies) involving in ILCC	• Earn profit	High. Will provide financial and technical support	Low. Co-operates but cannot intervene	Investors
Public	• Bond interests	High. Will provide financial support	Low. Not involved in the construction	Purchasing bonds issued by CDG
Residents	• Increase dividends • Improve quality of life	High. Using land or property as investment resources	Low. Not involved in the construction	Laying in land use rights

Note: A. Direct primary stakeholders: parties directly participate in the construction of ILCC.
B. Indirect primary stakeholders: parties indirectly participate in the construction of ILCC but important and have a high influence on the construction.
C. Secondary stakeholders: remaining players, including parties important but with low influence, less important and with low influence.

5.3.3 The Roles Involved Actors Play in Financial Management

After identifying the actors and the financial vehicles involved in ILCC, we now proceed to present the complete picture linking them with each other.

Figure 5-4 demonstrates how Shenzhen municipality organizes the funds for the low carbon city. The yellow boxes are the resources invested in the construction, while the green boxes are the actors involved. ILCC is a demonstration project of the China-EU Partnership on Sustainable Urbanization, so the top of the figure shows the collaboration between the Chinese central government and the EU. This collaboration provides support in terms of policy formulation and advice. Urban Investment and Financing Platform (UIFPs, more on them below) are the financial vehicles raising money from banks and at the capital market. Other private parties are involved, for example, the German company (ESI) invests in German Town, and local residents use land use rights to contribute to ILCC's construction.

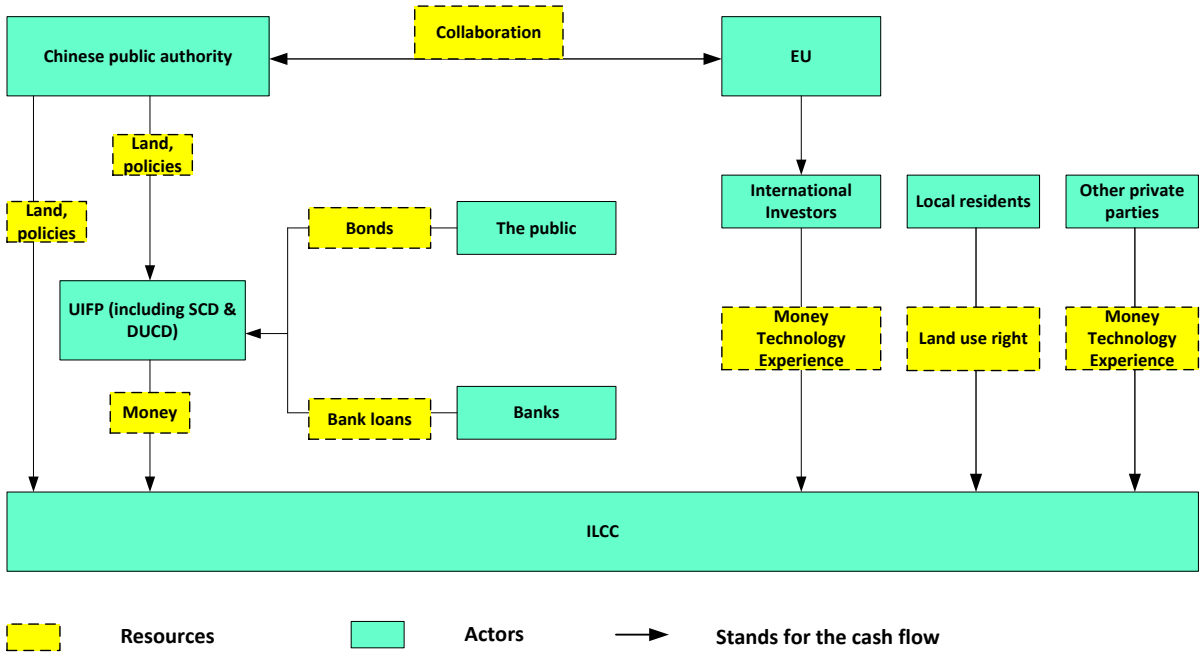


Figure 5-4 Shenzhen model (authors' own compilation)

5.4 Financial Vehicles Used in Shenzhen International Low Carbon City

5.4.1 Municipal-owned Urban Investment and Financing Platforms

CDG was founded in Shenzhen in September 2011 as a municipal-owned Urban Investment and Financing Platform (UIFP)[12]. Shenzhen municipality packed the prime assets of its state-owned companies (e.g., Shum Yip Group Limited, Shenzhen Airport Group, Shenzhen Yantian Port Co., Ltd., and their affiliated companies listed in the so-called A-share market[13] , and companies listed in H-share market[14] affiliated with Shenzhen Investment Ltd.) to invest

[12] UIFPs and UDICs are the same thing, so they are interchangeable in this dissertation.
[13] A-share market is also known as CNY common share market, being a place for issuing shares of China-based corporations and for institutes, organizations, or individuals in China (excluding investors from Hongkong, Macao, and Taiwan) to purchase and trade shares with CNY.
[14] It is a Hongkong-based share market, issuing shares of companies registered in mainland China.

in CDG to boost its investment capacity. Since ILCC is one of Shenzhen's major projects, it asked CDG to invest to ILCC with its significant financing capacity.

Normally, the construction of mega projects[15] under UIFP is done in the following way: the UIFP uses money as the initial investment while the local government uses land as its capital and they jointly set up a new project company. Then the project company raises money from banks and the capital market. However, ILCC uses a very different model. There is no project company in ILCC to arrange money since Shenzhen municipality does not invest land in it. Shenzhen municipality directly asked CDG to invest money in ILCC, giving CDG directly a critical role in ILCC's construction, especially at the initial stage. CDG was responsible for six major projects in the start-up area with a total investment of CNY 3 billion, roughly US $ 476.19 million (Interviewee 2, 04 March 2016), raising money through bank loans, registered private placement bonds and short-term financing bonds (Interviewee 3, 11 March 2016).The projects CDG is involved in include a temporary conference & exhibition center, a green renovation of Hakka circular dwellings, a green renovation of industrial premises, a small number of construction blocks including an aerospace science & technology center, road and other infrastructure construction, the Dingshan River Eco-Park, and an environmental management demonstration project. Table 5-2 offers a breakdown of the projects CDG constructed in the start-up area and the total investment of each project.

Table 5-2 Projects invested by CDG

Unit: in million CNY

Project	**Total Investment**
Temporary conference & exhibition center of the international low carbon city	189
Green reformation of Haka round houses	80
Green building reformation of industrial premises	461
Pilot block construction projects	2030
Construction of roads and infrastructure	34.74
Dingshan River Eco-park and environmental management demonstration project	150
Total	2944.74

Source: Interviews with CDG staff

[15] Bruzelius, Flyvbjerg, and Rothengatter (2002) argue that one of the characteristics of mega projects is that the cost of a project is over $1 billion. However, this amount is not a constraint in defining mega projects. The US Federal Highway Administration also defines mega projects as projects with a significant cost attract a wide public attention or political interest due to substantial direct and indirect influences on the community, environment, and budgets (Capka, 2004). In this research, the authors take the ILCC as a mega project in that ILCC has attracted a wide public attention, greatly influencing the Pingdi Sub-district, the environmental protection in the area, and the local authority's budgets. The total investment in the core area was estimated to be CNY 10 billion, roughly $1.59 billion (Interviewee 5, 17 March 2016).

5.4.2 Public-Private Partnerships

Planning the Village Area as a Whole

The Urban Planning, Land & Resources Commission of Shenzhen Municipality issued its 'Management Approaches for Pilot Projects of Making Overall Plans and Management of the Land Preparation Interests (Trial)' for public review on 26 June 2015. The document takes the land of the original rural collective economic organizations as the pilot object to prepare land as a whole within a village (zheng cun tong chou) and an area (pian qu tong chou) respectively. Shenzhen municipality adopts the above method to prepare land for the construction of the German Town in ILCC (see Figure 5-5).

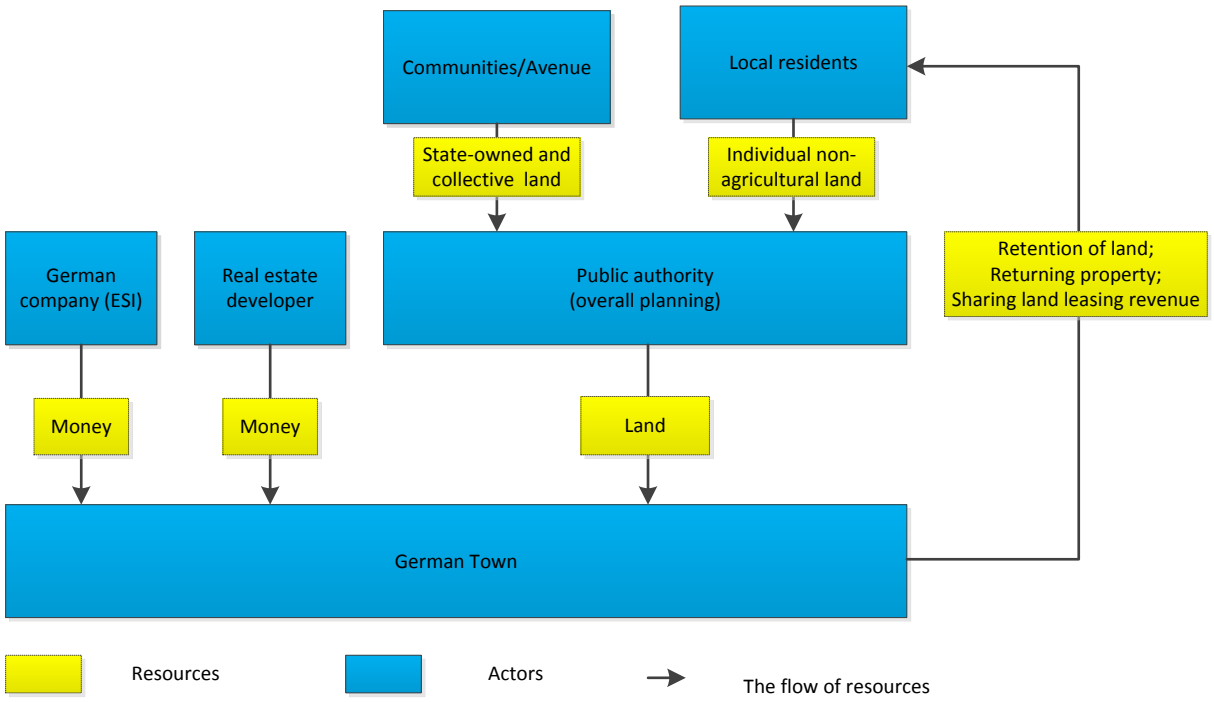


Figure 5-5 The PVAW model

Planning the Village Area as a Whole (PVAW) is an entirely new land preparation method, gathering state-owned land, collective land, individual non-agricultural land and other scattered lands together so that local governments, communities, and real estate developers can plan the area as a whole and hence maximize the interests of communities and residents. This is in fact no less than a revolutionary step in China, where residents are normally forced to move out of the area and receive compensation for their removal, sometimes adequate, sometimes not. PVAW abandons the traditional land preparation model which takes house acquisition as the primary method. Real estate owners in China have over the years evolved higher and higher expectations on the compensation standards for land acquisition. Most of them are no longer willing to accept merely monetary compensation, holding the view that the compensation is insufficient for them to afford a new property. They prefer to cling on to their ownership and/or land use rights when local governments expropriate lands so that they can claim a bigger share in the processes and fruits of land redevelopment. Retention of the land

under the PVAW development mode may involve the integration and functional adjustment of legitimate land use, which needs to be carried out in combination with planning activities. No longer developing different plots of land separately, PVAW arranges land for real estate and industry while including local resident interests in the redevelopment of the collective economy in the community, high-end industries, and public utilities. Residents have become shareholders in a package deal on area redevelopment. They can either let their properties to new tenants, establish collective enterprises on the land or otherwise engage in activities profitable or beneficial to them.

PVAW reduces the government's need to invest in land preparation since residents and rural collective organizations invest in ILCC with their land. Other local governments, units emerging after the original rural collective economic organizations have been disbanded, residents and other stakeholders can benefit from the PVAW through the following four ways, namely, appropriating land preparation funds (employed to compensate demolishing buildings and facilities above the land in ILCC), land retention, sharing revenues from land leasing and returning property.

The Metro + Property Development Approach

On 21 September 2015, the National Development and Reform Commission officially issued the 'Approval of the Adjustment Scheme about the Third Phase Construction Plan of Urban Rail Transit in Shenzhen (2011-2020)', stating that the Eastern extension of metro line 3 starts from Shuanglong Station, heads North via Longgang Avenue and Pingxi Road, and ends at Liulian station. The length of the extension is 9.4 km with seven stations. The line will pass through the old center of Pingdi Sub-district and provide direct access to ILCC. Planning and construction are scheduled for the years 2016-2020. The trial operation of the extension line will take place by the end of 2020.

Total investment in the project is CNY 6.8 billion (US $ 1.08 billion), of which 40% should be the capital funding arranged through fiscal funds from Shenzhen municipality while the rest can be funded from bank loans and other financing vehicles (NDRC, 2015). For the construction of the Eastern extension of line 3 the "metro + property" development approach is used (see Figure 5-6), which can substantially relieve financial pressure from local governments. The "metro + property" investment and financing model is a vehicle where local governments offer a subway company the franchise to construct and operate the metro. With the franchise, the subway company acquires the rights to develop both the metro and real estates along the line. The subway company will first subcontract the real estate development right to real estate companies. Then real estate companies develop commercial buildings, generating revenue through leasing and selling real estates. After that, real estate companies share part of the profit with the subway company. Accordingly, the subway company will use the profits to invest in the subway construction, adding value to real estates along the metro in turn.

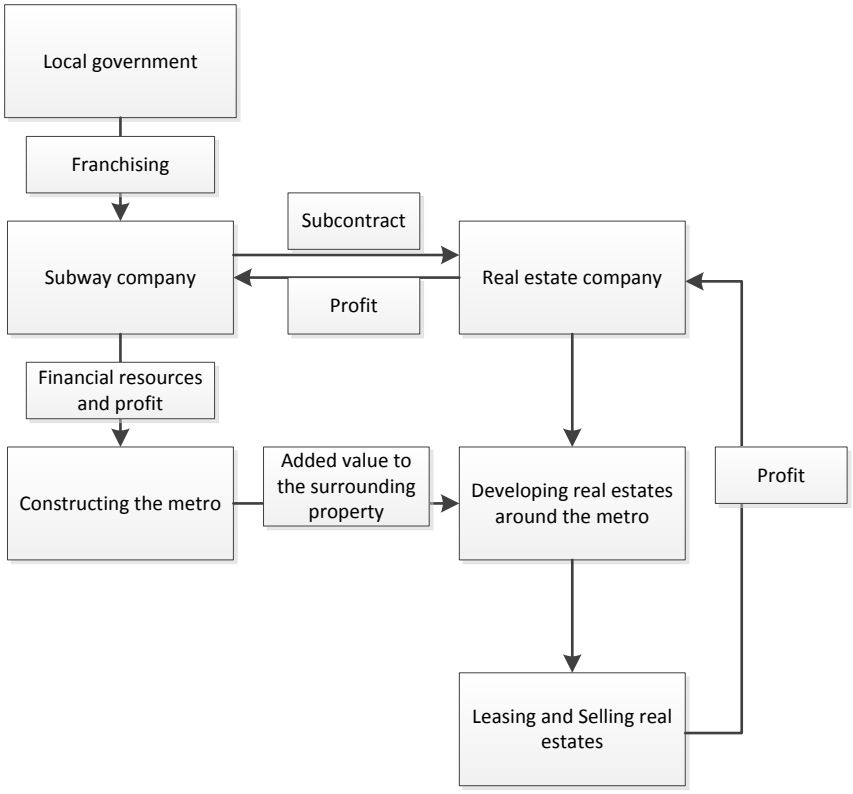


Figure 5-6 The Metro + Property development approach

Foreign Capital

Within ILCC, German Town is specifically one of the demonstration projects of the China-EU Partnership on Sustainable Urbanization (CEUPSU). It will play a critical role in the development of high-end technology and industrial cooperation. It is based in the start-up area and covers 250,000 m2 with a total investment sum of CNY 6 billion (US $ 952.38 million) and is expected for completion by 2020. Players from China and Germany co-founded a new company to develop the German Town. These parties consist of Liulian community (an organization provides community services for community members, such as health care services and sports and cultural services), DUCI, Euro Sino Invest (ESI), and China Construction Fangcheng Investment & Development Co., Ltd., of which ESI is a China-based company owned by the German family "Tucher & Smith" (Eurosinoinvest, 2015). German Town will be implemented in two phases and developed through PVAW and urban renewal. In the first phase, the Chinese party contributes land, while ESI invests money for the infrastructure construction (Interviewee 2, 04 March 2016). This cooperation expands the funding sources of ILCC.

Other Sources

Many private sector companies are also involved in the construction of the start-up area. ILCC-based enterprises have launched eleven projects with a total investment of CNY 3669 million (roughly US $ 582.38 million), further expanding the funding sources for ILCC.

5.5 Lessons and Implications

It is no exaggeration to state that in ILCC a number of financial innovations have been introduced deserving of consideration beyond just Shenzhen. Eco and low carbon city development are costly and lean heavily on the public purse. Most municipalities in China have chosen massive land lease as a way to circumvent their lack of investment funds, but this solution is neither economically nor socially nor environmentally sustainable. Shenzhen has established an Urban Investment and Financing Platform (UIFP) with the highest quality assets since its shareholders invested in the company with their prime assets. As such, it can raise a substantial amount of money through banks and the capital market. This made it unnecessary to lease land to pay for urban and infrastructure development. A number of important lessons can be drawn:

First, land acquisition and preparation has been a big challenge for the Shenzhen municipality since the total investment in the core area was estimated to be CNY 10 billion (roughly $1.59 billion) (Interviewee 5, 17 March 2016). To promote successful land acquisition, Pingdi Sub-district sought support from Longgang District to initiate innovative investment and financing methods to avoid high compensation fees and public uproar. In previous projects, land acquisition was dominated by the local government, and the government was the only investor. However, ILCC introduced a UIFP as a vehicle to provide money for land acquisition. This reduced the government's financial burden in preparing land in a short time. However, we should add that this practice just currently buffers the government's financial pressures, but it does have to pay back in the future (Zhan et al., 2017a). If the UIFP fails to repay its debts, Shenzhen municipality has to take them over since the platform is one of its financial tools. On the other hand, the UIFP also benefits from participation in ILCC's construction. With the backup of a large amount of money, it has helped the government to prepare land with an area of 1.22 million square meters, laying a solid foundation for the entrance of high-quality enterprises and the construction of mega projects.

Second, preparing land through Planning the Village Area as a Whole appears to be a true process innovation. ILCC is deploying by balancing the interests of governments, companies, and residents. On the one hand, residents have become investors so they can get dividends from investing land use rights in ILCC. On the other, it has reduced government expenditure in land acquisition and the tensions and conflicts between these three groups of actors.

Third, the 'metro + property' development approach was adopted to facilitate the development of the eastern extension of line 3. The government and the subway construction company share land premiums and real estate operating income, reducing the debt ratio of the local financing platform and the subway construction company. The practice is also conducive to attracting investment from private sectors and providing a diversified funding portfolio to reducing the risk of solely depending on public funds. The approach optimizes project costs and income. The integrated development of subway and real estate not only optimizes the co-evolution of design and development of the subway line and its surrounding property to achieve the optimal project income but also recovers costs in the process of construction and development to effectively control the risks. Under the 'metro + property' development approach, the real estate company provides financial support for subway

development with revenue generated from real estate, while the subway development adds value to the property around the subway (Li et al., 2014). The integration of subway and land use planning adds value to the land and promotes the use of bus services by offering a greater number of connection points for bus passengers.

The progress in ILCC thus far is largely due to the diversification of funding sources and innovative changes in organizational arrangements where a greater variety of stakeholders is incorporated in the development process. The combination of these measures reflects a promising application of stakeholder management and sustainable finance, which balances the interests of governments, enterprises, and residents and takes financial, social and environmental factors into consideration. The application of Public-Private Partnerships expands the funding sources, ensuring financial stability. PPP is obviously not new, but it enjoys strong support from the Chinese central government and is regarded as a cure for the high indebtedness local government faces. It should be noted here that PPP, as applied in ILCC, represents a broader spectrum of public-private collaboration forms such as Build-Operate-Transfer (BOT) and Build-Own-Operate-Transfer (BOOT) described in the literature and commonly utilized for infrastructure management in China. As such, PVAW, foreign capital, and the 'metro + property' development model should also be seen as more economically and financially sustainable versions of PPP. From a social point of view, the adoption of PVAW not only broadens the funding sources but also softens the tensions between governments, developers and residents and hence contributes to the sustainable community development. From an environmental perspective, a number of old buildings which otherwise would have been dismantled have been retrofitted to serve new purposes and rivers have been cleaned up. High carbon emission companies have been moved out while low carbon emission companies or service industries and knowledge centers entered. All of this can be seen as the first move to a decoupling of economic growth from the growth of environmental emissions, propagated in other contributions of this journal as 'ecological modernization' (Bayulken & Huisingh, 2015; de Jong et al., 2016). As a consequence, Longgang District has improved its performance in various environmental aspects. Although the GDP of the district increased from CNY 215.33 billion to CNY 317.71 billion (Shenzhen Longgang Statistical Information Net, 2017), the energy consumption per 10000 CNY GDP did not increase accordingly. On the contrary, it decreased from 0.458 tons standard coal in 2013 to 0.231 tons standard coal in 2016 (Shenzhen Longgang Statistical Information Net, 2017). Other evidence also indicates the improvement of the environmental performance in the area. For instance, the average concentration of PM 2.5 in Longgang dropped from 37 μg / m3 in 2012 to 29 μg / m3 in the first half of 2017, and the days of the air quality rated good or excellent rose from 85.5% in 2012 to 96.1% in the first half year of 2017 (Shenzhen Longgang Statistical Information Net, 2017). It should be noted that moving out high carbon emission companies is obviously environmentally friendly at the municipal level, but not necessarily at the national level: this depends on whether the relocation is combined with a quality upgrade of the industrial facility. This is largely the case for ILCC because Shenzhen feels a strong urge to shine internationally, but it is not inherent to the diversification of funding sources and other innovative financial arrangements chosen.

Taken as a whole though, Shenzhen and ILCC have developed a model of sustainable finance with less extensive financial and other support from the central government and foreign governments than Sino-Singapore Tianjin Eco-city and thus may offer more practicable lessons for other cities. This should certainly be seen as a major institutional and organizational step forward in achieving the triple bottom line in sustainable urbanization. That said, the exploration of new models of sustainable finance for urban development has only just begun.

6 Funding Sustainable Cities: A Comparative Study of Sino-Singapore Tianjin Eco-city and Shenzhen International Low-carbon City

This chapter is mainly based on the following peer-reviewed article:

- Zhan Changjie, de Jong Martin, de Bruijn Hans (2017) 'Funding Sustainable Cities: A Comparative Study of Sino-Singapore Tianjin Eco-city and Shenzhen International Low-carbon City,' *Journal of Environmental Management*, Under review

6.1 Introduction

Hundreds of millions of people migrated to cities in the past three decades which is unprecedented in human history (Liu & Salzberg, 2012). This trend still keeps increasing. It is projected that the urbanization rate will reach around 70% with roughly one billion people living in cities in 2030 (Zhang, 2013). This trend puts forward a big challenge both for the central and local governments in providing public products (services), housing, energy, and infrastructure. Additionally, the rapid growth of China's economy and population and the accelerated urbanization have brought great challenges in environmental management. Researchers and practitioners try to combine the environmental protection with urban development. In 2003, the UK government issued the 'UK Energy White Paper: Our Energy Future--Creating a Low Carbon Economy,' resulting in the development of low carbon or eco cities all over the world, especially in China. Following this trend, China has vigorously

promoted the development of sustainable cities[16] to alleviate the pressure caused by pollution problems to urban development, such as the construction of eco-cities, low-carbon cities, and low-carbon eco cities. Some have made big progress, such as Sino-Singapore Tianjin Eco-City (SSTEC) and Shenzhen International Low Carbon City (ILCC). However, most of these projects are not as successful as expected due to various kinds of problems (e.g., planning governance and financial issues) local governments face. For example, Shanghai Dongtan Eco-city has been indefinitely suspended because of land use right and financial problems (Miao & Lang, 2015). Additionally, the development of ecological housing and low-carbon economy leads to higher project costs. Accordingly, who would be the payer is also a problem (The UK-China Eco-Cities & Green Building Group, 2012).

The International Consensus on the Sustainable Development Goals and the 2030 Agenda underscore the need to find long-term solutions for addressing the challenges in funding sustainable development. It is projected that an annual investment of US $ 5-7 trillion will be required to achieve sustainable development goals, covering infrastructure, water supply, clean energy, sanitation, and agriculture (UNCTAD, 2014). Of these, developing countries need roughly US $ 3.9 trillion investment. However, merely US $ 1.4 trillion is in position while the rest US $ 2.5 trillion requires being filled by the public and private funds. The public fund such as fiscal fund merely supplies a small proportion of the total investment amount. For example, the total investment of green finance in China reach to 400 billion each year, yet the public fund only can supply less than 15% funds. As such, the study of how to provide financial support for the construction of sustainable cities has become one of the core considerations of academics and practitioners. For example, Baeumler and Mehndiratta (2012) figure out that balancing financial instruments and incentives is critical for the construction of sustainable cities. The Research Institute for Fiscal Science Ministry of Finance P. R. China (2015) studied the significant role of finance in addressing climate change from an institutional angle. The research group indicates that fiscal policies play a guiding role in approaching the climate change issue since authorities can employ incentives and punishments to handle different environmental impacts each project causes. Incentives such as tax exemptions or subsidies encourage positive impacts on the environment while punishments increase investors costs and internalize negative externality (Bovenberg & de Mooij, 1997; Engel et al., 2008; Sandmo, 1975). Therefore, it is significant to explore which financial toolkits can be used to fund the development of green projects.

Against this backdrop, we compare the financial instruments SSTEC and ILCC, two successful sustainable cities in China, employ to fund their construction. This article aims at addressing the following questions. (1) What are the similarities and differences in financing vehicles between Shenzhen International Low Carbon City and Sino-Singapore Tianjin Eco-City?; (2) What roles do the involved stakeholders play in providing stable funding for the construction?; and (3) Which financial toolkits can be employed by other sustainable cities in China and globally?

[16] We use sustainable cities as the umbrella term to stand for eco cities, low-carbon cities and eco low carbon cities since ‘sustainable cities’ is the most frequent co-occurrence term in the literature with other various city terms (Martin de Jong et al., 2015).

We depended on multiple sources to address these questions. Desk research was used to retrieve the academic literature as well as to obtain data from SSTEC and ILCC's websites, auditing reports of SSTEC, and other web-based reports (e.g., the World Bank, the United Nations Environmental Program, the NDRC Report, and the national audit report issued by Chinese National Audit Office). We subsequently interviewed 20 people whose work is related to the two cases. Of these, 11 people were working in or with SSTEC in the period April–July 2015, which consists of officials, developers, financial staff, and project managers. In February 2016, we revisited the SSTEC site and stayed there for one week to collect additional information. We also visited the ILCC site in the period February-March 2016 and interviewed nine people working in or with ILCC. The first author conducted interviews, and the language was Chinese. The interviewee's names were not listed due to reasons of confidentiality.

This article is structured as follows. Section 2 reviews the literature regarding financial instruments employed by cities. Section 3 presents the profiles of Tianjin and Shenzhen projects, providing relevant background information for the following studies. Section 4 is a comparative study, including the comparison of financing vehicles the two projects adopt, and stakeholders involved in the two cases. A generic model for funding sustainable cities is demonstrated based on the result of the analysis of similarities and differences. Section 5 is the conclusions.

6.2 Literature Review

With the development of the economy, countries take environmental issues more and more seriously and seek to transition their economy to sustainable development. This trend thus puts new challenges for local authorities in funding these projects. Therefore, both researchers and practitioners have tried hard to explore new financial instruments that can be employed to expand the financing sources. Merk et al. (2012) argue that the main financial instruments in the principal green urban sectors include taxes, user fees, grants, Public-private Partnerships (PPPs), land-based income, loans, bonds, and carbon finance. These financial instruments are used to finance the development of transportation, buildings, water/waste, and energy. Inman (2005) holds the view that local public services can be funded through user fees, resident-based taxation, and business-based land value taxes. Of these, user fees can be applied to both residential and business services, and resident-based taxation is adopted to finance residential services while business-based land value taxes are applicable for business services. Slack (2010) presents some financial instruments for large cities, including user charges, tax, intergovernmental transfers, borrowing, PPPs and development charges. Bahl and Linn (2014) divide financial instruments into own-source financing and external sources of financing on the basis of financial sources. Own-source financing includes user changes and betterment levies, property taxation, and non-property taxes while external sources of financing encompass intergovernmental transfers, borrowing, PPPs, and international aid. Z/YenGroup (2015) systematically explores financial instruments for financing sustainable infrastructures in cities. The research group identifies three instruments in general, namely, public finance, debt finance, and equity finance instruments. To be specific, public finance instruments include land sales, land or infrastructure asset leaseholds, PPPs & Private-finance initiatives

(PFIs), taxes, land value capture mechanisms, user charges & fees, grants and subsidies, building rights and planning permits. Debt finance instruments encompass loans and bonds, de-risking & credit enhancement instruments, and debt refinancing instruments while equity finance instruments consist of infrastructure equities listed, equity funds listed/unlisted, and equity-funded direct investments (e.g., special purpose vehicles (SPVs) and joint ventures (JVs)) in infrastructure. Instead of directly exploring financial instruments, Meltzer (2016) discusses how to use concessional climate finance to facilitate the development of low-carbon resilient infrastructure projects. Methods include (1) developing an enabling environment and co-financing packages; (2) supporting local banks, the development of financial instruments, and low-carbon technology; (3) strengthening monitoring of outcomes; and (4) improving cooperation between climate funds. Additionally, some researchers argue that if general fiscal investment and innovative financing strategies are sustainable depends on the following criteria: 'adequacy, stability, efficiency, equity, ease of implementation, and political acceptability' (Sun et al., 2014, p. 193).

Although researchers explore instruments to be employed for financing the development of sustainable cities, it does not mean that all these financial vehicles play equal roles in raising money. Bahl and Linn (2014) concluded that debt finance, PPPs, and land-based levies are effective instruments to finance city construction; intergovernmental transfers and grant finance are of paramount importance, and user charges and property taxes are critical yet underused. In general, the financial instruments large cities adopt should be in line with their responsibilities in providing infrastructure and services (Slack, 2010). Many researchers shed light on mobilizing private capital in that the involvement of private sectors can alleviate local authorities' financial pressure (Slack, 2010; Zhan et al., 2017). Therefore, local authorities should pay attention to the needs and interests of private investors (Sullivan et al., 2013) and provide political support to enabling conditions for the involvement of private parties (Jacobson & Choi, 2008; Osei-Kyei & Chan, 2015). PPPs and bonds are regarded as two effective ways to involve the private sector in the development of climate-related projects (Reichelt, 2010; Sullivan et al., 2013). On the one hand, PPP has been widely applied in many fields, yet it is still under development, particularly in developing countries. On the other hand, funds raised through green bonds merely take a small proportion of the projected amount needed to bridge the green funding gap (Reichelt, 2010). Still, the green bond market is booming since the amount raised through green bonds has been increased from $ 1 billion in 2007 to over $41 billion in 2015 (Climate Bond Initiative, 2015). To unlock the potential of green bonds, dialogues between policymakers and stakeholders should be strengthened to clear away barriers and improve the information transparency (Shishlov et al., 2016).

To have a concrete picture of how to finance sustainable cities, the following sections introduce and compare SSTEC and ILCC to present how they finance their development and how the adopted financial instruments balance different stakeholder's interests to achieve the goal of sustainability.

6.3 Overviews of Tianjin and Shenzhen Projects

6.3.1 Shenzhen International Low Carbon City

ILCC is a demonstration program in the collaboration between China and EU on sustainable urbanization, aimed at displaying China's achievements in low carbon technology. It is located in Longgang District, Shenzhen, China, at the border with Dongguan, and Huizhou in Guangdong province. ILCC was launched in 2012 and covers a planned area of 53.4 km2. Currently, the economy in Pingdi is still underdeveloped while carbon emission levels are high. As a flagship project of the China-EU Partnership on Sustainable Urbanization, Shenzhen municipality is trying its best to develop ILCC into a pilot area to realize a great-leap-forward in urban developmental planning under the concept of integrating industry with the city, green urban management and benefit sharing under the constraints of carbon indicators to eventually provide replicable pathways for low carbon development in future urbanization (Interviewee 1, 2 March 2016).

Location

ILCC is located in Longgang District, Shenzhen, China, at the border with Dongguan and Huizhou in Guangdong province (see Figure 6-1). People can reach Guangzhou, Dongguan, Huizhou, Zhuhai, Hongkong Central Area with about two hours by car from ILCC. The location is conducive to ILCC to use the neighbor cities' technology and resources.

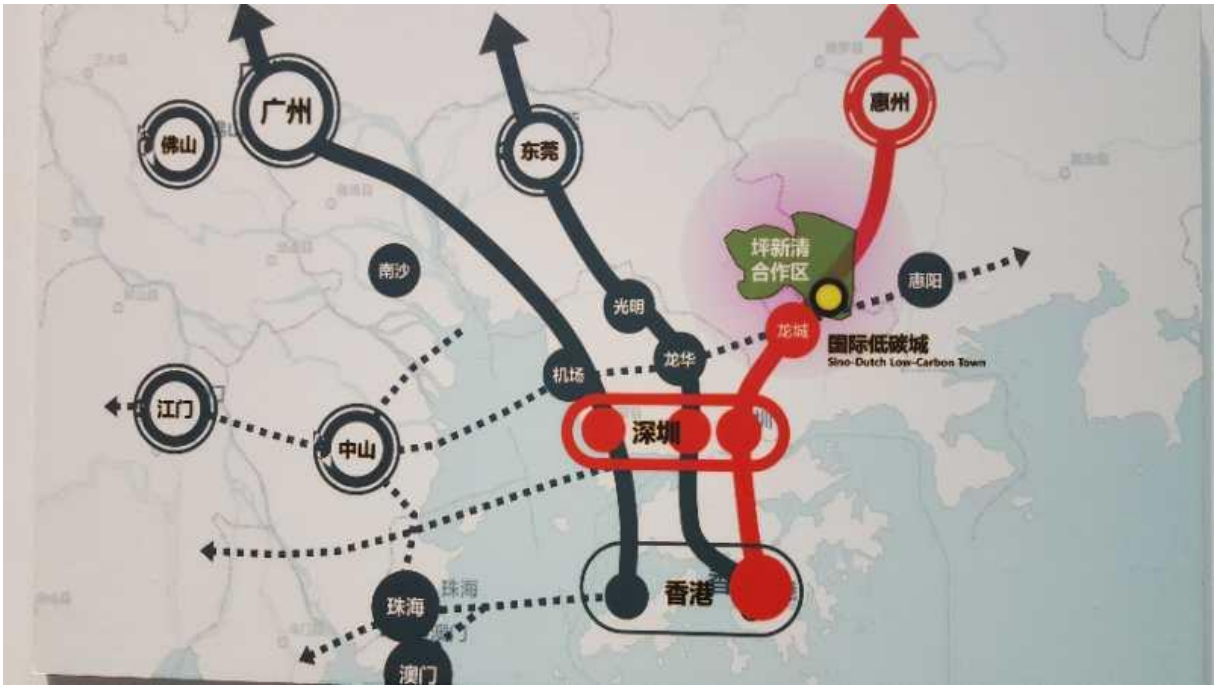


Figure 6-1 The location of ILCC

Source: Documents from ILCC

Goals

ILCC aims to be an international low-carbon demonstration area with 300 000 inhabitants. The low-carbon city would function as a low-carbon technology research and development

center and low-carbon technology integration application demonstration center, low-emission industry gathering center, low-carbon solution provider center, and low-carbon development service center.

Industrial planning

Industry admittance in ILCC mainly follows low carbon industry screening criteria and the selection principle. The target industries in Shenzhen include two parts, namely, endogenous industry and exogenous industry. The endogenous industries are mainly based on the leading and advantageous industries of Shenzhen municipality and Longgang District. The exogenous industries are mainly based on the strategic positioning of ILCC, starting from the industrial development trend and regional undertaking capacity. Endogenous industries include high-tech industry, modern financial industry, modern logistics industry, cultural industry, communications equipment, computer and other electronic equipment manufacturing industry, electrical machinery and equipment manufacturing industry, and power industry. Exogenous industries consist of the new materials industry, the new generation of information technology industry, bio-industry, the Internet industry, new energy industry, service outsourcing, tourism, and tourism agriculture industry.

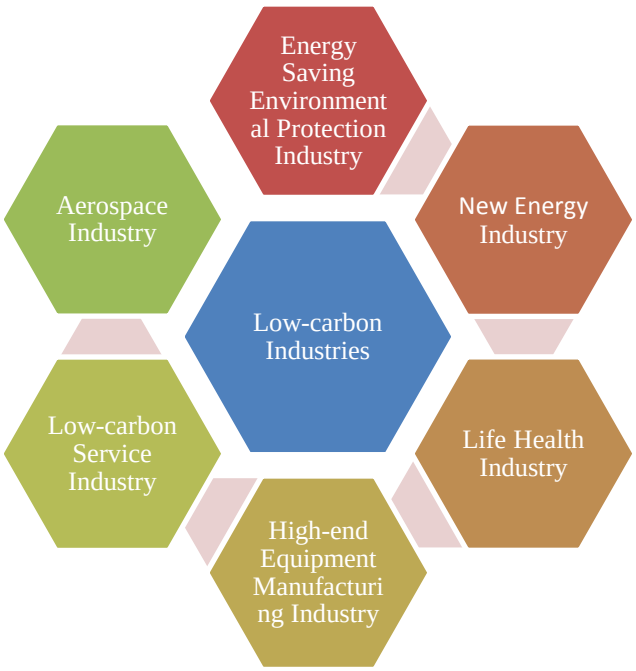


Figure 6-2 Low-carbon Industry Planning in ILCC

Source: ILCC (2017b)

6.3.2 Sino-Singapore Tianjin Eco-city

In November 2007, the Framework Agreement between People's Republic of China and Republic of Singapore about Building an Eco-City in the People's Republic of China and Supplementary Agreement of this framework were signed. It is a new highlight and the key project between the two countries following the establishment and development of Suzhou Industrial park. Sino-Singapore Eco-City aims to develop itself into a new city that is

economically vibrant, environmentally friendly, resource-efficient and socially harmonious, and provide a reference for the other cities in China.

Location

SSTEC is located in the core area of Tianjin Binhai New Area, which is 45km from Tianjin city center, 150km from Beijing, 40km from Binhai International Airport, and 20km from Tianjin Port. What is more, there are over 10 expressways sitting close to SSTEC, including Beijing-Tianjin-Tanggu Expressway, Beijing-Tianjin Expressway, Tangshan-Tianjin Expressway, Haibin Road, Jinbin Expressway etc., as well as three passenger railways, including Beijing-Tianjin Intercity Rail, Tianjin-Qinhuangdao PDL and Jinbin Light Rail Train, which makes the eco-city easy to connect to key areas around (see Figure 6-3). For example, it takes forty-five-minute driving to Tianjin Downtown, thirty-minute driving to Tianjin Binhai International Airport and ninety-minute driving to both Beijing downtown and Beijing Capital International Airport. The location of SSTEC couple with the well-developed transportation network has become one of the advantages for Tianjin to develop eco-city.

Figure 6-3 The location of SSTEC

source: brochure provided by SSTEC

Goals

The government of China and Singapore determined to jointly establish an Eco-city which is resource-saving, environment-friendly, economically robust and socially harmonious. This city will strive to realize that 'people live in harmony with people, with economic activities and with the environment; and the eco-city development is practical, replicable and scalable.

Sino-Singapore Tianjin Eco-city has a planning area bout 30km2 and will be established in 10 to 15 years with the estimated population of 350,000. The proportion of residential land use is approximately 40%, of industrial land use 10% and of commercial land use 3% (TEID, 2015).

Industrial planning

Green industries are key industries in SSTEC. The key industries, features, and industrial layout of SSTEC are displayed in table 6-1.

Table 6-1 Key industries, features and layout of SSTEC

Items	Contents
Key industries	Cultural creation, environment protection technology characteristic finance, information technology and related services, green building
Industrial characteristics	High-end, High-quality, High-tech, green industries, low-carbon industries, recycling industries, urban economy, office economy, headquarter economy, resource efficient, low energy consumption and zero pollution
Industrial Layout	National animation industrial park, national 3D Movie park, eco science park, eco industrial park and information industrial park

6.3.3 Sino-Singapore Tianjin Eco-city vs. Shenzhen International Low-carbon City

To have an overall picture of the two cities, Table 6-2 displays profiles of Tianjin and Shenzhen. From the table, we learn that Tianjin project started in 2007 with five years earlier than Shenzhen project. SSTEC covers 30 km2, 23.4 km2 less than ILCC. However, SSTEC is built in an area consisting of salt pans, saline-alkaline non-arable land, and polluted water bodies. Each component takes up one-third of the land. The construction of SSTEC has a symbolic meaning both in China and elsewhere since the Tianjin project builds a city from scratch on the barren land. In contrast, ILCC is built on the existing city yet makes the transition by upgrading its industries to lower carbon emission industries. The differences in these aspects require the central government to involve in the construction of SSTEC to a larger extent than the Shenzhen project.

Table 6-2 Comparison of profiles of Tianjin and Shenzhen

	Tianjin	**Shenzhen**
Year of launch	2007	2012
Total area	30 km2	53.4 km2
Location	SSTEC is located in the core area of Tianjin Binhai New Area, which is 45km from Tianjin city center, 150km from Beijing, 40km from Binhai International Airport, and 20km from Tianjin Port.	ILCC is located in Longgang District, Shenzhen, China, at the border with Dongguan and Huizhou in Guangdong province.
Geographic conditions	An area consisting of deserted salt pans, saline-alkaline non-arable land, and polluted water bodies	Nearly half of the Pingdi Sub-district is mountain area, of which, 40% natural reserve land; the other half has been urbanized.
Goals	To establish a replicable Eco-city characterized by resource-saving, environment-friendly, economy-robust and society-harmonious. Sino-Singapore Tianjin Eco-city has a planning area bout 30km2 and will be established in 10 to 15 years with the estimated population of 350,000.	To build a low-carbon technology research and development center and low-carbon technology integration application demonstration center, low-emission industry gathering center, low-carbon solution provider center, low-carbon development service center
Industries	Cultural creation, environment protection technology characteristic finance, information technology and related services, green building	Service industry, IT Industry, energy and environmental protection industry, modern agricultural industry, low carbon economic new material industry

6.4 Analysis

6.4.1 Financing Vehicles

Financing sustainable urban development has become a major issue, especially in Asian countries where the size and scale of construction efforts are vast. Here we compare the cases of ILCC and SSTEC to see the similarities and differences in financing vehicles they employ (see Table 6-3).

Table 6-3 Financial vehicles employed by Tianjin and Shenzhen

Financing vehicles	Tianjin	Shenzhen
Bank loans	x	x
Corporate bonds	x	x
Public-Private Partnerships		
- Preparing village area as a whole (PVAW)		x
- Metro + Property model		x
- Foreign capital	x	x
- Funds from domestic private investors	x	x
National and international Assistance		
Governmental funds and tax refund	x	
International assistant programs	x	

Sources: based on Zhan and de Jong (2018) and Zhan and de Jong (2017b)

ILCC uses bank loans, corporate bonds, and PPPs to provide funds for its construction. Similarly, SSTEC employs bank loans, corporate bonds, and PPPs. The assistance from national and international organizations also plays an instrumental role in funding SSTEC, yet the amount in ILCC is so limited that can be ignored. Bank loans and corporate bonds are both employed by SSTEC and ILCC. However, they differ from each other since bank loans and corporate bonds in Shenzhen case are carried out in the name of Shenzhen Special Zone Construction and Development Group Co., Ltd. (CDG), which is a financing platform. In contrast, bank loans and corporate bonds in Tianjin case are arranged through Tianjin Eco-city Investment and Development Co., Ltd. (TEID), which has been regarded as an innovation of the Tianjin project since TEID has six stakeholders and separates the functions of local authorities from the company (Zhan & de Jong, 2017b). Regarding bank loans, both projects have a close connection with banks so that they can obtain large loan sums. For example, TEID is strongly backed by the public sector, which is beneficial for the company to get bank loans because government-backed projects are regarded as more reliable (Ba & Yang, 2014). Additionally, TEID cooperates with 12 banks, diversifying the sources for getting bank loans. As for ILCC, CDG plays an instrumental role in acquiring bank loans. CDG, as a financing platform, helps the government raise funds for its construction. Shenzhen municipality packed the prime assets of its state-owned corporations to CDG, which is conducive for CDG to obtaining bank loans. In this aspect, the two projects are similar. However, corporate bonds issued by the two corporations are different. CDG issues bonds in the Chinese capital market while TEID issues bonds in the Singaporean capital market except for in China. It was the first time for the Tianjin-based non-financial company to issue bonds in the international

capital market, which is one of the major contributions of ILCC in funding sustainable cities (Financial staff 1 (TEID Tianjin China), 21 July 2015; Financial staff 2 (TEID Tianjin China), 23 February 2016).

Regarding PPP, the two cases are similar in using foreign capital and obtaining funds from domestic private investors. Foreign capital in the Tianjin case is predominantly from Singapore, including the Singaporean consortium led by Keppel Corporation, other Singapore-based companies, and the public in Singapore. However, ILCC has more diversified international cooperators. It originally wanted to utilize the same strategy as the Tianjin model to finance its construction. Put otherwise, Shenzhen municipality wanted the Dutch government to invest money in ILCC, yet it did not succeed in introducing the strategic partner since the Dutch party just wanted to play a consultancy role in the construction (de Jong et al., 2013). Shenzhen municipality since then tried to diversify its partners by introducing companies from Germany, the Netherlands, Japan, and America. This is one of the reasons for Shenzhen municipality to change the low-carbon city's name from Sino-Dutch Low-Carbon City into Shenzhen International Low-Carbon City (Interviewee 1, 2 March 2016). Uniquely, the Shenzhen case also makes use of preparing village area as a whole (PVAW) and 'metro + property' model to fund the low-carbon city, which is regarded as two innovations of the Shenzhen case in financing its construction. On the one hand, PVAW is a new means to consolidate and reserve land taking into account the benefits of original residents, small enterprises, and other scattered landowners. PVAW is not merely giving monetary compensation to landowners in ILCC but also allow them to participate in the construction by contributing their land. In the process, benefits of different stakeholders have been balanced, and thus social conflicts have been alleviated. On the other hand, the 'metro + property' model offers another option for local authorities to arrange financial issues. Local authorities grant the franchise to a subway company allowing it to construct and operate the metro. Meanwhile, local authorities also allow the subway company to develop real estate along the line to subsidize the loss of operating the subway in future. This practice adds value to the real estate due to the convenient transportation while the prosperous real estate, in turn, boosts the traveler flow and thus increase the revenues of the subway company. With the help of PVAW and 'metro + property' model, private parties have been mobilized to participate in the construction of ILCC, which relieves the local authorities' financial burden. PVAW reduces local government's expenditure on expropriating lands while 'metro + property' model decreases local government's costs in building the metro.

6.4.2 Stakeholders Involved in the Two Cases

The literature includes extensive discussion of how international, national and subnational actors and the balance of their benefits in the construction of sustainable cities influence the sustainable financing in the two cities (de Jong et al., 2016; Zhan & de Jong, 2017b, 2018). Since sustainable cities are long-term and huge investment projects, the risks are also high to invest in sustainable cities. As such, it is of paramount importance to balance the interests of different stakeholders.

The key to success is the active participation of actors from financial institutions, including central banks, regulators and prudential official institutions, standard-setters, governmental

departments (including the ministry of finance), and market-based rule makers (including stock exchanges and credit rating agencies). Other participants also play an instrumental role in the construction of sustainable cities.

Market-based participants: banks, pension funds, and analysts. They participate in the construction through leadership, knowledge development and expert guidance, alliance building, and advocacy participation.

Sustainable development communities: ministry of environmental, think tanks, civil society and institutions (e.g., UNEP), these participants bring professional knowledge, build alliances and build public awareness.

International organizations: involving financial system development - policy reform, knowledge development, standard setting and standard development and coordination. Individuals: as consumers of financial services, employees of financial institutions, participants in civil society - bring unique skills and how to relate the financial system to human needs and aspirations.

Most of the above participants need to join in such alliances to play their respective roles at the national, regional, and international levels.

Table 6-4 lists the major stakeholders involved in Tianjin and Shenzhen, including primary direct, primary indirect, and secondary stakeholders.

Table 6-4 Stakeholders involved in Tianjin and Shenzhen

A Primary direct	Tianjin	Shenzhen
Local Governments	x	x
Administrative Committee	x	
Urban Investment and Financing Platforms and subsidiaries	x	x
B Primary indirect		
Chinese Central Government	x	x
The Central Government of Other Countries	x	
Steering Committee		x
C Secondary		
Banks	x	x
Private Parties (including parties from other countries) involving the construction	x	x
The Public in China	x	x
The Public in Other Countries	x	
Other Companies Based in the Eco-city or Low-carbon City	x	x
Resident	x	x

Note: A. Direct primary stakeholders: parties directly participate in the construction of SSTEC and ILCC.
B. Indirect primary stakeholders: parties indirectly participate in the construction of SSTEC and ILCC but important and have a high influence on the construction.
C. Secondary stakeholders: remaining players, including parties important but with low influence, less important and with low influence.
Sources: based on Zhan and de Jong (2017b) and Zhan and de Jong (2018).

Primary direct stakeholders

From a primary stakeholder's perspective, the Tianjin project involves three major players, namely local governments, administrative committee, Urban Investment and Financing Platforms (UIFPs) and its subsidiaries. These players directly participate in the construction of SSTEC, making great contributions to the development of SSTEC. Local governments in SSTEC are responsible for promoting the development of the local economy and preserving the environment. The administrative committee, as the representative of the local governments, has the same interests as local governments yet predominantly focus on the implementation aspects. Tianjin Eco-city Investment and Development Co., Ltd (TEID) plays the role as a master developer, being responsible for (1) land acquisition, consolidation, and reserve in the Eco-city, and (2) investment, construction, operation, and maintenance of infrastructure and other public facilities in the eco-city.

The Shenzhen project does not have an administrative committee, unlike the Tianjin project. Its primary stakeholders include local governments and UIFPs. Local governments include both the municipal and district governments, namely Shenzhen Municipality, the low carbon office of Shenzhen Municipality, the low carbon office of Longgang District, and Pingdi Sub-district. Each plays its role in the construction. The municipal government is responsible for overall planning of the low-carbon city, which includes making the overall development plan, developing innovative management mechanisms, and drafting standards for the construction and admittance of newly entering industry. The district level governments stress the implementation function more. Their responsibilities cover overall planning, land acquisition, investment promotion, dealing with ILCC-based enterprises and defending the interests of residents. The UIFPs in the Shenzhen project include both the municipal and district level UIFPs, namely, CDG and DUCI. They are accountable for financing and investment, infrastructure development, investment promotion, operation, and management.

It should be noted that the two projects both have UIFPs yet different functions in each project. TEID distinguishes itself from other UIFPs since its ownership is diversified and the local authorities do not share profits from the company and are not responsible for its losses either. This means that TEID cannot be simply viewed as the local government's financial vehicle. TEID is set up as per the needs of SSTEC yet operates on the basis of the principles of marketization and professionalization (Civil servant (SSTECAC Tianjin China), 15 May 2015). Similarly, TEID's subsidiaries have diversified ownership as well, consisting of both Chinese and Singaporean firms. The objective of these subsidiaries is to make profits through involvement in the construction with their expertise in fields such as waste management and water treatment. However, CDG and DUCI in the Shenzhen project are financial vehicles of the municipal and district governments respectively, which were founded earlier than the launch of ILCC and aiming at financing for local governments. CDG and DUCI are also responsible for the investment and development of other projects in Shenzhen, acting on behalf of the municipal and district government, respectively. A UIFP usually would found a project company when it fulfills its responsibilities for local governments. However, CDG did not set up a project company to meet the requirements of the construction of ILCC, which resulted in a weaker role of CDG playing in ILCC compared with those UIFPs which set up project companies.

Primary indirect stakeholders

The policy support for the construction of SSTEC is characterized by 'strong national government support, paired with structured foreign involvement'(de Jong et al., 2016). Both the Singaporean and Chinese central governments are involved in the eco-city, having a great deal of influence on SSTEC at the national level yet these impacts are indirect. For example, the Chinese and the Singaporean central government together set the eco-city's goal to build a replicable eco-city in SSTEC. The extensive political collaboration contributes to the progress SSTEC made. The Chinese central government stipulates the overall planning yet does not involve in the implementation. The Singaporean government offers its experiences in environmental protection yet also looks for more opportunities to transfer its capital, technology, and knowledge. The extensive participation of the Singaporean government in SSTEC is a solid guarantee of the sustainable funding provision.

The Shenzhen project is a demonstration program in the collaboration between China and EU on sustainable urbanization. It involves multiple transnational investors yet does not have countries acting roles as the Singaporean government in SSTEC. Different from SSTEC, ILCC set up a steering committee, which is the representative of National Development and Reform Committee consisting of relevant ministries and commissions and Shenzhen Municipality. The steering committee oversees the progress of the low-carbon city, yet the impact is very limited.

Secondary stakeholders

Banks, private parties, the public in China and other countries, and residents are viewed as the secondary stakeholders due to their roles in the sustainable city. These stakeholders cannot influence the policies in the eco-city or the low-carbon city, but they play an instrumental role in funding the construction.

Regarding the Tianjin case, bank loans, bonds, and PPPs are the major financing vehicles employed in SSTEC. Accordingly, the stakeholders cover banks, the public in China and Singapore, and both China-based and Singapore-based private companies. Banks contribute to the construction through loans, which is one of the most traditional and reliable players in offering money for various construction. The public from China and Singapore provides their funds through buying bonds in the capital market. In the Tianjin case, in addition to the strong political support, the private parties from both countries are involved in the eco-city, including transnational and domestic investors (Miao & Lang, 2015; Zhan & de Jong, 2017b). From the Singaporean side, a Singaporean consortium led by Keppel Corporation is heavily involved in the development of the project, investing CNY 4 billion in the eco-city. Additionally, the Singaporean government also encouraged Singapore-based companies to expand their business in the low-carbon city by providing subsidies for them. From the Chinese side, many companies involved in the construction by investing their money through TEID's subsidiaries.

Similarly, banks, the public, and private parties are also involved in the Shenzhen project. Banks merely play a role in providing loans for UCG to support the construction. In the Shenzhen model, local governments are the real debtors especially when UCG cannot pay back its debts. The public provides funds for the project through buying bonds at the capital

market. Additionally, multinational investors such as ESI (a German company), and Japanese and American companies bring their capital to the project as well as their skills, technology, and other resources.

However, there are some differences in the involved stakeholders in the two projects, especially private parties. First, Tianjin issued bonds in the Singaporean capital market, which distinguishes its financing method from other projects since TEID is the first Tianjin-based non-financial company issuing bonds in the international market. Second, SSTEC mainly cooperates with Singaporean, yet ILCC cooperates with multiple transnational investors. Singaporeans are extensively involved in the construction of SSTEC, but there are no multinational investors playing roles as significant as Singaporean corporations in ILCC. The practice in ILCC makes the financing sources more diversified than SSTEC, reducing the risks the high dependency on a single country brings about. Third, local residents also play roles differently in the construction. Residents play a role as service payers in the Tianjin case while residents in ILCC also act as investors through contributing their land use rights. The practice in Shenzhen changes the benefit distribution mechanism. Residents can share the fruits of the ILCC development as well as other major investors. This practice takes the disadvantaged group into account and thus reduces the conflicts between residents and local governments.

6.4.3 A Generic Model for Funding the Construction Sustainable Cities

With the help of the analysis of financial vehicles the two cases employ and the stakeholder analysis, we come to the following model for funding sustainable cities in China by taking the stakeholder's benefits into account. Figure 6-4 is a generic model for funding sustainable cities, which illustrates the relationships between each stakeholder and what they invest in the construction of sustainable cities. The key factors of the model are demonstrated below.

Local governments are the initiators of the development of sustainable cities, and the Chinese central government mainly provides preferential policies to promote the development of these programs. Currently, various sustainable cities in China are developed under the supervision of ministries and commissions. Without national support, it is difficult to carry out projects successfully. For example, the failure of Dongtan project was mainly due to the developer's failure in obtaining land conversion permit from the central government (Miao & Lang, 2015). Therefore, the policy imperatives and various resources input from public authorities are key to the development of sustainable cities in the Chinese context.

Transnational governmental collaboration is crucial for projects to gain renown in the international market, which is conducive to attracting transnational investors to the project. China is still a developing country and lags behind in many aspects such as water treatment and the transformation of high carbon-emission industries to low carbon emission ones. The participation of international counterparts brings not only money but also technology and skills.

UIFPs are either state-owned or state-holding enterprises, playing instrumental roles in arranging various resources. They are representatives of local governments to raise money from banks and the capital market. Some UIFPs are listed on stock exchanges, making them

responsible to the public rather than merely representing local governments. However, the role of UIFPs is changing since the National Audit Office of PRC reported that local governments are at high risk in dealing with implicit debts through UIFPS (NationalAuditOfficeofPRC, 2013). Currently, local governments try to operate UIFPs based on the principle of marketization and propose to implement PPPs to reduce their financial burden (Zhan et al., 2017a).

Concession agreements with public authorities give permission to private parties to charge fees from the public. For example, the application of 'metro + property' model allows the involved players to get paid through selling the properties along the metro line and collecting fees from metro travelers.

The public is another important financial source for the construction while residents are the cash inflow for the development of sustainable cities to guarantee the revenues under the PPPs financing way.

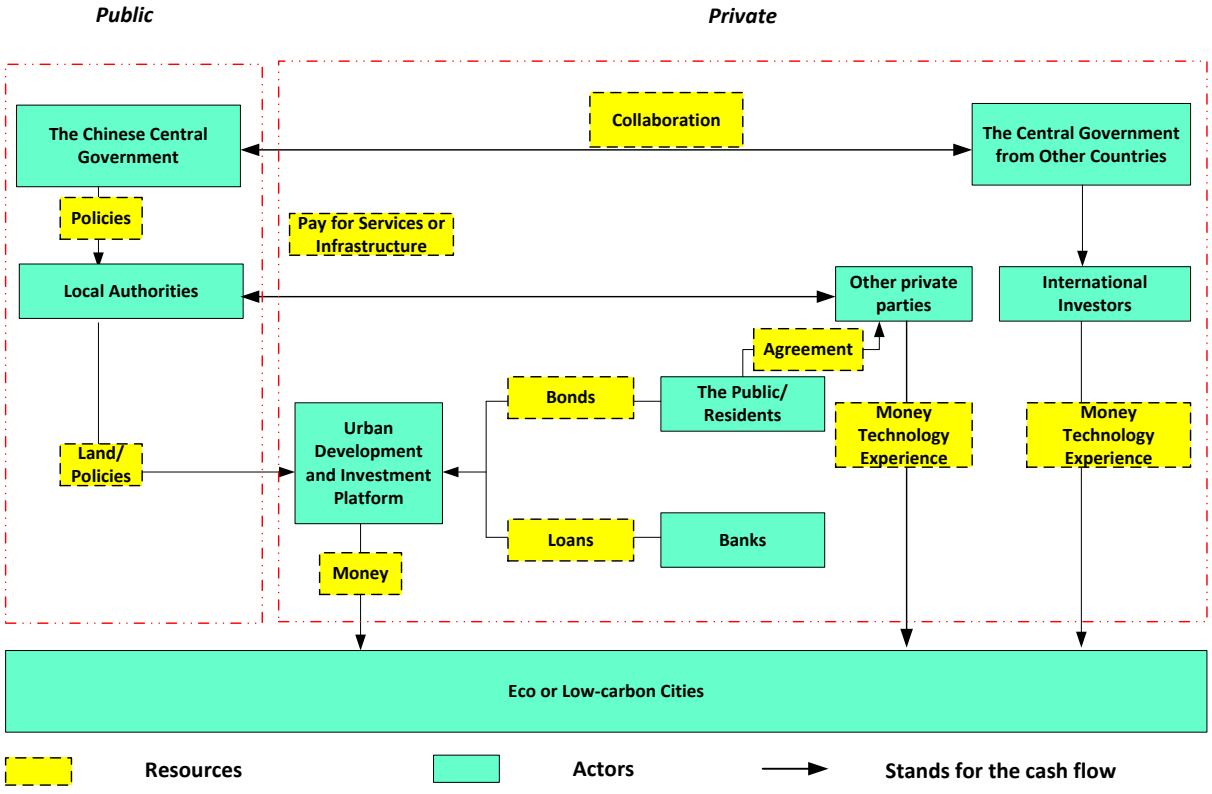


Figure 6-4 A generic model for funding sustainable cities

6.5 Conclusions

We compared SSTEC and ILCC to gain insights into the similarities and differences in funding sustainable cities and thus to provide references for future sustainable projects. The two cases both rely on bank loans, corporate bonds, and PPP to provide funds for their construction, which are traditional vehicles for funding sustainable cities. There is no doubt that other projects can resort to these tools, but these are far less than enough to raise money for the development of sustainable cities.

Therefore, light should be cast on the innovative practices in SSTEC and ILCC, diversifying the funding sources. The Tianjin project offers experience in issuing bonds in the international capital market, which is the first bond issued by a non-financial institute based in Tianjin China. Issuing bonds in the international capital market is an efficient way to raise large sums of money and makes the project more influential domestically and globally (Meltzer, 2016). This would be especially important to climate finance and thus should be encouraged by the Chinese authorities. However, we should not forget that the master developer in SSTEC successfully issued bonds in Singapore due partly to the assistance from the Chinese central government. Therefore, it is critical to making changes in institutional arrangements to eradicate the barriers for non-financial corporations to issue bonds internationally. Regarding the Shenzhen project, planning village area as a whole and arranging finance through 'metro + property' provide a replicable and operable example for other cities in funding urban renewal and community transformation and dealing with the issue how residents can share the benefits of urban development with developers. These innovative financing practices from Tianjin and Shenzhen projects can be applied to other similar projects in China and globally. Taken as a whole though, Shenzhen and ILCC have developed a model of sustainable finance with less extensive financial and other support from the central government and foreign governments than SSTEC and thus may offer more practical lessons for other cities. This should certainly be seen as a significant institutional and organizational step forward in achieving the social, environmental, and economic goals in sustainable urbanization.

The generic financing model developed based on the experiences obtained from the two cases provides a reference for other projects in financing their construction. However, the model is not a 'one size fits all' model. It is essential to take into consideration local conditions when other projects use this model to make financial arrangements.

Tianjin and Shenzhen are both highlighted for their innovation in financing sustainable urban development, yet the supporting facilities to the financing mechanism are not yet sufficient. Currently, the environmental influence has not entirely been taken into account when institutions carry out investing and financing activities. Therefore, authorities at the national and subnational levels should incorporate the environmental influence into the calculation of return on investment (ROI). With proper policy support, the internalization of negative externalities will increase operating costs. In this scenario, organizations may not launch projects that have negative environmental externalities since the increase in operating costs may lead to negative ROI. Accordingly, internalizing positive externalities will add value to companies and increase ROI, encouraging funds flow to environmentally friendly projects. Therefore, financing for sustainable projects requires the collaboration between individuals, organizations, and governments as well as the balance of different stakeholders' interests.

7 Conclusions and Reflections

7.1 Introduction

Rapid urbanization and heavy industrialization have led to a boom in the Chinese economy. However, it also challenges the Chinese government in coping with environmental problems. Echoing the world trend of developing eco and low carbon cities, China also launched a host of eco, low-carbon, and eco low-carbon projects under the umbrella of sustainable cities. The development of sustainable cities is costly and leans heavily on the public purse. However, fiscal funds are largely insufficient, and hence only a small portion of public money can flow into the field of sustainable cities. How to expand funding sources has become an enormous challenge to the Chinese government. To bridge the gap between fiscal revenue and expenses, most municipalities in China have chosen massive land lease and UIFPs as means to raise money, but these solutions are unsustainable due to the scarcity of land and the lack of transparency by arranging money through UIFPs. Therefore, it is imperative to explore ways to facilitate future master developers to finance their construction more sustainably.

Against this backdrop, in this dissertation, the central research question that has been put forward is: 'what financial toolkits can be employed to facilitate the development of sustainable cities in China?' With the help of extensive research, the results are synthesized below to answer the following sub-questions (1) 'what can be learned from the case studies?' (2) 'which practice can be replicated to the construction of other sustainable cities and which not?' and (3) 'what suggestions can be given to the Chinese authority for funding sustainable cities based on the case studies?' Additionally, the theories 'triple bottom line', 'impact investing,' and 'stakeholder theory' are examined in the research to see if the construction of SSTEC and ILCC can balance different stakeholders' interests and how the two projects meet the requirements of triple bottom line and impact investing. The stakeholder theory is used to

analyze what roles each actor plays in the two projects, what benefits they obtain by participating in the construction, and thus how their interests are balanced. The rest two theories are employed to see if initiators and investors invest responsibly. Results indicated that the goal of economic, social, and environmental sustainability could be achieved through proper financial arrangements by taking into account the interests of different stakeholders.

The rest of this chapter will be arranged as follows. Section7.2 synthesizes the answers to the research questions. Section 7.3 discusses what should be done to perfect the financial toolkits in future. Section 7.4 presents the limitations and future work.

7.2 Answers to the Research Questions

How have Chinese governments traditionally arranged finance for the extensive investments in infrastructure, how has the emphasis on funding sources shifted over time and what is the new trend in funding?

In the past few decades, urban infrastructures in China have seen an enormous upgrade, and due to large-scale urbanization, many more investments are due in the coming years. To figure out what financial instruments could be employed for financing urban development in the future, we reviewed the historical evolution of the urban development financing and found that it has gone through three phases. The first stage is from 1949 to 1977, which is also known as the planned economy stage. Money for local economic activities was determined by budgetary choices at this stage. The second phase is from 1978 to 1993, called the reform exploration and pilot stage. At the end of the 1970s, the urban population increased dramatically due to the liberation of the rural labor force, which put forward new needs and wishes for urban infrastructure. All these factors challenged the central government and local governments in terms of their financial arrangements. Gradually, Chinese governments began to explore new financial vehicles for urban development. They levied new taxes, raised tax rates, made use of foreign capital and implemented responsibility contracts at various government levels to broaden fiscal revenues. Although the responsibility contracts at various government levels brought a variety of merits, they also created many headaches such as a slow-down in the constitution of an integrated market and a weakening of the central government's ability to control macroeconomic developments. The period from 1994 to the present is called socialist market economy, going through three most significant reforms, namely, (1) tax sharing system, which is a fiscal management system that separates central and local revenue sources in accordance with certain tax categories; (2) land concessions; and (3) the formation of Urban Development and Investment Corporations (UDICs), through which local authorities can borrow money from the market and quickly develop public facilities.

The tax sharing system dramatically reduced local governments' revenues and hence funds for urban construction, driving local authorities to increase their revenues through land concessions. Additionally, UDICs were adopted to cope with financial deficiencies in this period. Land concessions and UDICs gave an enormous boost to the development of China's urban infrastructure. However, they can now also be viewed as unsustainable vehicles due to the scarcity of land and the invisibility of high indebts. Therefore, local governments try to

explore more sustainable financing vehicles, which partly contributed to the popularity of PPP and municipal bonds recently. The introduction of these vehicles does not occur in a void but should be understood as the path-dependent consequence of historical evolution of funding arrangements for urban development. Since path-dependent evolution will steer the finance of urban infrastructure development in new directions once actors perceive the drawbacks of existing institutional arrangements as unsustainable and in need of further reform.

How is Sino-Singapore Tianjin Eco-city (SSTEC) funded? How do the involved actors balance their interests in participating in the construction, and which lessons can be drawn for other eco-cities in China and globally?

Sub-question 1 answered how China financed urban development from a historical perspective, demonstrating a holistic picture of financial sources available to the authorities. However, in reality, each case varies greatly in how to finance its construction. Therefore, this research thoroughly studied SSTEC and ILCC to take a closer look at what financial instruments they have adopted and what lessons can be drawn from their experience. This section provides answers for sub-question 2 by investigating the case of SSTEC.

SSTEC was taken as the case in that it is currently the best-known and arguably the most successful large-scale sustainable new town development project in China. As a consequence, experiences obtained from the case are of paramount significance for other sustainable cities both in China and globally. The results showed that SSTEC enjoys a great variety of funding sources. Bank loans, corporate bonds, international assistance programs, government grants and tax refunds, and private capital are the main ones. Accordingly, a great many players are involved, including the governments of both China and Singapore, state-owned, private, and multinational enterprises, banks, and the public. Therefore, how to balance the interests of these involved players becomes a significant issue facing the project initiators in the construction.

We established that the critical factor contributing to progress in the project is the extensive and highly structured collaboration between the two national governments. The binational collaboration has created many preferential conditions such as the setup of an elaborate organizational structure and support from the highest authorities including eradicating barriers for the issuance of bonds in the international capital market. The Singaporean government also encourages Singapore-based enterprises to invest in the eco-city by providing subsidies for them. It is their firm backing that gives a host of other, 'lower' yet essential players the confidence that this is a 'no fail mega-project,' one they can safely invest in. Additionally, the broad involvement of the private sector, a market-based operation model and the issuing of bonds in Singapore, which all contribute significantly to Tianjin eco-city's financial viability. The broad involvement of the private sector relieves part of the financial burden from local governments, while the bonds issued in the international market lowers the interest rate for master developers. The strong backing from two collaborated governments at the national level is one of the most important conditions for the progressive development of SSTEC which ensures the involved parties can realize their interests in the construction. Achieving the stakeholders' goals is one of the drivers for them to continuously invest in the eco-city.

Players can benefit from their participation in the construction, which is conducive to maintaining the social stability in addition to creating a sustainable city. However, projects like SSTEC with firm backing from collaborated governments at the national level are also risky since the development of such projects dramatically relies on policies. The change of leadership would bring risks to the project since the new leader may change previous policies. Additionally, if the relationship between the two collaboration countries deteriorates, the favorable conditions may disappear. Seen from this angle, the binational collaboration may be a significant drag on the development of sustainable cities. However, even if risks may exist, we should not deny the instrumental contribution of binational collaboration making to the progressive development of SSTEC. Without support from the Chinese and Singaporean governments, the master developers of SSTEC would be still bedeviled by financial problems, and they could not make such progress.

Many lessons can be drawn from SSTEC. On the one hand, the Sino-Singapore collaboration at the national level is far less likely to be replicated to other eco-cities, since this requires an enormous willingness on the part of other countries to invest human resources, money, and other resources into the construction of sustainable cities in China. Therefore, local authorities should not simply imitate SSTEC to introduce other nations to develop new projects. On the other hand, light should be cast on the involvement of private parties in the development of sustainable cities and issuing bonds in the international capital market, which are effective ways to expand financing sources and are replicable to other projects.

Which financial vehicles are utilized in Shenzhen International Low-carbon City, in what way these contribute to sustainability and which lessons can be drawn from it for other eco and low carbon cities in China and elsewhere?

Financing sustainable urban development has become a major issue, especially in Asian countries where the scale of construction efforts are vast. Shenzhen International Low Carbon City (ILCC) is a demonstration project of the China-EU Partnership on Sustainable Urbanization (CEUPSU) and an intriguing example for understanding innovative forms of funding with the specific aim to do this in environmentally, socially and economically sustainable ways. We found that ILCC relies on financial instruments including bank loans, corporate bonds, preparing village area as a whole (PVAW), metro + property model, foreign capital, and funds from domestic private investors. In general, these instruments can be categorized as Urban Investment and Finance Platforms (UIFPs)[17] and Public-Private-Partnerships (PPP) in a broader context. Bank loans and corporate bonds are arranged through UIFPs while the rest is organized under the framework of PPP. However, a broad approach to PPP is chosen in which stakeholder involvement is crucial and social conflicts are avoided by balancing the interests of various stakeholders.

Light should be shed on PVAW and 'metro + property' model. On the one hand, PVAW is a new means to consolidate and reserve land, taking into account the benefits of original residents, small enterprises, and other scattered actors who own land use rights. PVAW is not merely giving monetary compensation to landowners in ILCC but also allow them to

[17] UIFP and UDIC have the same meaning.

participate in the construction by contributing their land. In the process, benefits of different stakeholders have been balanced, and thus social conflicts have been alleviated. The 'metro + property' model offers another option for local authorities to arrange financial issues. Local authorities grant the franchise to a subway company allowing it to construct and operate the metro. Meanwhile, local authorities also allow the subway company to develop real estate along the line to subsidize the loss of operating the subway in future. This practice adds value to the real estate due to the convenient transportation while the prosperous real estate, in turn, boosts the traveler flow and thus increase the revenues of the subway company. The two practices provide replicable and operable examples for other cities in funding urban renewal and community transformation and dealing with the issue how residents can share the benefits of urban development with developers. Although the two practices are well trade-off each party's benefits and help local authorities relieve their financial burdens, it is far more than enough. Conditions should be created to attract more private investors to enter the market both in the narrow and broad sense of PPP. The results show that ILCC is environmentally sustainable by promoting low carbon transition, socially sustainable through resident and villager involvement, and financially viable through diversification of funding sources, which is in line with the philosophy of triple bottom line, blended value, and impact investing.

Based on previous case studies, what are the similarities and differences in financing vehicles between Shenzhen International Low Carbon city and Sino-Singapore Tianjin Eco-city, and is there a financial model can be applied to future sustainable cities in China and globally?

The study of Tianjin and Shenzhen cases provides insights into how each sustainable city arranges finance in China. Based on the previous research, a comparison of the two cases was conducted to find out the similarities and differences so that a generic financing model can be constructed as a reference model for other sustainable cities in China and elsewhere. We found the two cases are similar in many aspects. They both depend on bank loans, corporate bonds, and PPP to provide funds for their construction although they may have some differences in details. We also found the major differences in the two cases, which would be valuable for the construction of other sustainable cities to expand funding sources yet could well balance the involved stakeholder's interests. The Tianjin project offers a reference in issuing bonds in the international market, which has a significant meaning for other projects in diversifying financing sources by using bonds. This would be especially important to climate financing since issuing climate bonds would be an effective way to offer funds for resilient climate projects (Meltzer, 2016). Regarding the Shenzhen project, preparing village area as a whole and arranging finance through 'metro + property' provide a replicable and operable example for other cities in funding urban renewal and community transformation and dealing with the issue how residents can share the benefits of urban development with developers. Taken as a whole, ILCC has developed a model of sustainable finance with less extensive support from the central government and foreign government in comparison with SSTEC, offering a more practical reference for other projects in China. After all, it is impossible for the central government to input as much political and economic support as the Tianjin case into sustainable cities.

Although the two cases have already made innovation in financing, these innovations are very limited, predominantly focusing on the coordination of finance, resources, and human being yet considering less the environmental factor. Therefore, the role of finance playing in environmental protection should be stressed more in future financing activities.

We further present a generic model (see Figure 6-4) to help future projects cope with financing issues. However, the model is not a 'one size fits all' model. Local conditions, including institutional and legislative framework and the degree of local authorities interacting with other parties, should be taken into account when other projects use this model to arrange financial issues.

7.3 What Is Next?

This research investigated what financial instruments have been applied to the construction of sustainable cities in China and what lessons can be drawn for other sustainable cities. By comparing the existing literature about financing sources available for the development of sustainable cities with the two cases studies, it is established what financial vehicles have been used and what needs to be done so that they can be used in a broader range (see table 7-1). From table 7-1, it can be learned that the traditional financial market is still the most vital financing source in China. This situation has begun to change since 2015. China became the largest issuer of green bonds over the world in 2016 (Brüggemann, 2017). Regarding using private capital, the absolute size of public funds invested in the field of climate change has increased significantly in recent years both at the national and subnational levels. Additionally, projects sponsored by PPP have sprung up recently with the stimulus of policies. However, green bonds and PPP are not fully mobilized. Therefore, further actions should be taken to boom the market.

Table 7-1 Potential financial instruments for the construction of sustainable cities

Financing vehicles	Tianjin	Shenzhen	Possibility to be employed in future
Bank loans	√	√	High
Corporate bonds	√	√	High
Public-Private Partnerships			High
- Preparing village area as a whole (PVAW)		√	High
- Metro + Property model		√	High
- Foreign capital	√	√	Medium to High
- Funds from domestic private investors	√	√	Medium to high
National and international Assistance			Medium
Governmental funds and tax refund	√		Medium
International assistant programs	√		Medium

Sources: based on Zhan and de Jong (2018), Zhan and de Jong (2017b), and Z/YenGroup (2015)

Green funds based on PPP

First, it is critical to establish green industry funds based on PPP. It has reached a consensus to promote the development of green industry fund through PPP. Green funds will play an instrumental role in the current financial system in China due to the diversified funding sources. Green development funds are significant complementary of green credit in that they can guide private capital to increase investment in green industries, promoting the development of low-carbon industries. Additionally, the establishment of green industry funds based on PPP can mobilize private capital to participate in the development of environmental protection industries, which is a critical path for promoting the development of green industries.

Meanwhile, it is also essential to effectively play the local governments' role in guiding fundraising and investment. The Chinese government should refine and implement various policies to support private capital to invest in the different fields of green city construction, such as sewage treatment and urban landscape. These policies include the lower entry criteria for private sectors to invest in sustainable cities, tax relief, subsidies, and other measures.

Promoting the development of the government bond market

At the beginning of 2016, the State Council issued 'Opinions on Deepening the Construction of New Urbanization,' which requires local governments to accelerate the promotion of sustainable cities. Based on the urban agglomeration, this opinion aims to achieve the harmony development of big, medium, and small cities and towns by steadily promote the transition towards sustainable cities. The promotion of new urbanization needs to combine proactive fiscal policies with monetary policies. Additionally, the development of new urbanization requires local governments to invest a large sum of money in infrastructure, public service, and affordable housing, putting enormous financing and refinancing pressure on local governments. Referring to the international experience, the issue of municipal debts can be a useful means for local authorities to solve investment and financing issues related to environmental protection industries in the process of urbanization. Meltzer (2016) also indicates that green bonds play an instrumental role in attracting investors, particularly institutional investors. However, green bonds must have the right financial rewards to attract private investors and make use of public credit efficiently (Reichelt, 2010). Therefore, it is worthwhile for the Chinese government to think over problems such as how local governments could innovatively promote the development of sustainable cities in future through issuing green bonds and guiding investors to invest in sustainable infrastructure and environmental protection industries.

Additionally, it is stated in 'Opinions on Deepening the Reform of the Investment and Financing System' that local authorities should vigorously develop direct funding to support the provincial government to develop government bonds legally. As an important channel to increase the proportion of direct financing, the bond market is showing momentum of rapid expansion. As an important measure of government investment and financing reform, the development of government bond markets should be the top priority.

Information disclosure

Currently, the platform for disclosing green financial information is not sound yet. Investors lack financial information to assess the bond issuing enterprise and thus could not make their investment decisions. There is no effective and timely information communication platform, providing financial institutions, enterprises, financial supervision, and environmental protection departments with information that can be exchanged and shared through joint meetings and credit system.

Considering the enormous differences between the local government's financial situation and financing environment, local governments should follow the progressive principle when issuing bonds in future. Local governments should establish a risk-control framework based on laws and regulations, which should take the information disclosure as the core to control debt size, rate credit, precaution risks, establish sinking funds, and resolve the crisis. From the perspective of government, it provides a guarantee from the source for the effective prevention of municipal bond risks. From the perspective of the development of financial markets, the disclosure of information facilitates investors to make investment decisions and thus reduce the operational risks.

7.4 Research Limitations and Future Work

7.4.1 Limitations

Due to time limitations, the research only conducted two case studies, namely, Sino-Singapore Tianjin Eco-city and Shenzhen International Low-Carbon City. They are regarded as two successful cases so far. However, this research did not present unsuccessful cases in detail. What lessons can be drawn from failed cases has not been approached yet in this research, which limits the application of the study.

This research predominantly leaned on interviews and desk research to collect data, so the results of this research are presented qualitatively. This was partly because financial data are confidential to the involved players, allowing the interviewees to provide very limited information. They were afraid of being blamed for leaking sensitive company information. Therefore, merely limited financial data were displayed in the research.

Additionally, this research merely compared how sustainable cities are financed in the Chinese context. It did not take into account international cases, which leads to the missing out of international experiences for the construction of sustainable cities.

7.4.2 Future Research

Based on the above limitations, there remains much to be studied. The two most important things can be done in future to make progress in this direction.

First, the generic financing model drawn from this research has not been tested yet. It is essential to apply the model to the construction of sustainable cities in the future. The application of the generic financing model will test if the practices in the above two cases are replicable to other cases. For example, we would learn that if the issue of bonds by a non-financial enterprise can be applied to a city without strong backing from the central

government. Additionally, planning the village area as a whole in Shenzhen cases is also an innovative practice, which needs to be tested as well to see what conditions should be met to apply it in other cases.

Second, it is helpful to compare Chinese and international sustainable cities in terms of their financial practices. China just started developing sustainable cities in recent years, and its financing system lags behind that of many developed countries. Therefore, the comparative study of Chinese and international cities would be conducive to the successful construction of sustainable cities in China.

Appendix I Summary

Introduction

Currently, more and more people live in cities, and this leads to an enormous increase in global GHG emissions. Cities are blamed for the cause of environmental problems. Therefore, countries over the world aim to approach these problems by launching sustainable city programs. On April 22, 2016, China signed the Paris Agreement at the United Nations Headquarters in New York and formally promised that carbon dioxide emissions in China would reach the peak around 2030, and it would strive for reaching the peak as soon as possible. However, the transition to sustainable cities requires governments to invest a large sum of money. It was projected by IEA in 2010 that the total investment to projects responding to climate change may amount to US $ 220 billion each year between 2010 and 2020 and about US $ 1 trillion each year between 2020 and 2030. Against this backdrop, how to fund the development of sustainable cities becomes a pressing problem the Chinese government faces. Previously, it was a common practice for the Chinese government to resort to off-budget means such as land concessions and Urban Development and Investment Corporations (UDICs) to bridge the money gap. However, these tools are viewed as unsustainable due to the scarcity of land and the imbalance of benefit appropriation among different stakeholders caused by land finance and the lack of transparency financing through UIFPs. Therefore, this research aims to expand the funding sources through exploring the possibilities for the involvement of private sectors in the construction of sustainable cities and their roles playing in achieving climate goals nationally.

To achieve the research objectives, interviews and desk research were employed to collect data. The first series of interviews was carried out between April and July 2015 in Tianjin, China while the second series was conducted between February and March 2016 in Tianjin and Shenzhen, China. Regarding desk research, multiple data sources were leaned on to retrieve information, including the websites of Sino-Singapore Tianjin Eco-City (SSTEC) and Shenzhen International Low-carbon City (ILCC), auditing reports of SSTEC in the past few years (retrieved from the website of the Shanghai Stock Exchange), and other web-based reports (e.g., the World Bank, the United Nations Environmental Program, the National Development and Reform Commision (NDRC) Report, and the national audit report issued by Chinese National Audit Office). With the help of these methods and materials, the major findings are presented below.

Historical evolution in financing urban infrastructure development in China

In the past few decades, urban infrastructures in China have seen an enormous upgrade, and due to large-scale urbanization, many more investments are due in the coming years. To figure out what financial instruments could be employed for financing urban development in the future, the historical evolution of the urban development financing was reviewed, and we established that financing urban development in China has gone through three phases. Each phase has different emphasis on financial sources.

The first stage is from 1949 to 1977, which is also known as the planned economy stage. Money for local economic activities was determined by budgetary choices at this stage.

The second phase is from 1978 to 1993, called the reform exploration and pilot stage. At the end of the 1970s, the urban population increased dramatically due to the liberation of the rural labor force, which put forward new needs and wishes for urban infrastructure. All these factors challenged the central government and local governments in terms of their financial arrangements. Gradually, Chinese governments began to explore new financial vehicles for urban development. They levied new taxes, raised tax rates, made use of foreign capital and implemented 'responsibility contracts' at various government levels to broaden fiscal revenues. Although the 'responsibility contracts' at various government levels brought a variety of merits, they also created many headaches such as a slow-down in the constitution of an integrated market and a weakening of the central government's ability to control macroeconomic developments.

The period from 1994 to the present is called socialist market economy, going through three most significant reforms, namely, (1) tax sharing system, which is a fiscal management system that separates central and local revenue sources in accordance with certain tax categories; (2) land concessions; and (3) the formation of Urban Development and Investment Corporations (UDICs), through which local authorities can borrow money from the market and quickly develop public facilities. The tax sharing system dramatically reduced local governments' revenues and hence funds for urban construction, driving local authorities to increase their revenues through land concessions. Additionally, UDICs were adopted to cope with financial deficiencies in this period. Land concessions and UDICs gave an enormous boost to the development of China's urban infrastructure. However, they can now also be viewed as unsustainable vehicles due to the scarcity of land and the invisibility of high indebts. Therefore, local governments try to explore more sustainable financing vehicles, which partly contributed to the popularity of PPP and municipal bonds recently. The introduction of these vehicles does not occur in a void but should be understood as the path-dependent consequence of historical evolution of funding arrangements for urban development. Since path-dependent evolution will steer the finance of urban infrastructure development in new directions once actors perceive the drawbacks of existing institutional arrangements as unsustainable and in need of further reform.

Historical evolution in financing urban infrastructure development in China demonstrates a holistic picture of financial sources available to the authorities. However, in reality, each case varies greatly in how to finance its construction. Therefore, SSTEC and ILCC were investigated to take a closer look at what financial instruments the two cases have adopted and what lessons can be drawn from their experience.

Financing Sino-Singapore Tianjin Eco-city

SSTEC is currently the best-known and arguably most successful sustainable new town development project in China. Through the case study, we learned that SSTEC enjoys a great variety of funding sources. Bank loans, corporate bonds, international assistance programs, government grants and tax refunds, and private capital are the main ones. A great many

players are involved, including the governments of both China and Singapore, state-owned, private, and multinational enterprises, banks, and the public. It is essential to balance these stakeholder's interests so that they are willing to invest in the construction.

We established the financial viability of Tianjin eco-city is due largely to the broad involvement of the private sector, a market-based operation model and the issuing of bonds in Singapore. Of these, a market-based operation model and issuing bonds in the international capital market are very precious practices for other projects. Additionally, the firm backing from both Chinese and Singaporean government creates preferential conditions for the eco-city development. The Chinese central government gives many preferential policies to SSTEC, which was conducive to financing its construction since it is common sense that government-backed projects are more creditworthy than those without backing from governments. The extensive collaboration between Chinese and Singaporean government also contributes to the successful issue of bonds in Singapore, making a historical record for a non-financial corporation to issue bonds in the international capital market.

However, the lessons drawn from SSTEC should be applied vigilantly. The Sino-Singapore collaboration at the national level is far less likely to be replicated to other eco-cities since this requires an enormous willingness on the part of other countries to invest human resources, money, and other resources in the construction of sustainable cities in China. Additionally, risks are along with the extensive binational collaboration since the collaboration would be influenced by the political relationship. Therefore, local authorities should not simply imitate SSTEC to introduce other nations to develop new projects. However, the involvement of private parties in the development of sustainable cities and issuing bonds in the international capital market are effective ways to expand financing sources and are replicable to other projects.

Financing Shenzhen International Low-carbon City

ILCC leans on a set of financial toolkits to provide financial support for its construction, including UIFPs and PPP. Bank loans and corporate bonds are arranged under the name of UIFPs while PPP covers Planning the Village Area as a Whole (PVAW), 'Metro + Property' model, and foreign capital. The diversified financial sources mean that various stakeholders are involved in the construction, including local governments, local construction and development corporations, the steering committee of ILCC, banks, the public, residents and other private parties. Under the financial arrangement, whether the interests of different stakeholders can be well balanced becomes a critical indicator to gauge the sustainability of the financial model in ILCC. By studying the financial vehicles ILCC employs, we established that ILCC takes into account the social, economic and environmental factors and thus well balance the interests of different stakeholders.

How does ILCC reach the goal of balancing the interests of different stakeholders is due largely to the diversification of funding sources and innovative changes in organizational arrangements where a greater variety of stakeholders is incorporated in the development process. The combination of these measures reflects a promising application of stakeholder management and sustainable finance, balancing each stakeholders' interests.

The application of PPP also greatly contributes to funding the eco-city construction sustainably. Light should be shed on PVAW and 'metro + property' model. On the one hand, PVAW is a new means to consolidate and reserve land, taking into account the benefits of original residents, small enterprises, and other scattered actors who own land use rights. PVAW is not merely giving monetary compensation to landowners in ILCC but also allow them to participate in the construction by contributing their land. In the process, benefits of different stakeholders have been balanced, and thus social conflicts have been alleviated. The 'metro + property' model offers another option for local authorities to arrange financial issues. Local authorities grant the franchise to a subway company allowing it to construct and operate the metro. Meanwhile, local authorities also allow the subway company to develop real estate along the line to subsidize the loss of operating the subway in future. This practice adds value to the real estate due to the convenient transportation while the prosperous real estate, in turn, boosts the traveler flow and thus increase the revenues of the subway company. These practices present how urban developers deal conflicts with residents through sharing benefits, which provides a replicable and operable example for other cities in funding urban renewal and community transformation because conflicts between urban developers and residents are still common in contemporary China.

To sum up, ILCC is environmentally sustainable by promoting low carbon transition, socially sustainable through resident and villager involvement, and financially sustainable through diversification of funding sources.

A Comparative View towards Financing Sustainable Cities

Based on the individual case study, the two cases were compared to gain further insights into the similarities and differences in funding sustainable cities and thus to provide references for future sustainable projects. The similarities in funding sustainable cities were summarized after comparing the two cases. To be specific, they both rely on bank loans, corporate bonds, and PPP to provide funds for their construction although they may have some differences in details.

However, the differences obtained from the two cases would be more valuable since they are regarded as innovative practices, which would expand the financing sources and facilitate master developers to raise more money to meet the needs. The Tianjin project provides a model in extensive and highly structured binational collaboration yet not fully replicable. However, the experience in issuing bonds in the international market is more valuable since it is an effective way to offer funds for resilient climate projects. Regarding the Shenzhen project, preparing village area as a whole and arranging finance through 'metro + property' provide a replicable and operable example for other cities in funding urban renewal and community transformation and dealing with the issue how residents can share the benefits of urban development with developers.

Taken as a whole though, Shenzhen and ILCC have developed a model of sustainable finance with less extensive financial and other support from the central government and foreign governments than SSTEC and thus may offer more practicable lessons for other cities. This

should certainly be seen as a major institutional and organizational step forward in achieving the triple bottom line in sustainable urbanization.

Additionally, a generic financing model was also presented to help future projects cope with financing issues. However, the model is not a ‘one size fits all’ model. Local conditions should be taken into account when other projects use this model to make financial arrangements.

Appendix II Samenvatting

Inleiding

Op dit moment zijn meer en meer mensen in steden gevestigd en dus leiden ze tot de grote toename van de uitstoot van broeikasgassen wereldwijd. Steden hebben de schuld voor de oorzaak van milieuproblemen. Daarom proberen landen over de hele wereld deze problemen te benaderen door duurzame stadsprogramma's op te zetten. Op 22 april 2016 ondertekende China de Overeenkomst van Parijs op het hoofdkwartier van de Verenigde Naties in New York en beloofde formeel dat de uitstoot van kooldioxide in China de piek rond 2030 zou bereiken en dat deze zou streven naar het bereiken van de piek zo snel mogelijk. De overgang naar duurzame steden vereist echter dat overheden een grote som geld investeren. Het werd verwacht door IEA in 2010, wat het totale investeringsproject is dat naar verwachting elk jaar tussen 2010 en 2020 zal evolueren naar US $ 220 miljard en tussen 2020 en 2030 jaarlijks ongeveer US $ 1 biljoen. De ontwikkeling van duurzame steden is een urgent probleem in de ogen van de Chinese overheid. Eerder was het een gebruikelijke praktijk voor de Chinese overheid om toevlucht te nemen tot middelen buiten het budget, zoals landconcessies en Urban Development and Investment Corporations (UDIC's) om de geldkloof te overbruggen. Deze hulpmiddelen worden echter als onhoudbaar beschouwd vanwege de schaarste aan land en de onevenwichtigheid van de uit UIFP's voortvloeiende voordelen. Daarom is dit onderzoek gericht op het uitbreiden van de financieringsbronnen door het verkennen van het potentieel voor de betrokkenheid van private sectoren bij de constructie van duurzame steden en hun rol bij het bereiken van nationale klimaatdoelen.

Om de onderzoeksdoelstellingen te bereiken, moest ik via interviews en desk research gegevens verzamelen. De eerste reeks interviews werd uitgevoerd tussen april en juli 2015 in Tianjin, China, terwijl de tweede reeks werd uitgevoerd tussen februari en maart 2016 in Tianjin en Shenzhen, China. Met betrekking tot desk research waren er meerdere databronnen beschikbaar, waaronder de websites van Sino-Singapore Tianjin Eco-City (SSTEC) en Shenzhen International Low-carbon City (ILCC), auditrapporten of SSTEC in de afgelopen jaren (opgehaald) van de website van de Shanghai Stock Exchange) en andere webgebaseerde rapporten (bijv. de Wereldbank, het Milieuprogramma van de Verenigde Naties, het rapport van de nationale ontwikkelings- en hervormingscommissie (NDRC) en het nationale auditrapport van de Chinese nationale rekenkamer). . Met behulp van deze methoden en materialen worden de belangrijkste bevindingen hieronder weergegeven.

Historische evolutie bij de financiering van de ontwikkeling van stedelijke infrastructuur in China

In de afgelopen decennia heeft de stedelijke infrastructuur in China een enorme upgrade gekend en vanwege de grootschalige verstedelijking zijn er de komende jaren nog veel meer investeringen nodig. Om erachter te komen welke financiële instrumenten kunnen worden overwogen voor de financiering van stedelijke ontwikkeling in de toekomst, is de historische ontwikkeling van de financiering van stedelijke ontwikkeling bekeken en heb ik vastgesteld

dat de financiering van stedelijke ontwikkeling in China drie fasen heeft doorlopen. Elke fase heeft verschillende nadruk op andere financiële bronnen.

De eerste periode loopt van 1949 tot 1977, ook bekend als de fase van de geplande economie. Geld voor lokale economische activiteiten werd in dit stadium bepaald door budgettaire keuzes.

De tweede fase is van 1978 tot 1993, de hervormings- en proeffase genoemd. Aan het eind van de jaren zeventig nam de stedelijke bevolking dramatisch toe als gevolg van de liberalisering van de landelijke beroepsbevolking, wat nieuwe behoeften en wensen voor stedelijke infrastructuur impliceert. Al deze factoren worden door de centrale overheid en lokale overheden aangevochten in termen van hun financiële regelingen. Geleidelijk aan begonnen Chinese regeringen nieuwe financiële voertuigen voor stedelijke ontwikkeling te verkennen. Ze heffen nieuwe belastingen, verhogen belastingtarieven, maken gebruik van buitenlandse verantwoordelijkheid en voeren 'verantwoordelijkheidscontracten' op verschillende overheidsniveaus om de belastinginkomsten te verbreden. Hoewel de 'verantwoordelijkheidscontracten' op verschillende overheidsniveau's verschillende verdiensten hebben opgeleverd, hebben ze ook veel kopzorgen gecreëerd, zoals een vertraging in de samenstelling van de geïntegreerde overheid en het vermogen om macro-economische ontwikkelingen te beheersen.

De periode van 1994 tot heden wordt socialistische markteconomie genoemd, waarbij drie belangrijkste hervormingen worden doorlopen, zeg maar, (1) systeem voor belastingverdeling, een fiscaal beheersysteem dat centrale en lokale inkomstenbronnen scheidt in overeenstemming met bepaalde belastingcategorieën; (2) landconcessies; en (3) de vorming van stedelijke ontwikkelings- en investeringsmaatschappijen (UDIC's), waardoor lokale autoriteiten geld van de markt kunnen lenen en snel openbare voorzieningen kunnen ontwikkelen. Het systeem voor het delen van belastingen verlaagde de inkomsten van lokale overheden en daarmee de middelen voor stedelijke bouw aanzienlijk, waardoor lokale autoriteiten werden gedwongen hun inkomsten te verhogen via landconcessies. Daarnaast zijn UDIC's goedgekeurd om financiële tekortkomingen in deze periode op te vangen. Grondconcessies en UDIC's gaven een enorme impuls aan de ontwikkeling van de stedelijke infrastructuur in China. Ze kunnen echter nu ook als niet-duurzame voertuigen worden beschouwd vanwege de schaarste aan land en de onzichtbaarheid van hoge schulden. Daarom proberen lokale overheden duurzamere financieringsvehikels te verkennen, die mede hebben bijgedragen aan de populariteit van PPP en gemeentelijke obligaties onlangs. De introductie van deze voertuigen gebeurt niet in een vacuum, maar moet worden opgevat als het padafhankelijke gevolg van een historische evolutie van financieringsregelingen voor stedelijke ontwikkeling. Aangezien padafhankelijke evolutie de financiering van de ontwikkeling van stedelijke infrastructuur in nieuwe richtingen zal sturen zodra actoren de nadelen van bestaande institutionele regelingen als onhoudbaar ervaren en verdere hervormingen nodig hebben.

De historische evolutie van de financiering van de ontwikkeling van de stedelijke infrastructuur in China toont een holistisch beeld van de financiële bronnen waarover de

autoriteiten beschikken. Daarom zijn SSTEC en ILCC onderzocht om nader te bekijken welke financiële instrumenten de twee gevallen hebben aangenomen en welke lessen kunnen worden getrokken uit hun ervaring.

Financiering van Sino-Singapore Tianjin Eco-city

SSTEC is momenteel het bekendste en misschien wel meest succesvolle duurzame nieuwe stadsontwikkelingsproject in China. Door de case study stelde ik vast dat SSTEC een grote verscheidenheid aan financieringsbronnen heeft. Bankleningen, bedrijfsobligaties, internationale hulpprogramma's, overheidssubsidies en belastingteruggaven en particulier kapitaal zijn de belangrijkste. Er zijn heel veel spelers bij betrokken, waaronder de regeringen van zowel China als Singapore, staatsbedrijven, particuliere en multinationale ondernemingen, banken en het publiek. Het is essentieel om de belangen van deze belanghebbenden in evenwicht te houden, zodat ze bereid zijn om in de constructie te investeren.

Ik heb vastgesteld dat de financiële levensvatbaarheid van Tianjin Eco City grotendeels te danken is aan de brede betrokkenheid van de particuliere sector, een op de markt gebaseerd bedrijfsmodel en de uitgifte van obligaties in Singapore. Hiervan zijn een op de markt gebaseerd bedrijfsmodel en het uitgeven van obligaties op de internationale kapitaalmarkt zeer kostbare praktijken voor andere projecten. Bovendien creëert de stevige steun van zowel de Chinese als de Singaporese overheid gunstige voorwaarden voor de ontwikkeling van de ecostad. De Chinese centrale overheid geeft veel preferentieel beleid aan SSTEC, wat bevorderlijk is geweest voor de financiering van de constructie, omdat het gebruikelijk is dat door de overheid gesteunde projecten kredietwaardiger zijn dan die zonder steun van overheden. De uitgebreide samenwerking tussen de Chinese en de Singaporese overheid draagt ook bij aan de succesvolle uitgifte van obligaties in Singapore, waardoor het een historisch record wordt voor een niet-financiële onderneming om obligaties uit te geven op de internationale kapitaalmarkt.

De lessen getrokken uit SSTEC moeten echter waakzaam worden toegepast. De samenwerking tussen Sino en Singapore op nationaal niveau zal veel minder waarschijnlijk worden gerepliceerd naar andere ecosteden, omdat dit een enorme bereidheid van andere landen vereist om menselijke hulpbronnen, geld en andere middelen te investeren in de bouw van duurzame steden in China. Bovendien gaan risico's gepaard met de uitgebreide binationale samenwerking, omdat de samenwerking beïnvloed zou worden door de politieke relatie. Daarom moeten lokale autoriteiten SSTEC niet simpelweg imiteren om andere landen te introduceren om nieuwe projecten te ontwikkelen. De betrokkenheid van private partijen bij de ontwikkeling van duurzame steden en de uitgifte van obligaties op de internationale kapitaalmarkt zijn echter effectieve manieren om financieringsbronnen uit te breiden en kunnen worden gerepliceerd naar andere projecten.

Financiering van Shenzhen International Low-carbon City

ILCC steunt op een reeks financiële toolkits om financiële ondersteuning te bieden voor de constructie, inclusief UIFP's en PPP. Bankleningen en bedrijfsobligaties worden gerangschikt

onder de naam UIFP's, terwijl PPP de planning van het dorpsgebied als een geheel (PVAW), het 'Metro + Property'-model en buitenlands kapitaal omvat. Door de gediversifieerde financiële bronnen zijn verschillende belanghebbenden betrokken bij de bouw, inclusief lokale overheden, lokale bouw- en ontwikkelingsbedrijven, de stuurgroep van ILCC, banken, het publiek, bewoners en andere private partijen. Met betrekking tot de financiële regeling is het de vraag of de belangen van verschillende belanghebbenden goed in balans zijn, een kritieke indicator om de duurzaamheid van het financiële model in ILCC te meten. Door het bestuderen van de financiële constructies die ILCC toepast, heb ik vastgesteld dat ILCC rekening houdt met de sociale, economische en milieufactoren en zo de belangen van verschillende belanghebbenden goed in evenwicht houdt.

Hoe ILCC het doel van het afwegen van de belangen van verschillende belanghebbenden bereikt, is grotendeels te danken aan de diversificatie van financieringsbronnen en innovatieve veranderingen in organisatorische regelingen waarbij een grotere verscheidenheid aan belanghebbenden wordt opgenomen in het ontwikkelingsproces. De combinatie van deze maatregelen weerspiegelt een veelbelovende toepassing van stakeholdermanagement en duurzame financiering, waarbij de belangen van alle belanghebbenden worden afgewogen.

De toepassing van PPP draagt ook in grote mate bij aan de duurzame financiering van de eco-city-constructie. Speciale aandacht verdienen PVAW en het 'metro + eigendom'-model. Aan de ene kant is PVAW een nieuw middel om land te consolideren en te reserveren, rekening houdend met de voordelen van oorspronkelijke bewoners, kleine ondernemingen en andere verspreide actoren die landgebruiksrechten bezitten. PVAW geeft niet alleen financiële compensatie aan landeigenaren in ILCC, maar staat hen ook toe om aan de bouw deel te nemen door hun land bij te dragen. In het proces zijn de voordelen van verschillende belanghebbenden in evenwicht gebracht en zijn sociale conflicten dus verlicht. Het 'metro + eigendom'-model biedt een andere mogelijkheid voor lokale autoriteiten om financiële problemen te regelen. Lokale autoriteiten verlenen de franchise aan een metrobedrijf, waardoor het de metro kan bouwen en exploiteren. Ondertussen laten de lokale autoriteiten de metromaatschappij ook toe om vastgoed langs de lijn te ontwikkelen om in de toekomst het verlies van de exploitatie van de metro te subsidiëren. Deze praktijk voegt waarde toe aan het onroerend goed vanwege het handige vervoer, terwijl het welvarende onroerend goed op zijn beurt de reizigersstroom stimuleert en zo de inkomsten van het bedrijf in de metro verhoogt. Deze praktijken tonen hoe stedelijke ontwikkelaars conflicten aangaan met bewoners door het delen van voordelen, wat een repliceerbaar en bruikbaar voorbeeld is voor andere steden in de financiering van stadsvernieuwing en gemeenschapstransformatie omdat conflicten tussen stedelijke ontwikkelaars en bewoners nog steeds gebruikelijk zijn in het hedendaagse China.

Kortom, ILCC is ecologisch duurzaam door het bevorderen van een koolstofarme overgang, sociaal duurzaam door betrokkenheid van bewoners en dorpsbewoners en financieel duurzaam door diversificatie van financieringsbronnen.

Een vergelijkende kijk op de financiering van duurzame steden

Op basis van de individuele case study werden de twee cases vergeleken om meer inzicht te krijgen in de overeenkomsten en verschillen in de financiering van duurzame steden en zo te

voorzien in referenties voor toekomstige duurzame projecten. De overeenkomsten in de financiering van duurzame steden zijn samengevat na vergelijking van de twee gevallen. Om specifiek te zijn, vertrouwen ze allebei op bankleningen, bedrijfsobligaties en PPP om fondsen te verstrekken voor hun constructie, hoewel ze misschien wat verschillen in details hebben.

De verschillen uit de twee cases zijn echter waardevoller omdat ze worden beschouwd als innovatieve werkwijzen, die de financieringsbronnen zouden uitbreiden en masterontwikkelaars zouden helpen meer geld te verdienen om aan de behoeften te voldoen. Het Tianjin-project biedt een model in een uitgebreide en zeer gestructureerde binationale samenwerking die niet overal repliceerbaar is. De ervaring met het uitgeven van obligaties op de internationale markt is echter waardevoller omdat het een effectieve manier is om fondsen te bieden voor veerkrachtige klimaatprojecten. Wat betreft het project in Shenzhen, de integrale voorbereiding en het regelen van financiën via 'metro + onroerend goed', biedt een repliceerbaar en bruikbaar voorbeeld voor andere steden voor de financiering van stedelijke vernieuwing en transformatie van de gemeenschap en het aanpakken van de kwestie hoe bewoners de voordelen van stedelijke ontwikkeling kunnen delen met ontwikkelaars.

Over het geheel genomen hebben Shenzhen en ILCC een model ontwikkeld voor duurzame financiering met minder uitgebreide financiële en andere steun van de centrale overheid en buitenlandse regeringen dan SSTEC en kunnen daardoor mogelijk meer praktische lessen bieden voor andere steden. Dit moet zeker worden gezien als een belangrijke institutionele en organisatorische stap voorwaarts in het bereiken van de drievoudige bottom line in duurzame verstedelijking.

Daarnaast werd ook een generiek financieringsmodel gepresenteerd om toekomstige projecten te helpen omgaan met financieringsproblemen. Het model is echter geen 'one size fits all'-model. Lokale omstandigheden moeten in aanmerking worden genomen wanneer andere projecten dit model gebruiken om financiële regelingen te treffen.

Appendix III List of Publications

1. Zhan Changjie, de Jong Martin, de Bruijn Hans (2018) 'Funding Sustainable Cities: A Comparative Study of Sino-Singapore Tianjin Eco-city and Shenzhen International Low-carbon City,' *Journal of Environmental Management, Under review*

2. Zhan Changjie, de Jong Martin (2018) 'Financing Low Carbon Cities: The Case of Shenzhen International Low Carbon City,' *Journal of Cleaner Production,* 180,116-125

3. Zhan Changjie, de Jong Martin. (2017) 'Funding Sino-Singapore Tianjin Eco-city: What Lessons Can Be Drawn for Other Large-scale Sustainable City-Projects,' *Sustainability* 9 (2), 201

4. Zhan Changjie, de Jong Martin, de Bruijn Hans, (2017) 'Path Dependence in Financing Urban Infrastructure Development in China: 1949-2016', *Journal of Urban Technology*, 24(4), 73-93

5. Li Ying, Zhan Changjie, de Jong Martin, Lukszo Zofia. (2015), 'Business Innovation and Government Regulation for the Promotion of Electric Vehicle Use: Lessons from Shenzhen, China,' *Journal of Cleaner Production*, 134: 371-383

6. de Jong Martin, Joss Simon, Schraven Daan, Zhan Changjie, Weijnen Margot. (2015), 'Sustainable-Smart-Resilient-Low Carbon-Eco-Knowledge Cities; Making Sense of a Multitude of Concepts Promoting Sustainable Urbanization' *Journal of Cleaner Production,* 109: 25-38

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