A Comparison of Sprawl in the US and China:
Applicability of Smart Growth Strategies to Chinese Cities

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Abstract

This thesis identifies the differences in patterns and causes of sprawl between Chinese cities and US cities and examines the applicability of smart growth strategies to Chinese cities. Sprawl in the US is characterized as extensive dispersion at significantly low population densities. In contrast, sprawl in Chinese cities is characterized as excessive outlying expansion at high population densities and tendency towards both dispersion and fragmentation on urban fringe. Sprawl in the US is the consequences of both market force and public policy. Despite the market force, sprawl in China is mainly due to local governments' strong incentives to develop more land to collect land leasing fees for infrastructure development. Fragmentation in suburbs is also an unintended effect of protection of farmland. By analyzing four smart growth strategies, including Urban Growth Boundary, Priority Funding Area, Transit-Oriented Development and Brownfield Redevelopment, this study concludes that most smart growth strategies would only have limited effectiveness in curbing sprawl in China. To address sprawl in China, policies should focus on infill development, providing affordable housing in the inner city, encouraging urbanization and economic growth in the less developed areas, and ensuring a significant and long lasting local revenue source.

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Chapter 1 Introduction

Urban sprawl, characterized as uncontrolled and low-density suburban development, has become a major issue facing many cities in both U.S. and China. This kind of development often relates to the problems such as traffic congestion, environmental degradation, loss of farmland and open space, etc. The smart growth movement was born in the US, designed to limit sprawl and mitigate its negative impacts. According to the ten principles of smart growth listed by the US Environmental Protection Agency (EPA), the idea of smart growth is to advocate compact and mixed land use; promote transit, bicycle, and pedestrian-friendly projects; encourage urban infill and redevelopment; conserve natural resources, etc. (Song & Ding, 2009).

Since economic reforms commenced in 1978, China has been experiencing rapid urbanization. In 2010, about half population lived in the urban area and China has the largest urban population in the world (World Bank, 2013). At the same time, problems relating to urban sprawl seem more severe in China. However, it deserves more in-depth analysis and further research, when considering whether the principles of smart growth are applicable to China. Sprawl in China is quite different from that in the US and results from different factors. For example, smart growth promotes compact cities, mixed land use, high density, and multiple transportation choices. In Chinese cities, however, average density is already ten times higher than that in US cities, vehicle used per capita is far lower, and land is more mixed-used (Cohen, 2008). In contrast to the low-

density sprawl in the US, sprawl in China is characterized as excessive outlying development and fragmentation on urban fringe at relatively high level of densities and mixed land use. Central city does not decline in China and people who cannot afford housing in the central city move to suburbs (Zhang, 2000). American people prefer having their own house in suburbs, while Chinese people still prefer living in inner city (Huang, 2007). Moreover, patterns and causes of urban sprawl in China differ from those in the US. Local governments in China have more significant impact on sprawl. In contrast, sprawl in the US might be mainly the consequences of both market force and public policies. Specifically, the main driving force of urban sprawl in China is local governments' willingness to convert more rural land into urban land and lease them to generate more revenues for infrastructure construction. Thus, smart growth should be understood in the context of Chinese cities when implementing strategies to combat sprawl.

It is not clear whether the smart growth strategies and tools used in the US can successfully address urban sprawl in China. There are many organizations, both public and private, that adopt different kinds of strategies to achieve smart growth against sprawl in the US, such as inclusionary zoning, transfer of development rights (TDR) and purchase of development right (PDR), infill development, business improvement district (BID), urban growth boundary (UGB), priority funding area (PFA), transit-oriented development (TOD), etc. (Smart Growth Network, 2005). Even though these strategies have addressed sprawl to some extent, the debates about the effects of smart growth strategies continue even in the US. In the report "Evaluation of Criticism of Smart Growth",

a number of criticisms are listed, ranging from increase in regulation, congestion, social and economic costs, to the reduction in affordability and individual freedom. For example, UGBs are criticized as a major cause to the increase in housing price in Portland. The impact of UGB on development is mixed. A study on land development in Eastern Tennessee suggests that the UGB slowed the pace of development in urban areas, but accelerated development in the rural–urban interface (Cho et al., 2007). Moreover, PFA in Maryland also received many criticisms. For instance, the definition of which programs are growth-related is vague, and it lacks regulatory power to directly limit development beyond PFAs (Lewis et al., 2011). Therefore, considering the arguments on the impacts of smart growth strategies in the US, we need to be much more careful to study their applicability to Chinese cities.

The research questions I would like to answer in this thesis include:

1. How does urban sprawl in China differ from that in the US, in terms both patterns and causes?
2. Do the smart growth strategies achieve their desired goals in the US?
3. Can these strategies address urban sprawl in China?

This thesis mainly use literature review to capture the characteristics and causes of sprawl in the US and China, and identify the effectiveness and unintended effects of smart growth strategies in the US. Based on the findings through literature review, I will discuss whether the unintended effects of smart growth strategies would limit their effectiveness in Chinese cities and whether they could address sprawl in China. Four smart growth strategies I choose to

discuss their applicability to Chinese cities include: UGB, PFA, TOD, and brownfield redevelopment. First, these four strategies address "where" and "how" growth should occur and cover most of smart growth principles, including compact and mixed land use, promoting non-auto traffic modes, infill development, preserving farmland, etc. Second, UGB, TOD, and brownfield redevelopment are widely discussed by Chinese scholars and most Chinese literature hold positive attitude on their applicability (Jiang et al., 2007; Duan et al., 2009; Song & Ding, 2009). UGB is viewed as a potential effective tool for farmland preservation and compact development. PFA, compared to UGB, reveals the trend of smart growth strategies evolving from a directly regulatory mechanism to a market-based incentive mechanism. In addition, most planers in China also believe TOD could alleviate traffic congestion and encourage more people to use public transit (Lin & Zong, 2006; Zhang & Liu, 2007). Brownfield redevelopment is one of the key strategies for infill development and local governments in China have begun to enact regulations regarding brownfield redevelopment in recent years (Can, 2007; Li, 2011).

Thorough analysis of applicability of smart growth strategies to Chinese cities can only be realized through better understanding of the difference between China and the US. Thus, it is necessary to recognize the patterns and causes of sprawl in each country. Chapter 2 reviews different ways to measure sprawl and compares the characteristics and causes of sprawl in China and the US. Chapter 3 reviews the principles of smart growth and how smart growth strategies have evolved from direct regulatory mechanism to market-based mechanism. In

addition, I discuss whether these principles are suitable for containing sprawl in China and identify the potential barriers for implementation. The next four chapters examine the applicability of four smart growth strategies to Chinese cities, including UGB, PFA, TOD and Brownfield Redevelopment. I discuss the principles and effects of each strategy in US cities, barriers for implementation, and its potential effectiveness in containing sprawl in Chinese cities. The last chapter summarizes the key findings and answers the primary research question about how sprawl in China and the US differs from each other and whether smart growth strategies are suitable for Chinese cities. Then, some policy recommendations are offered to address sprawl in China.

Chapter 2
Measuring and Comparing Sprawl in the US and China

This chapter reviews literature about different ways to measure sprawl both in the US and China. Based on the existing literature, the difference between US and China in sprawl patterns and the causes are identified.

What's Sprawl?

In order to compare sprawl in China and in the U.S., there is a need to clarify what sprawl is. However, the concept of urban sprawl suffers from difficulties in definition. "Most people would be hard pressed to define urban sprawl, but they know it when they see it" (Ewing, 1994). For example, sprawl may be obvious in the presence of a suburban strip mall, or a network of roads with huge blocks and narrow sidewalks, or an isolated low-density residential neighborhood far away from shops and workplaces.

Sprawl means different things to different people, and it has been defined from different perspectives in the US. Some define sprawl as a process of land development. Consensus has been built on that sprawl doesn't equate to urban growth or suburbanization. It is a pattern of growth in an "unplanned, ad hoc manner" (Ewing, 1994). Urban sprawl refers to "excessive" spatial growth of cities (Brueckner, 2000). Although cities must expand in responding to population growth, urban sprawl indicates that too much spatial growth occurs, taking up too much space and encroaching excessively on farmland and open spaces. It is also defined as the process in which the expansion of urban area occurs at a much

faster pace compared with population growth in the same area (Ewing et al., 2002). Sprawl could be always recognized through its negative effects on urban forms and on the quality of life, such as low-density and large single-family subdivisions, mismatch between jobs and housing, loss of farmland, environmental contamination, traffic congestion, auto-dependent lifestyle, urban decline, etc.

In most cases, sprawl is defined as some certain patterns of land use. The simplest definition refers to sprawl as a low-density development, either in terms of low population density or low building density. Sprawl is further defined in terms of some undesirable land-use patterns, including scattered development, leapfrog development, strip or ribbon development, or continuous low-density development (Ewing, 1994). Galster (2001) identified eight conceptual dimensions of land-use patterns for sprawl, including density, continuity, concentration, clustering, centrality, nuclearity, mixed uses, and proximity, as described in **Table 2.1**. He defined sprawl as a pattern of land use that presents low values of all or some of these eight dimensions. This way to define sprawl suggests that urban sprawl can be in different forms with different combinations of these dimensions.

Table 2.1 Dimensions of Sprawl

Dimension (sprawl presents low values of all or some of these dimensions)	Definition
Density	The average number of residential units per square mile of developable land
Continuity	The degree to which developable land has been built upon at urban densities in an unbroken fashion
Concentration	The degree to which development is located disproportionately rather than spreading evenly throughout.
Clustering	The degree to which development has been tightly bunched
Centrality	The degree to which development is located close to the central business district (CBD) of an urban area
Nuclearity	The extent to which an urban area is characterized by a mononuclear pattern of development
Mixed uses	The degree to which different land uses commonly exist within the same small area
Proximity	The degree to which different land uses are close to each other

Source: Galster et al., 2001

Ewing (1994) argues that sprawl is a matter of degree and it has multiple dimensions- density, land use, and time. Using land-use patterns to define sprawl can hardly distinguish sprawl from other similar forms of development. For example, the line between scattered development and polycentric development and the line between leapfrog development and economically efficient discontinuous development are not clear. The difference between different development patterns is just a matter of degree. It is impossible to define the threshold between sprawl and non-sprawl without considering the impacts. Furthermore, the land-use pattern definition neglects the time dimension of sprawl. Without giving a definition of sprawl, Ewing (1994) focuses on two characteristics shared only by sprawl, poor accessibility and lack of functional open space. Poor accessibility indicates that the sprawling land use pattern would

increase unnecessary traveling distance. For instance, leapfrog development increases the distance between developed areas, and low-density development makes everything far apart. Lack of functional open space indicates that in the sprawling development the open spaces are in private hands or too small for community uses, and the leftover lands are unavailable for framing or are just idled. Instead of trying to exactly match up certain archetype with sprawl, defining sprawl in this way recognizes both the impact of land use patterns and the matter of degree.

In China, driven by rapid urbanization and industrialization, Chinese cities have experienced dramatically spatial expansion since early 1990s. For instance, the share of total built up areas in large cities increased from 68.8 percent to 76.4 percent in just four years between 1998 and 2002 (Ding & Zhao, 2011). As land development has been out of control and the construction land has kept expanding blindly, scholars have tried to define Chinese urban sprawl in different ways. Jiang (2007) argued that sprawl in China refers to the rapid, low-efficient and disorderly growth of non-agricultural land towards peripheral areas. Li and Yang (2006) defined urban sprawl in China as a pattern of city growth, which is like a "pancake-style (*Tan Da Bing*)", excessively expanding to occupy arable land. Some scholars focusing on human geography and sociology regarded urban sprawl as a by-product of suburbanization, while some refer sprawl in China to low-density urbanization (Qi & Lu, 2008). Wang and Zhang (2010) have used the "Great Leap Forward" in urbanization to describe urban sprawl, which is characterized as high-speed urban growth, excessive land use per capita, and

extravagance of public facility construction (Wang & Zhang, 2010).

All these definitions of sprawl indicate that sprawl is a cluster of land use patterns which could be all or some of the eight dimensions indicated in Table 2.1, and would lead to problems such as poor accessibility, decline of central cities, environmental issues, loss of natural resources, etc. Sprawl in different places might have different patterns and result in different issues. Therefore, in the absence of a clear way to define sprawl, it would be better to describe rather than defining it. In general, sprawl could demonstrate one or more of the following characteristics:

- Unlimited outward extension towards undeveloped areas;
- Low density development;
- Low degree of mixed land use;
- Leapfrog development;
- High automobile-dependence;
- Commercial strip development along highways;
- Poor accessibility;
- Extensive expenditures on infrastructure;
- Decline of central cities;
- Loss of farmland and open space;
- Employment decentralization;

Measuring Sprawl

Sprawl has been measured by a number of researchers, reflecting the

dynamics of sprawl in one metropolitan area, evaluating the spatial distribution of sprawl within a region, or comparing sprawl in different metropolitan areas in the US or internationally. Since sprawl has been defined in various ways, the most common difficulty in measuring sprawl is pinning down the multi-dimensions of sprawl. It is clear that one measure alone is not sufficient to understand sprawl. Adopting different definitions of sprawl would lead to different approaches of measuring sprawl.

Population-based measures are the simplest approach to evaluate sprawl. When sprawl is defined as an excessive growth of suburbs, measuring sprawl could focuse on the location of population growth. As sprawl can be described as a low-density development, density is the most important indicator for measuring sprawl. When sprawl is defined as the expansion of urban area at a much faster pace compared with population growth in the same area, the ratio of population growth rate to built-up area growth rate is adopted. Since the population-based measures cannot reflect the spatial forms of sprawl, multiple dimensions of land use patterns should also be measured. These spatial-based measures could include the extent of built-up area, continuity, concentration, clustering, centrality, nuclearity, mixed use, and proximity (Galster et al., 2001). When defining sprawl from the perspective of its impacts, a number of detailed and policy-relevant measures should be added, such as measures of auto dependence, distance to jobs, transportation options, and accessibility, etc. These measures reveal the direct concerns of residents and policy-makers.

Bhatta et al. (2011) argues that most of these attempts above to measure

sprawl are at a relative scale. Even though sprawl has been measured from multiple dimensions- growth rate, density, spatial configuration, and impacts, all of them have failed to create a black-and-white distinction between a sprawled city and a compact city. A threshold between sprawling and non-sprawling could differ among countries due to different development patterns.

Measuring sprawl in the US

Several studies have focused on population density. By defining sprawl as that land is developed at a faster rate than population, Fulton et al. (2001) conducted the first national study to measure the urban land consumption relative to population change in the U.S. metropolitan areas and concluded that most metropolitan areas in the US were consuming land for urbanization much more rapidly than they were adding up population. From 1982 to 1997, the amount of urban land in the US increased by 47% and population grew by only 17% (Lopez & Hynes, 2003). In this sense, most U.S. metropolitan areas were sprawling more rapidly. The west was home to some densest and least sprawling metropolitans, and the Northeast and Midwest experienced rapid decrease in density and they had the most sprawling cities. Lopez et al. (2003) also strictly related sprawl to density and he divided tracts in each metropolitan area into high-density tracts, low-density tracts, and rural density tracts. Sprawl trends and distribution in metropolitan areas were evaluated through analysis of the population change in high-density tracts and low-density tracts between 1990 and 2000. The results showed that sprawl had increased in many metropolitan areas. More people lived in low-density areas with higher population growth rate. A similar sprawl

distribution was also identified that the West sprawled least, and the South and the Northeast sprawled most. Furthermore, a number of sprawl areas located along the Interstate highway corridors. Population density as a measure of sprawl, by any means, is not perfect to reveal the multi-dimension of sprawl, but it provides a basic understanding about how to relate sprawl to land use.

When sprawl is defined as certain kinds of land use patterns, Galster et al. (2001) distinguished a variety of land use patterns and developed eight detailed land-based measures in Table 2.1. The lower degree of each dimension, the higher degree of sprawl could be observed. Galster (2001) used six of these dimensions to rank 13 metropolitan areas and the results appeared to be a little different from the results when measuring sprawl only using density. Besides the Midwest was identified to be the area with the least degree of sprawl, the Northeast was also home to the least sprawling metropolitan areas, which is opposite to the findings using population density measuring sprawl. Furthermore, Galster's study shows that a larger urban area does not mean that it is more sprawled, and sprawl does not have the same characteristics or dimensions.

When regarding sprawl as a matter of degree and it has multiple dimensions, its impacts should be considered when measuring sprawl. Smart Growth America developed a composite sprawl index measuring sprawl impacts on life quality with four dimensions: residential density; neighborhood mix of homes, jobs, and services; strength of activity centers and downtowns; and accessibility of the street networks (Ewing et al., 2002). This study not only presents a highly detailed portrait of sprawl but also analyzes the consequences of

sprawl for people. In other words, policy-relevant measures are integrated with population- and land-based measures. The growth patterns are not the same: some areas sprawl badly in all dimensions, some do better in all dimensions, and others are more of a "mixed bag" with different characteristics (Ewing et al., 2002). The relation between urban sprawl and quality of life shows that traffic and transportation-related problems appear to increase in sprawling areas. People living in more sprawling areas tend to drive further distance, suffer more polluted air, and walk and use transit less, etc.

Different understanding of sprawl leads to different measurements, reflecting various characteristics and distributions of sprawling areas in the American metropolitan areas. Some characteristics of sprawl in the US could be identified. They include: low density development, segregation of different land uses, decline of metropolitan centers, sparse or disconnected street networks, leapfrog development, low concentration, low accessibility, high auto dependence, etc. The distribution of sprawl in the US is ambiguous. Even though conventional wisdom suggests that the Northeast sprawls least and the West sprawls most, the research results vary when using different ways to measure sprawl.

Measuring sprawl in China

Most western studies on sprawl take a whole city as the unit for analysis, in order to reflect the sprawling situation in a region or compare the degree of sprawl between metropolitan areas. In China, such studies have also been conducted. For example, by adopting the definition that sprawl refers to higher

land expansion rate compared to population growth rate, Wang and Zhang (2010) measure sprawl in 35 large and middle-sized cities in China using the ratio of urban built-up area growth to population growth between 1999 and 2008. The results show that most of the cities have experienced sprawl at a higher urban built-up area growth rate of 122.67% and a lower population growth rate of 47%, indicating low-density expansion. Sprawl in China shows apparent regional features in that the east region sprawls the most and the west sprawls at a relative low level.

Many other studies focus on sprawl patterns over time within cities in the eastern part of China, where sprawl is supposed at a higher level, such as Beijing, Guangzhou, and Shenzhen. Jiang et al. (2007) measures sprawl in Beijing from three aspects including spatial configuration, growth efficiency, and external impacts. Sprawl in Beijing also features low-efficiency growth. Building density and population density are lower than the previous development level. The economic output is not as high as expected and GDP density is much lower than that of previous developed land. The negative impacts of sprawl on Beijing refer to huge loss of high quality arable lands in suburbs, loss of open spaces, and increased distance between job locations and residential areas. In terms of the internal differentiation of sprawl in Beijing, the north part sprawls more compared with the south and severe sprawling happens in marginal areas of the near suburbs and the areas between highways. Four sprawl patterns in Beijing are identified: randomly expansion on urban fringe, strip development along highways, scattered development of industrial land, and leapfrog development of residential and

industrial area. Zhao (2011) designs two indicators to measure sprawl in Beijing, including urban growth indicator and urban form indicator. The results indicate that the city center, planned peripheral constellations, and rural-urban fringe have experienced different patterns of growth. The city center has experienced the decrease in population, household and employment density, and the degree of mixed land use. The planned peripheral constellations have experienced high population growth and industrial development, high growth in jobs-housing balance, and more compact development shape. The rural-urban fringe has high population growth and housing development, but experiences decrease in population density, the degree of mixed use and concentration. This study indicates the compact development could be achieved under the plan and strict growth management in planned peripheral constellations, whereas both market and political forces contribute to the sprawl on urban-rural fringe.

Sun et al. (2012) quantifies different urban growth patterns in Guangzhou, including infilling growth, edge-expansion, and outlying growth between 1979 and 2008. The results show that at the initial period of urban growth, the urban area expanded mainly as outlying development, causing fragmentation and dispersion. As urban growth continues, newly built urban areas started to fill in the vacant non-urban areas inwards. With increasing infill development, the urban area became more compact. Xi et al (2007) also shows that the landscape in Guangzhou becomes more fragmented due to the initiation of urbanization. When the degree of urbanization increases, the landscape will become more aggregated. Additionally, urban sprawl in Guangzhou shows a distinctive multi-center pattern,

which is different from that of other Chinese cities (Yu & Ng, 2007). Two rapid development suburban areas gradually appeared and could be clearly identified in 2002. The internal differentiation of sprawl in Guangzhou indicates that the northern area is mainly residential sprawl due to increasing demand for housing and the southern area is concentrated industrial sprawl due to government policies trying to attract investment.

Shenzhen, a city near Guangzhou with rapid economic growth and urban expansion, is another popular city for study on sprawl in China. Qi and Lu (2008) examine the annual growth rate of built-up area and the annual population growth rate between 2001 and 2005 and conclude that Shenzhen has experienced a dramatically decrease of population density. By analyzing the dynamics of different land uses, they identify that industrial land and residential land have grown most rapidly, contributing to urban sprawl in Shenzhen. The contribution of industrial land to urban expansion was 84.06% in 2004 (Qi & Lu, 2008). Thus, the low density, excessive urban expansion in Shenzhen is most due to the growth of industrial and residential land, especially the industrial land.

To summarize the existing studies on China's urban sprawl, some common features can be identified. Urban sprawl in China is a kind of unplanned excessive urban expansion companied with problems like arable land loss, open space loss, increasing traffic burdens, etc. Sprawl into suburbs is characterized by fragmentation, irregular landscapes, discontinuous development, strip development, leapfrog development, low efficiency growth, and decrease in the degree of mixed use and concentration. The eastern region in China sprawls the

most and the west sprawls the least, which is consistent with the economic development levels. Sprawl in China is mainly due to residential and industrial growth in suburbs, especially newly established industrial areas. However, sprawl in different cities or even in different suburb areas within one city shows different patterns. For example, the urban-rural fringe in Beijing has experienced low-density and fragmented development, whereas the planned peripheral satellite towns have experienced more compact development with high degree of mixed use. Guangzhou exhibits a more complex process of urban sprawl different from other Chinese cities. It features a multi-center pattern of sprawl. Urban growth shows sprawl patterns only during initial urbanization, but development would turn to be more compact and infill when the urban area grows to a threshold.

Comparing sprawl in the US and China

Even though there is plenty of research about sprawl in the US and China, few studies directly compare sprawl in the two countries due to difficulties in pinning down the elusive concept of sprawl, defining what types of land are "urban", and determining what areas should be considered (Schneider & Woodcock, 2008). Furthermore, because of the different development patterns, it is difficult to compare the degree of sprawl among cities in different countries, especially between a developed country and a developing country. For example, when using population density to measure sprawl, Chinese cities would be much more compact compared with the US cities, because the population density in Chinese cities are always much higher. But this does not mean Chinese cities sprawl less than US cities. Sprawl in China and the US differs in both patterns and

causes.

Schneider and Woodcock (2008) compared the urban form and growth across 25 mid-sized cities in different countries including China and the US between 1990 and 2000. Three dimensions of sprawl have been explored- amount and rate of urban expansion, land use pattern (built-up density, fragmentation, scatter), and population density. As a result, Chinese cities are classified into frantic-growth cities due to their extremely rapid land conversion rate at high population densities and tendency towards both dispersion and fragmentation on urban fringe. US cities are expansive-growth cities with extensive dispersion at significantly low population densities. Huang et al. (2007) compared five distinct dimensions of urban sprawl among 77 metropolitan areas around the world and concluded that urban sprawl in developing countries bears little resemblance to the sprawl in developed countries. Sprawl in Chinese cities, especially those in the coastal area, is distinguished by moderate centrality, higher density, complexity, and low level of open space. The sprawl in US cities shows significantly low level of centrality, lower density, and low degree of centralization, but high level of open space.

According to existing research, some similarities and differences on the characteristics of sprawl in China and the US can be identified:

1. Population density

   Land expansion rate is higher than the population growth rate in both countries. Even though population density drops in sprawling cities in both countries, population density in Chinese cities is still much higher

than that in US cities. Density was calculated by comparing the population of the urban agglomeration to the extracted urbanized area. Huang et al. (2007) compared 77 metropolitan areas and found cities with very low density, below 3000 persons/ sq km, include all US cities and cities with greater than 10 000 persons/sq km include all cities in China. For instance, population density in Beijing is 12,843 persons/sq km persons, 22,398 in Shanghai, and 20132 in Tianjin. In contrast, population density in Boston is 6615 persons/sq km persons, 3049 in Baltimore, 1636 in Phoenix (Huang et al., 2007).

2. Urban expansion

   Urban expansion rate in Chinese cities is much higher than that in the US. U.S. cities expand in a scattered form and far from the central urban core, while Chinese cities expand at the edge of urban core or adjacent to the existing urban land but fragmentation on urban fringe. Larger amounts of new urban land on fringe, periphery and hinterland could be identified both in the US and Chinese cities, such as Guangzhou and Baltimore (Schneider & Woodcock, 2008).

3. Urban forms

   When compared with non-sprawling cities within each country, the sprawling metropolitan areas demonstrate relatively a low degree in continuity, concentration, centrality, mixed uses, and proximity. When comparing Chinese sprawling cities with US sprawling metropolitan areas, Chinese cities seem more compact with higher population density. The

concentric road systems in Chinese cities direct the development around the city center, whereas the interstate highways systems in US, which always pass through the city center, encourage development along the highways and far away from city center. Therefore, the commercial strip development is not an obvious character of sprawl in Chinese cities (Zhang, 2000). The sprawl in Chinese cities, especially those in the eastern region, is characterized as extremely rapid urban expansion at high population densities and tendency towards both fragmentation and leapfrog development on urban fringe.

4. Significance of central city

   Urban expansion does not cause decline of central city in China. Even though population in the center city declines, it does so because of the high housing price in city center (Zhang, 2000). For example, the housing price in the four central districts in Beijing has increased by more than10 times during the last decade (Beijing Municipal Bureau of Statistics, 2012). Unlike the decay of inner cities in the US, large cities in China still remain prosperous. The urbanization rate (% urban population) has increased by around 15% in China but only 3% in the US in the last two decades (World Bank, 2013). Central city in China always has more job opportunities, better environmental quality and better public services. Since late 1950s, following residential suburbanization, large amounts of employment in the US has been relocated to suburbs. For the period of 1963 to 1977, in the largest twenty-five metropolitan areas in U.S., total

manufacturing employment in central cities declined by about 0.7 million (19 percent), while their suburbs gained 1.1 million (36 percent). At the same time, total central city retail and wholesale employment was stagnant and trade employment in the suburbs increased by 1.8 million (110 percent) (Logan & Golden, 1986). Total employment decreased by about 21% in Baltimore city, Maryland, since 1990 (Bureau of Labor Statistics, 2013). In contrast, employment in Chinese cities has kept increasing in the past decades. For instance, annual employment in Beijing, one of the most sprawling cities in China, has increased by around 20% in the last two decades (China City Statistical Yearbook, 1990 and 2010).

5. Dependence on automobile

   Even though ownership of vehicles has dramatically increased in China, most people, especially those live in suburbs, cannot afford a car. Public transportation is still the major commuting mode, which constitutes around 40% of total trips. The national vehicles/1000 population is 12.4 in China, much lower than that in the US, 779.4 (Schneider & Woodcock, 2007; World Bank, 2013). In Beijing, one of the most congested cities where 1% of China population drive 10% of China's vehicles, the vehicles/1000 population was only 122 in 2004 and increased to 250 in 2012, still much lower than the US level (Hao et al., 2006; Liu et al., 2009; Beijing Municipal Bureau of Statistics, 2012).

6. Negative impacts of sprawl

Chinese cities and U.S. cities both suffer from the high cost of urban sprawl. US cities need to provide services for new developed suburbs and experience urban decline and concentration of poverty in city center at the same time. Chinese cities have established many new development districts in suburbs but had no financial ability to complete, resulting hundreds of hectares of idle land on the urban edge. Even though problems such as loss of farmland, loss of open space, air pollution, and traffic congestion could be found in both Chinese cities and US cities, the situation in China seems much more severe. The amount of open space in urban areas in China is already much lower than that in the US cities. Considering the scarcity in land resources, urban sprawl in China has already threatened the food security. In 2008, the amount of arable land decreased about 2,000 hectare, and by the end of 2010, arable land per capita in China is only about half of the world level and 1/6 of the U.S. (China City Statistical Year Book, 2008-2010). Thus, the primary motivation of growth management in China is to preserve cultivated land and ensure food security (Zhang, 2000).

Causes of sprawl in China

Inefficient and excessive urban expansion and fragmentation on urban fringes characterize urban sprawl in China, differing from the low-density sprawl in U.S. cities. This can be understood as the outcomes of a range of different economic, social and political determinants. Sprawl in the U.S. is a consequence of both market forces and public policies. Along with income growth and

decrease in transportation cost, a large amount of middle class families who wish to own large houses move to the suburbs. Many manufactories and other industries have also relocated to suburbs, taking advantage of the low land price and proximity to labor market. Some public policies further encouraged low-density development and low degree of mixed land use, such as single-use and low-density zoning, exclusionary zoning, etc. Municipalities sometime even subsidized the cost of infrastructure to un-or under developed areas, incentivizing the creation of communities away from city centers (Ewing et al., 2002). In contrast, sprawl in China is an outcome of rapid urbanization and industrialization, and both intended and unintended effects of public policy. Local governments in China have played a more significant role in the process of sprawl (Zhang, 2000).

While sprawl presents a pattern of population growth in suburbs, sprawl in China is mostly due to urbanization and industrialization, which is unlike the US cities where sprawl results from population suburbanization, followed by job and commercial suburbanization. Mieszkowski and Mills (1993) described urban sprawl in US cities as "flight from blight". People move to live in suburb in order to escape from problems in inner cities, such as congestion, higher tax rates, higher crime rates, crumbling infrastructures, low-performing public schools, greater presence of poor and minorities, etc. Change of life style, preference for large houses and large lawns, and dependence on automobiles further contribute to the residential suburbanization and decay of central cities in the US.

In China, urban sprawl is characterized by both industrial and residential sprawl (Qi & Lu, 2008). Residential sprawl is caused by rapid urbanization and

increase in housing demand, and industrial sprawl is caused by both market forces and public policies. Sprawl happens mainly in the eastern region of China, which is home to most of the major cities with economic or political significance and experiencing rapid urbanization. Beijing, as the capital city of China, represents an economic, political, and cultural center, attracting millions of people from other places in China. Meanwhile, since Beijing owns most of the best universities in China, there is a large amount of graduates every year who wish to stay there. The population in Beijing increased from about 13 million to around 20 million in just one decade between 2000 and 2010. Because of the high housing price in the inner city, most of the new-comers have to live in suburbs. After the economic reform in 1978, Shenzhen has been designed as the Special Economic Zone, creating a number of job opportunities, especially in labor-intensive industries. Therefore, millions of workers have been attracted to these cities. Since a number of industrial zones or economic districts are established in suburban areas to attract investment, migrant workers from other cities or rural area are directed to the suburbs. And then, housing development is also boosted in suburbs because these migrant workers tend to live near their workplaces and they cannot afford the high housing price in the central city. Therefore, rapid urbanization, economic development and industrialization in cities in eastern China attract people from less-developed cities or rural areas, leading to population growth in suburbs without decay of the central city. As Chinese people still prefer to live in inner city which always offers better public services, and many suburbanites cannot afford cars, lifestyle change and construction of

highways seldom contribute to China's sprawl.

Compared with the private ownership of land in the US, land in China is owned by the state or collectives. Therefore, institutional and policy factors always play a more important role. Chinese style sprawl is both an intended consequence of political manipulation of land development on urban fringe and an unintended effect of national policy for farmland protection (Deng & Huang, 2004; World Bank, 2007).

Local governments tend to development more land in suburbs than necessary to attract investment and generate revenues. One most sprawling land use pattern in China is the establishment of "development zone" in suburbs. Chinese local governments have set up a large number of development zones that are often large and discontinuous from center city, characterized as leapfrog development and encroaching farmlands (Ding & Zhao, 2011). These lands are expropriated from peasants and local governments invest in basic infrastructures. The initial intent of local governments setting development zone is to speed up economic growth, satisfy increasing land demand, attract foreign investors and compete with other localities in response to market forces. However, a large portion of land inside development zones is still vacant, especially in the eastern region of China. In 2004, it is estimated that 4,735 development zones, 70% of the nation's total, were almost entirely vacant zones created by provincial or municipal governments (World Bank, 2007).

Moreover, local government has strong incentive to development land to generate revenue because of the huge pricing difference between the

compensation price paid by local governments for undeveloped land and leasing price of land use rights. After the reform of the fiscal system, a tax sharing arrangement between local governments and central government is adopted, within which local governments can share tax revenues, but most funds that previously came from central government are cut. This means local governments need to find its own financial resources for infrastructure construction and other public services. As a result, land, as the most valuable commodity, is always used by local governments to generate revenue from leasing land use rights. Therefore, the main driving force of urban sprawl in China is local government's willingness to expropriate and lease more undeveloped land in suburbs. At the same time, the decentralization of land regulation power has facilitated local governments to realize this goal.

Urban sprawl in China is mainly marked by fragmented and discontinuous development on urban fringe instead of low-density sprawl in the US. The fragmentation is the unintended outcome of protection of basic agricultural land. In response to the concern that local governments are consuming too much farmland, the central government implemented policies to protection basic agricultural land. As a result, local government redeveloped villages that are not classified as agricultural land and leaving behind isolated agricultural land within fragmented built-up urban areas. Thus, according to the protection of basic farmland, unproductive agricultural plots closed to developed areas cannot be developed while villages far away from built-up areas can be developed, leading to fragmentation on urban fringe.

Compared with American style urban sprawl, which is mainly caused by market forces and problematic public policies, urban sprawl in China is mainly caused by rapid industrialization and urbanization, and by local government's desire for economic development and thirst for revenue from public land leasing. The solution to Chinese style urban sprawl needs to control urban expansion, mitigate the negative impact, and address the root causes. Due to different sprawl patterns and causes, solutions to sprawl in the US should be applied with cautions to Chinese cities. More compact form and increasing density may be less a solution to Chinese style urban sprawl, considering the different characters of sprawl in China. Additionally, the root cause of sprawl is closely related to China's land system. Applying Smart Growth strategies to Chinese cities without adaptation would diminish their effectiveness.

Chapter 3
Smart Growth and Its Implementation in the US

Concerns over the consequences of urban sprawl in U.S. metropolitan areas have led to increased advocacy for more compact and traditional urban development. Sprawl has aggravated the decline of urban communities and congested streets, accelerated loss of natural resources and deterioration of environment, and increased fiscal burdens of local governments. Many people including environmentalist, planners, and farmers have questioned the social costs and wisdom of current sprawl-type development. These include mismatch between housing and workplace, abandonment of brownfield in older communities while infringing upon open spaces and farmlands, and auto-dependent life style, etc. Since people need jobs, tax revenues, and other benefits that come with development, the problem is not growth per se, but dysfunctional growth (Dowling, 2000). The problem of sprawl is that it fails to provide these growth benefits without degrading environment, increasing traffic congestion, or diminishing sustainability.

What's smart growth?

In recent years, smart growth is used to provide an alternative development pattern based on a set of principles and strategies that have evolved over time. In general, in contrast to the traditional anti-growth movements, smart growth does not mean no growth at all, but to grow smart by addressing two issues: "where" and "how" development should occur (Krueger & Gibbs, 2008). In terms of

"where", smart growth promotes growth in the developed areas with existing infrastructures, such as city centers, urban cores, older suburbs, or historic districts. Smart growth reduces development on farmland, newly urbanized land, and environmental sensitive land, and promotes compact development within existing urban areas. In terms of "how", smart growth stands for a family of related policies that are designed to let growth enhance communities and improve people's daily lives avoiding the negative effects of sprawl. Smart growth addresses the "how" issue by recognizing the connection between development and quality of life (Smart Growth Network, 2005). Though there is no single form for smart growth, development under smart growth is more compact, is more walkable and transit-oriented, and has a higher degree of mixed land use. In general, smart growth should invest time, attention, and resources to make development economically practicable to enhance quality of life and promote environmental sustainability (Smart Growth Principles & Practice, 2002).

Principles of smart growth

Smart growth does not mean the same thing to everyone (Krueger & Gibbs, 2008). Different governmental agencies and nonprofit organizations have developed their own principles of smart growth in their desired ways to achieve particular goals. Table 3.1 examines different principles that are shared among different smart growth groups, including U.S. Environmental Protection Agency (EPA), Smart Growth Network (SGN), U.S. Department of Housing and Urban Development (HUD), U.S. Department of Agriculture (USDA), American Planning Association (APA), Smart Growth America (SGA), Sierra Club, Trust

of Public Land (TPL), National Association of Home Builders (NAHB), and Urban Land Institute (ULI). The most widely adopted and comprehensive principles of smart growth are the ten principles adopted by EPA and SGN, listed in the first column of table 3.1. The core areas of concerns vary among different groups. For example, for HUD and NAHB, the core areas of interest for smart growth are providing affordable housing and building pedestrian- and transit-oriented communities regardless of the location of growth and no matter on developed land or greenfield. For USDA, in contrast, the core area of interests is to direct growth towards built-up areas to preserve open space and farmland. TPL focuses on making existing communities more attractive and livable through increasing open space, protecting recreation and natural resources, and improving access to parks and greenways. In contrast, Sierra Club believes a compact, walkable and transit-oriented community would be more attractive.

Different principles of smart growth have received different priorities. Principles regarding providing a variety of transportation choices and preserving open spaces, farmland and other environmental sensitive areas have been given highest priority. Nine of the ten organizations have listed them as their principles. This reflects that the negative effects of sprawl have received most concerned in the US, such as poor air quality, loss of farmland and open space, and traffic issues. Other widely shared principles of smart growth include mixed land uses, compact development, affordable housing, walkable and attractive neighborhood with a strong sense of place, and redevelopment of existing communities.

Table 3.1 Principles of Smart Growth

EPA/SGN	HUD	USDA	APA	SGA	Sierra Club	TPL	NAHB	ULI
Mix land uses	X	X	X	X			X	X
Take advantage of compact building design	X		X	X		X		
Create a range of housing opportunities and choices	X		X	X			X	
Create walkable neighborhoods	X	X	X		X		X	
Foster distinctive, attractive communities with a strong sense of place	X		X	X		X		
Preserve open space, farmland, natural beauty, and critical environmental areas		X	X	X	X	X	X	X
Strengthen and direct development towards existing communities		X		X	X	X		X
Provide a variety of transportation choices	X	X	X	X	X		X	X
Make development decisions predictable, fair, and cost effective			X	X				X
Encourage community and stakeholder collaboration in development decisions								X

Source: YE L., MANDPE S. & MEYER P. (2005) What is smart growth – really? *Journal of Planning Literature* 19, 301-319.

Smart growth vs. sprawl

The term "Smart Growth" is particularly used in the US, and it is designed to provide an alternative growth pattern that is opposite to American style sprawl. As discussed in chapter 2, since sprawl in China differs from that in the US, two issues have arisen: 1. Is smart growth the prescription for Chines style sprawl? 2. What is the priority of smart growth principles if applied in China? Table 3.2 compares several features of smart growth, American style sprawl and Chinese style sprawl.

Table 3.2 Smart Growth and Sprawl

	American Style Sprawl	Smart Growth	Chinese Style Sprawl
Density	Lower density, dispersed activities	Higher density, clustered activities	Higher density, clustered activities
Growth pattern	outward development, decline of central city	Infill development, compact development, directing development in existing communities	outward development, prosperity in central city, fragmentation in suburbs
Land use mix	Single use, segregated	Mixed	Higher level of mixed use than US cities. Trend to single use in new developed areas, such as industrial parks.
Scale	Larger scale. Larger blocks and wide roads	Small scale. Smaller blocks and roads	Larger scale. Larger blocks and wide roads
Public services (shops, hospitals, schools)	Large scale. Automobile access required	Small and local. Accommodating walking and biking	Large scale. Available for transit access
Transportation	Auto-oriented transportation. Land use poorly suitable for walking, cycling, and public transit.	Multiple transportation choices. Land use supports walking, cycling, and public transit.	Public transit oriented transportation. Some new developed areas discourage walking and cycling.
Open space, farmland, and public space	Emphasis on private realm (yards, shopping malls, gated communities). Infringe upon open space and farmland	Emphasis on the public realm (public parks, pedestrian areas, streetscapes). Preserving open space and farmland.	Emphasis on public realm. Infringe upon open space and farmland

Some principles of smart growth can correct the features shared by both American style sprawl and Chinese style sprawl. For example, since growth in both China and the US happens in suburbs, periphery or even rural areas, infringing upon farmland and some environmental sensitive areas, applying smart growth principles in China can direct growth towards existing communities and developed areas with existing infrastructures. Loss of farmland and open space has been regarded as a serious negative impact of both American style sprawl and Chinese style sprawl. Thus, principle regarding preserving farmland and open space should be also applicable to Chinese cities. Even though Chinese style sprawl does not lead to the decline of central cities, the "where" issues that addressed by smart growth principles could be applicable to Chinese cities. In

terms of “how”, smart growth emphasizes accessibility, which reduces the distance between work place, public services, and homes. Therefore, principles of smart growth regarding compact development and designing for walkable communities should be also relevant to China.

In terms of some other features of Chinese style sprawl, such as density and transport, growth in China seems smart already. Compared to low-density sprawl and auto-oriented development in the US, density in Chinese style sprawl is much higher and public transit is still a major mode of transportation and many people still walk or cycle. However, the accessibility in Chinese metropolitan areas seems even worse. The goal of smart growth is shorter trips and providing multiple transportation choices in response to American style sprawl that results in longer but faster automobile trips (Litman, 2011). Chinese style sprawl also results in longer trips, even though multiple modes are provided. Less job-housing balance increases commuting distance. In some major metropolitan areas in China, people who work in the central city have to live in suburbs due to high housing price. They use public transit to work because they cannot afford a car either. In addition, poorly designed road system and increasing vehicle ownership result in serious traffic congestion. Though many people use buses, they are still stuck in traffic congestion. In China, high density might be an extra burden on public transit and leading to longer waiting time for getting on subway trains or buses. Thus, only increasing density or providing multiple transportation choices cannot address the accessibility and traffic issues in China as expected.

American style sprawl is usually ascribed to lacking comprehensive plan

or coordination between jurisdictions and between stakeholders. Planning in the US is mainly a local matter. Zoning is the major tool for land use planning and regulation at local level, which segregates different land uses. Many localities lack comprehensive plan. The private ownership of land induces a number of challenges to governments' regulation on land use. Thus, smart growth encourages coordination between jurisdictions and stakeholders, like public participation in the planning process, to balance private interests and public interests. Smart growth also advocates both planning vertical consistency and horizontal consistency, which addresses consistency between state, regions and municipalities and consistency between different localities and between different elements of plans. In other word, local governments must balance local issues and needs while recognizing land use planning issues at regional or state level. Therefore, smart growth proposes to shift the planning power to regional level from local level in order to enhance coordination between jurisdictions and address issues like the decline of central cities or loss of farmland. In contrast, Chinese style sprawl shows different features regarding the planning process. The planning system in China is highly centralized, and localities' plans need to be consistent with plans at the upper level of governments. In large cities, suburbs and central city are always under same local jurisdiction in China. Since land in China is public-owned, regulations on land face much less challenges from the private sector. In other words, China already has a top-down planning system and large cities are already at regional level, which is suitable for smart growth. Even though there is still plenty room for improvement in terms of vertical and

horizontal consistency in China, as smart growth advocates, it's not the root of Chinese style sprawl, which is local government's desire for economic development and thirst for revenue from land leasing. The central government is already concerned with loss of farmland and threat of sprawl on food security, and has designed several sprawl control strategies. However, when implementing these strategies at the local level, local governments face a dilemma of either achieve economic development by leasing more land or supporting the central policy of controlling sprawl. Therefore, alleviating the conflicting interests between the central government and local governments and how to ensuring local revenue resources should be the key to address sprawl in China.

Principles of smart growth should receive different priorities in China. Since food security is the most concerned issue related to sprawl, preserving farmland should be on the top of the list. However, current central regulation to protect basic agricultural land has the unintended consequence of fragmented development in urban fringe. This is because the regulation does not remove local governments' incentives to expropriate and develop more land than necessary. Traffic problems are also serious in China, but the focus should not be on providing a variety of transportation choices, because public transit is still the major mode. Smart growth in China should emphasize improving the job-housing balance and efficiency of road and public transit to accommodate high density. While encouraging people to use public transit, to walk or to cycle, affordable housing should be provided near their work places.

Smart growth strategies

Smart growth programs are typically packages of both regulations and incentives, because smart growth grew out of growth control and growth management in the 1970s and 1980s, shifting from direct regulatory mechanism to market-based mechanism to combat sprawl. A "third wave" model has been developed to describe evolution of smart growth (Godschalk, 2000; Krueger & Gibbs, 2008). In the early 1970s, some growth control policies were imposed on local development in several states such as Hawaii, Vermont, Florida, and Oregon, due to concerns over environmental problems, loss of farmland, etc. In this phase, direct governmental intervention was implemented via mandatory regulations of development such as zoning and subdivision ordinances, as well as urban growth boundary. For example, Oregon developed comprehensive statewide programs and created urban growth boundary to prevent encroachment of farmland and open spaces. Vermont enacted the Environmental Control Act to limit development in areas with environmental concerns, and new development was required to gain regional approval. In the second wave during the 1980s, growth control gave way to growth management, or shifting from controlling growth to planning for growth. The concerns were expanded beyond environmental problems to the infrastructure cost and quality of life. In the second phase, the direct regulation of land use and development was still used. At the same time, cost-benefit analysis was adopted to avoid extra fiscal burdens on government. The focus was shifted from direct environmental concerns to whether local authorities could afford the cost of infrastructure for new growth.

Growth management was dealing with lagging provision of infrastructure to new development, which is closely linked to the quality of life.

The third phase of smart growth started in the late 1900s and continued to shift away from direct governmental intervention and regulation. Smart growth emphasizes the tripartite goals of economy, environment and quality of life. The smart growth movement has been marked as an evolution from anti-growth movement to growth-accommodating movement, which created a market-based mechanism to combat sprawl. Smart growth strategies moved away from government regulation or intervene to policies that focus on providing incentives to revitalize central city, infill development, etc. For example, to preserve open space and farmland, while concentrating development in existing communities, Maryland has established Priority Funding Areas (PFA) in areas with rich infrastructure to attract growth to these areas by providing funding. Contrary to Oregon-style regulatory approaches, which explicitly indicate the location of growth, PFA is just a system of incentives and disincentives. The power to combat sprawl has shifted from government regulation, to cost-benefit analysis, and finally to the invisible hand of the market. Since smart growth programs were built on the previous programs and added market incentives to direct the location of growth, smart growth programs are usually combinations of incentives and mandates. Incentives include planning assistance grants, funding for growth in existing communities, variance for state requirements, etc. Mandates include designation of growth and rural areas, land us regulations, urban growth boundary, mandatory local plans and implementation, etc.

Miller and Hoel (2002) divided smart growth strategies into three categories: regulatory, financial, and educational. Regulatory strategies have been adopted since "growth control" period. A notable example is urban growth boundary in Portland, Oregon, which restrained new development in rural areas. Other regulatory strategies address issues regarding land use, density, street design through changing zoning ordinance or regulations to achieve goals like compact development, mixed land use, or transit-and pedestrian-oriented development. These changes include reducing minimum lot size, encouraging mixed-use buildings and mixed land use, increasing density near transit stations, setting standard for narrow streets, sidewalks and bicycle lanes. Financial strategies provide additional funding to influence development in smart ways. For example, funding can be used for subsidies to people who live near their workplace, or to redevelopment of downtown areas or existing communities, or for reducing developer fees when meeting "smart growth" criteria. Educational strategies are adopted to conduct community vision to build the consensus between citizens, developers, and government officials. Educational strategies also include redefining "American dreams" - owning a single-family detached house on a large lot.

Issues for implementation of smart growth strategies

Anthony Downs (2005) noticed that "smart growth is much more talked about than actually carried out in practice", because implementation of smart growth principles or policies always encounters many obstacles in the US.

The first obstacle is that support for smart growth comes from relatively

small interest groups rather than from the general public. These interest groups include environmentalists, urban planners and local officials, and some real estate developers (Downs, 2005). Environmentalists, such as the Sierra Club, are concerned about the loss of farmland and open space and other environmental issues caused by sprawl. Urban planners and local officials are concerned about local governments' high fiscal burden of building infrastructures for new developed area, and thus they advocate to direct growth to existing communities in a denser and compact form. Some real estate developers who desire to create large-scale mixed-use projects promote smart growth principles in order to get permission from the local government, but they only focus on a particular site. However, lacking support from the general public, especially from local homeowners, would challenge implementation of smart growth policies. Homeowners in suburbs might prefer suburban life style and want to maintain their property value, which makes smart growth proponents difficult to persuade them to support adoption of smart growth policies. Because smart growth will limit development in suburbs and people believe smart growth policies that advocate higher density will cause other issues such as congestion. Thus, to accomplish such persuasion and gain support from the general public is critical for implementing smart growth policies.

The second obstacle comes from the change of development patterns. Since smart growth is designed as an alternative development pattern compared to sprawl in the U.S., changing from sprawl to smart growth inevitably associates with redistribution of development benefits and costs. Shifting from sprawl to

smart growth means a change of location and pattern of future growth, thereby radically changes who gains and who loses from development. For example, smart growth shifts growth from suburbs to urban areas and development would be denser, more compact and more mixed-use. This shift reduces the chance of homeowners in suburbs to capture benefits from growth, such as increase in land value. Meanwhile, this shift increases the chance of homeowners in the city to capture benefits from compact and mixed-use development, such as the increase in land value. As a result, yesterday's potential gainer, such as the homeowner in suburbs, would oppose smart growth strategies due to loss of future potential benefits.

The third obstacle relates to shifting power over land use planning from the local level to the regional level. When dealing with sprawl, several jurisdictions would be involved, because suburbs and city in the US belong to different local governments. Government's action at the regional level is required when implementing some smart growth strategies. For example, when implementing policies like urban growth boundary to limit outward urban expansion, individual localities alone can hardly achieve this objective. Even though a local government can establish its own urban growth boundary, it cannot stop growth in green space beyond its political boundary, unless all localities in the region set their own urban growth boundaries, which almost never happens (Down, 2005). Localities are also too small to limit long-distance leapfrog development. Only state governments or regional authorities have the ability to create regional urban growth boundary to restrict locations of development. However, lacking regional

government or regional authorities diminishes the effectiveness of implementation of smart growth policies in the US. Metro, the elected regional government for the Portland metropolitan area, is responsible for planning at the regional level and has established urban growth boundary effectively. Other than Metro, regional planning power is very limited in most places. Even though there is some regional planning power over transportation planning in Metropolitan Planning Organizations, lacking coordination with local plans for land use, housing or other developments still inhibits implementation of smart growth policies. Furthermore, there is a sentiment that power over land use should be at the local level, even among prompters of smart growth, such as urban planners and local officials. Thus, implementation of smart growth strategies has been restricted due to lack of regional planning power and because of resistance to shifting power and authority from the local level to the regional or state level.

Finally, while many people have realized the negative impacts of sprawl, they are also worried about the unwanted side effect of smart growth strategies, which further inhibits implementation of smart growth policies. For instance, many homeowners reluctant to permit affordable housing or increase in density in their neighborhoods, because they fear that provision of additional affordable housing for lower-income households would decrease the values of their own homes and that higher density would lead to more traffic congestion and more crowded schools and other facilities. Therefore, any policies that try to increase the density would encounter strong opposition from homeowners living nearby (Downs, 2005). Another example is the impact of urban growth boundary on the

availability of affordable housing. Many people criticize that urban growth boundary causes housing price to rise substantially. Since urban growth boundary limits the supply of land and housing and the demand for housing is unchanged or even increases, housing price has increased as a result. That's why smart growth is always criticized due to its inconsistency with housing affordability (Nelson, 2004). Brownfield redevelopment is one important component of infill development. In order to attract investment to redevelop brownfields, legal liability and cleanup standards are always loosened. However, because communities around brownfield are always low-income or communities of color, the environmental justice issue would be raised when minorities receive a lower level of environmental protection. Furthermore, smart growth strategies are also criticized as their inability to achieve their promised objectives. For example, building additional transit facilities fails to address traffic congestion, because it only encourages bus riders rather than private car drivers to use transit or because the dramatic population and vehicle ownership growth overturns the improvement of transit (Downs, 2005).

Lessons learnt from smart growth in the US

Even though sprawl has been identified in Chinese cities and American metropolitan areas, Chinese style sprawl exhibits different characteristics and is caused by different factors compared to American style sprawl. Smart growth was designed to combat American style sprawl and there is a huge gap between China and America in terms of politics, economy, society and culture. Thus, directly applying smart growth into Chinese cities without any adaptation might fail to

address Chinese style sprawl as effectively as expected. Principles of smart growth should be selected to implement in Chinese cities. Based on the comparison between American style sprawl, Chinese style sprawl and smart growth, some principles of smart growth could be helpful to design policies to address sprawl in China, such as preservation of farmland and open spaces, providing affordable housing, infill and compact development, etc. Some principles to Chinese cities do not seem as crucial as to American metropolitans, such as high density development, mixed land use or providing multiple transportation choices, because these principles have been already achieved in the process of urban growth in China. Furthermore, since smart growth is derived from growth management and shifted from direct government regulations to a market-based mechanism, smart growth might hardly address the root cause of sprawl in China, which goes beyond market.

Several lessons can be learnt from the implementation of smart growth in America. The first lesson regards how to gain support for smart growth. In the US, while many interest groups support smart growth, lacking support from the public, especially homeowners, inhibits the implementation of smart growth strategies. Thus, educating the public and gaining supports from homeowners would be essential to the success of smart growth. In contrast, land in China is not privately owned. Therefore, compared to homeowners in the US, homeowners in China play much less significant roles in the process of urban development, especially in the land use policymaking process. However, the key is to gain support from local governments in China. The central government wishes to

contain sprawl due to the threat to food security imposed by sprawl in China. But the central government's concern conflicts with local governments' desire to lease more land to gain revenues, which would inhibit the implementation of smart growth strategies. Therefore, ensuring local revenue resources would be crucial to gain support from local governments in China to implement smart growth strategies.

Another obstacle that inhibits the implementation of smart growth in America is shifting planning power from the local level to the regional or state level. Achieving smart growth needs coordination between different jurisdictions, thus planning at the regional level is necessary. In US history, only when facing some crisis at state or higher levels, such as infringing environmental sensitive areas or facing severe environmental issues, significant land use planning powers have been shifted to regional level (Down, 2005). In China, since loss of farmland has already threatened food security, it is necessary to empower government at the regional or higher level to make plans and implement sprawl containment policies. In contrast to the US, where planning is a local matter, large cities in China are already at regional level and planning system in China is much more centralized. The plan at each level should be consistent with plans at the upper level of governments. Thus, the planning system in China, which shows relatively higher level of vertical consistency, has a much more suitable ground for implementing smart growth principles. The focus should be achieving the "horizontal consistency" between different localities and between different sector plans regarding economic development, urban master plan, land use,

transportation, etc.

The unwanted side effects of smart growth strategies may also inhibit their implementation in China. Smart growth policies deserve more analysis about their impacts, considering the different economic, political, and social environment in China. For example, since urban growth boundary is criticized as it contributes to increasing housing price in the US, more studies need to be conducted about the impact of urban growth boundary on housing price in China and how to maintain housing affordability when outlying development is restricted. It should be careful when applying smart growth strategies to Chinese cities.

The last lesson learnt is that achieving smart growth is possible, but policies in different regions must focus on their own key objectives (Ingram et al, 2009). In the US, different localities have their own priority policy area. The Boston metropolitan area, Massachusetts, faces challenges such as lack of affordable housing and little land for new development. Therefore, the priority policy area in Boston is focused on infill redevelopment and affordable housing. In contrast, the Portland metropolitan area, Oregon, faces loss of farmland, and therefore the smart growth priority policy area is to establish urban growth boundary to restrict development on farmland. Challenges in different regions in China are also different. High housing price and traffic congestion are more severe in developed areas, and thus affordable housing and transportation should be their priority policy area. Loss of farmland and natural resources and environmental degradation are the major challenge for some less developed areas, and thus limiting outlying development should be their policy priority area. No single

approach is right for all places. Smart growth policies and programs should be designed for each region based on its own policy priority area.

Chapter 4
Urban Growth Boundary (UGB) and Its Applicability to Chinese Cities

The following four chapters discuss the principles and effects of four smart growth strategies in the US and their applicability to Chinese cities. This chapter discusses urban growth boundary, its effectiveness and implementation in the US, and its applicability to Chinese cities.

What is UGB?

An urban growth boundary (UGB) is an officially adopted line that separates an urban area from rural area or conservation area. UGBs are usually set for a certain period of time, such as 20 years, to accommodate the needs of urban development within UGBs and protect farmlands and other resource lands from urban sprawl. UGB is considered as not only a strong containment policy, but also a proactive growth management tool to influence future development patterns.

UGBs addresses one of the major issues of smart growth: where development should occur. Considered as an efficient approach to prevent urban sprawl, UGBs directly limit the outward extension of new development and delineate where urban development may take place and where it may not. Areas, which may be appropriate for additional development and denser development, are contained into UGBs, such as city centers, urban cores, older suburbs, historic districts, or areas with adequate infrastructures. UGBs promote high-density, compact and contiguous urban development. Areas where land should be preserved, such as open space, farmland, and natural resources, will not be

contained into UGBs. Development outside UGBs is severely restricted or prohibited. For example, land outside UGBs is zoned for rural uses only, such as farmland, forest or low-density residential use. Thus, UGBs control urban expansion into rural areas, and at the same time, urban services could be more efficiently distributed within the boundary (Jun, 2004).

UGBs are more than just a line separating cities from undeveloped areas. UGBs are used for managing and planning for future residential and commercial development. UGBs should be maintained to supply a sufficient amount of land to accommodate urban growth for a certain period of time. Thus, they significantly affect the growth and location of population and development, and influence the urban spatial structure at both local and regional levels (Woo & Guldmann, 2011). As well as setting UGBs, development is always phased in order to achieve more contiguous and more efficient development. Additionally, UGBs attempt to connect future development to the existing urban services and infrastructures, in order to mitigate the economic burden of sprawl on local governments.

In the US, more than 100 cities and counties have adopted UGBs and Tennessee, Oregon, Washington are the states that have adopted statewide policies mandating the creation of UGBs by local governments (Cho et al, 2006). In China, UGBs are more discussed than brought into practice, even though most of the previous studies tend to hold a positive attitude toward UGBs and advocate applying UGBs into Chinese cities (Wang, 2009; Liu, 2007; Huang & Tian, 2008).

Impacts of UGB

Applying UGBs into Chinese cities should be careful because of the mixed impacts of UGBs. Proponents believe that UGBs have succeeded in preserving open space and farmland, effectively shaping urban forms, and revitalization of central cities, etc. Opponents argue that UGBs have not contributed to more contiguous and compact urban form, but causing some negative unintended effects, such as increase in housing price, low-density city edge, or traffic congestion, etc. (Jun, 2004; Weitz & Moore, 2007; Cho, et al., 2008).

The primary purpose of UGB is to encourage development inside UGBs and limit development outside UGBs. In reality, however, the impact of UGBs on location of development is mixed. Some studies indicate that development occurs more likely within UGBs and UGB seems to be successful in urban revitalization and limit urban sprawl. For example, by examining building permit location during 1991 and 2002 in Pierce County, Washington, Carlson and Dierwechter (2007) concluded that UGB has succeeded in directing residential development into areas inside UGB with an increase of building permits inside UGB from 53% in 1991 to 77% in 2002. Cho et cl (2006) also found that land parcels within the UGB in Knox County, Oregon, were 2.9% more likely to be developed than land parcels outside UGB.

However, some other studies found that UGBs have different impacts in different areas. Cho et al (2008) examined spatially varying impacts of UGBs on land development in Tennessee and found that UGBs contained land development

into UGBs and city boundaries in urban areas, but accelerated land development beyond UGBs in rural-urban interfaces. In urban areas, land parcels within UGBs were 0.97% and 0.2% more likely to be developed than land parcels outside UGBs in Downtown and Suburban submarkets. In contrast, in urban-rural interfaces, land parcels within UGBs were 0.05% less likely to be developed than land parcels outside UGBs. Nelson and Moore (1993) studied the impact of UGBs in Portland, Oregon. The analysis shows that rural residential development has occurred immediately outside UGBs, resulting in a low-density residential ring around much of the UGB in the metropolitan area. This would make the extension of UGBs more difficult in the future because the opposition from residents on the ring.

Another unintended impact of UGBs is its mixed effect on housing price. This has been in the center of controversy against smart growth. Opponents of UGBs argue that UGBs have caused land and housing market distortion, resulting in rising housing price (O'Toole, 2007). For example, housing price in Portland, Oregon, has dramatically increased since the implementation of UGBs. Portland had the highest percentage increase in average housing price among 32 metropolitan areas between 1990 and 2000, and UGBs are criticized as the main cause for the rapid increase in housing price (Jun, 2006). Indeed, UGBs would lead to higher land prices by limiting the supply of developable land. However, higher land prices need not translate into higher housing prices. If higher land prices and constraints on land supply reduce housing supply, housing prices would rise. But if developers are allowed to develop with higher density, then the

housing supply will not be reduced significantly. Additionally, other studies found that there is no significant relationship between UGB and housing price in Portland. Portland's rapid increase in housing prices should be attributed to the surge in housing demand caused by population and income growth, rather than UGBs' constraint on the land supply (Knaap & Nelson, 1992; Nelson et al., 2002). Nevertheless, though UGBs need not raise housing prices if sufficient housing production meets market demand, it could hardly contribute to increased affordability in central cities.

The mixed effect of UGBs on housing affordability is also significant to Chinese cities. In the U.S., people move to live in suburbs because of the blight in cities and their preference for large houses. In contrast, people in China still prefer living in cities, and they move to suburbs because they cannot afford the high housing price in inner cities. In other words, low affordability of housing in inner cities is one factor that contributes to residential sprawl in China. Thus, if implementation of UGBs would cause housing price to rise, urban sprawl in China might be aggravated by UGBs. Furthermore, since housing affordability within UGBs will be reduced when development outside UGBs is restricted, affordable housing issues, which many Chinese metropolitan areas have been suffered from for years, will be exacerbated. Therefore, applying UGBs to Chinese cities should be coupled with other policies that ensure sufficient housing supply and affordability within in the urban core.

Implementation of UGB

Despite the mixed impact of UGBs, issues related to implementation of

UGBs in the U.S. also negatively affect the effectiveness. Inhibited by obstacles like strong opposition from heavily affected groups, redistributing benefits and costs, and shifting power from local to regional bodies, Anthony (2005) concludes that UGBs are very unlikely to be implemented. Issues regarding how to establish UGBs and when to expand it directly influence the effectiveness of UGBs.

Limiting outward extension of new developments by UGBs will arouse opposition among landowners in outlying areas and developers, while it may receive supports from owners in old urban areas who can benefit from high-density development. But losers are likely far more than winners (Down, 2005). Because landowners in outlying areas deprive of their development right, losers in outlying areas may feel their loss more strongly than winners feel their gains and some winners even oppose high-density development because of concerns over congestion or safety. Thus, affected groups in outlying areas blocked from future development will strongly oppose the implementation of UGBs.

The other obstacle that negatively affects the implementation of UGBs is the need to shift power from local to regional authorities. Only the regional or state government can both establish urban growth boundary for the entire region and prohibit leapfrog development beyond the urban growth boundary. Among different urban containment policies in 135 metropolitan areas in U.S., state-mandated UGBs more effectively limit the outward extension of new development than locally adopted UGBs (Woo & Guldmann, 2011). Under state-mandated UGBs, urban growth is likely to be concentrated within central cities or developed suburbs and does not take place in surrounding areas beyond UGBs.

Under locally adopted UGBs, urban growth might be only limited in central cities but spillover effects or leapfrog development may occur in surrounding areas beyond UGBs. However, many local officials and citizens are opposed to shift any power over land use decisions from the local government to any regional or higher-level agencies (Down, 2005). Thus, they tend to either oppose the implementation of UGBs or establish locally adopted UGBs, which would inhibit the effectiveness of UGBs.

Though the planning power is shifted to regional bodies in some places, such as Portland, Oregon, the establishment of UGBs is still a difficult political process because of conflicts between local governments and regional governments. The effectiveness of UGBs still depends on local governments (Nelson & Moore, 1993). During the designation of UGBs, local governments often prefer larger UGBs to accommodate more urban development, while regional governments prefer smaller UGBs in order to preserve more rural land. For example, the Land Conservation and Development Commission (LCDC) in Oregon, which oversees Oregon's land-use laws and writes standards for and reviews county and city planning, always forces local governments to reduce the amount of land contained within UGBs. Even though LCDC has certain powers over local development plans and LCDC has allowed less land for urban development, implementation and effectiveness of UGBs and state's planning policies still depend on the extent to which local governments follow regional goals.

Designation and change of UGBs also prove difficult in practice. The first

problem is how much land should be contained within UGBs. Allocating too much land within UGBs will not prevent sprawl or hardly achieve compact development within UGBs; too little land could cause land and housing price to rise. Oregon's Statewide Planning Goals (2010) states that UGBs should be established based on a 20-year population forecast to accommodate 20 years' development needs. In other words, how much land should be contained within UGBs shall be determined according to the prediction of the rate of future urban growth. However, it is difficult to estimate the rate of future urban growth, and therefore, making determining how much land should be included within UGBs a difficult problem. For example, when the first UGB was adopted in the Portland metropolitan area, Oregon in 1979, 78,000 acres of developable land was included. In 1994, only 39,000 were actually developed (Knaap & Hopkins, 2001). Because the UGB was so large, most development has been restricted within UGBs, but occurred at far lower densities and less compact than anticipated.

Another issue is when to expand UGBs and how much land should be added. When urban development reaches UGBs and the areas inside UGBs are efficiently built out, it is reasonable to expand UGBs to include more areas to accommodate additional urban growth. Knaap and Hopkins (2007) compare two systems adopted for determine when and how to expand UGBs, but neither of them are perfect. If using the time-driven system, UGBs are reexamined and expanded periodically regardless of the rate of urban growth. For example, UGBs in Portland, Oregon, must be reexamined every 4 to 7 years to make sure areas

within in UGBs are sufficient for 20 years' development needs. If using the event-driven system, rather than depending on predetermined time, UGBs are reexamined and expanded when development within UGBs reaches a predetermined level in terms of density, population, etc. Though the time-driven system could provide certainty on when UGBs expand, the amount of additional land is hard to determine because of uncertainty of future needs for land. Too little additional land will cause land inflation during the next periodic time, and too much additional land will facilitate leapfrog development. The event-driven system monitors current development and is much more likely to keep the appropriate amount of land for development, but the date to expand UGBs is uncertain, which is important to developers and other land use policies. Failure to ensure certainty over both expansion date and the amount of additional land will inhibit the effectiveness of UGBs.

Applicability of UGB to China

Along with rapid urban growth in China, urban development has spread into rural areas, resulting in dramatically reduction of farmland. In 2008, the amount of arable land decreased about 2,000 hectare, and by the end of 2010, arable land per capita in China is only about half of the world level and 1/6 of the U.S. (China City Statistical Year Book, 2008-2010). The rapid loss of farmland has threatened food security in China. Therefore, limiting the outward extension of new development is critical in the process of urban growth in China. However, even though China has some advantages for implementing UGBs, the effectiveness of UGBs may be limited.

Large cities in China are in effect equivalent to the metropolitan areas in the U.S., containing urban areas, suburbs and rural areas. For example, Beijing, considered as one of the most sprawling cities in China, has a population of about 20 million, about 3 times of the population of Washington D.C, and has an area of 16,411 km², about 10 times of Washington D.C. (Wang & Zhang, 2010). Beijing contains 16 urban districts (some urban districts remain rural) and 2 rural counties, like a metropolitan area. The municipal governments are actually at the regional level. When cities in China, like Beijing, implement policies to limit outward extension of new development, these policies are already at regional level. Additionally, even though each city prepares its own comprehensive plan or makes planning decisions, the top-down and highly centralized planning system in China would facilitate the coordination between different localities. Thus, implementation of UGBs in China would face far less opposition against shifting planning power from local to regional level.

However, the establishment and implementation of UGBs might confront several difficult problems in China. The central government concerns over food security and tend to limit development on arable land, but local governments tend to expropriate more rural land and lease land to developers to gain revenue or attract investment. The conflicts between local governments and the central government would make the establishment of UGBs a difficult political process in China. Even though local governments could be forced to adopt smaller UGBs, the effectiveness of UGBs still depends on local governments. Only after land expropriation by government, rural land could be leased to developers for non-

agriculture uses. UGBs could restrict developers in the U.S., but it is doubtful whether UGBs could restrict local governments in China, since local governments are responsible for implementation of UGBs and they also contribute to urban sprawl. Local governments can just expand UGBs to develop more land for revenue, regardless whether the amount of land within UGBs sufficient or not for development needs. If UGBs cannot prevent local governments from expropriating rural land for collecting revenue, UGBs would hardly address sprawl in China.

The mixed effects of UGBs might also be found in China. Whether UGBs can effectively contain urban growth in China is unclear. One study examines the effects of urban construction boundary (UCB), with an implementing mechanism similar to the UGBs, on land development in the past 20 years in Beijing (Han et al., 2009). The results showed that UCBs were limited in directing urban growth within the boundary. Large amount of urban growth had occurred immediately outside the UCBs and urban growth outside UCBs has a larger share of total growth in Beijing. This might be due to the limitation of prediction on future population and lacking a timely mechanism to monitor and adjust UCBs.

Based on the experience of UCBs, the establishment and change of UGBs in China would be challenged by the uncertainty of urban population growth. In China, the traditional method for estimating urban growth rate is based on the prediction of population scale of a city. During the central planning period, population of a city is controlled through the household registration system, under which individual is identified as a permanent resident of an area and has little

freedom to work or live in other places. While the strict control of population might be effective for population prediction, it could take little effects after the economic reform in China when the household registration system has gradually loosened its limitation on mobility. The huge floating population of about 200 million people in China makes the prediction of urban growth rate a difficult problem. For example, in 1983, the population of Beijing, including both permanent population and floating population, was predicted to be 10 million by 2000, but this number was quickly reached in 1986 (Han et al., 2009). Therefore, determining how much area should be included within UGBs will be difficult in China because of uncertainty on population prediction and urban growth rate. Furthermore, the top-down planning system in China might result in a long and complicated approval process for adjusting UGBs, failing to accommodate the demand for land in good time.

Additionally, if the implementation of UGBs increases housing prices, UGBs will fail to address residential sprawl in China, because the high housing price in inner cities has forced people to live in suburbs. UGBs alone could hardly improve the affordability in the inner cities, and therefore, it could hardly contain sprawl in Chinese cities. Other policies, such as infill development and providing affordable housing in inner cities, should be accompanied with UGB to achieve compact development.

In conclusion, China needs to limit the outward extension of new development to preserve farmland. While UGBs are considered as an effective tool for this purpose, its mixed impact on land development and on housing price

might cause unintended negative effects in Chinese cities and have limited effectiveness in containing sprawl. The implementation of UGBs still depends on local governments. If local governments' desire for revenue is not accommodated, UGBs will fail to prevent local governments in China from developing more land in suburbs.

Chapter 5
Priority Funding Areas (PFA) and Its Applicability to Chinese Cities

This chapter discusses Priority Funding Areas, its effectiveness and implementation in the US, and its applicability to Chinese cities.

What's PFA?

Priority Funding Area (PFA) is an innovative way to direct more growth into certain areas and less growth into others based on incentives. PFAs contain urban growth by restricting state growth-related spending to PFAs designated by local governments. Local governments designate PFAs by identifying where they want urban growth to take place, where it has already occurred, and where it needs financial support from the state. Thus, these areas always include existing communities, existing population and business centers, growth areas adjacent to those centers, or strategically selected new centers. Then, the state provides supports and funding for growth-related projects in these areas that encourage development such as highways, sewer and water construction, economic development assistance, new office facilities, etc. The logic behind PFAs is simple (Lewis et al., 2009). It assumes that the investment in infrastructure would shape urban growth patterns and the state pays a significant portion for infrastructure. PFAs utilize the impact of state spending on urban growth to influence development decisions made by local governments and by developers. The goal is to use the power of the state funding as incentives to promote development and revitalization in developed areas, while discourage development

outside PFAs.

Compared with UGB, PFA is a much weaker alternative urban containment policy (Woo & Guldmann, 2012). Although PFAs encourage growth in developed areas, PFAs do not have regulatory power to prohibit development outside PFAs (Shen & Zhang, 2007; Lewis et al., 2009). Unlike UGBs, which impose direct restrictions on urban growth by indicating where it is allowed to take place and where not, PFAs only encourage development within certain areas by providing financial support but usually allow development beyond PFAs. Development that occurs beyond PFAs will not receive state funding on infrastructures, which becomes the burden for the developer. PFAs are more focused on financial issues related to urban sprawl than limiting urban growth. PFAs try to minimize the governments' economic burden on costs of public services for newly developed areas (Woo & Guldmann, 2012). Furthermore, PFAs are more flexible and can be changed by local governments with state approval, while UGBs are periodically revised to accommodate 20 years of urban growth (Howland, 2007). In addition, UGBs require land use decision power to shift from the local level to the regional level, while PFAs allow local governments to retain their land use decision-making authorities and the designation and change of PFAs rely on local discretion.

In the U.S., Maryland is the only state to establish PFAs and entirely relies on state incentives to contain urban growth to areas inside PFAs (Howland, 2007; Hanlon et al., 2010). Under the Smart Growth Area Act passed in 1997, county governments are responsible for designating PFAs, which include major

municipalities, heavily developed areas in Baltimore-Washington corridor, and other areas meeting the state minimum requirements based on land use, density, and water and sewer service criteria. The state targets their funding for growth-related projects inside these PFAs.

Impacts of PFA

Studies indicate that PFAs have helped curtail urban sprawl in a limited way. While PFAs do contribute to concentrate urban development, job growth, and investments in infrastructure, some studies argue that PFAs fail to limit development outside and are not consistent with the goals to concentrate development inside PFAs (Knaap, 2005; Howland, 2007; Hanlon et al., 2010; Lewis et al. 2009). Additionally, the effectiveness of PFAs varies among local jurisdictions and among different economic sectors (Knaap, 2005; Shen & Zhang, 2007; Lewis et al., 2009).

Investment in water and sewer infrastructures was more likely inside PFAs during 1997 and 2002. Evidences show that state funding has influenced urban growth patterns in Maryland and areas receiving more state funding were more likely to invest infrastructure inside PFAs (Howland, 2007). However, in areas facing more development pressure with higher population growth rate and with a stronger local tax base, investment in infrastructure would be more likely outside PFAs (Howland, 2007). Thus, investments in infrastructure are not completely limited to inside PFAs and PFAs fail to prevent sprawl thoroughly.

Some studies also show that PFAs fail to prevent the spillover effect of land development. Hanlon et al. (2010) find that agriculture parcels inside PFAs

have a lower probability remaining agricultural uses than agriculture parcels outside PFAs. In other words, PFAs increase the probability of land use conversion from agriculture use to urban use inside PFAs, and therefore encourages development inside PFAs. Shen (2007) also concludes that lands within PFAs changing from non-urban use to urban use are 2.6 times higher than land outside PFAs. However, PFAs are not strong enough to completely preserve agriculture lands outside PFAs or to avoid sprawl in areas outside PFAs. The probability of agriculture land outside PFAs remaining in agriculture use is 89%, only 7%higher than agriculture land inside PFAs (Hanlon et al., 2010). Thus PFAs have achieved their goals only to limited extent.

The reason for the spillover effect of PFAs might be that other factors have greater impacts on land development than PFAs. The other factors might include the size of a parcel, distance to urban center or highways, etc. Hanlon et al. (2010) find that if land areas outside PFAs facing great market pressure for development, they will be much more likely developed. Thus, even though PFAs reduce likelihood land parcels outside PFAs to be developed and direct some investments in infrastructure inside PFAs, this incentive-based smart growth strategy is not strong enough to prevent urban sprawl.

Some other studies even indicate that the effects of PFAs on land development have not contributed to contain urban growth at all. During 1990 and 2004, percent of the single-family houses developed outside of PFAs has increased, and density has declined within PFAs (Dawkins et al., 2012). Lewis et al. (2009) find that annual percentage of parcels developed outside PFAs rose and

parcels decreased in size, while the number of parcels developed for residential use inside PFAs fell and parcels increased in size. Therefore, if the goal of PFAs is to concentrate development and increase density within PFAs, the observed effects of PFAs have been going in the opposite direction.

The effectiveness of PFAs might vary among different economic sectors. Knaap (2005) examines the associated effect of PFAs and Job-Creation Tax Credits program, which is intended to encourage job creation within PFAs. In general, while more jobs have been created inside PFAs since 1997, job growth is not observed in every economic sector. Sectors, such as primary, manufacturing, and transportation, communications and utilities do not experience job growth inside PFAs, while employment in finance, insurance, real estate and services has been increased inside PFAs. Explanations might be the location of economic sector and the extent of each sector's dependence on infrastructure have significant influence on the effectiveness of PFAs. If the economic sector is more dependent on infrastructures and employment is located mostly in urbanized areas, the incentive-based program will be more likely to create more jobs inside PFAs. For example, since the primary sector and manufacturing always require large amounts of empty land and are more likely located in suburbs, usually outside PFAs, primary and manufacturing tend to grow less inside PFAs. Thus, PFAs have limited effects in preventing job sprawl in some sectors.

The effects of PFAs might also vary significantly among jurisdictions. PFAs have achieved desired goals in some localities, but less effective in others (Shen, 2007; Lewis et al., 2009). For example, PFAs have reinforced compact

development in urbanized counties with strong growth management policies in Maryland, such as Baltimore and Montgomery; and PFAs have concentrated development in counties where previous land development was highly scattered, such as Anne Arundel County in Maryland. However, PFAs have failed to change the spatially scattered pattern of urban development in Garrett County in Maryland. It seems the effectiveness of PFAs might be limited in rural or periphery counties (e.g. Garrett) to achieve compact development, where land value is lower and land experiences less development pressure than urbanized counties (e.g. Baltimore, Montgomery) (Lewis et al., 2009). Therefore, local economic, political, and social environments might also have significant impact on the effectiveness of PFAs.

Considering the mixed effects of PFAs in containing urban development, the potential impacts of PFAs in urban development in Chinese cities deserve further studies. Learning from the experience in Maryland, the localities that highly rely on state funding for infrastructures will achieve better outcomes concentrating urban development within PFAs. However, since PFAs fail to prevent spillover effects of urban development, PFAs are less effective than UGBs. Additionally, the varying effectiveness of PFAs among economic sectors and across local jurisdictions might inhibit the success of PFAs in China. Since urban sprawl in China is characterized as industrial sprawl compared with the residential sprawl in the U.S., if the effectiveness of PFAs is limited in industries like primary industry, manufacturing, and transportation, communications and utilities, PFAs could hardly effectively prevent Chinese style sprawl. Furthermore,

PFAs have achieved limited effects in rural or periphery jurisdictions, such as Garrett County in Maryland. The primary purpose in China to combat sprawl is to prevent urban development infringing upon rural areas, and therefore, the effectiveness of a smart growth policy in rural and periphery areas is crucial in China. Obviously, PFAs might fail to achieve this goal in China.

Implementation of PFA

While the process of establishment and implementation of PFAs can be completed relatively quickly and facing much less political conflicts than UGBs, the intrinsic weaknesses of PFAs would inhibit its effectiveness in preventing urban sprawl. These weaknesses include issues regarding the criteria for the establishment of PFAs, the process of implementation at local level, and the sources for financial incentives.

Since the criteria for the establishment of PFAs is based on existing densities or infrastructure, several issues have been raised (Howland, 2007; Knaap & Lewis, 2007; Knaap & Frece, 2007; Lewis, 2009). First, because PFAs should contain areas that already have sewer service, some areas, which are never regarded as growth areas, have been included. For instance, some areas are served by sewer just because of the need for extension of sewer services from other places. These areas are qualified for PFAs but not designated as traditional growth areas, and therefore, PFAs might direct development into undesired areas. Additionally, based on current criteria, PFAs are not contiguous in rural areas, such as in Frederick County in Maryland, which would encourage fragmented and leapfrog development. PFAs in some areas are drawn larger than necessary to

accommodate development, and thus the effectiveness of PFAs would be limited in increasing land use efficiency or achieving compact development.

PFAs have not been incorporated into the local land use decision making process, because there is no requirement that PFAs should be linked to local comprehensive plans or zoning. PFAs are not referred in comprehensive plans of many counties or localities in Maryland, which are guidance to decisions on zoning and land use (Knaap & Frece, 2007). Therefore, state funding for PFAs could hardly influence local land use patterns and the effectiveness of PFAs in changing local planning and zoning still depends on local discretion. In other words, while the state could provide incentives for local government or developers to concentrate development inside PFAs, local governments can make their own choices to respond or not, according to local development needs rather than broader goals at the regional level. Thus, lacking connection between PFAs and local comprehensive plans, PFAs are not strong enough to influence the local land use decision and hardly prevent sprawl.

Evidence shows that PFAs programs do not provide sufficient incentives to make a significant difference in development trends (Howland, 2007; Knaap & Lewis, 2007). For instance, in terms of the water and sewer in Maryland, local governments are the major source of funding and state funding only covers around 8% of total investments. Overall, state spending in Maryland for projects inside PFAs is only a relatively small portion of the state budget. On the other hand, barriers for development inside PFAs seem further inhibit the effectiveness of PFAs. Barriers might include citizen opposition for high-density development,

custom preference for mobility and suburban life style, previous standard and regulations which was applied for suburban development but not suitable for urban high-density development, and higher costs of development due to the scarcity of land inside PFAs and more regulatory burdens (Dawkins et al., 2012). Therefore, if developers or local governments still have the choice to develop outside PFAs when facing these barriers for development inside PFAs and incentives are not large enough, they would choose to develop outside PFAs.

Applicability of PFA to China

PFAs might be most likely to be effective in areas where there is sufficient funding for infrastructure development from the regional or national authorities, and where local governments highly rely on that funding. Additionally, market plays a more important role than PFA when determining where and how the development would occur.

In China, there are five major sources of funds available for urban infrastructure development, including budgetary allocation from central and local governments, local fiscal revenues, collection of fees and user charges, borrowing from both domestic and foreign sources, and self-raised funds (Wu, 2010). Among these, budgetary allocation only constitutes a limited portion, about 15% in 2005. Specifically, the central budgetary allocation only consist 1.15% in 2005. Obviously, funds from the central government for local infrastructure are far from sufficient to have impact on local land use patterns. In addition, cities in the eastern region where sprawl mainly occurs are less dependent on budgetary allocation than those in the western region. Thus, PFAs would have limited

effectiveness in containing sprawl in the eastern region. Furthermore, cities in the eastern region are more dependent on land leasing fees. In 2005, about 20% of funds for infrastructure development in eastern region came from fees and user charges, especially from land leasing fees, which is much higher than the national average (16%) and western region (8%). Because local governments' desire for revenue is the main cause of sprawl, sprawl in the eastern cities would be hardly limited if they are highly dependent on the revenue from land leasing fee for infrastructure development. Additionally, studies on PFA in Maryland indicates that development is most likely to occur outside PFAs in areas facing great growth pressure, especially when incentives are not sufficient and land value within PFAs is higher (Howland, 2007; Hanlon et al., 2010). Since Chinese cities are always facing great development pressure because of the rapid increase in urban population, development could be hardly limited to PFAs as expected.

The intrinsic weakness of PFAs, lacking regulatory power to prevent development outside PFAs, is not consistent with the primary goal for China to address sprawl. The central government is highly concerned over the loss of farmland, and therefore preventing urban development infringing upon farmland is the primary goal for implementing smart growth in China. Since the effectiveness of PFAs in protecting farmland and in preventing spillover development into rural areas is limited, PFAs implemented might not be an effective urban containment policy in China. Thus, regulatory urban containment policies might be better suitable for China than incentive-based policies. Additionally, this incentive-based policy leaves the power to determine where

development should occur not only to developers or local governments, but to the invisible hand of the market. Therefore, PFAs could hardly address the root causes of sprawl in China, which goes beyond market. For instance, without clearly indicating where development should or should not occur, local governments could just establish PFAs in city peripheries based on their need for revenue rather than based on the principle to concentrate development within existing urban communities. Developer might also tend to develop the land in suburbs, taking advantage of the low land price.

In conclusion, China could learn from the principle behind PFAs to make development in inner cities or desired areas more feasible and less expensive than other places to contain excessive urban expansion, such as increasing density and providing subsidies. PFAs would be more effectiveness if combined with other regulatory policies, such as protection of basic farmland, in order to restrict development on arable land. In other words, a combination of carrot and stick might be more effective in concentrating development and prevent sprawl in China. However, PFA also has limited effectiveness in preventing local government from developing more land for revenue.

Chapter 6
Transit-Oriented Development (TOD) and Its Applicability to Chinese Cities

This chapter discusses the principle of Transit-Oriented Development, its effectiveness and implementation in the US, and its applicability to Chinese cities.

What's TOD?

Transit-oriented development (TOD) represents an innovation in urban planning, which promotes transit ridership through integrating urban land use planning with transportation. The assumption is that the change in built environment would change people's travel behavior. Basic principles of TOD include: high-density development, mixed land use, short distances to transit station, pedestrian and bicycle friendly design, and high quality of transit services (Cervero et al., 2004; Zhang & Liu, 2007).These features are used to encourage more people to use public transit and make transit services more convenient. Additionally, TOD need not exclude auto uses. Rather, TOD just creates an environment with higher accessibility, in which public transportation is more focused than automobiles.

The primary goal of TOD is to increase transit ridership and to achieve broader goals such as economic development in TOD communities and smart growth. Since most land development in the U.S. has a relatively low density and standard zoning separates different land uses, private automobiles are the basic transportation means. Therefore, changing the land use pattern into high density and mixed use is crucial for US cities to launch TODs. Higher transit capacity

needs to be supported by high density and higher level of mixed land use. Transit in the U.S. always has less attraction due to the street design that is not suitable for walking or biking, better highway systems, long distances to transit stations, and poor services. Concentrating development around transit centers within walking distance, making streets suitable for non-auto uses, and providing high-quality transit services would make transit more attractive and convenient, and encourage both previous transit users and auto users to use transit.

Impacts of TOD

TOD has been demonstrated to achieve its original goals and several other benefits in the US. The premise that changing urban built environment is an effective way to reduce auto dependence is supported by a large volume of studies (Chakraborty, 2013). A report from Victoria Transportation Policy Institute has summarized different built environment factors and their impact on people's travel behavior (Litman, 2012). Built environment factors include regional accessibility, density, land mix use, transit accessibility, and street design, etc. Regional accessibility refers to the distance of location to regional urban center, and residents in central area typically drive 10% – 40% less than at urban fringe (p.4). Residents in neighborhoods with higher population or housing unit density would have lower vehicle miles travelled (VMT) (p.4). Mixed land use refers to the proximity between different land uses, and higher mixed-use areas have 5%-15% less VMT (p.5). Residents with higher accessibility to transit services would drive 10%-30%fewer miles (p.5). If the street is designed more suitable for working, residents would walk 2-4 times more and drive 5%-15% less than

residents in more auto-oriented neighborhoods (p.6). Application of the principles of TOD tends to reduce total vehicle miles traveled by 3% and 5% (Cervero et al., 2007). Research findings also have shown that residents living in TOD communities used transit more frequently than people living elsewhere (Loo et al., 2010). In a TOD community, commuters use transit two to five times more than other commuters in the same region (Cervero, 2008). The primary benefit of TOD in the U.S. is to increase transit ridership and decrease auto dependence, and other benefits might include revitalization of transit neighborhoods, increase in the amount of affordable housing, congestion relief and improved street design and safety for pedestrian and cyclists (Cervero et al., 2007).

However, early studies could hardly build the causality between TOD and people's travel behavior, considering the effect of self-selection. Self-selection refers to "the tendency of people to choose residential locations based on their travel abilities, needs and preference" (Cao, 2009). Hammond (2005) did a survey in UK and found that more than half of the respondents selected commute mode before or simultaneous with making their decision on residential location. Thus, it is not clear whether the built environment causes the differences in travel behavior or people make residential location decisions based on their expected built environment and preferred travel patterns. In other words, it is not clear whether the built environment changes people's travel behavior or just changes people's residential location. Both socio-demographics and residential and travel preference could be the sources of self-selection. For instance, low income households with no cars would prefer to live in an urban traditional neighborhood

with better access to transit and they use transit more. Thus, it would not be possible to say the higher frequency of transit use among these households is caused by better accessibility. Transit-seeking households are more likely to reside near a transit station and use transit more; people who prefer driving would choose to live in auto-oriented suburban neighborhood and drive more; people who like to walk would tend to live in the neighborhood with better walkability and walk more (Schwanen & Mokhtarian, 2005). Ignoring the effect of self-selection might overestimate the true effect of TODs on travel behavior.

Cao et al. (2009, 2010) reviewed 28 empirical studies and concluded the proportion that built environment accounts for the total impact on travel behavior ranges from 28% to 87% and self-selection explains the remaining part. Self-selection has been found to have higher influence on individuals' travel behavior in the city center than that in the suburbs (Cao, 2010). Based on their distance to regional center, Cao et al. (2010) classified neighborhoods in the Research Triangle Metropolitan area of North Carolina into urban area, inner-ring suburb, suburb and exurb. The results indicated that the father away the location from the city center, the larger the share of the contribution of built environment on VMD. One potential explanation might be that residents in urban areas might have more travel choice, that they could drive cars and also take advantage of the relatively good transit services in urban areas (Cao et al., 2010). Studies also found built environment had higher impact on transit use and non-auto modes and self-selection have higher impact on driving. Cao (2009) examined the "true" effect of neighborhood type on travel behavior in Northern California. The results

indicated that the effect of neighborhood type on driving distance was 18 miles per week, accounting for 12% of individuals' overall VMD. The effect of neighborhood type account for 61% of the total observed walking differences and 86% transit using differences between neighborhoods.

Similar situations might be observed in China that self-selection might significantly influence people's travel behavior. TOD might have limited effectiveness in switching drivers to public transportation users. In Chinese cities, the improvement of transit services mainly attracts people shifting from other modes of public transportation to transit. For instance, 75.4% of bus rapid transit users in Beijing are derived from previous bus users (Renne & Wells, 2003). Only 12% of people indicate that they use automobiles because it is inconvenient to use public transportation or transit services are not attractive (Deng & Nelson, 2012). Thus, it would be reasonable to predict that most people who use transit in TOD communities might be previous public transportation users rather than automobile users, even though TOD would make transit more convenient and attractive.

Applicability of TOD to China

TOD is necessary for Chinese cities, considering the dramatically increase in vehicle ownership and issues like congestion caused by decreasing in job-housing balance. In Beijing, the number of private vehicles has sharply increased from less than 10,000 in 1987 to 120,000 in 1995, 1 million in 2001, 1.5 million in 2004, and 2,289,000 in 2008 (Liu et al., 2009). Consequently, traffic congestion has become more serious and threatens air quality. In addition, the decrease in the job-housing balance, cause longer commuting time and distance.

For instance, though a number of transit projects have been built in Beijing, only housing projects have followed the rail station networks, but jobs and businesses have not (Zhang, 2007). Therefore, the idea of TOD, which promotes integration of land use and transportation planning to increase transit ridership, should be suitable for Chinese cities. Furthermore, since studies find that TOD is highly valued in large and congested cities with a booming economy, Chinese cities might have a better rationale for implementation of TOD (Cervero et al., 2007).

However, the application of TOD principles might have limited effectiveness in increasing transit ridership in China, considering the different urban growth patterns. Even though some new developed areas in suburbs and new redeveloped areas in inner cities have a tendency to low-density, low level of mixed land use and huge blocks not suitable walking or biking, most traditional neighborhoods in Chinese cities seem already transit-oriented. In terms of density, Chinese cities have a much higher population density than US cities. In terms of mixed land use, China traditionally has a mixed land use patterns, even though there is a trend to decrease in new developed areas. For instance, different land uses are mixed with each other and most buildings have shops or other commercial facilities on lower floors and residential apartments on upper floors. In terms of street design, Chinese cities were historically mono-centered with high density and the primary transportation mode was public transit. Street design in most areas is suitable for walking or bicycling with separated sidewalks and bicycle lanes. Thus, it seems that most Chinese cities have already done a better job on the principles of TOD. However, on the other hand, because land use is

already mixed and at a higher density throughout Chinese cities, any gains from the future development of TOD may be marginal if the principle of diminishing returns holds (Ding & Zhao, 2011). Since public transportation is the major traffic mode, TOD principles might have limited potential to further increase transit ridership.

China still has a long way to achieve effective TOD due to the fragmentation of planning system and difficulties in restricting vehicle use. TOD promotes integration of land use with transportation. Thus, TOD calls for coordination between different government agencies, especially the ones responsible for land use planning and the ones responsible for transportation planning. However, China's institutional landscape in terms of land use planning and transportation planning could be hardly called coordinated. Because land use plan (drafted by urban planning agency) and transportation plan (drafted by transportation bureau) are formulated and approved by different hierarchical government agencies, the fragmented system fails to offer a communication and coordination mechanism among different plans (Song & Ding, 2009, p.185). For example, transportation planners in the city of Dalian revealed that any thought and information on land use planning was regarded as confidential by urban planning agencies, and urban planners rarely shared land use plan and information with them (Mu & Jong, 2012). As a result, transportation plan is solely based on traffic demand information from surveys, and is separate from land use plans.

In addition, China has been experiencing a dramatical increase in vehicle ownership during the past twenty years. If this trend could not be slowed, the

effectiveness of TOD in increasing transit ridership in China would be very limited. However, difficulties in restricting vehicle ownership could hardly be addressed by just changing built environment, at least in the near future. A survey shows that the primary reasons for most people owned a car is to commute or prefer driving, or just because they can afford it, (Epanel, 2010). Only 12% of people drive because it is inconvenient to use other transportation modes (Epanel, 2010). Owning a private vehicle in Chinese culture stands for higher social status, and whether owning a car is more dependent on people's preference and the affordability, rather than built environment. Thus, along with the increase in personal income, more and more people can afford a car, and the trend of increasing vehicle ownership is difficult to be stopped or slowed by TOD projects. Additionally, car industry in China plays an important role in supporting overall GDP growth. In 2010, car industry in China consisted of more than 5% of total GDP (Duan et al., 2012). Car industry is one of the major areas in China to attract foreign investment. Therefore, controlling vehicle purchase or use may be not consistent with the need for economic growth in China and requires adjusting the economy structure, which will not be achieved in the near future.

In conclusion, China might have a better rationale for implementation of TOD, considering severe air pollution and traffic congestion. However, the effectiveness of TODs might be limited due to the principle of diminishing returns, considering the already high degree of density and mixed land use pattern, and pedestrian and bicycle friendly urban design in Chinese cities. In addition, the effectiveness of TOD might also be diminished by some difficulties stemming

from the fragmented planning system and difficulties in restricting vehicle ownership.

Chapter 7
Brownfield Redevelopment and Its Applicability to Chinese Cities

This chapter discusses the principle of Brownfield Redevelopment, its effectiveness and implementation in the US, and its applicability to Chinese cities.

What's Brownfield?

Brownfield redevelopment is a new urban land use strategy to achieve infill development, address urban decay and limit urban sprawl in conjunction with other smart growth strategies, such as UGBs. The US Environmental Protection Agency (EPA) defined brownfield as "abandoned, idled, or underutilized industrial and commercial facilities where expansion or redevelopment is complicated by real or perceived contamination". The American Planning Association (APA) defined brownfield as "vacant or underused properties passed over for development due to actual or perceived contamination or other obstacles" (APA, 2005). For instance, brownfields can be large abandoned industrial facilities or traditional manufacturing plants. They can also be small commercial lots, such as gas stations. In general, brownfield refers to undeveloped and contaminated (known or perceived) land in inner city and needs treatment before development.

Brownfield is one of the consequences of deindustrialization. Former industrial plants were redistributed to suburbs and left vast amounts of land for reuse. These lands are labeled as brownfields with many constraints on its redevelopment, because they are perceived or suspected to be contaminated.

However, the cause of deindustrialization in China distinguishes itself from that in the US. In the US, deindustrialization was primarily a voluntary movement as the business owners pursuing larger profits and searching for optimal locations for most cost-efficient production (Li, 2011). The improvement of transportation technologies has dramatically decreased the transportation cost that manufactories no longer need to stay in the metropolitan center. As a result, they chose to move to less developed regions close to highways for less expensive labor and lower land value (Cowie & Heathcott, 2003; Lin, 2011). In China, in contrast, the relocation of manufacturing enterprises was subjected to the displacement pressure from the government due to environmental, economic and political concerns. Since most of these manufacturing enterprises are state-owned, the industrial relocation was primarily led by a series of industrial policies, planning regulations and land use plans (Li, 2011). State-owned heavy industries used to be located outside the urban area. However, due to the rapid urbanization and continuous expansion of urban area, factories formerly located on city edge were in urban core areas. Meanwhile, these factories had a long history of using antiquated equipment and poor environmental management, causing serious oil and air pollution and public concerns (Xie & Li, 2010). In addition, there are limited spaces for facility upgrading and expansion in urban areas, constraining local economic development. One strategy policy-makers used to address these issues was to encourage heavy polluting industries to move out of the urban area. For example, in 1984 the Beijing Municipal Government issued **Notice on Providing Preferential Policies to Polluting Enterprises to Be Relocated**,

which gave enterprises a number of options for acquiring funds for factory construction in new locations (Beijing Municipal Government website). In 1999, Beijing municipal government decided to accelerate relocation and about 130 factories were relocated in the following 5 years (Li, 2011).

Both U.S. and China contain a large number of brownfield sites in urban areas. In U.S., EPA estimates there are more than 450,000 brownfield sites nationwide (http://epa.gov/brownfields/). In China, the closing and relocation of old polluting industrial enterprises has also left behind vast polluted industrial and commercial areas, such as heavy metal contaminated sites, organic contaminated sites, electronic waste sites, etc. (Xie & Lin, 2010). For example, by 2007, more than 200 plants were relocated in Beijing city, making 8.78 million m^2 of land available for reuse. The Ministry of Environmental Protection estimated that there should be more than 300,000 brownfield sites in China. Brownfield is a counterpoint to the term greenfield, which usually refers to undeveloped land located in suburbs, but ready for development without treatment, such as farmland, woodland, wetland, etc. Therefore, redevelopment of brownfields could take development pressures away from greenfield and contribute to two primary smart growth goals: (1) preserving open space, farmland, and critical environmental areas; (2) strengthening and directing development towards existing communities.

Impacts of Brownfield Redevelopment Acts

The regulatory framework for brownfield site management has evolved from Superfund Act to Brownfield Act in the US. These regulations try to

encourage investment on brownfield redevelopment and set the standard for cleanup, but they also have some unintended effects including high costs of cleanup, environmental justice, and limited effectiveness in containing residential sprawl.

Superfund Act

After some public health and environmental incidents caused by brownfield sites such as Love Canal in the 1970s, the U.S. Congress passed the first brownfields law, the Comprehensive Environmental Reponses, Compensation and Liability Act (CERCLA) in 1980, also known as Superfund, and passed the Superfund Amendments and Reauthorization Act in 1986. The goal of these acts is to identify the responsible parties and compel them to perform cleanups, setup cleanup standards, and establish a trust fund for cleaning up brownfield sites when no responsible party could be identified (http://epa.gov/brownfields/).

The act stipulates that the responsible parties should pay for the entire costs of cleanup, based on the "polluter pays principles". Four classes of parties are identified under CERCLA. These parties include the current owner or operator of the site, the owner or operator of a site when pollution occurred, the person who arranged for pollution, and the person who transported a hazardous substance, pollutant or contaminant to site selected by the transporter (Gong, 2010). The CERCLA established a "strict, joint and several, and retroactive" liability for potentially responsible parties (Howland, 2007). "Strict" means regardless of whether an action was legal or not at the time it was taken, the party

should be responsible for the cleanup and costs of remediation. “Joint and several” means that if two or more parties are found liable for cleanup, one or all of the parties are responsible for the entire cost and EPA leaves the burden of dividing liabilities to parties involved. In addition, the acts also provided fund for contaminated sites when no parties found responsible for cleanup. The acts created a tax on chemical and petroleum industries and the tax went to a trust fund for remediating abandoned brownfield sites (EPA website). CERCLA collected $1.6 billion over 5 years after it passed and its amendment increased the size of the fund to $ 8.5 billion. Concerning for the public health and environmental tragedies caused by brownfields before, in the initial stages of the superfund, contaminant removal and permanent cleanup were the main objectives and standards (Gong, 2010).

The most important achievement of the Superfund and its amendments is that the law clearly defines who is liable for the cleanup. Since Superfund adopted a rather strict responsibility system, both prior and current owners and both polluters and parties contributing to the contamination should hold liability. As a result, at least one responsible party could be identified for the contamination and would be compelled to pay for the entire costs of cleanup. However, while the Superfund constrained the misuse of contaminated sites, it has been criticized for some unintended effects of the stringent regulations.

The Superfund has been criticized as a major barrier to the redevelopment of brownfield. Its strong liability provision and high cleanup standards led to many brownfields remain idle and undeveloped for years (Howland, 2007). Since

the liability fell on both previous and current owners, even though they might not have caused pollution, the fear of future liability kept investors away from brownfields. In addition, superfund required contaminated sites should be completely cleaned up before any type of reuse, which further increased the redevelopment cost and discouraged reusing or selling a brownfield. As a result, the high risk of future liability and high remediation costs made brownfield redevelopment impossible. Some even criticized that Superfund was contributing to urban deterioration and poverty (Hula 1999). Another unintended effect is that the Superfund's liability provision has led to massive litigations among responsible parties (Lin, 2011). When more than one party has been identified responsible for the cleanup, the division of liability and costs between parties are left to themselves. Large enterprises with more economic and political resources would be in a better position to protect themselves, causing unfair cleanup burdens to small enterprises. Critics of Superfund argued that it was necessary to remove barriers and encourage cleanup and redevelopment of brownfield by reducing regulatory burdens, relieving liability for future cleanup, and providing financial support (Alberini, 2005).

Brownfield Act

The goal of brownfield redevelopment has changed from purely focusing on environmental cleanup to economic redevelopment. Studies found that the most important measurements of brownfield redevelopment were creation of jobs and increase in local tax base (Lange & MxNeil, 2004; DeSousa, 2005). Since the 1990s, a series of brownfield regulatory reforms have been implemented and

flexible liability regulation and incentive-based approaches have been adopted to encourage brownfield redevelopment. For instance, more than 48 states adopted Voluntary Cleanup Programs (VCP) to protect public health and environment and to accelerate the cleanup (Lin, 2011). In Maryland, VCP was established in 1997 to clarify parties who do not hold responsibility and protect parties who complete cleanups from future liability. The program also provided grants, loans or tax credits for brownfield redevelopment. In Massachusetts, The Brownfield Act was signed into law in 1998. The act relieved liabilities of future owners who did not cause or contribute to the contamination and provided loan-interest loans, grants and tax credits from brownfield redevelopment projects.

In 2002, one important legislation, the Small Business Liability Relief and Brownfields Revitalization Act, also known as the Brownfield Act was passed to protect innocent parties and expand financial support for brownfield redevelopment (http://epa.gov/brownfields/). The act exempted potential responsible parties' liability when the contamination they contributed is below certain levels and protected parties who completed cleanups under VCPs from future Superfund enforcement. The act also clarified the requirement for future owners needed to meet to become innocent owners and to fend off Superfund liability. Besides the liability relief, the act also provided various funds for site assessment, cleanup and community job training for brownfield redevelopment.

Studies found that liability relief and financial incentives did have positive impact on brownfield redevelopment. Alberini et al. (2005) surveyed real estate developers in the U.S. and examined how different market-based and incentives

influence their decision on investing in brownfield redevelopment. The findings indicated that liability relief is worth about 21% of the value of brownfield redevelopment project and financial incentives would also encourage cleanup and redevelopment of brownfield. In addition, the redevelopment of brownfield created jobs and increased local tax revenue (Howland, 2007). For example, in California, 315 brownfield redevelopment projects created 21,000 jobs and $475 million tax revenues (Bartsh & Deane, 2002). Howland (2007) reviewed a number of brownfield redevelopment case studies and summarized that average projects could create about 10 jobs per acre.

However, brownfield redevelopment is still facing some challenges to revitalize local economies. The first challenge comes from the condition of the neighborhood itself around a brownfield. In the 1950s, the relocation of manufacture plants left behind vacant and contaminated industrial sites, as well as unemployed workers. At the same time, urban core became blighted with low property value and local government failed to maintain infrastructure, but it attracted low-income and people of color coming to the neighborhoods around these brownfields. As a result, brownfields are often found in distressed neighborhoods with concentration of poverty, crime, deteriorating infrastructure and low-skilled workers (Howland, 2007; Lee & Mohai, 2011). For instance, McCarthy (2006) found communities in Milwaukee with income level lower than poverty level comprised 32 percent of city land and 56 percent of brownfields. The disparity in brownfield redistribution not only cause environmental justice issue that communities of color and low-income suffer higher environmental

burdens, but also result in difficulties in translating brownfield redevelopment into local economic development. The conditions of the distressed neighborhoods, such as lack of skilled workers, concentration of crime and deteriorating infrastructure, are the barriers for redevelopment. In other words, brownfield cleanup and redevelopment alone is not enough to stimulate local economy, generate jobs and increase tax bases in distressed neighborhoods. Because of the scarcity of public resources, planners and policy makers always decide to redevelop the brownfields in areas with better condition and more development potential. For instance, McCarthy (2006) found that 69 financially supported brownfield redevelopment projects in Milwaukee were all concentrated in the nonminority and nonpoor census tracts. As a result, whether a brownfield would be redeveloped is based on its development potential, rather than its contamination level.

Another important reform is the change in cleanup criteria. Traditionally, contaminant removal and permanent cleanup were the main objectives of brownfield redevelopment. As a result, more aggressive treatment technologies have been always adopted and driven up the costs of cleanup. In recent years, risk management became the main focus to control cleanup costs. Under this approach, contaminations need not to be removed completely but just to an acceptable risk level for the intended land use. The risk-based approach could link potential land uses and cleanup standards, and be more cost-effective (Graves, 1997; Gong, 2010). Because different environment and land use will lead to different levels of risk, the risk could be managed by setting restrictions on

land use or cleaning up to an acceptable risk level. The most aggressive treatment is reserved for the highest concentrations of contaminants or for principal threats and less costly technologies, such as containment and institutional controls, could be used for low-level contamination (Graves, 1997).

However, the risk-based cleanup criteria also caused some problems for brownfield redevelopment. The cleanup standard for industrial and commercial uses are lower than the Superfund standards, and remediating an equally contaminated site for residential use is much more complicated (Lee & Mohai, 2011). Because the cost of cleaning up to residential standards is high and old industrial areas always make housing less viable, and because industrial or commercial project always have greater financial feasibility, a majority of brownfield projects end up industrial or commercial land uses (Walker, 2004). Wernstedt et al. (1999) found that brownfields that were redeveloped into residential uses have not been as common as they were in the earlier years of the Superfund Act. As a strategy of infill development, the risk-based cleanup standard has discouraged the provision of housing on previous brownfield sites. Therefore, the effectiveness of brownfield redevelopment in reducing residential sprawl would be limited.

Applicability of Brownfield Redevelopment to China

The relocation of old and polluting industrial plants in China left behind a large amount of brownfields in urban areas. Chinese governments have realized the issue of brownfield in recent years after several incidents in some major cities, such as Beijing and Wuhan. Scholars argued that China's environmental

protection and brownfield regulations would probably follow a similar trajectory in the US, since China is still at an early stage in the formation of a brownfield regulatory system (Cao & Guang, 2007; Li, 2011). Brownfield redevelopment could be a win-win strategy for both economy and environment, and it could also control urban sprawl and support the Chinese national policy of protection of basic farmland.

Since former industrial land in urban areas in China has become most preferred by developers in China, compared with U.S., brownfields have an opposite fate in China where they are redeveloped quickly by developers (Lin, 2010). Three types of land are the main sources for urban development in China: agricultural land, old residential land, and industrial land. Agricultural land used to be the major source of urban development because local governments could take agricultural land from farmers by paying very low compensation based on agricultural outcomes. However, after the central government started concerning food security and promulgated the Ordinances on the Protection of Basic Farmland, any development involving agricultural land would be under strict surveillance. Old residential land attracted developers because its location close to urban centers and developers could spend very little on compensation for former residents to get the land before 2000. However, the situation changed after a series of laws and regulations clarified the standards for residents' compensation and their property rights. For example, Beijing promulgated the Implementation Measures to Speed up the Rebuilding of Beijing's Dilapidated Housing in 2000, which stipulated detailed standards for compensation. Developers would always

encounter residents who do not satisfied the compensation and fail to move, need to devote much more time for negotiation, and spend more money on compensation. In contrast, Former industrial land always located in urban areas and already contained basic infrastructures for redevelopment. Additionally, the redevelopment only needs an agreement among developers, local governments, and the enterprises who owned the land, instead of negotiating with a large number of residents. As a result, all of these points make industrial land in China to be the most attractive to real estate developers, and the brownfields in China face great pressure for development (Li, 2011). Therefore, considering these brownfields contain serious pollutant, it is necessary and urgent for government in China to enact brownfield redevelopment laws to ensure environmental safety and public health.

Currently, China has no specific law regarding brownfield remediation and redevelopment. Legal requirements for soil pollution and liability are scattered in several laws such as Environmental Protection Law, Land Management Law, and Solid Waste Pollution Prevention Law (Jian & Li, 2010). However, none of them are specific to brownfield redevelopment and they are mainly targeting agricultural land instead of urban land (Li, 2011). For instance, the Environmental Protection Law states all level of government should sustain land quality, but this provision only applies to agricultural environmental protection. The Land Management Law states government should take measures to improve soil quality and soil fertility and prevent desertification, salination, soil erosion and soil pollution. But urban land still is not the concern. Even though the

Solid Waste Pollution Prevention Law regulates industrial solid waste, but it does not specify how to redevelop brownfield and fails to clarify liability or provide funding for cleanups. After the poisoning incidents during construction on brownfields, several local brownfields management policies have been issued. For example, Beijing Environmental Protection Bureau released two documents after the poisoning incidents during construction of subway station. The Notices on Effective Prevention and Control of Environmental Pollution for Industrial Enterprise Relocations and the Notice Regarding Implementation of Soil Environmental Assessment after Enterprise Relocation have been issued to identify the liability and regulate the procedure for soil assessment, remediation standard, and redevelopment (Li, 2011). However, these documents are not law and therefore carry very limited enforcement power.

China should learn from U.S. experience to avoid the unintended effects of Superfund that the stringent liability regulatory system and high cleanup standard scared away developers and left a number of Brownfield idle. The future brownfield law in China should not only clarify the liability and adopt risk-based cleanup standard, but also provide incentives such as liability relief and financial incentives to encourage brownfield redevelopment.

The incentive-based cleanup standard might be more effective in limiting residential sprawl in China. Chinese cities are experiencing rapid urbanization and increasing demand for housing. Within metropolitan areas, the land and housing price has been rising dramatically. In Beijing, the average sales price rate of residential buildings increased 40% within four years from 2002 to 2005 (Lin,

2011). Therefore, the real estate market would absorb as much land as possible, including brownfields, to support new construction. In addition, the industrial land use is restricted in inner cities in China. Therefore, the brownfields in China would be redeveloped mostly to residential and commercial uses, sometimes an office and apartment building complex. For example, in the project of redevelopment of the first textile manufacturer in China, a total land area of 930,000 m^2 was redeveloped into apartment and commercial buildings. Brownfields in China would be more likely redeveloped into residential uses than U.S., and thus the incentive-based approach could achieve both the goals of reducing cleanup costs and limiting residential sprawl in China.

However, there are several challenges to implementing similar brownfield acts in China. First, because most relocated industrial sites and plants in China are owned by state-owned-enterprises, in theory, the liability would be assigned to these state-owned-enterprises and finally pass to the state (Li, 2011). However, it will not be an easy task in reality, especially when other private parties are involved. Private parties are always at a disadvantage position when negotiating with the state owned enterprises in the process of dividing liability. In addition, it would impose a heavy financial burden on the state, which has been already suffering from the shortage of funding to establish fund for brownfield redevelopment and to provide financial incentives. Second, implementation of brownfield laws would suffer from the weak enforcement power of environmental protection authorities in China (Xie & Lin, 2010; Li, 2011). Even though each level of government has environmental bureaus, these local environmental

bureaus always do not have sufficient power to enforce environmental laws or policies, because they are under the direct leadership of local governments and local political leaders often prioritize economic development at the expense of environment.

In conclusion, China should learn from U.S. to build a legal framework for brownfield cleanup and redevelopment, and adopt an incentive-based method to attract investments and encourage redevelopment. Some issues need to be addressed. First, even though the "polluter pays" principle seems fair in theory, but in reality, the state would face a significant financial burden, because most brownfields are owned by the state-owned-enterprises. Experience in the US indicates that liability relief would encourage developers to invest in brownfield redevelopment. Second, permanent and completely cleanup would result in high cost and long remediation time. Due to the time constraint, China also needs to adopt a risk-based method. Third, China should also establish a brownfield fund and provide financial incentives in various ways, such as tax credits, low-interest loans, and grants. Finally, the enforcement power of environmental authorities needs to be strengthened to improve the effectiveness of brownfield redevelopment laws and policies.

Chapter 8

Conclusion: Rethinking Smart Growth in China and Policy Recommendation

This Chapter summarizes the key findings and answers the primary research questions about how sprawl in China differs from the US and whether smart growth strategies are suitable for Chinese cities. Then, some policy recommendations are offered to address sprawl in China.

Rethinking Smart Growth in China

Do Chinese cities experience sprawl? The answer is clearly yes. Even though Chinese cities have higher density and higher degree of mixed land use, they have been experiencing sprawl with different patterns caused by different factors. Sprawl in US cities is characterized as extensive dispersion at significantly low population densities. In contrast, sprawl in Chinese cities, especially those in the eastern region, is characterized as extremely rapid urban expansion at relatively high population densities and tendency towards both dispersion and fragmentation.

Sprawl in China is more of a process of urbanization and industrialization instead of residential suburbanization in the US. Sprawl in China is mainly the consequence of industrial and residential growth in the suburbs. Deindustrialization in the US is caused by market forces and companies' willingness to seek optimal location for most cost-efficient production. In Chinese cities, in contrast, industrial growth in suburbs is mainly caused by local governments' desire for economic development and policies that require

relocation of manufacturing enterprises to suburbs. Local governments have developed more land than necessary for industrial uses in suburbs, hoping to attract investment and speed up local economic growth. Local governments have created a large number of economic zones and high-tech districts, hoping to attract investments and compete with other localities. However, the over-supply has resulted in many vacant and under-utilized lands in the suburbs. In 2004, it is estimated that 70% of the nation's total development zones were almost entirely vacant zones created by provincial or municipal governments (World Bank, 2007).

Since sprawl in China is due to rapid urbanization, central cities in China have not declined. Residential sprawl in Chinese cities is mainly due to increase in urban population and excessive rural-urban migration. Urban population in China has increased from 300 million to 600 million, from 27% of the nation's total population to 50%, in the last two decades (World Bank, 2010). The growth in big cities, especially those in the eastern region of China, outpaced medium-size and small cities, and sprawl has been observed mainly in those cities. The large cities in the eastern region have greater political or economic significance, such as Beijing and Guangzhou, or launched economic reform earlier than other cities, such as Shenzhen. Therefore, a large number of migrants from rural areas or less developed cities streamed to these coastal cities. The population of migrant workers grew from 30 million in the 1980w, to around 70 million in the mid-19902s, and about 150 million in 2005 (World Bank, 2007). Most of these migrant workers live in suburbs because their work places are located there in the

economic zones and they cannot afford the high housing price in the inner cities. In contrast to the suburbanization process in the US described as "flight from blight" and the American Dream owning a single-family detached house on a large lot, Chinese people still prefer living in inner city which offers better public services, such as better hospitals and schools. It is the dramatically increasing housing price that has scared away the new-comers.

Brueckner (2000) argues that the sprawl in the US is mostly the result of both market forces and public policies. In contrast, the root causes of sprawl in Chinese cities are beyond the explanation of market forces. The excessive urban expansion and low-efficient and fragmented development on urban fringe are both an intended consequence of political manipulation of land development on urban fringe and an unintended effect of national policy for farmland protection.

The root cause of sprawl in China is local governments' strong incentives to expropriate and lease more undeveloped land in the outskirts to generate revenues. After the fiscal reform in 1994, tax revenues have been recentralized, but expenditure assignments for local governments remained unchanged (Wu, 2010). The huge fiscal gap requires local governments to find other financial resources for infrastructure construction and other public services. Since land is the most valuable commodity and because there is a great pricing difference between the compensation paid by local governments to owners of rural land and leasing price of land use rights to developers, local governments have a very strong incentive to convert more agricultural land to non-agricultural uses than necessary for revenues. In the more sprawling cities in the eastern region, about

20% of funds for infrastructure development came from fees and user charges, especially from land leasing fees, which is much higher than the national average (16%) and western region (8%) (Wu, 2010). As a result, more land has been developed than necessary on urban fringe, infringing upon farmland. In addition, the fragmented and discontinuous development pattern in China is the unintended outcome of protection of basic agricultural land (World Bank, 2007). Because the agricultural land is protected, the undeveloped land or villages close to farmland have been developed leaving behind isolated land used for agricultural purposes, resulting in fragmentation on urban fringe.

Despite the differences in sprawl patterns and causes, the negative impacts of sprawl in both countries require strategies to address urban sprawl. Chinese cities have been suffering similar problems as US cities, such as air pollution, traffic congestion, and loss of farmland and open space, etc. The central government has been already concerned about the food security resulted from loss of arable land.

Could smart growth address urban sprawl in China?

Smart growth advocates an alternative development pattern in the US, including high-density and compact development or infill development with multiple transportation choices, etc. The goal of smart growth is to preserve farmland and open space, decrease auto dependence, relieve economic burden for local governments, etc. Some principles of smart growth, such as preserving farmland and infill development, are applicable to Chinese cities.

Chinese cities have already done a better job on some smart growth

principles, such as high-density development and mixed land use. Therefore, any gains from future development of high-density and mixed land uses would be marginal if the principle of diminishing returns holds. Furthermore, the principle of using mixed land use to reduce travel distance might not work well in Chinese cities (Ding & Zhao, 2011). Mixed land use affects non-work-related trips more than home-based commuting trips. Mixed land use would only be effective when home-based commuting trip accounts for a small portion of total trips due to its inelasticity. In the US, home-based commuting trip accounts for less than 30% in both morning and afternoon rush hours. In contrast, this share could be as high as 75% in Chinese cities. The mixed land use would make traffic management in China more difficult. Thus, the effectiveness of mixed land use on reducing auto trips and alleviating congestion would be limited in China.

Since smart growth strategies have evolved from direct regulatory mechanism to market-based mechanism to combat sprawl, they can hardly address the root cause of sprawl in China, which goes beyond market. If local governments' alternative revenue resources cannot be ensured, their strong incentives to lease more land for development would not be removed and the central government's top concern for food security would not be addressed. US smart growth strategies deserve more consideration on their applicability and potential unintended side effects when trying to apply them to Chinese cities.

Table 8.1 Smart Growth Strategies and their Applicability to Chinese Cities

Smart Growth Strategy	Principle and goal	Impacts in the US	Implementation	Applicability to China
Urban Growth Boundary (UGB)	An officially adopted line separating rural area and urban area; Directly limit outward extension of new development; Preserve farmland, open space and other natural resources	Development occurs more likely within UGBs; Encourage low-density residential ring immediately outside UGBs; Potential to increase housing price in inner city;	Strong opposition from landowners in suburbs and from local officials; Difficulties in determining how much land should be contained within UGB and when to expand UGB	Suitable for the goal of protection of farmland; Limited effectiveness in restricting local governments' action; Potential of increasing housing price would further encourage residential sprawl; Limitation of traditional method for predicting land demand and lacking a timely mechanism to monitor and adjust UGBs
Priority Funding Area (PFA)	An incentive-based approach that uses state spending on urban growth to attract development to certain areas, such as developed area, areas meeting standards regarding density, land use and infrastructural criteria; Indirectly contain sprawl	Very limited effects on urban containment; Market has greater influence than PFA on developers' decision; Fail to contain sprawl in areas facing great development pressure;	Lacking sufficient funding to provide enough incentives to influence development decision;	Lacking regulatory power might fail to contain sprawl in cities facing great development pressure; Local governments are highly dependent on the land leasing fee for infrastructure development; Learning the principle of PFA: making development in desired areas more feasible and cost less; Need to combine with other regulatory policies
Transit-Oriented Development (TOD)	Encourage people to use transit and walk by increasing density and degree of mixed land use, and improving street design around transit stations;	TOD can encourage people to drive less and use non-auto transportation modes more; Self-selection has greater effects on driving and in urban areas;	Integrating transportation plan with land use plan	Suitable for the goal to alleviate traffic congestion; Future gains from high density and mixed land uses might be limited in urban areas; Fragmentation of planning system and trend of dramatically increase in vehicle ownership would limit its effectiveness
Brownfield Redevelopment (BR)	Redevelopment of contaminated former industrial land to achieve infill development	Superfund Act resulted in high costs of cleanup; BR is not sufficient to stimulate local economy in distressed neighborhood; Risk-based cleanup criteria would limit the effectiveness in reducing residential sprawl	Liability for contamination should be clarified; Regulations and cleanup standards should achieve a balance between attracting investment for redevelopment and environmental safety	BR is suitable for Chinese cities to achieve infill development; China has a large amount of brownfields, facing greater development pressure; The incentive-based cleanup standard might be more effective in limiting residential sprawl in China

Table 8.1 lists four smart growth strategies as examples to show their applicability to Chinese cities. Some of them have limited effects on containing sprawl in both U.S. and China. For instance, PFA, as an incentive-based approach, lacks regulatory power to limit sprawl. In the US, if incentives provided by state or regional government are not sufficient or areas are facing great development pressure, PFAs might fail to achieve the goal containing development inside designated areas. In China, local governments are highly dependent on land leasing revenue for infrastructure development. Cities, especially those in the eastern region, have been experiencing rapid urbanization and industrialization, inducing high demand for land. Therefore, PFAs would also have limited effectiveness in addressing sprawl in China. Even though Chinese cities could learn from the principle of PFA to make development inside desired areas more feasible and cost less, implementation of PFAs should be companied by other regulatory policies, such as protection of agricultural land.

Based on US experience, some unintended effects of smart growth strategies might also diminish their effectiveness. The principle of UGB is suitable for the goal to preserve farmland in China, and the top-down planning system and public land ownership would produce less opposition to its implementation. However, the unintended effects would encourage low-density residential ring along UGBs and increase housing price within UGBs, especially when too little land is assigned within UGBs. The residential sprawl in China is mainly due to high housing price in inner cities and dramatically growth of urban

population. Due to the large amount of floating population, prediction of future population in major metropolitan areas is always difficult and underestimated. Lacking a timely mechanism to monitor and adjust UGBs, therefore, it is more likely that UGB in China would contain insufficient land to accommodate future population and result in rising housing price. If these unintended effects cannot be addressed, UGB would further encourage residential sprawl in China.

Even though TOD has been demonstrated to increase transit ridership and decrease vehicle miles traveled, the success in the US does not mean it would achieve the expected effects in China, considering the different urban patterns. In China, cities already have a high degree of density and mixed land use, and public transportation is the major mode, TOD might have lower potential to further increase transit ridership. Furthermore, car industry plays an important role in supporting GDP growth, especially local economies, and is a major area to attract foreign investments. Along with the increase in personal income, vehicle ownership would keep rising, and thus the effectiveness of TOD would be limited.

Among these four smart growth strategies, only brownfield redevelopment can be suitable and effective in Chinese cities, which demonstrates the importance of infill development to Chinese cities. Because sprawl in China is mainly characterized as leapfrog development and fragmentation, infill development can have high potential to change this development pattern. In addition, the former industrial sites are always located near the city center, and face great development pressure, they are suitable for high-density and transit-oriented development and they are more likely redeveloped into residential uses. Thus, brownfield

redevelopment and other infill development strategies can play a significant role in reconfiguring and retrofitting urban land in Chinese cities.

However, none of these smart growth strategies could address the root cause of sprawl in China. If local governments highly depend on the revenue from land leasing for infrastructure, the trend of excessive urban expansion would not be slowed. In addition, combined with national policy of farmland protection, fragmented development pattern on urban fringe could hardly be altered. Furthermore, if smart growth could not mitigate the conflicts between the central government' concern on food security and local governments' desires for revenue for infrastructure, the effectiveness of any urban containment policy at the local level would be limited.

Policy Recommendation

In order to restrain excessive outlying expansion and fragmentation, and mitigate negative impacts of sprawl in China, policies at both local and regional level should be focused, as well as policies regarding future fiscal reform.

First, infill development is important for Chinese cities. The leapfrog and fragmentation development pattern in China indicate the potential for infill development. Around 15% of land in China's built-up areas is vacant in 2000, and this number has been keeping increasing (World Bank, 2007). If the vacant land can be developed at high density, the development pressure on urban fringe would be relieved. Taking the city of Tianjin as an example, if developed at higher density, the vacant land could absorb 45% of all population growth to 2020 (World Bank, 2007). In addition, most of the vacant lands are at prime locations

near the urban center. Redevelopment of them would improve land efficiency and revitalize local economies. In suburbs, policy regarding protection of basic farmland should be flexible. In some places, isolated farmland should be sacrificed and allowed for development in order to achieve infill and efficient land use patterns (World Bank, 2007).

Second, more affordable housing should be provided in inner cities in order to limit residential sprawl in suburbs. In China, living in suburbs is mainly due to high housing price in inner cities. Most people in China still prefer living in inner cities if they can afford the price. In addition, if more affordable housing is provided around the employment center in inner city, the job-housing balance could also be improved. Therefore, in the process of infill development, affordable housing should be emphasized.

Third, policies at the national level should encourage urbanization and economic growth in cities in the central and western region, especially the medium-size and small city. Because the eastern region in China is suitable for foreign trade and cities there have launched economic reforms earlier to attract foreign investments, the development of major cities in the eastern region have outpaced other cities. They are like magnets that attract a huge number of migrant workers from rural or less developed areas. As a result, rapid population growth has driven up the demand for housing and price, leading to residential sprawl. Therefore, stimulating economic development, creating more job opportunities, and increasing investment for infrastructure to speed up urbanization in the central and western cities would alleviate the burden of cities in the eastern region

accommodating the large amount of migrant workers.

Fourth, other revenue sources should be ensured to relieve local fiscal stress. The large fiscal gap between expenditure responsibilities and revenue capacity of local governments results in local governments' high dependency on extra-budgetary revenue sources, especially fees for leasing land use rights, which is the root cause of sprawl in China. Property tax could be an effective tool to increase local governments' revenue (Song & Ding, 2009). The logic behind property tax is that public investments on infrastructure would increase property value and local governments collect part of this betterment through property tax and reinvest in infrastructure or other public services. The current tax system more focuses on the transaction stage than the possession stage and excludes owner-occupied residential property (Man, 2012). Therefore, China's current tax system significantly restricts governments' ability to capture value from the booming housing market. In 2011, Shanghai and Chongqing were permitted to collect property taxed on newly purchased second homes and luxury properties. Future fiscal reform in China should aim to establish a system to tax existing residential property based on the assessed market value in order to make the property tax a significant and long lasting revenue source for local governments.

Limitations and Future Research

The most substantial limitation to this thesis is the research method. The discussion on applicability of smart growth strategies to Chinese cities is mainly based on existing literature and my own understanding and knowledge of urban development in China. Given the limitation of my own knowledge, some

arguments seem to lack strong evidence. Future research should focus on in-depth cases studies and interviewing both planners and policy-makers in China to identify the circumstances under which smart growth strategies would be more successful in Chinese cities.

Bibliography:

Alberini, A., Longo, A., Tonin, S., Trombetta, F., & Turvani, M. (2005). The role of liability, regulation and economic incentives in brownfield remediation and redevelopment: Evidence from surveys of developers. *Regional Science & Urban Economics, 35*(4), 327-351.

Beijing Municipal Bureau of Statistics, 2012 National economic and social development statistics bulletin, Source*: http://bjrb.bjd.com.cn/html/2013-02/07/content_47113.htm*

Beck, Eckardt C. (1979). The Love Canal tragedy. EPA Journal, *Source: http://www.epa.gov/history/topics/lovecanal/01.html*

Bhatta, B., Saraswati, S., & Bandyopadhyay, D. (2010). Urban sprawl measurement from remote sensing data. *Applied Geography, 30*, 731-740.

Blair, R., & Wellman, G. (2011). Smart growth principles and the management of urban sprawl, *Community Development*, 1-17.

Brueckner, J. K. (2000). Urban sprawl: Diagnosis and remedies. International Regional Science Review, 23(2), 160-171.

Burchfield, M., Overman, H. G., Puga, D., & Turner, M. A. (2006). Causes of sprawl: A portrait from space. The Quarterly Journal of Economics, 587-635.

Burchell, R. W., & Mukherji, S. (2003). Conventional development versus managed growth: The costs of sprawl. *American Journal of Public Health, 93*(9), 1534-1540.

Bureau of Labor Statistics, U.S. Department of Labor, Local Area Unemployment Statistics *1990–2010, Source:* http://www.bls.gov/lau/#data

Can, Kang & Guan, Hua. (2007). Brownfield redevelopment toward sustainable urban land use in China (in Chinese). *Chinese Geographical Science, 17*(2), 127-134.

Cao, X., Mokhtarian, P. L., & Handy, S. L. (2009). The relationship between the built environment and nonwork travel: A case study of northern California. *Transportation Research, Part A, 43*(5), 548-559.

Cao, X., Xu. (2010). Exploring causal effects of neighborhood type on walking behavior using stratification on the propensity score. *Environment and Planning A, 42*, 487-504.

Cao, X., Mokhtarian, P.L., Handy, S.L., (2009). Examining the impacts of residential self-selection on travel behaviour: a focus on empirical findings. Transport Reviews 29, 359–395.

Carlson, T., & Dierwechter, Y. (2007). Effects of urban growth boundaries on

residential development in pierce county, washington. *Professional Geographer, 59*(2), 209-220.

Cervero, R. (2007). Transit-oriented development's ridership bonus: a product of self-selection and public policies. *Environment and Planning A, 39*, 2068-2085.

Cervero, R., & Day, J. (2008). Suburbanization and transit-oriented development in china. *Transport Policy, 15*(5), 315-323.

Cervero, R., & Sullivan, C. (2011). Green TODs: Marrying transit-oriented development and green urbanism. *International Journal of Sustainable Development and World Ecology, 18*(3), 210.

Chen, H., Jia, B., & Lau, S. S. Y. (2008). Sustainable urban form for Chinese compact cities: Challenges of a rapid urbanized economy. *Habitat International, 32*, 28-40.

Cheng, F., Geertman, S., Kuffer, M., & Zhan, Q. (2011). An integrative methodology to improve brownfield redevelopment planning in chinese cities: A case study of futian, shenzhen. *Computers, Environment and Urban Systems, 35*(5), 388-398.

Chakraborty, A., & Mishra, S. (2013). Land use and transit ridership connections: Implications for state-level planning agencies. *Land Use Policy, 30*(1), 458-469.

China City Statistical Yearbook, 1990-2010.

Cho, S., Chen, Z., Yen, S. T., & Eastwood, D. B. (2006). Estimating effects of an urban growth boundary on land development. *Journal of Agricultural and Applied Economics, 38*(2), 287-298.

Cho, S., Poudyal, N., & Lambert, D. M. (2008). Estimating spatially varying effects of urban growth boundaries on land development and land value. *Land use Policy, 25*(3), 320-329.

Cho, S., Omitaomu, O. A., Poudyal, N. C., & Eastwood, D. B. (2007). The impact of an urban growth boundary on land development in knox county, tennessee: A comparison of two-stage probit least squares and multilayer neural network models. *Journal of Agricultural and Applied Economics, 39*(3), 701-717.

Cohen, David -Tanugi. 2008. *Smart growth & traffic in Chinese cities: Balancing population density and traffic congestion for overall energy savings*. National Resources Defense Council.

Cowie, Jefferson, and Joseph Heathcott. 2003. Beyond the Ruins: The meanings of Deindustrialization. Ithaca, NY: Cornell University Press.

Dawkins, Casey & Sartori, Jason & Knaao, Gerrit (2012). Barriers to development inside maryland's priority funding areas: Perspectives of planners, developers, and advocates. *National Center for Smart Growth,*

University of Maryland.

Department of Land Conservation and Development. (2010). Oregon's Statewide Planning Goals & Guidelines.

Deng, F. F., & Huang, Y. (2004). Uneven land reform and urban sprawl in China: the case of Beijing. *Progress in Planning, 61*, 211-236.

Deng, T., & Nelson, J. D. (2013). Bus rapid transit implementation in beijing: An evaluation of performance and impacts. *Research in Transportation Economics, 39*, 108-113.

DeSousa, Christopher. (2005). Policy performance and brownfield redevelopment in milwaukee, wisconsin. *Professional Geographer* 57 (2): 312-27.

Ding, Chengri, & Zhao, Xingshuo. (2011). Assessment of urban spatial-growth patterns in China during rapid urbanization. *The Chinese Economy,* 44(1), 46–71.

Duan, Degang, Lu, Shouyi & Tian, Tao (2009). Some preliminary exploration of urban establishment management system (in Chinese). *Planners, 25*.

Dowling, T. J. (2000). Reflections on urban sprawl, smart growth, and the Fifth Amendment. *University of Pennsylvania Law Review, 148*(3), 873-887.

Ewing, R. H. et al., (2002). Measuring sprawl and its impact. *Smart Growth America.*

Ewing, R. H. (1994). Characteristics, causes, and effects of sprawl: A literature review. *Environmental and Urban Studies, 21*(2), 1-15.

Feng, Li, (2009). Applying remote sensing and GIS on monitoring and measuring urban sprawl, a case study of China. Institute of Regional Development Planning, University of Stuttgart.

Fulton, William et al., (2001). Who sprawls most? How growth patterns differ across the us. Center on Urban & Metropolitan Policy.

Galster, G., Hanson, R., Ratcliffe, M. R., Wolman, H., Coleman, S., & Freihage, J. (2001). Wrestling sprawl to the ground: Defining and measuring an elusive concept. *Housing Policy Debate, 12*(4), 681-717.

Gerber, E. R., & Phillips, J. H. (2005). Evaluating the effects of direct democracy on public policy: California's urban growth boundaries. *American Politics Research, 33*(2), 310-330.

Glaeser, E. L., & Kahn, M. E. (2004). Sprawl and Urban Growth. In J. V. Henderson and J. F. Thisse (Eds.), *Handbook of Regional and Urban Economics, Volume 4.* (pp. 2482-2527).

Godshalk, David R. (2000). Smart Growth Efforts Around the Nation.

Source: www.iog.unc.edu/pubs/electronicversions/pg/.../article2.pdf

Gong, Yuyang. (2010) International experience in policy and regulatory

frameworks for brownfield site management. World Bank.

Hanlon, Bernadette & Howland, Marie (2010). Hotspots for growth: Land use change and priority funding area, policy in a transitional county in the US. *Presented at the Smart Growth Conference in 2007.*

Han, Hao-ying et al. (2009). Effectiveness of urban construction boundaries in Beijing: an assessment. *Journal of Zhejiang University, 10(9):1285-1295.*

Han, S. S. (2010). Urban expansion in contemporary China: What can we learn from a small town?. *Land Use Policy, 27*, 780-787.

Hao, Jiming et al., "Controlling vehicular emissions in Beijing during the last decade." *Transportation Research Part A* 40 (2006) 639–651

Howland, M. (2007). Employment effects of brownfield redevelopment: What do we know from the literature? *Journal of Planning Literature, 22*(2), 91-107.

Howland, M., & Sohn, J. (2007). Has Maryland's priority funding areas initiative constrained the expansion of water and sewer investments? *Land use Policy, 24*(1), 175.

Huang, J., Lu, X. X., Sellers, J. M. (2007). A global comparative analysis of urban form: Applying spatial metrics and remote sensing. *Landscape and Urban Planning, 82*, 184-197.

Hula, Richard C. (1999). *An assessment of brownfield redevelopment policies: The Michigan experience*. Ann Arbor: Department of Political Science and Urban Affairs, Michigan State University.

Hammond, D. (2005) Residential location and commute mode choice. Doctoral dissertation, University of Wales, Cardiff.

Hollander, Justin B. 2009. Polluted, and dangerous: America's worst abandoned properties and what can be done about them. Burlington, VT: The University of Vermont Press

Ingram, K. G., Carbonell, A., Hong, Y., & Flint, A. (2009). *Smart growth policies: An evaluation of programs and outcomes*. Cambridge, MA: Lincoln Institute of Land Policy.

Ingram, K. Gregory, and Hong, Yu-Hung. 2009. *Evaluating Smart Growth: State and Local Policy Outcomes*. Cambridge [Mass.]: Lincoln Institute of Land Policy.

Jabareen, Y. R. (2006). Sustainable urban forms: Their typologies, models, and concepts. *Journal of Planning Education and Research, 26*, 38-52.

Jiang, F., & Liu, Hesheng &Yuan, Hong. (2007). Searching for a Solution to Urban Sprawl: Policy Instruments and Evaluation of Growth Management. *Planners,1* , 33-38.

Jiang, F., & Liu, S., & Yuan, H., & Zhang, Q. (2007). Measuring urban sprawl in

Beijing with geo-spatial indices. *Journal of Geographical Sciences*, 469-478.

Ji, W., Ma, J., Twibell, R. W., & Underhill, K. (2006). Characterizing urban sprawl using multi-stage remote sensing images and landscape metrics. *Computers, Environment and Urban Systems, 30*, 861-879.

Jun, M. (2004). The effects of portland's urban growth boundary on urban development patterns and commuting. *Urban Studies, 41*(7), 1333.

Jun, M. (2008). Are portland's smart growth policies related to reduced automobile dependence? *Journal of Planning Education and Research, 28*(1), 100.

Kenworthy, J. R. (2006). The eco-city: ten key transport and planning dimensions for sustainable city development. *Environment and Urbanization, 18*(1), 67-85.

Ketkar, Kusam. (1992). Hazardous waste sites and property values in the state of New Jersey. *Applied Economics* 24:647-59.

Knaap, G. J., & Hopkins, L. D. (2001). The inventory approach to urban growth boundaries. *American Planning Association.Journal of the American Planning Association, 67*(3), 314-326.

Knaap, Gerrit-Jan. (2007). The Sprawl of Economics: A Response to Jan Brueckner. *Lincoln Institute of Land Policy, Working Paper.*

Krueger, R., & Gibbs, D. (2008). 'Third wave' sustainability? Smart growth and regional development in the USA. *Regional Studies, 42*(9), 1263-1274.

Lange, Deborah, and Sue McNeil. (2004). Clean it and they will come? Defining successful brownfield development. *Journal of Urban Planning and Development* (June): 101-8.

Lewis, R., Knaap, G., & Sohn, J. (2009). Managing growth with priority funding areas: A good idea whose time has yet to come. *American Planning Association.Journal of the American Planning Association, 75*(4), 457-478.

Li, F., Liu, X., Hu, D., Wang, R.,Yang, W., Li, D., & Zhao, D. (2009). Measurement indicators and an evaluation approach for assessing urban sustainable development: A case study for China's Jining city. *Landscape and Urban Planning, 90*, 134-142.

Li, Xin. (2011).Brownfield in China: How Cities Recycle Industrial Land. *Doctoral Dissertation, Massachusetts Institute of Technology.*

Lin, Qun, & Zong, Chuanling. (2006). Practicing Transit-Oriented Development Plannig in Shenzhen (in Chinese). *Urban Transport of China, 4*, 5-10.

Liu, Zhili, & Li, Chuanyan, & Li Cheng.(2009) "Traffic Impact Analysis of Congestion Charge in Mega Cities." *Journal of Transportation Systems Engineering and Information Technology* 9: 57-62.

Litman, Todd (2011). *Evaluating Criticism of Smart Growth*. Victoria Transport Policy Institute.

Litman Todd (2012). Land Use Impacts on Transportation: How Land Use Factors Affect Travel Behavior. *Victoria Transportation Policy Institute*

Logan, John R., & Reid Golden. 1986. "Suburbs and Satellites: Two Decades of Change." *American Sociological Review* 51:430-437.

Lopez, R., & Hynes, H. P. (2003). Sprawl In The 1990s: Measurement, distribution, and trends. *Urban Affairs Review, 38*(3), 325-355.

Loo, B. P. Y., Chen, C., & Chan, E. T. H. (2010). Rail-based transit-oriented development: Lessons from new york city and hong kong. *Landscape and Urban Planning, 97*(3), 202-212.

Man, Yanyun. (20012). China's Property Tax Reform: Progress and Challenges. *Lincoln Institute of Land Policy.*

McCarthy, Linda. (2006). Off the mark? Economic efficiency in targeting the most marketable sites rather than spatial and social equity in public assistance for brownfield redevelopment. Milwaukee: Department of Geography, University of Wisconsin–Milwaukee.

Mokhtarian, P.L., & Cao, X., (2008). Examining the impacts of residential self-selection on travel behavior: a focus on methodologies. Transportation Research Part B: Methodological 42, 204–228.

Mu, R., & Jong, M. d. (2012). Establishing the conditions for effective transit-oriented development in china: The case of dalian. *Journal of Transport Geography, 24*, 234-249.

Myung-Jin, J. (2006). The effects of portland's urban growth boundary on housing prices. *American Planning Association.Journal of the American Planning Association, 72*(2), 239-243.

Mori, K., & Christodoulou, A. (2011). Review of sustainability indices and indicators: Towards a new City Sustainability Index (CSI). *Environmental Impact Assessment Review*.

Nelson, Arthur C.& Moore, Terry. (1993). Assessing Urban Growth Management. *Land Use Policy, 48*(16), 3511-3536.

Portney, K. E. (2002). Taking sustainable cities seriously: A comparative analysis of twenty-four US cities. *Local Environment, 7*(4), 363-380.

Qi, Lei, & Lu, Bin. (2008). Urban sprawl: A case study of Shenzhen, China. *44th ISOCARP Congress.*

Renne, John L. & Wells, Jan S. (2003). Emerging European-style planning in the United States: Transit-oriented development. a Paper for Presentation at ACSP-AESOP 2003, Leuven, Belgium.

Renne, J. L. (2009). From transit-adjacent to transit-oriented development. *Local*

Environment, 14(1), 1-15.

Sangyun Lee & Paul Mohai. (2012). Environmental justice implications of brownfield redevelopment in the United States, *Society & Natural Resources: An International Journal, 25:6, 602-609*

Schneider, A., & Woodcock, C. E. (2008). Compact, dispersed, fragmented, extensive? A comparison of urban growth in twenty-five global cities using remotely sensed data, pattern metrics and census information. *Urban Studies, 45*(3), 659-692.

Schwanen, T., & Mokhtarian, P. L. (2005). What affects commute mode choice: Neighborhood physical structure or preferences toward neighborhoods?. *Journalof TransportGeography, 13*, 83–99.

Shen, Q. (1997). *Urban transportation in Shanghai, China: Problems and planning implications*. Malden, MA: Blackwell Publishers.

Smart Growth Network (2005). *Getting to smart growth, 100 policies for implementation*. Smart Growth Network

Sun, C., Wu, Z., Lv, Z., Yao, N., & Wei, J. (2012). Quantifying different types of urban growth and the change dynamic in Guangzhou using multi-temporal remote sensing data. *International Journal of Applied Earth Observation and Geoinformation*, 1-9.

Song, Y. (2005). Smart growth and urban development pattern: A comparative study. *International Regional Science Review*,*28*(2), 239-265.

Song, Y., & Knaap, G. (2004). Measuring urban form: Is Portland winning the war on sprawl?. *Journal of the American Planning Association, 70*(2), 210-225.

Song, Yan, & Ding, Chengri. 2007. *Urbanization in China: Critical issues in an era of rapid growth*. Cambridge [Mass.]: Lincoln Institute of Land Policy.

Song, Yan, and Ding, Chengri. 2009. *Smart urban growth for China*. Cambridge [Mass.]: Lincoln Institute of Land Policy.

Sung, H., & Oh, J. T. (2011). Transit-oriented development in a high-density city: Identifying its association with transit ridership in seoul, korea. *Cities, 28*(1), 70-82.

Tregoning, H., Agyeman, J., & Shenot, C. (2010). Sprawl, smart growth and sustainability. *Local Environment, 7*(4), 341-347.

Walker, Kristi. (2004). Locating opportunities for brownfield redevelopment in St. Louis. Master's thesis, University of St. Louis.

Wang, J., & Zhang, J. (2010). Measurement on the urban spreading in China: Empirical study based on the panel data of 35 large and middle cities. *Economist, 10*, 56-63.

Weitz, J., & Moore, T. (1998). Development inside urban growth boundaries: Oregon's empirical evidence of contiguous urban form. *American Planning Association.Journal of the American Planning Association, 64*(4), 424-440.

Wei, Y., & Zhao, M. (2009). Urban spill over vs. local urban sprawl: Entangling land-use regulations in the urban growth of China's megacities. *Land Use Policy, 26,* 1031–1045.

Wernstedt, Kris, Robert Hersh, and Katherine Probst. (1999). Grounding hazardous waste cleanups: A promising remedy. *Land Use Policy* 16:45-55.

Wolman, H., Galster, G., Hanson, R., Ratcliffe, M., Furdell, K., & Sarzynski, A. (2005). The fundamental challenge in measuring sprawl: Which land should be considered?. *The Professional Geographer, 57*(1), 94-105.

World Bank. (2007). The Fragmented City: Issues in Urban Land Use in China. *The Word Bank Report.*

World Bank, 2013. National Development Indicators. Source: *http://ddp-ext. worldbank.org/ext/DDPQQ/member.do?method=getMembers&userid=1 &queryId=35.*

Woo, M., & Guldmann, J. (2011). Impacts of urban containment policies on the spatial structure of US metropolitan areas. *Urban Studies, 48*(16), 3511-3536.

Wu, Weiping. (2010). Urban infrastructure financing and economic performance in China. *Urban Geography*, 2010, **31**(5),648–667.

Wu, Fulong., Jiang Xu, and Anthony Gar-On Yeh. 2007. *Urban development in post-reform China: State, market, and space,* New York: Routledge.

Xi, J., & Cho, N. N. (2007). Spatial and temporal dynamics of urban sprawl along two urban–rural transects: A case study of Guangzhou, China. *Landscape and Urban Planning, 79,* 96-109.

Xie, Jian & Li, Fasheng. (2010). Overview of the current situation on brownfield remediation and redevelopment in China. *World Bank.*

Ye, L., Mandpe, S., & Meyer, P. B. (2005). What is "smart growth?"—Really?. *Journal of Planning Literature, 19*(1), 301-315.

Yu, X. J., & Ng, C. N. (2007). Spatial and temporal dynamics of urban sprawl along two urban–rural transects: A case study of Guangzhou, China. *Landscape and Urban Planning, 79,* 96-109.

Zhang, T. (2000). Land market forces and government's role in sprawl. *Cities, 17*(2), 123-135.

Zhang, M. (2004). The role of land use in travel mode choice: Evidence from boston and hong kong. *American Planning Association.Journal of the*

American Planning Association, 70(3), 344-360.

Zhang, Ming, & Liu, Jing. (2007). The Chinese edition of transit-oriented development (in Chinese). *Urban Planning Forum, 1*, 91-96.

Zhang, K. (2007). The review of the measurement of urban sprawl. *International Urban Planning, 22*(2), 67-71.

Zhao, P. (2011). Managing urban growth in a transforming China: Evidence from Beijing. *Land Use Policy, 28*, 96-109.

Zheng, Z., & Yu, G. (2011). Study on the mechanism evolution of China's urban-rural integration development planning and its land system in practice. *Energy Procedia, 5*, 1852-1858.