

THE RISE OF CHINA ***AND ITS ENERGY IMPLICATIONS***



**The Future of Urban Sprawl in China and Its Impact on
Transportation Oil Use**

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The Future of Urban Sprawl in China

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I. Introduction¹

In the next couple of decades, projections suggest that the number of urban Chinese residents will likely grow by an amount equal to the entire current population of the United States, about 300 million people. Cities will have to grow to absorb this massive influx of new urban residents, and how they expand will have profound implications for the need for personal automobiles and demand for oil to power those vehicles.

The cities could expand in ways that minimize transportation oil use. These cities would be high density, have close-by options for employment and entertainment, and offer high accessibility to transit. Using the language of Western planners, these cities would demonstrate “smart growth” and “transit-oriented development” (TOD).

Yet these cities could also grow in sprawling ways that essentially require extensive private vehicle use. The United States, for instance, has many of these sprawling cities unfriendly to public transportation including Atlanta and Houston. As is the case in these cities, once they are set up in sprawling ways, it is very difficult to go back and substantially alter them to make them more conducive to public transportation.

This paper estimates the potential oil savings if Chinese cities are built in ways that encourage smart growth and TOD and are able to maintain city density at 2010 levels. If China can keep the density of its cities constant, it can realize savings of 270,000-590,000 b/d in 2020 and 1.2-2.3 million b/d in 2035. The paper surveys the degree to which the Chinese government has historically supported and is currently promoting goals and policies consistent with goals of smart growth and TOD, the barriers to implementation of these policies, and evidence of whether cities have been sprawling. The last section looks forward to see if the historical trends might change over the next couple of decades as Chinese cities continue to grow.

Since the economic reforms of 1978, the central government has not specifically promoted smart growth or TOD. Some of its policies correspond with smart growth principles, while some do not. Policies that could limit city sprawl have been undermined by local governments eager to

The Future of Urban Sprawl in China

raise revenue by leasing land to developers. Widespread decentralization of power in China makes it difficult for the central government to control the growth of cities. Macro-level data are spotty but indicate, along with more qualitative reports, that cities in China have become less dense. That cities have become less dense is consistent with what is expected as countries become wealthier. However, infrastructure spending on public transportation has picked up in recent years, a trend that is likely to continue.

Though the central government has historically made little or no sustained effort to encourage smart growth, there are hints that plans designed to limit the amount of land useable for cities or the design of cities themselves will be enforced or at least encouraged in the future. Concerns about food security will keep weighing on Chinese leaders and could get them to finally adhere to their own goals for farmland preservation, which would limit the sprawl of cities. As for the actual plans concerning the design of cities themselves, statements in the most recent 12th 5-Year Plan (5YP) suggest that promoting high-density development in existing cities is now seen as desirable. Some other rhetoric promoting “low carbon cities” and recent programs that facilitate international collaboration and education also suggest that cities could grow in ways consistent with smart growth in the future. With support in the 12th 5YP and support at many levels of government, public transportation infrastructure spending will likely continue to increase, barring any more accidents or scandals with rail.

But it is still very possible that cities in China will keep expanding and becoming less dense, reducing available farmland as they grow. There is no concerted effort yet to change the incentive structure for local governments, who are desperate to lease land for developers because they lack sufficient ability to raise tax revenue. Leaders think about more immediate concerns than the impact of smart growth on future oil use, and the change in rhetoric has occurred very recently. Only with public transportation it is possible to be relatively confident that spending and interest in expanding city bus and rail networks will continue, given traffic and pollution problems and the very visible nature of the projects.

II. The Connections Between China's Growing Urban Population and Transportation Oil Consumption

Population Trends and Urbanization in China

Since economic reforms began in China, the Chinese population has urbanized very quickly, and expectations are that it will continue to rapidly urbanize. In 1978, the percentage of Chinese living in urban areas was only about 18 percent (Guangtao et al. 2010). As of November 2010, according to the Chinese Census, there were over 665 million urban Chinese, representing almost exactly 50 percent of the population (Ma 2011). Since 1978, urban areas have gained almost 500 million residents, or an average of about 15 million per year. The urban population rose by 207 million from 2000 to 2010, an increase of more than 20 million per year (Haub 2011).

Analysts expect this urbanization trend to continue. In 2009, the UN expected the urban Chinese population to reach about 850 million by 2025, 905 million by 2030, and 1 billion by 2045 (UN Population Division 2009). The McKinsey Global Institute (MGI) projects an even more rapid urbanization, reaching 926 million urban residents by 2025, or 64 percent of the population (Woetzel 2011a). MGI believes China is on track for one billion urban residents by 2030. These estimates assume urban population growth of roughly 250 million to 350 million in the next 20 years, close to the current total population of the U.S. as of the most recent Census of 309 million (Memmott 2010).

According to MGI, almost 70 percent of the new urban population from 2005 to 2025 is expected to come from migration from rural to urban areas (MGI 2009). This migration is particularly important because these migrants have a great potential to dramatically change the built environment of cities; depending on which cities they move to and where they move within cities will either support smart growth and TOD or make it more difficult to achieve. MGI expects almost 250 million to migrate into urban areas in those two decades. In contrast, according to MGI estimates, the largest share of the increasing urban population in the 1990-2005 period was the acquisition of adjacent land by urban governments and incorporation of

those people into existing urban areas (37 percent of the increase, or 118 million people). MGI estimates that about 100 million migrated between 1990 and 2005.

It should be cautioned that although urbanization will inevitably continue, projecting exact figures is very difficult. As of 2009, the UN underestimated the number of urban Chinese in 2010 by about 30 million, even as it expected the country's population as a whole to be roughly 15 million higher than it was (UN Population Division 2009). A more modest estimate shown in Toth, Cao and Hizsnyik (2008) is that there will be 775 million urban residents in 2025, although this still implies that more than 100 million Chinese will become urban residents as compared with 2010. In any case, China's urban population should grow by levels that are counted in the hundreds of millions, with very important implications for the development of cities.

The Link Between the Layout of Cities and Private Vehicle Use in Other Countries

Studies show a strong link between what is described as the "built environment," which is the design and layout of cities and towns, and personal vehicle use. Lower vehicle use translates into lower oil consumption. Following intuition, vehicle use, as measured in vehicle kilometers traveled (VKT) and oil use is much lower in a compact area with a strong public transportation network such as Manhattan in New York City than it is in a far-flung suburb of a sprawling city. Recent research indicates these differences can be quite substantial. While none of the studies cited in this section includes China, the results will be used to provide a first-order approximation of the effect of built environment characteristics on Chinese cities.

Very aggregate approaches initially suggest an empirical link. VKT per person in "light-duty" vehicles (cars and trucks that are typically owned by private consumers) at the same level of income was about 4,000-7,000 km/person in Japan and various Western Europe countries and 9,000-12,000 km/person in the U.S., Canada and Australia (Millard-Ball and Schipper 2011). Residents of the U.S. drive three times as much those in Japan. Unsurprisingly, according to Angel et al. (2011) when analyzing a sample of 120 representative cities in the world in the year 2000, the 13 cities studied in the U.S., Canada and Australia only had a density of 23 people per hectare (p/ha), or about one-third of the 67 p/ha in the 19 cities studied from Europe and Japan.

The Future of Urban Sprawl in China

The enormous differences in personal vehicle travel among developed areas of the world suggest a very wide range of possible outcomes for China.

However, more nuanced approaches are needed, and recent studies have used more disaggregate approaches to more precisely estimate the impact of the built environment. Kim and Brownstone (2010) use data from the 2001 U.S. National Household Travel Survey (NHTS) and find that a given household that is forced to move from an urban area to suburban area increases its VKT and transportation oil use by about 40 percent. A household forced to move from an urban to “town” area (somewhat akin to what are often called “exurbs” on the fringes of cities) increases its VKT by 60 percent and transportation oil use by over 65 percent. In absolute terms, a household in an area 1,000 housing units per square mile more dense (about 8-13 more p/ha) will drive and consume about 7 percent less. The authors noted that those who live in denser, more urban areas tend to drive more efficient vehicles, thereby often reducing oil use by a greater amount than what the reduction in VKT would suggest.

Other studies, which use varying techniques, have generally found substantial impacts as well. For instance, using data from 1990, Bento et al. (2005) find that moving a household from a city with the characteristics of Boston, which is quite dense and has public transportation, to one with the characteristics of more sprawling Atlanta, increased VKT by 33 percent. Moving from New York to Atlanta, which was about a third as dense, increased VKT by almost 80 percent.

Some studies specifically focus on a particular geographic area. Brownstone and Golob (2009) and Kim and Brownstone (2010) use 2001 NHTS data from California and find somewhat less robust results than their national figures, though some of the difference is attributable to higher levels of driving among the urban population in California. Bhat and Guo (2007) find that the built environment affected vehicle ownership in the San Francisco area. While that paper does not explicitly analyze the effect of the built environment on vehicle ownership, the decision to not own a vehicle can contribute to the reduced VMT seen in denser, more urban areas.

To make it easier to compare these studies, it is possible to analyze the effect of doubling the density of residents. Studies suggest that doubling density often reduces driving by about 20

percent. A literature search by MGI (2009) finds that doubling residential density reduces driving by between 20 and 30 percent. The national results from Kim and Brownstone (2010) of moving a family between urban and suburban areas, which are about a third as dense, also suggests that doubling density reduces VKT by a little under 20 percent, as does work by Heres-Del-Valle and Niemeier (2011) using 2000-2001 survey data from California. Similarly, an average of six major metropolitan areas using data from 1990 suggests that doubling density from 10 p/ha (roughly the density of the Houston metropolitan area at that time) to 20 p/ha (a little less than the density of New York's metropolitan area in 1990) decreases VKT by between 20 and 25 percent (Bento et al. 2005). Certain other studies, such as the study of California from Brownstone and Golob (2009), find a smaller impact of doubling density on VKT, though Cervero and Murakami (2010) find a larger effect.

These studies have controlled for the possibility that this connection between the built environment and VKT is not a spurious reflection of people who dislike driving choosing to live in denser and more urban areas. This effect is known as the endogeneity bias. Without controlling for the endogeneity bias, the apparent effect of the built environment on VKT may be even larger (Cao, Mokhtarian, and Handy 2009). Kim and Brownstone (2010) find that a given suburban household drives 120 percent more than the same urban household, about 22,000 miles per year compared with slightly over 10,000 miles/year, a substantially larger difference than the 40 percent increase seen in the model when an urban household is forced to move to the suburbs. However, both Ewing and Cervero (2010) and Chatman (2009) suggest that if anything, residential self-selection works the opposite way. They argue that there is likely a latent demand for transit, but some people cannot find accessible neighborhoods and must drive, even if they would prefer to do so less.

Still, considering there are many differences between urban and suburban areas and cities such as New York and Atlanta, researchers disagree to some extent over which particular key features of the built environment are most important.

Researchers originally divided the key features into the “three D’s” of density, diversity and design. This division has since been expanded in some studies to “five D’s,” which also includes

destination accessibility and distance to transit. Some studies also include demographics or demand management policies, which includes parking supply and cost. Definitions of the five D's are as follows, as they appear in Ewing and Cervero (2010).

- **Density:** This is usually a particular population variable divided by unit area. The density variables such as housing or employment are occasionally measured as well.
- **Diversity:** This is a measure of the variety of land uses in a given area. Entropy measures of diversity are frequently used, in which low values indicate single-use city layouts with housing, work and entertainment more geographically separated and isolated.
- **Design:** This measures a wide variety of street characteristics, including average block size, proportion of four-way intersections, and number of intersections per mile. Dense urban grids with many four-way intersections are usually preferable to curving suburban streets. More pedestrian-friendly variables are sometimes included such as sidewalk coverage.
- **Destination accessibility:** Somewhat similar to diversity, it can be measured at regional or local scales. It has been measured both relatively simply (e.g. distance from home to the closest store or the number of jobs and attractions in a given travel time) and in more complex ways (gravity models of trip attraction).
- **Distance to transit:** This is usually measured as the average of the shortest street routes from houses and workplaces to the nearest rail or bus stop. Other measures the distance between transit stops, or the density of transit stops or miles of transit routes in a given area.

The meta-analysis by Ewing and Cervero (2010) reviewed more than 200 studies in order to compute elasticities of VKT given the five “d” variables. Surprisingly, once other factors were controlled for, density had the smallest effect of the five. As shown in Table 1, density has an elasticity of -.04, which means that a doubling of density should only reduce VKT by four percent. The authors suggest that density is an intermediate variable that becomes less important once other factors are considered. (Imagine residents of a skyscraper inaccessible by transit and miles away from any jobs, stores or entertainment. Unless they carpool, they likely drive a lot.)

Table 1. Effects of Built Environment Variables on Vehicle Kilometers Traveled

		Total number of studies	Number of studies with controls for self-selection	Weighted average elasticity of VKT (<i>e</i>)
Density	Household/population density	9	1	-0.04
	Job density	6	1	0.00
Diversity	Land use mix (entropy index)	10	0	-0.09
	Jobs-housing balance	4	0	-0.02
Design	Intersection/street density	6	0	-0.12
	% 4-way intersections	3	1	-0.12
Destination Accessibility	Job accessibility by auto	5	0	-0.2
	Job accessibility by transit	3	0	-0.05
	Distance to downtown	3	1	-0.22
Distance to Transit	Distance to nearest transit stop	6	1	-0.05

Source: Ewing and Cervero (2010)

Despite its apparently small importance on its own, density is still a good proxy for these other variables. In general, people who live in dense areas are more likely to live near jobs and shopping, and it often makes more sense to have public transportation options nearby high concentrations of people. However, it is clear that other aspects of the layout of cities are important as well, including public transportation.

For the purposes of this paper that tries to generalize trends across China, density is the most straightforward quantitative measure that can be analyzed. Distance to transit will be indirectly studied by tracking the growth of public transportation networks and use in cities. The approach to diversity, design and destination accessibility is less direct. Some examples of cities with low levels of diversity, destination accessibility, or poor design are mentioned, but there are only quantitative indicators for a few cities such as Beijing.

The promotion of cities that rate highly on these five “d” variables is similar to the concept known among Western planners as “smart growth” (EPA 2011). Smart growth emphasizes compact building design (density), mixed land uses (diversity and destination accessibility), walkable neighborhoods (good design), and a variety of transportation choices (transit accessibility and distance to transit). Other aspects of smart growth are not the focus of this

paper, such as encouraging community and stakeholder involvement, but they do not conflict with cities that have urban patterns that reduce oil use.

Another term frequently employed is transit-oriented development (TOD), which focuses more on public transportation and accessibility to transit options (Federal Transit Authority). In many ways, smart growth encompasses TOD, but it is included in the paper to emphasize that the development of cities is more than the arrangement and density of buildings; the transportation infrastructure is also very important (Yusuf and Nabeshima 2008).

Possible Future Development Patterns and Their Effects on Density and VKT

In a recent report, Angel et al. (2011) analyzes the factors that lead to density of cities around the world. From their current levels, the most significant features that should affect future density in China are income growth and the population size of individual cities. Income growth leads to less dense cities, likely because residents are more likely to own personal vehicles, making longer commutes more feasible. Meanwhile, cities with larger populations tend to be denser. Of these two factors, income appears to have a greater impact, as shown in Table 2, and it is reasonable to assume that income will grow at a faster rate than the population of most cities.

Table 2. Results of a Doubling of Various Factors on City Density

	Analysis of 120 Cities	Analysis of 3,646 Large Cities
Income/capita	-40%	-25%
City Population	+19%	+16%
Gasoline Prices	+16%	Not significant ²
Arable Land Per Capita	-25%	-27%

Source: Angel et al. (2011)

In its forecasts of energy use, the International Energy Agency assumes that gross domestic product (GDP) per capita in terms of purchasing power parity will increase by an average of 7.3 percent/year from 2008 to 2020 and by 3.8 percent/year from 2020 to 2035 (IEA 2010). This growth will roughly double GDP/capita from 2010 levels by 2020 and increase 2010 GDP/capita by about 3.5 times by 2035. According to the UN, the number of urbanized Chinese residents is expected to increase by roughly 18 percent from the 2010 Census levels by 2020 and 42 percent by 2035 (UN Population Division 2009). With these two factors, higher GDP/capita and larger

city populations, density would fall by the amounts shown in Table 3, assuming that the new urban population will increase the size of existing cities by equal amounts.

Table 3. Projected Percentage Decline in Urban Density from 2010 Levels Given Higher Income and More Urban Residents

	Assuming Analysis of 120 Cities Figures	Assuming Analysis of 3,646 Large Cities Figures
2020	-38%	-23%
2035	-55%	-36%

These changes in density should have a substantial effect on VKT. The previous estimates show that doubling density roughly reduces VKT by 20 percent, which also means that halving density should increase VKT by 25 percent. Using these values, these changes in density mean that Chinese residents in 2020 should drive anywhere from about 6 to 14 percent more than if density were to stay constant at 2010 levels. The effect of the density declines becomes more pronounced by 2035, with expected VKT increases of 13 to over 30 percent.

MGI (2009) suggests four different scenarios for how cities in China may develop between 2005 and 2025, and their densities vary widely. The plan with the most spread-out development that emphasizes the growth of smaller cities has an expected density (23 p/ha) that is about half of the plan that concentrates city growth in the largest cities (57 p/ha).

Another issue to consider is the potential impact of further loss of arable land per capita. China already has relatively little arable cultivated land per person, ranking 175th in the world (MGI 2009). Land is expected to become even scarcer in the next couple of decades. Using the estimates from MGI (2009) of China’s trendline loss of arable land, and UN population growth estimates, arable land per capita would fall about 23 percent between 2005 and 2025 (UN Population Division 2009).³

However, the effect of lower levels of arable land per capita on density works differently than it does for higher levels of GDP/capita or greater population size of cities, making its effect on density and VKT more complicated. Both GDP/capita and the size of cities directly affect density in predictable ways; when citizens get wealthier, they are more likely to own vehicles

and find it comfortable to travel longer distances, and cities with greater population encourage factors such as more public transportation that increase density. Meanwhile, arable land is lost when growing low-density cities encroach upon agricultural lands. In other words, low density development reduces arable land—even though the data and common sense dictate that a lower amount of arable land will result in cities that *more* dense.

The link is that the loss of arable land (or the threat of losses) triggers responses that limit the spatial growth of cities, thereby increasing density. For the purposes of this paper, the threat of loss of arable land and the reduced capacity to reliably and affordably feed the population can act as a galvanizing force on the government to try to encourage high density development. It can also tend to increase the price of agricultural land, reducing the financial incentive of cities to annex and lease land (Lichtenberg and Ding 2009).

As the Angel et al. (2011) paper notes, other factors can be important as well, but they tend to lack quantitative estimates, or their future trends are uncertain. Such factors include future gasoline prices and future income inequality. Angel et al. (2011) does have a clearly relevant finding is that cities with high initial densities are more likely to lose density faster. According to work explained in Medlock, Soligo, and Coan (2011), the weighted density of Chinese cities is currently roughly 2-4 times levels of some major economies in Western Europe and about 6-8 times levels in the U.S. or Canada. This high initial density could suggest that the density of Chinese cities would decrease faster than expected if administrative measures are not taken.

Transportation Oil Use in China—What Is At Stake

According to Medlock, Soligo, and Coan (2011), fuel consumption for all road transportation vehicles is expected to be 4.8 million barrels per day (b/d) in 2020 and 10 million b/d in 2035, assuming current fuel economy standards. These estimates already assume that China will follow the development pattern of western countries and continue on a path of reduced city densities. However, if China could keep its density constant, avoiding the VKT increases of 6 to 14 percent by 2020 and 13 to 30 percent by 2035 compared with 2010 levels that are already integrated into the demand estimates, it would be able to save between 270,000-590,000 b/d in 2020 and 1.2-2.3 million b/d in 2035.

The Future of Urban Sprawl in China

It should be noted that these estimates analyze all road transportation demand, including demand from trucks carrying freight that should be less sensitive to changes in density. Thus, actual reductions in demand would likely be smaller than these estimates.

MGI (2009) also shows that oil use is sensitive to density assumptions. The analysis has four scenarios for how China might grow through 2025. The “supercities” scenario involves 15 Chinese cities of at least 10 million, 11 of which would have 25-35 million residents. “Hub and spoke” involves central cities (hubs) and surrounding smaller cities (spokes), somewhat like what currently occurs around Shanghai, and 11 of these enormous clusters averaging 60 million residents each would account for nearly 75 percent of the urban population. Finally, there is the “distributed growth” scenario in which much of the population expansion occurs in cities of 1.5-5 million people, and the “townization” scenario in which population growth is concentrated in cities of 500,000-1.5 million people. MGI argues that that last two are the closest to the current trajectory in China, though it finds the townization scenario to be quite unlikely.

The first two scenarios, supercities and hub-and-spoke, lead to higher density. If hub-and-spoke can occur at higher levels of density, there is a greater potential to reduce oil use, as shown in Table 4, but this is true because hub-and-spoke leads to a higher level of urban transport energy use than other scenarios, (in equivalent terms about 700,000 b/d higher than supercities in 2025) due to greater use of cars in wealthy spoke cities. According to Woetzel (2011b), most urban transport energy use is in the form of oil.

Table 4. Effect of Increasing Density on Transport Energy Use Depending on Urban Pattern in 2025 (in million b/d equivalent)

Type of Urbanization (Average Expected Density in p/ha)	Oil Savings if Density of Middle- to Low-Income Europe (44 p/ha)	Oil Savings if Density of Rest of Asia (79 p/ha)	Oil Savings if Density of Major City Average (90 p/ha)
Supercities (57)	0	.42	.84
Hub and spoke (37)	.22	.91	1.85
Distributed growth (27)	.41	.90	1.96
Townization (23)	.29	.45	1.27

Source: MGI 2009 and author’s calculations

The Future of Urban Sprawl in China

However, MGI (2009) argues that supercities and hub-and-spoke patterns increase GDP/capita because of a concentration of talent and investment in these large cities or clusters, and this higher income leads to more urban oil use, the majority of which is used for transportation (Woetzel 2011b). This difference is expected to be quite large, as GDP is supposed to be 16 percent higher in the supercities projection than in the trendline projection. Of the four scenarios, the most urban oil use is in scenarios with the largest, most dense cities that also are the wealthiest. This apparent tension between economic growth and types of city construction that usually tend to increase density and reduce VKT is relevant, but it should be kept in mind that larger cities are less energy intensive per unit of GDP, and higher density reduces oil use independently regardless of the type of urbanization China experiences.

This distinction between ways of increasing density is important. Policies that increase density in a city of a given size should reduce VKT. However, another approach that usually increases density involves increasing the size of cities, but the extra income this method generates outweighs the density benefits in terms of oil use, according to analyses such as the one by MGI (2009). Fundamentally, there are separate effects of density on VKT and income on VKT, an issue studied in various papers (e.g. Medlock and Soligo 2001).

The built environment of cities in China is most likely to affect intra-city transportation oil use, which is primarily from personal vehicles that currently run on gasoline. In the U.S., some 75 percent of light-duty vehicle miles traveled come from trips under 50 miles, so intra-city use is highly important to overall personal vehicle use (NHTS 2011). In China, many highways are toll roads, and there is a push to increase high-speed rail, both of which could further reduce the importance of inter-city light-duty vehicle travel.

The effect of smart growth and TOD could reduce the need for inter-city or freight transport as well, but it is more of a second-order effect. For instance, if residential areas are located accessibly to long-haul bus or rail lines, the need to use cars for long-distance transportation would likely tend to diminish. The effect of smart growth on freight transportation, which generally occurs between cities, seems even more disconnected from smart growth initiatives. However, it is possible that denser cities would reduce some intra-city freight (like delivering

packages, for example) or better facilitate using rail that could be directed to one central location in a city rather than many distribution points in a sprawling city. Some very preliminary research suggests that sprawl leads to more commercial truck VKT (Bronzini 2008). Rail is much less energy- and oil-intensive than trucking (Kamakaté and Schipper 2009). Rather than primarily looking at large inter-city projects, this paper will tend to focus on growth and development within individual cities.

III. Historical Policies and Trends Affecting Land Use, Urban Form and Transportation

The main potential influences the government has over smart growth and TOD come from land-use and urban planning, as well as transportation plans and funding. Land-use planning divides China's land use into five categories that are supposed to limit the amount of land available for development and protect farmland. Urban planning generally refers to city-specific conceptions of where urban development such a residential and commercial construction should occur. Urban transportation planning addresses city-level road, public transportation and transportation management and logistics (Zhang, Song and Ding 2009).

Some of the planning doctrines have favored smart growth, but usually as an unintended result of an entirely different concern or ideology. For instance, farmland preservation has been a powerful driver of land use planning, primarily due to concerns about food supply, but this goal also tends to limit the spatial growth of cities and promotes more compact development. Other goals, such as reducing overcrowding in the center of cities, tend to increase sprawl.

On the whole, analysts say many of these plans have been weak and poorly enforced. Since the late 1980s, when a real estate market began, market incentives often dictate where construction occurs. A 1994 change in tax law that reduced funding for lower-level governments increased the incentive for municipalities to lease land rather than protect farmland (Ding and Song 2009). Investment in road construction also increased substantially in the late 1990s and throughout much of the last decade, although recently urban transportation spending has picked up.

Density has very likely declined in Chinese cities in the past few decades, which corresponds to expectations given rising incomes. Policies that have reduced overcrowding and led local governments to lease land to stay solvent have if anything exacerbated this loss of density beyond what would be expected in a free market. Recently, funding for public transportation has picked up, a sign that cities are beginning to grow in accordance with the goals of TOD. The example of Beijing shows that municipal government policies can be partially effective in influencing the growth of cities with determined policies, but not all local governments are as organized as Beijing's.

Basics of Land Use, Urban and Transportation Planning in China

China has four types of plans: comprehensive, specialized, sector and regional. Land use plans are considered specialized plans, and they are generally carried out at five administrative levels, beginning with the national government and followed by a corresponding plan from provinces, prefectures or cities, counties and townships (Zhang, Song and Ding 2009). Since the Land Resources Management Act (1988), the Ministry of Land Resources (MLR) has developed three national land use plans for between 1990-2000, 1997-2010 and 2006-2020. The national land use plan establishes quotas for five types of land use. Three of the five – protected/preserved farmland, basic farmland and farmland that can be converted to urban use – concern the availability of agricultural land, demonstrating the focus of the government on ensuring available food supplies. The other two land-use categories are land for urban and economic growth, and land development and usage conversion. The provincial governments then establish their own quotas based on the national plans, followed by the lower-level administrations.

Urban planning, unlike land use planning, begins at the provincial rather than national level. It consists of at least a master plan and, afterward, a detailed plan. Additionally, for municipal cities and towns where a county government is located, a City-Town System Plan is supposed to be established before the Master Plan to avoid inconsistency.⁴ These steps are specified in the 1989 City Planning Act (later redrafted in 2007) and the 2006 Explanatory Notes of the City Planning Act. The process involves both urban planning agencies at both national and local levels (Song and Pan 2009). Such agencies include the Ministry of Housing and Urban-Rural Development, formerly known as the Ministry of Construction, as well as more local urban

planning commissions or bureaus. The City Planning Act specifies that coordination should occur among various agencies with important plans, and these agencies can include the MLR as well as bureaus covering issues such as water, transportation and public works.

Transportation planning occurs at both the regional and urban levels. Regional transportation planning involves many special plans developed by the Ministry of Communication (MOC) and the corresponding departments at lower levels (Zhang, Song and Ding 2009). This planning helps determine the national road network and river transportation. The Ministry of Railway develops the national rail plan, and 18 regional bureaus oversee the development of regional and local rail.

Meanwhile, urban transportation planning, which is particularly relevant to this paper, is a component of urban planning and is overseen by city urban planning agencies. A fairly local effort, it addresses four topics: roads, public transportation, and transportation logistics and management (Zhang, Song, and Ding 2009). Large cities tend to make separate plans for each topic.

Broad Constraints to Promoting Smart Growth

Rather than promoting smart growth, Song and Pan (2009) argue that the essential goal of urban planning has been the promotion of economic growth. A closely related goal they discuss is “urban entrepreneurialism,” in which a municipality tries to increase its economic competitiveness with more land resources, foreign investment and more revenues. Some cities try to improve their competitiveness is by building superfluous buildings or very wide streets as an attempt to improve their “image” (Campanella 2008).⁵ These actions of cities are unsurprising considering the central government has encouraged economic growth and decentralization, and local governments have been given more autonomy in their pursuit of growth (Zhao 2011).

The close linkage between government and business, sometimes referred to as “local-state corporatism,” has promoted development and with little regard for smart growth (Zhao 2011). Governments are willing to partake in activities such as “capital switching,” in which some Chinese government agencies provide capital for development, thereby facilitating construction,

regardless of whether it promotes sprawl or smart growth. Some of the most influential firms in urban development have close ties with the cities and city governments where they are based (Ma 2004). Some cities have set up municipal development and investment companies to help with the funding and operations of infrastructure projects and are allowed to borrow money on the government's behalf. In terms of land use, some land leasing has been negotiated privately rather than sold at an open auction, and there are estimates of negotiated rates for land that were barely 10 percent of official rates if they were conducted in an auction format (Hsing 2010). Such sweetheart deals have allowed developers to use much more land than if they had to pay full price.

Incentives for local party leaders (cadres) heavily favored promoting economic growth over control of how the growth affected the built environment. The leaders of the local governments—as well as those at higher levels—were solely or overwhelmingly judged on how well they presided over economic growth in their region, and other goals were secondary (Hsing 2010). Cadres are now supposed to achieve more than economic growth in order to be promoted and, in theory, they could be judged on how well they preserve farmland or promote compact development (Yaping and Min 2009). However, smart growth is not part of the expanded range of issues on which cadres are measured such as providing health and education (Saich 2008).

Finally, many analysts have criticized the land use and urban planning processes as doing a poor job of keeping pace with the dynamism of urbanization in China. Yaping and Min (2009) argue that planners have been surprised at the tempo of economic and demographic growth and their effect on land use. Similarly, Ma (2004) and Zhao (2011) say that planners cannot keep up with the rapid transformation of the economy and the rapid growth of construction, and Song and Ding (2009) argue that the plans do not recognize the power of the Chinese land market and market forces. Plans sometimes do change, but they sometimes respond to whims of specific projects championed by powerful people and investment groups (Ma 2004).

Historical Policies and Outcomes Relevant to Specific Aspects of Smart Growth and TOD

In addition to documenting the broad issues affecting smart growth, it is possible to analyze specific factors that contribute to smart growth and TOD. This paper separates them into four

categories: intra-urban form, agricultural land use policy, transportation, and the distribution of urban population.⁶ Governments at various levels can have significant impact on all four of these factors.

Intra-urban form concerns the spatial layout of cities and whether they achieve some of the “five D’s” (particularly intra-city density, diversity, design, and destination accessibility) discussed in Section II. Agricultural land use involves how closely national goals to protect agricultural land from development have been followed. If land use plans are poorly followed, cities should have a greater tendency to sprawl. The third issue, transportation, primarily deals with whether public transportation systems or extensive road networks get built, which will clearly affect travel behavior. Finally, the distribution of urban population has an uncertain effect; while smaller cities tend to be less dense, MGI (2009) contends that a larger percentage of the population in smaller cities will also lead to lower levels of GDP growth, which should tend to limit transportation oil use.

In terms of intra-urban form, government policies show no consistent pattern of being supportive of smart growth or detrimental to it, but supportive policies have rarely been followed. Various qualitative indicators tend to point to some degree of sprawl and low-density construction. Meanwhile, the national agricultural land use plan has been extremely explicit in calling for limits to how much land can be converted for development, which would tend to support higher-density cities. However, tax rules that impoverish local governments unless they can lease significant amounts of land have limited the effectiveness of the land use plan, and it appears that more farmland has been lost than what the national land use plan allocated. As for transportation, the government seems to have substantial influence over its development, and priorities have changed recently in a direction favorable to smart growth. While investment heavily favored road construction in the late 1990s and through much of the last decade, recent trends indicate a large movement toward rail investment by the central government and a noticeable increase in local government public transportation spending. Finally, the Chinese government has promoted the growth of cities under a half-million residents, and although precisely comparable data are not available, slightly more than half of new urban residents between 1990 and 2005 are living in cities of fewer than 750,000 residents.

Before analyzing each of the categories in turn, the data concerning changes in the overall density of cities will be presented. Density is the simplest, most straightforward way to provide a quantitative look at how cities are developing, though it is certainly not the only important variable. Changes in density are results of all of the factors covered in this section. While intra-urban form is clearly very important, increased agricultural land use for development will tend to reduce density, as will movements of population into smaller cities, extensive road transportation at the expense of public transportation, and slower economic growth.

Analyzing the Changing Density of Chinese Cities

The quickest macro way to look at whether cities in China are growing in a sprawling or more compact way would be to compare the population with what is known as the “urban built-up area.” For China, the built-up area is defined as having an average population density of at least 15 p/ha or being contiguous to that area (Chan 2009). However, such a process is somewhat difficult for China. Most population data other than the census and a survey conducted every five years count the registered population, which can differ quite substantially from the actual population living in a particular city (Chan 2007).

Most sources suggest that cities have gotten less dense, though not all. Yang Weimin, secretary general of the National Development and Reform Commission, said in March 2011 that in the 21st century, the urban built-up area of the country had expanded by 50 percent while the urban population only increased by 26 percent (NDRC 2011). According to Yeh, Xu, and Liu (2011), the annual growth rate of the urban population was four percent, while the urban built-up area grew about six percent/year from 1981 to 2008. Density in this urban built-up area, which currently has about half of all urban residents, declined from about 110-120 p/ha in 1981 to about 87 p/ha by 2008. A rough approach involves looking at the density of individual cities; one calculation of urban densities of the built-up area of six major Chinese cities averaged about 146 p/ha in 1995, but data from Demographia for 2010 for the same cities averaged a little under 60 p/ha, suggesting a substantial loss of density (Knapp and Zhao 2009; Demographia 2011). However, Tian and Ma (2009), using data from the China Statistical Yearbook between 1995 and 2005, report that the urban population increased by 59.7 percent, roughly the same rate as the urbanized area, which increased by 65.7 percent.

The Future of Urban Sprawl in China

A difficulty with much of the data is that it is usually easier to find data on the density of urban districts rather than built-up areas. Urban districts are under the control of a city government, but much of the land can remain fairly rural. It is an administrative classification rather than a description of how urbanized the land actually is (Zhao, Lü, and Woltjer 2009). As an administrative classification, it only changes when cities expand and convert rural counties into urban districts. For instance, using China City Statistical Yearbooks for 2001 and 2009 data, the average density of the urban areas of the roughly 300 cities covered fell by about 7 percent. However, about two-thirds of the cities technically increased their density, and a significant reason why was that about one-third of cities did not increase the size of their districts at all in that period, so any increase in population would be registered as an increase in density. Therefore, claims such as those made by the Urban China Initiative (UCI) that 71 percent of the cities it studied increased in terms of population density between 2007 and 2009 are questionable because it likely is analyzing the administrative definition, not to mention that the data are counting registered rather than actual population (Woetzel et al. 2010).

Intra-Urban Form

In the years before the economic reforms of 1978, China was fairly conducive to smart growth principles, mostly by accident or necessity. Many urban workers were residents of “danwei” work unit compounds. These compounds included the place of work, housing that was employer-provided or very subsidized, and basic amenities. A worker rarely had to travel anywhere outside of a short bicycle commute. In terms of land use, the spatial extent of the cities was relatively modest, limiting the potential for sprawl and future high levels of oil use if motor vehicles became more common in the future (Feng, Wu, and Logan 2008). The population remained overwhelming rural, never increasing above 20 percent of the population (UN Population Division 2009). Despite the danwei work units and the relatively small cities, the plans themselves were not thought out in a way that would reduce energy use; a common pattern included industrial quarters in the northwest and east, a cultural-education section in the northwestern suburbs and satellite towns in outer suburbs (Feng, Wu, and Logan 2008).

Since 1978, the urban population has increased dramatically, and the national government has generally tried to discourage the continuation of the state-owned danweis and provide or allow

for housing with more space than the small, cramped quarters typical of the danweis. Fewer workers in danweis means that workers tend to live farther away from their jobs and will have longer commutes. Decentralized and more single-use development patterns that require more oil for transportation also become more common.

This decline of the danweis is largely inevitable in an economy that is becoming more market-oriented like China's. Danweis require state-owned firms that provide all housing and necessities for their employees, whose other options for employment and residence are limited. In a market economy, firms will tend to cluster, and jobs and housing will respond to relative prices for rent.

As for modern urban planning, some of the goals could be interpreted in ways quite favorable to the promotion of smart growth principles. The 2006 Explanatory Notes, while general in nature, tell urban planners to consume natural resources efficiently, protect ecological resources and promote sustainable development (Song and Pan 2009).⁷ In order to prepare the master urban plan, municipal governments are supposed to evaluate the carrying capacities of the natural and ecological systems. Furthermore, the City-Town System Plan that comes before the Master Plan is supposed to “propose goals in environmental protection, land and water preservation [and] energy consumption and conservation” (Song and Pan 2009).

In addition to the urban plans, the government has issued many guidelines that tend to support the core principles of smart growth, including density and mixed-use development. In 1990, the National Urban Land Use Classification and Planning Standard prescribed residential population density in large cities should be no less than an average of 140 per hectare (Zhao 2011). This level is much higher than most cities in the developed world and is roughly equal to some selected cities in developing countries as of the year 2000 (Angel et al. 2011). Additionally, through primarily on farmland, a 2006 regulation restricts construction of developments with low-density and wide boulevards (Appleyard et al. 2007).⁸ The National Residential Areas Planning Criterion from 1994 also promoted mixed-use development in new urban areas (Zhao, Lü, and Woltjer 2009).

The Future of Urban Sprawl in China

However, with decentralization increasing the power of local governments, some of these central government directives are not followed. For instance, Ding (2011) says that the policy to encourage residential density of 140 p/ha is unheeded. Additionally, the government has encouraged moving outside the center city to relieve overcrowding, allowed citizens to have more living space, and eliminated dilapidated housing. In 1978, per-capita floor space in urban areas was a tiny 6.7 meters squared (m^2), a figure that increased over four-fold to $28 m^2$ by 2007 (Wang et al. 2010). As a comparison, per capita urban living space was $37m^2$ in France in 1999 and $67m^2$ in the U.S. in 2003 (Appleyard et al. 2007). From 1990-1997, one-third of the buildings in the old center city of Beijing were structurally unstable and dangerous, leading the Beijing government to redevelop and reconstruct much of the area (Ding and Lichtenberg 2009). Such programs to reduce overcrowding and unsafe housing are very socially laudable, but the methods Chinese leaders have used of sending residents outside of city centers tends to reduce density and increase transportation oil use.

In qualitative terms, many Chinese cities are experiencing suburbanization. This suburbanization includes large box stores similar to what is found in American suburbs, and the growth of suburban retail outlets tends to increase commuting distances (Campanella 2008). Suburban communities in China are not completely counter to smart growth principles – they are complete with housing, jobs and retail outlets, and Feng, Wu, and Logan (2008) believe it is doubtful that suburbanization will reach the levels of North American cities – but they tend to make private automobile use more desirable.

Other spatial patterns that tend to increase the need for driving have also been identified. Ding (2009) describes five “dumb” growth patterns prominent in China:

“(1) sporadic employment centers and industrial zones within a metropolitan area [sic]; (2) uncoordinated and chaotic land development patterns; (3) over-clustering of homogenous nonresidential uses, such as 10 universities clustered in a university complex; (4) urban villages or villages in cities; (5) leapfrogging urban growth and urban sprawl”

The Future of Urban Sprawl in China

Another problematic pattern involves “ribbon” development alongside roads and highways that tend to invite private vehicle use (Yusuf and Nabeshima 2008). There are frequently illegal developments in some rural townships that tend to be far from city centers, sometimes called “local urban sprawl” (Hsing 2010; Yaping and Min 2009). These communities often lack infrastructure but provide housing to less wealthy residents, some of whom are migrants into urban areas. On the other end of the income distribution, some wealthy Chinese are choosing to live in “villas” that are in purely residential communities that are designed for auto ownership and are relatively far from employment or shopping areas (Campanella 2008).

Still, there is a near-term benefit of wealthier people who often live, at least part of the time, closer to the center of cities where there is a greater likelihood of shorter commutes and public transportation. Ding (2004) shows that for Beijing between 1993-2000, the land price for residential properties was higher closer to the center of the city than toward the suburbs. Even in cities with many skyscrapers in the center of cities, the apartments are so expensive that they are often for the wealthy, who sometimes treat them as investment properties, while those of lesser means have to live in the suburbs (Qian 2011). This gap, which has likely continued as the real estate markets have matured, effectively means primarily well-off citizens will live close to the city center and have less need for personal vehicles, although some wealthier residents choose to have second homes in more suburban areas (Ma 2004). For instance, Feng, Wu and Logan (2008) report that as of 2000, areas of Beijing with high levels of education and most likely higher incomes are relatively close to the core in the northern and western parts of the city. Eventually, however, if the Chinese economy and wages continue to grow, at some point, even those who live in more affordable communities farther from the city center and are considered middle-class by Chinese standards will have the resources to purchase vehicles and use them.

Agricultural Land Policy

Land in China is technically owned by the state government and is either considered rural or urban. Before the period of economic reforms, land was allocated by administrative means, but it changed dramatically with the Land Administration Law, especially the 1988 amendment, which stated that “land use rights can be transferred in accordance with the law” (Yaping and Min

2009). With this change, land can still not be sold, but land can now be leased for very long periods of time.

Since 1990, various aspects of land use plans have been very favorable to smart growth. In the 1990s, the Chinese government promulgated a variety of policies and administrative orders that were designed to increase land protection (Yaping and Min 2009).⁹ These policies included mandates that China's cultivated area not fall below a certain threshold, all governments above the county level had to designate certain particular farm land as protection zones, protected lands could only be transferred to construction use with State Council approval, the central authority would draft an annual quota of new construction land for each municipality, and farm land lost to conversion had to be replaced by new farm land. Other restrictions on farm land grouped land by productivity (Ding 2009). High quality and high productivity farmland could not be converted to long-term non-agricultural use, and other conversion of other farmland had time limits and required State Council approval.

However, the ability to lease land led to the opening of a huge market for land that is difficult for central land-use plans to overcome. A thriving market is already a challenge to any centrally-dictated land-use or urban plans, but the push for political and economic decentralization as well as a host of incentives hinder the ability of central plans to constrain land being taken for purposes of construction and urban development. Chinese cities have significant control over their development, a concept some have called a "Duke Economy" (Feng, Logan, and Wu 2008).

These local governments face a host of incentives that encourage them to lease substantial amounts of land. One major issue is that they lack sufficient revenues, making the leasing of land much more enticing. In 1994, China's tax system went through a large overhaul that increased the tax revenue going to the central government to the detriment of local governments (Yaping and Min 2009). Previously, the central government had run persistent deficits, but suddenly the central government began running surpluses, while local governments found themselves in a deficit (Lichtenberg and Ding 2009). In China, local governments are supposed to provide many public services such as unemployment insurance, social security and welfare that fall under the purview of higher-level governments in most other societies, leading to a much higher level of

sub-national spending as a proportion of total Chinese government expenditures than other countries at similar stages of development (Saich 2008).

The portion of municipal revenue that comes from land leasing has been very high in some cities. It can account for between quarter and half of municipal revenues (Knaap and Zhao 2009). In the mid-2000s, this “conveyance fee” that local governments get for leasing the land was estimated to account for 27 percent of local government revenue (Lichtenberg and Ding 2009). The Budget Law of 1995 also prevents local governments from issuing bonds, further restricting their choices for raising revenue (Saich 2008). Unsurprisingly, with so much revenue at stake, the value of converting this land can greatly exceed the value of protecting it. Local-level governments have tried a variety of means of raising revenue in addition to leasing land, but they haven’t been sufficient on their own (Saich 2008).

Local urban governments have been able to exploit rules to earn huge profits from requisitioning rural land, thereby expanding the size of urban areas and potentially leading to sprawl. These urban governments, often municipal governments, can take rural, village land when it is in the “public interest” (Hsing 2010). This “public interest” is often interpreted very broadly, and local governments have often requisitioned rural land for what more clearly would benefit government coffers or developers.

The local urban governments have benefitted from a history of paying rural landowners a small fraction of the value of the land, allowing local urban governments to make huge profits by leasing land. It is widely believed that the compensation for rural land requisition is very low, and fragmentary, anecdotal evidence suggests that the conveyance fees can be 10 to 20 times the amount they paid the village residents, although some of them also receive status as urban residents (urban hukou) as part of their compensation (Lichtenberg and Ding 2009). In Beijing in the early 2000s, land costs contributed about 60 percent of redevelopment costs of urban areas compared with 30 to 40 percent of the cost of converting rural land (Knapp and Zhao 2009). This difference helps promote sprawl on urban fringes of cities rather than development closer to the core.

It should be noted, however, though they will not by themselves strongly encourage smart growth, recently there have been policy changes that may reduce the incentives of local leaders to lease land or increase development at all costs. Shanghai and Chongqing both introduced property taxes in 2011 (China Briefing 2011). Property taxes can in theory provide a steadier stream of revenue to local governments, reducing the incentive to lease land. Still, property taxes are no panacea for sprawl—the U.S., after all, has property taxes and is far from a model of smart growth or TOD—and the policy was most likely put in place to try to curb real estate speculation.

Data from Chan (2009) suggest that much more farmland has been lost than the national land use plan called for. The national land-use plan targeted that cultivated land nationally would only fall from 1.3 million kilometers squared (km^2) in 1997 to 1.28 million km^2 by 2010. However, by 2005, surveys indicate that there were only 1.22 million km^2 still used, or 95.4 percent of the 2010 goal. It should be noted that it is difficult to know exactly how much cultivated land is in use nationally because these numbers are from a self-reporting system rather than a comprehensive auditing system (Ding 2011; Chan 2009).

Surprisingly, the surveys indicate that only about six percent of this loss was due to new construction (Chan 2009). The majority of lost cultivated land was a result of programs to replant forests and grasslands in response to flooding in 1998. In 2007, the replanting programs were halted for further review.

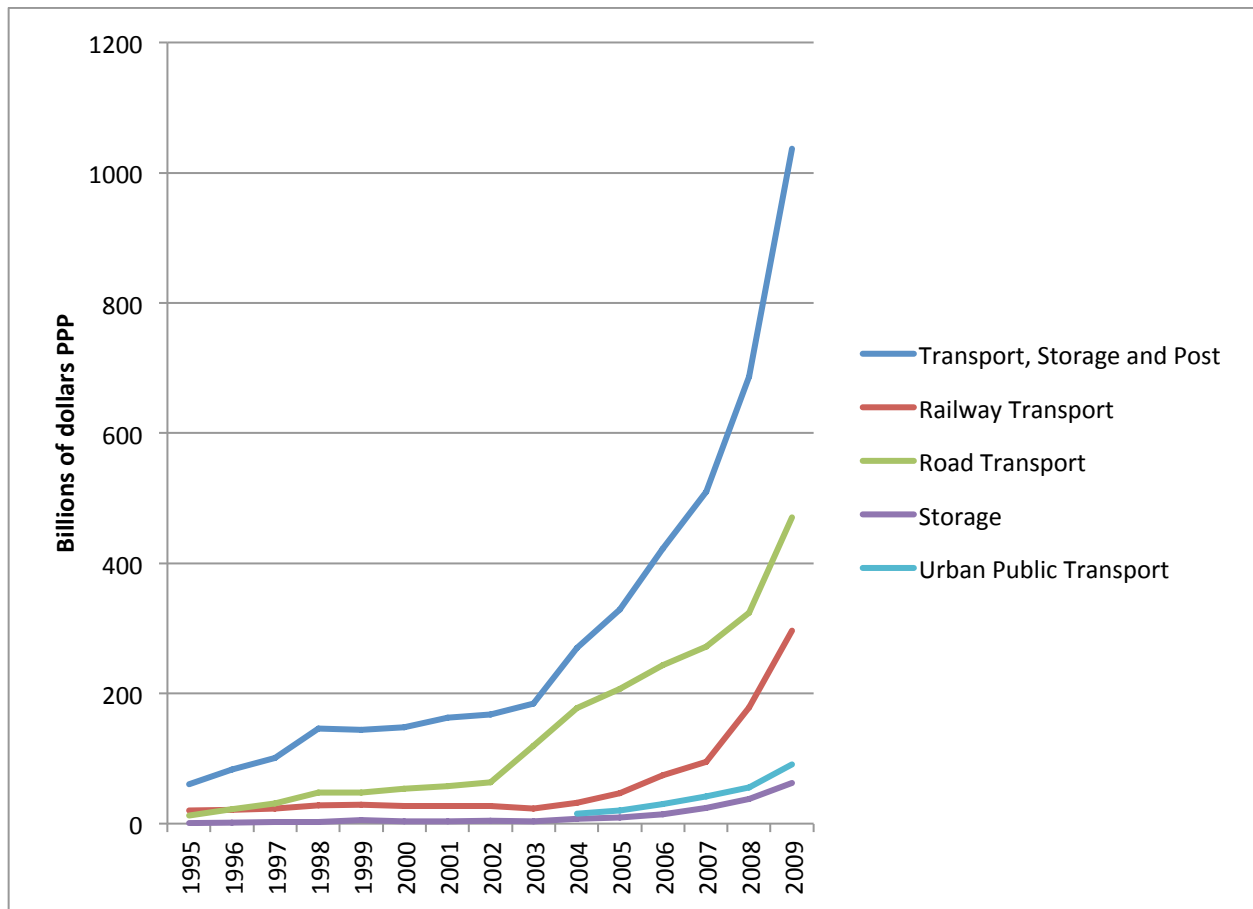
Since 2005, it appears as though the loss of cultivated land has slowed somewhat. As of 2008, China reportedly had 1.217 million km^2 of cultivated land, which is only a small decline from levels in 2005 (China Statistical Yearbook 2010). Still, these data are uncertain considering there was an ongoing survey at that time.

Transportation Priorities

Transportation is an area where government priorities can have substantial influence. Starting in the mid-1990s to roughly the mid-2000s, Chinese transportation investment patterns heavily favored roads. As seen in Figure 1, which looks at investment in fixed assets in urban areas, road

investment first outpaced rail in 1996 and in 2004 peaked at over 65 percent of total transport, storage and post investment (China Statistical Yearbook, various years). Recent years have seen a sharp increase in all forms of transportation investment. By 2009, road investment was still the largest single component of total transport, storage and post investment, but its share had fallen to about 45 percent. Urban public transportation data only were reported beginning in 2004.

Figure 1. Urban Investment in Transportation (in billions of 2005 U.S. dollars, Purchasing Power Parity)



Source: China Statistical Yearbook, various years; Heston et al. (2011); Bureau of Labor Statistics (2011)

The boom in road construction is especially apparent with high-speed expressways, which are similar to the U.S.'s Interstate Highway System. In 1998, China had less than 10,000 kms of expressways. By 2005, China had more than four times as much, 41,000 kms, and it increased by more than another 50 percent in the following four years to 65,100 kms (China Statistical Yearbook 2009). Although overall road construction has grown more slowly since 2005, it has still increased the total length of roads in China increased a little over 15 percent, from 3.35

The Future of Urban Sprawl in China

million km to 3.86 million km (China Statistical Yearbook 2009). To put these figures in context, the length of China’s expressways in 2009 is about 85 percent of the length of the U.S. Interstate System (75,440 km, or 46,876 miles) and 60 percent of the length of the U.S. roads as of 2003 (6.515 million km) (Department of Transportation; Statinfo).

The growth of road construction is also very apparent within individual cities. Beijing, for instance, now has five “ring roads,” which are beltways around the city (Sperling and Gordon 2009).¹⁰ The outmost three ring roads were all completed since 2000, with much of the construction occurring in the first half of the last decade.

However, the proportion of total transportation investment going toward urban public transportation has increased since 2004 (see Table 5). The increase is not as stark as it has been for railroads, but it is notable that while the increase in rail investment was a result of central government expenditures, urban mass transit increased primarily because of the choices of local governments. Local governments are also responsible for the majority of road investments in urban areas, so a change in their focus toward public transportation appears to be responsible for the shift.

Table 5. Transport, Storage and Post Construction and Investment Expenditures in Urban Areas

	2009 Investment Percentage of Total	2004 Investment Percentage of Total	2009 Percentage of Investment from Central Gov’t	2004 Percentage of Investment from Central Gov’t
Rail	28.6%	11.9%	91.0%	88.9%
Road	45.4%	65.8%	1.8%	4.3%
Urban Public	8.7%	5.5%	1.5%	0.1%
Water	7.2%	7.5%	18.3%	19.9%
Other*	10.1%	9.2%	9.3%	47.6%

* Includes Air, Pipelines, Transport Services, Storage, and Post

Sources: China Statistical Yearbook (2005 and 2010)¹¹

Certain local governments, with the prodding of the central government, are shifting their focus back away from cars. In 2004, Shanghai banned nine million bicyclists from main roads in the city (Sperling and Gordon 2009). Yet in 2006, the central government strongly called for local

governments preserve or restore bike lanes (Forbes). Since then, Shanghai began converting car lanes back to bike lanes in 2007. Beijing announced a plan in 2010 of improving bicycle lands and bike rental programs with the goal of increasing the number of cyclists by 25 percent by the end of the 12th Five-Year Plan. (Watts 2010). It should be mentioned, however, that some believe that Beijing is too polluted, congested and dangerous to support a return to widespread bicycle use (Qian 2011).

Though the relative increase in spending on urban public transportation seems modest, actual construction spending more than doubled and investment spending jumped by almost 3.5 times between 2004 and 2009. These spending increases coincided with a rapid increase in subway and Bus Rapid Transit (BRT) systems. As of March 2009, fifteen cities in China were building subway lines and a dozen more were planning them (Bradsher 2009). BRT usually involves a dedicated lane on roads specifically for buses, although in some cases buses use high-occupancy vehicle (HOV) lanes. By mid-2012, BRT operates in 14 Chinese cities. Of the 14, all but two have opened in 2006 or later (Bus Rapid Transit). By 2030, MGI (2009) expects China could build over 170 mass transit systems.

The increase in urban transportation expenditures has likely also benefitted regular city buses, which according to UCI will remain the primary means of public transportation and “will probably be the linchpin of urban mass transit for the foreseeable future” (Woetzel 2011a). The UCI goes on to describe the city of Qingdao, which increased bus ridership by 17 percent per capita from 2005 to 2008 by adding routes and transit hubs and focusing development along bus lines. On the whole, the UCI says that public transportation in China has been improving and at least meets the developed world standard, with the average number of bus trips per person in Chinese cities rising from 117 to 150 from 2006 to 2008, with some first-tier cities at much higher levels (Woetzel et al. 2010).

On the whole, the investment in urban public transportation may be helping to stabilize the percentage of trips taken in public transportation vehicles, as seen in a study of transportation use and CO2 emissions in 17 Chinese cities through 2006 (Darido, Torres and Mehndiratta 2009). That study, the China-Global Environment Facility Urban Transport Partnership Project, also

concluded that cities showed a clear shift toward private vehicles, with many fewer people taking non-motorized modes such as walking or bicycling.

The recent shifts among local governments toward urban public transportation and the national government toward rail are promising, as are the increases in subways and BRT systems. However, the sheer number of cities that need public transportation networks is simply astounding. As of 2008, 133 urban areas had at least 750,000 urban residents, and yet those urban residents only accounted for about 43 percent of China's urban population (UN Population Division 2009). The rest are in hundreds of smaller cities that are unlikely candidates for fancy subway systems. Much of China's transportation future depends on those local governments encouraging buses and non-motorized transportation, as well as following smart growth principles.

Distribution of Urban Population

As explained earlier, population that is distributed in smaller cities goals will tend to lead to cities that are less dense, but it may lead to lower levels of GDP/capita (Angel et al. 2011, MGI 2009). Since the 1989 City Planning Act, the Chinese government tries to "strictly control" the dimensions of cities with a population of greater than 500,000 but "reasonably develop" smaller cities, which effectively is a bias toward the promotion of smaller cities (Song and Pan 2009). According to a 2004 Medium and Long-term Energy Conservation Plan released by the National Development and Reform Commission, smaller cities will likely be more car-intensive. The Plan states that road public transportation should be the priority in large cities, with rail as "auxiliary" and private motor vehicles as "supplementary" (NDRC 2004). Yet while the plan attempts to de-emphasize private cars in large cities, it gives equal billing to road public transportation and private vehicles in smaller cities, saying that "road public transport and private vehicle transport shall become the main development direction." The 12th 5YP also makes distinctions of the types of public transportation that should be available in cities of different sizes (12th 5-Year 2011b).

Looking at the data, it is clear is that a significant proportion of Chinese residents who are becoming urban residents (either because they move or are annexed into urban areas) reside in small and medium-sized cities or outside of cities altogether. The UN has urban population data

for cities with more than an estimated 750,000 residents as of 2008 (UN Population Division 2009). Slightly less than half of the 255 million people who became urban residents between 1990 and 2005 live in one of the cities that has over 750,000 residents. While the trend is toward larger cities—only 38 percent of the urban population as of 1990 lived in these cities—a large portion of urban residents do not live in these cities.

There is some direct evidence that the push for smaller Chinese cities has lowered output, though considering that China has grown at roughly nine percent per year since economic liberalization began in 1978, which is already extremely rapid development from an historical perspective, it is difficult to imagine that more concentrated urbanization into large cities would have increased growth rates much further. Au and Henderson (2005), for instance, use data from 1990 and 1997 to conclude that a large fraction of Chinese cities were undersized due to migration restrictions, which led to large income losses. However, there may be fewer if any benefits of huge cities, unlike the MGI (2009) argument. Au and Henderson (2005) find that benefits eventually reach a peak at a certain city size and then slowly decline, and Fu and Hong (2011), using 2004 China manufacturing census data, conclude that while productivity increases with city size, the effect becomes negative for cities over two million people.

Another potential issue is where population growth and urbanization occurs. The Economist Intelligence Unit (2010) documents the 20 fastest-growing Chinese cities, which tend to be in the center of the country rather than on the coast, the region that has led development since economic liberalization in 1978. The average incomes in these cities are also expected to grow more quickly than in the current richest cities. If rail infrastructure cannot keep pace, such growth could lead to more traveling on roads between these cities and those on the coast, and it could also increase the need for moving freight between cities on roads (Medlock, Soligo, and Coan 2011).

Beijing: A Case Study of the Power of Urban Plans

Beijing is a case study of whether central government and municipal plans can be effective. It indicates plans can be partially effective, as the government has a degree of influence but is still strongly subject to the power of the market and other incentives. Cities less established than

Beijing, however, may not even be able to match Beijing's ability to affect housing and population trends.

With its urban master plan in 1982, Beijing began to emphasize greenbelts, a ring of land outside of the center of a city that was supposed to be free from development (Zhou, Lü, and Woltjer 2009). Such policies have been tried, with mixed success, in the U.K. and South Korea (Bae 2009). Beijing's urban plan also emphasized suburban development in "constellations" outside of the greenbelt. Following a broader national trend, Beijing since the early 1980s has also tried to reduce overcrowding in the central core of the city.

In a series of papers, Pengjun Zhao and his colleagues analyzed the spatial growth of Beijing between 1990 and the present (e.g. Zhao 2011; Zhao, Lü and Woltjer 2009). They found that all these policies were partially successful, with the results of the push to reduce overcrowding in the central part of the city arguably the most successful in terms of corresponding with Beijing's original goals.

Data on the greenbelts suggest that they may not have substantially reduced population growth, but they did increase density within the greenbelt. In his papers, Zhao and his colleagues divided the central six districts with their associated 139 sub-districts of Beijing into five zones that are essentially concentric. Starting from the center of the city, they charted changes in the city core, followed by mixed urban areas, the greenbelt, the peripheral constellation areas and finally the outer suburban areas. Between 1990 and 2000, population growth was the slowest in the inner two areas and the quickest in the outer two, with the greenbelt in the middle, suggesting that the greenbelt did little to reduce population growth (Zhao, Lu, and Woltjer 2009). They found that the net population density of the greenbelt, however, increased by the most of any area, which they attributed to the land development control. From 2000 to 2009, the data from Zhao (2011) indicate that the population of the greenbelt has increased more slowly than the closer-in mixed urban area, though it should be warned that 2009 figures are more likely a reflection of registration status rather than actual population in these regions.

Table 5: Population Growth in Zones of Beijing

	Growth Between 1990-2000	Growth Between 1990-2009	Growth Between 2000-2009
Center	-8.4%	-10.3%	-2.1%
Mixed Urban Area	45%	66.5%	14.8%
Greenbelt	75.7%	93.7%	10.2%
Peripheral Constellations	93%	137.2%	22.9%
Outer Suburban Areas	93.5%	120.6%	14.0%

Sources: Zhao, Lü, and Woltjer (2009); Zhao (2011); author’s calculations

As also seen in Table 5, between 2000 and 2009, the data available indicate the constellations grew more quickly than the more far-flung outer suburban areas, apparently showing the policies to be effective to some degree. Also, in both decades since 1990, the center of the city actually lost population. This population loss occurred in a city whose urban population has expanded from 6.8 million to an estimated 12.2 million, or by about 80 percent, from 1990 to 2009 (UN Population Division 2009). Some of this loss may be due the market encouraging suburbanization, especially as residents have more transportation options, but it hints that the government may be effective at urban policies that actually enhance sprawl rather than limiting it.

Another issue is the spatial makeup of the city in terms of the other “d’s” that encourage lower VKT: diversity, design, destination accessibility, and distance to transit. While it is sometimes unclear what the city government tried to promote in terms of these issues, the central six districts of Beijing as a whole scored better on nearly all of them in 2009 relative to 1990 except for the net density of employment (Zhao 2011). The central core of the city generally moved in the opposite direction, however, with lower density of employment, less mixed-use and a worse jobs-households balance than before. On the whole, Zhao (2011) was fairly impressed with Beijing’s ability to contain growth in the greenbelt and improve these other factors associated with lower VKT that he collectively called promoting “urban compactness,” though he noticed issues with unexpected growth in more suburban areas and decreases in some of these measures in various sub-districts, especially in the city center.

IV. Looking to the Future

In order to project how cities will grow in the next couple of decades, it is necessary to separately consider land-use, urban, and transportation plans. There is a reasonable likelihood that the current status quo will continue, with land-use plans being ineffective and urban plans not necessarily corresponding to smart growth principles and not being followed well, while public transportation infrastructure spending continues to pick up.

However, trends could change in a direction that promotes more smart growth and TOD, particularly for land-use and urban plans. Projecting food demand and supply strongly suggests that Chinese leaders should be concerned about food security. This concern could lead them to finally enforce land-use plans and try to encourage higher density and more smart growth in order to limit the encroachment of cities onto agricultural land. Additionally, there has recently been central government rhetoric and plans promoting specific smart-growth principles such as encouraging high-density development in existing urbanized areas. Related rhetoric and interest in “low-carbon cities” could eventually include smart growth.

Yet the major incentives that drive local governments to lease land have not been addressed, and it is unclear what the incentives are to local governments to support urban plans that encourage high-density smart growth. According to Chengri Ding (2011), politicians, as in other countries, are focused on near-term challenges and solutions that show immediate benefits. This focus is quite useful for getting public transportation networks such as subway systems built, but it hinders more gradual changes in urban patterns toward more high-density, mixed-use spaces. The growth of public transportation projects is therefore likely to continue, while land-use and urban planning that promote smart growth may very well continue to lag.

Unless Chinese governments change course and begin to strongly focus on encouraging higher-density cities, the density of cities will likely continue to fall as incomes increase. Growth of public transportation systems would encourage development more in line with smart growth and TOD, but it can be substantially enhanced with land-use and urban plans (Anderlini 2010).

Future Land-Use Planning: Agricultural Constraints Could Finally Lead to Enforcement

China has a longstanding policy of trying to protect agricultural land by restricting its conversion in national land-use plans, but these goals have not been met. Local governments are still starved for revenue and able to lease land at much higher rates than the compensation paid to rural residents; an estimate released in September 2011 based on survey data found that rural residents only receive one-fifteenth of what developers pay for leasing rights (Bradsher 2011). Unless these fundamental incentives change, it does not appear that anything dramatic will change in terms of agricultural land protection. Development will continue to expand outward, taking away agricultural land. It should be noted that if food output is squeezed too much from growing cities, it will push up the price of agricultural land and tend to eventually limit sprawl, but this scenario would imply that the price of food itself would likely be high and volatile, a situation the government would rather avoid.

Rather than large-scale change in the short-run, some incremental changes may be occurring. Jonathan Woetzel of McKinsey thinks the government is “beginning to emphasize density in planning more, as land conversion rights are increasingly hard to come by” (Woetzel 2011a). The central government has also banned many state-owned enterprises from being the lessee in land deals and has put restrictions on banks so they cannot as easily lend to developers (“Building” 2011). As previously mentioned, there have also been pilots of property taxes in Shanghai and Chongqing, which could provide a steadier stream of income (China Briefing 2011).

But to analyze the likelihood of major changes in policy going forward, it becomes necessary to estimate the severity of agricultural land-use availability. China already has a low level of cultivated land per person, and this will only get worse as cities expand, consumers demand more meat, and the population—though slowly—continues to increase. The central government is not necessarily concerned about its population starving, but it would like ensure reliable and affordable food for its population. The price of pork, the staple meat in the Chinese diet, increased by nearly 60 percent between January and September 2011 (Pierson 2011). Many years of volatile food prices could antagonize residents and put the power of Chinese leadership at risk.

The Future of Urban Sprawl in China

The combination of expanding cities and increased meat consumption may be worrisome enough to encourage the Chinese government to change its policies and eventually reduce the incentive for local governments to lease land in order to remain solvent. Between 1991 and 2009, grain output per hectare increased at an annual rate of about 1.3 percent, and the same was true comparing the similar timeframe 1990-2005 (China Statistical Yearbook; MGI 2009). China might be able to continue this rate of growth in efficiency, as its output per hectare is still about 20 percent lower than that seen in developed countries such as the U.S. and Japan (MGI 2009). Yet even if output continues to rise at previous levels, supply may still not keep up with demand.

MGI (2009) projects that depending on the growth patterns of cities, agricultural land will decrease by between 7 and 22 percent between 2005 and 2025, with a trendline of 15 percent. The least land is lost in the dense hub-and-spoke and supercities scenarios, while the most is lost if smaller cities grow quickly. Adding in population growth, which is expected to be about 11 percent between 2005 and 2025, leads to a reduction in arable land/capita of between 16 and 30 percent by 2025, with a trendline of a 23 percent reduction.

With just this loss of arable land, grain output per hectare would have to grow by 0.8%-1.8%/year, with a trendline of 1.3%/year. In other words, just the expected growth in population and city size requires the previous efficiency gains of 1.3%/year to continue. Yet these estimates assume that the Chinese diet will remain the same, which is very unlikely.

As countries get wealthier, its residents demand more meat and animal products (Delgado 2003). Eating meat is an inefficient means of consuming calories; because animals do not convert all the calories from the crops they eat into calories that humans can consume, more land is required to grow crops for a carnivorous population than for a primarily vegetarian population. For instance, it takes 4-5 times as many Calories of grain that a human could consume in order to get one Calorie of pork (Smil 2000). Meanwhile, beef, which is the least efficient meat, requires closer to 15 Calories of grain.

Chinese residents already eat a relatively high amount of meat given their level of income, but it still has room to grow. China's level of consumption of animal products is higher than Japan's

(FAO 2009). However, considering meat output has increased fairly rapidly by 2.7%/year between 2000 and 2009 with no sign of abating, and it is not yet anywhere near the consumption level of the U.S., Chinese consumption of animal products is likely to continue to increase (FAO 2009; China Statistical Yearbook). In grain-equivalent terms, which also take into account the Calories needed to feed livestock to produce animal products, an average Chinese resident between 2003-2005 required about 5,000 Calories of grain production per day while a U.S. resident needed roughly 8,000.¹² Of the difference, over 60 percent was due to the higher levels of animal product consumption in the U.S., with about 30 percent due to greater levels of consumption and waste in the U.S. and a little under 10 percent from American's propensity to eat inefficient kinds of meat such as beef.

These figures present an opportunity to think of the constraints facing China. If the loss of agricultural land is at the low end of the estimates from MGI (2009), Calorie consumption per person could increase by between 400-500 Calories per person and China would be in the same situation it is in now, assuming efficiency increases can continue at 1.3%/year. Even this scenario may be uncomfortable for the central government considering that this is a relatively small increase in consumption compared with the 3,000 additional Calories required to be grown to currently feed Americans. Still, this scenario leaves China much less vulnerable to volatile food prices or potential shortages and should be very attractive to the central government, encouraging it to promote high-density and/or larger cities. It seems reasonable that the fear of problems from insufficient agricultural land could push the government to reform the tax system so local governments are not so desperate to lease land.

Future Urban Planning: Rhetoric and Collaboration Favorable to Smart Growth, but Unclear Outcomes

Very recently, leaders in China and the text of plans have begun hinting that high-density development is considered desirable in China. In addition, concepts that could dovetail well with smart-growth initiatives have become more common such as a concern about sustainability and cities that emit low amounts of carbon. "Eco-cities" that would use little or no oil have been proposed, and there is willingness to collaborate with outside experts concerning smart growth initiatives.

However, at this point, it is very unclear that anything concrete will be done to promote smart growth, especially high-density development. As expert Chengri Ding notes (2011), achieving smart growth in urban planning is a very-low level concern for most Chinese leaders, who have to focus on problems that are facing the country right now or would rather have showy projects that are easily seen. High-density urban planning generally shows its benefit decades from now when the country is using substantially less oil. In another interview, JingJing Qian (2011) says that emphasizing high density tends to be an unpopular idea, and even though senior officials of the Ministry of Housing and Urban-Rural Development have pointed out the problems associated with wide roads and the wasteful use of land in the past, it has had difficulty getting local governments to focus on the issue. The 12th 5YP still calls for alleviating the pressure of city centers, which suggests a continued push to reduce density, at least in some cities (12th 5-Year 2011).

In terms of emphasizing growth of small or large cities, the 12th 5YP is continuing more emphasis on the growth of smaller cities, and it has a strategy to divert resources to smaller cities so the biggest cities are not as burdened (Qian 2011). This path would suggest that many new urban residents will move to smaller cities, generally following the trendline from MGI (2009) or even in the direction of the scenarios where much of the new urban population moves to smaller cities. A story circulated that there was a proposal to “Turn the Pearl Delta Into One” and create a connected supercity of 42 million including Guangzhou and Shenzhen (Moore and Foster 2011). However, authorities in Guangzhou immediately denied such a project was being planned, though it did admit that there are plans for three economic circles (the other two near Beijing and Shanghai) with an integrated system of infrastructure, planning, environmental protection and basic public services (Langdon 2011).

Rhetoric Favorable to Smart Growth

In terms of rhetoric favorable to smart growth, which is suggestive that there may be some push for high-density development in the future, some of the most intriguing statements have been made very recently or are in the 12th 5YP released in March 2011. They first appeared in the proposal of the Central Committee for the 12th 5YP released in October (“Authorized” 2010). In late March, a few weeks after the release of the 5YP, Yang Weimin, Secretary General of the

The Future of Urban Sprawl in China

National Development and Reform Commission, strongly criticized low-density and decentralized development (NDRC 2011). He even made the connection between this decentralized pattern of development and energy, saying that the energy supply cannot bear the stress, not to mention the effect on agriculture. He repeated statements verbatim from the 5YP to “reasonably set the development boundary of cities, increase the population density in existing urban areas, prevent the over-expansion of the areas of extra-large cities, and standardize development of new urban districts,” all of which could correspond with smart growth, especially increasing population density. Mr. Yang noted that the NDRC will research and make a prioritized special plan for urbanization development, but it is unclear when this will happen.

More specifically, of the four statements, “reasonably set the development boundary of cities,” applies to all cities China and implies limiting the spatial size of cities. Increasing population density is a goal of smaller cities, and standardizing development also applies to smaller cities, but primarily those that will be developed in the future (“Welcome New” 2011). Increasing population density will primarily come from improved land protection, land-use efficiency, and urban functions. “Preventing the over-expansion of the areas of extra-large cities” is a continuation of the policy to promote the population growth of smaller cities rather than larger ones, which tends to reduce density but could also lead to lower GDP/capita (“Second Five” 2011). Xiwen Chen, the Deputy Chief of the Office of the Rural Work Leading Group of the Party on March 26 noted that it is impossible to depend on large cities to sustain all of the increase in the urban population, though they would continue to develop as well (“Development and Reform” 2011).

These statements collectively could be quite effective at reducing transportation oil use at a given time, if they are implemented. By both promoting high density and population growth of smaller cities, Chinese leaders are directly addressing density and doing so in a way that may further reduce oil use by potentially leading to lower levels of GDP/capita. Additionally, setting the development boundary of all cities would limit the spatial extent of cities and reduce the prevalence of sprawl.

Other rhetoric is less directly related to smart growth and focuses on low-carbon or sustainable cities, but these could likely be integrated with smart growth concepts in the future. The most visible statements came from the recent Shanghai World Expo 2010. Its motto was “Better City, Better Life,” and a “better” city was often envisioned as being sustainable and low-carbon. The “Shanghai Declaration,” the final statement of the Shanghai Expo, captures this interest in building cities with the environment and future in mind (Shanghai World Expo). The first of the goals listed is “To Establish an Ecological Civilization Oriented toward the Future,” which includes many tenets of sustainability, including a focus on urban planning:

“Cities should respect nature, consider the urban ecological environment as an asset, integrate environmental issues into urban planning and administration, and accelerate the transition to sustainable development. They should promote the use of renewable energy sources and build low-carbon eco-cities. They should strongly advocate for conservation of resources and promote environment-friendly manufacturing. Cities and their citizens should join together to create sustainable lifestyles and an ecological civilization in which people and environment co-exist in harmony.”

This focus on sustainability and low-carbon cities corresponds with the evaluations of China analysts who have noted that China’s leaders have recently seemed more concerned with sustainability and the environment in addition to economic growth (Powell 2011; Woetzel 2011a). Respected academic institutions such as the Chinese Academy of Social Sciences in 2009 also support construction of low-carbon cities to reduce energy emissions and developing a low-carbon economy (“China to Develop” 2009). This concern with also appears to be true at a local level (Hammer 2010). In the past couple of years, mayors have tried to one-up themselves to get a green reputation, and nearly all leaders are supportive of and use buzzwords that connote sustainability (Wagner 2011).

However, the Shanghai Declaration and the interest in sustainability and low-carbon cities rarely if ever directly use oil consumption as a reason to pursue the goals. The Declaration does mention the need to conserve resources, and part of the introduction of the declaration lists resource shortages as a problem that better-designed cities can help solve. Reducing oil and

energy use seem to be reasons to support these kinds of cities, but they show up more as subtexts than primary rationale.

Plans that Emphasize Low-Carbon Development

This focus on lower-carbon cities is showing up in various plans. Notably, the descriptions of them do not tend to explicitly mention oil use as a reason for promoting them, though they seem to likely correspond with smart growth ideas, especially if urban planning is involved. In August 2010, the National Development and Reform Commission (NDRC) began a national low-carbon province and low-carbon city experimental project for five provinces and eight cities¹³ that are at different stages of development (People's Daily Online 2010). According to the plan, a primary goal is to "actively promote low-carbon lifestyles and consumption patterns in order to help tackle global climate change." Xie Zhenhua, deputy director of the NDRC focused explicitly on climate change, calling it "one of the important strategies of China's economic and social development."

Some other cities had previously put forward suggestions and objectives of becoming low-carbon cities, and a low-carbon city, the Turpan model zone in the western Xinjiang province, broke ground in May 2010 (People's Daily Online 2010).¹⁴ The Turpan model zone is supposed to be "the national new-energy model city" with low-carbon policies including urban planning. As of February 2011, the supporting policies had not yet been drawn up, so the degree to which urban planning will be affected outside of the Turpan model zone is unclear (Xiaohui 2011).

"Eco-cities" have also received a great deal of attention, though they have run into many problems. "Eco-cities" are supposed to demonstrate some of the latest zero-carbon energy technologies, and 90 percent of traffic with the Tianjin Eco-City, which is currently planned for completion in 2020, is supposed to come from public transportation (Inhabitat). According to Richard Brubaker (2010), professor of sustainability at the China Europe International Business School, based in Shanghai, there were about 30 eco-cities in various stages of development as of June 2010. Another planned eco-city, Dongtan, planned for Chongming Island about an hour by ferry outside of Shanghai, has run into financing issues (Brenthouse 2010). Those two eco-cities are being designed for 350,000 to 500,000 residents. At that size, about 1,000 would need to be

built to accommodate the influx of urban residents in the next couple of decades, so the primary use of eco-cities appears to be a way to showcase development methods that can be used elsewhere.

Willingness to Partner with the Outside to Support Smart Growth

China is willing to work with outside groups on its development of more sustainable cities through many conferences and collaborations. Such conferences include the Partnership for Urban Innovation Global Conference 2010, “Towards a Low-Carbon City: Environmental Protection and Urban Responsibilities”, The International Conference on China's Urban Transition and City Planning, and the Asian Urbanization Conference.¹⁵ There are also annual conferences such as the International Urban Planning and Environment Symposium and yearly meeting of the International Association for China Planning.

One notable conference to highlight was the 2nd International Association for China Planning (IACP) Conference held in Beijing in 2008, whose conference theme was “Ecological Cities: Design, Development and Management for Sustainability.” The conference was strongly backed by the government, as it was officially supported by then-named Chinese Ministry of Construction. Key professional organizations in China organized or co-organized it, including the Urban Planning Society of China (UPSC) and the China City Planning Association (CCPA). Conference topics and tracks all had an environmental focus and included Energy, environment and economic development; Eco-cities, design and life quality; Green urban transportation; Energy management and renewable resources; Transition to sustainability in rapidly growing regions; Green construction and green building; and Financing ecological cities. The fourth IACP conference in 2010 was co-sponsored by the U.S. Department of Housing and Urban Development (IACP 2010).

On a more local-level, the Joint U.S.-China Collaboration on Clean Energy (JUCCE) works with the government-mandated National Center for Mayoral Training to provide mayors of small- and medium-sized cities case studies that form “a roadmap of city-level energy efficiency programs” (JUCCE 2007 and in Chinese). The course can cover land use and transportation

among other issues. Over 680 cities participate in the project. Chinese mayors are also attending energy and environment training programs at top U.S. universities (Hammer 2010).

Individual cities are also acting to improve their urban planning, as seen in Beijing, where the city’s Planning and Design Institute is collaborating with one of the top design firms in the world AECOM, to help the city expand in a sustainable manner (Chiao 2011; AECOM History).

Future of Transportation Plans: Increased Public Transportation Very Likely

Intra-city public transportation investment, as described earlier, overwhelmingly occurs at a local level. This financing and planning by a whole host of actors makes predictions difficult, but many factors suggest that public transportation construction will continue at its strong pace or accelerate.

The central government, though it has somewhat limited influence, is pushing cities to invest in public transportation. The 12th 5YP has much more explicit goals concerning public transportation than the 11th that finished in 2010. According to the 12th 5YP for the transportation sector, development of public transportation is prioritized with a primary emphasis on BRT and local trains for large cities. Lanes for BRT and track length is supposed to reach 10,000 km. As seen in Table 7, there are various goals depending on the size of the city (12th 5-Year 2011b).

Table 7: Public Transportation Goals in the 12th 5YP

Population of Cities	Primary Public Transportation Feature	Percentage of City 300m or Less from a Public Transportation Stop
Over 3 Million	Rail and BRT (with bus and trolleybus filling in gaps)	85%
1-3 Million	Bus and Trolleybus (with moderately developed rail and BRT)	75%
<1 Million	Bus and Trolleybus	70%

Source: 12th 5-Year 2011b

Other goals in the 12th 5YP include having a national “public transit city” construction demonstration project that is supposed to be implemented in 30 cities. Bus stations are supposed

to be within a 500 meter radius anywhere in a city, with transit options available within five minutes. There is a goal to increase the share of trips from public transportation to 50 percent by 2015. As a comparison, on a more local level, Shanghai has crafted a few three-year action plans on energy, and the 3rd three-year plan from 2007 to 2009 included a goal that public transport passenger volume would represent a third of all transport modes (Ruet et al. 2010).

In comparison, there were no explicit quantitative targets in the 11th 5YP. Similar to the 12th 5YP, there was a goal to prioritize the development of urban public transportation, but otherwise the goals were more about encouraging capital to construct public transportation and having a subsidy to get more riders (Ministry of Construction 2006). These subsidies have continued, and it is extremely cheap to use public transportation (Qian 2011).

Local leaders can point to public transportation projects to burnish their green credentials. Cadres are now supposed to be judged on more than economic growth, so reducing traffic burdens and environmental pollution inside cities could lead to advancement (Yaping and Min 2009). Traffic in China has become notorious, the most egregious example being a 10-day traffic jam in 2010 outside of Beijing (Wines 2010).

It is possible that something could happen and public transportation projects could slow down. A Shanghai subway accident in September 2011 injured over 200 (Barboza 2011). Given the tragic crash of a high-speed rail train that killed 40 in Zhejiang Province in July 2011, more accidents could make citizens leery of public transportation projects, delaying their construction (Barboza and LaFraniere 2011). Another issue is that public transportation is not an obvious panacea for traffic; subway lines in Beijing have been extremely crowded recently (Qian 2011). Finally, iff there is a housing bubble and many banks cut back lending, financing for transportation projects would likely become more difficult.

Yet barring these disasters, it appears that public transportation construction is the aspect of urban planning associated with smart growth and TOD most clearly going forward with support of leaders at multiple levels of government.

V. Conclusions and Future Research Needs

Up to this point, China has made little concerted effort to incorporate smart growth principles into its cities, though local governments have recently been investing more in public transportation systems. Some of the most powerful policies of the central government that call for reducing overcrowding in cities and take away funding from local governments, have actually likely increased sprawl beyond what would be expected in a country with a rapidly growing GDP.

The fear of high and volatile food prices, not to mention the more remote but still possible chance for actual food shortages, may encourage the central government to change local government incentives and policies to more closely enforce its land-use plans. Meanwhile, the 12th 5YP could be a watershed plan in terms of explicitly calling for higher density in existing cities, among other policies that could be seen as encouraging smart growth.

The implementation of these policies should be followed, and it would help to have more widely available urban form indicators in order to better track how cities are expanding around the country. The relationship in China between transportation oil use and built environment factors including transit access is an important area of study in case it differs from the link seen in the U.S. Finally, a better understanding of the decision process of lower-level leaders who play a significant role in determining how cities will develop and what roads and public transit will be built could lead to more effective policy actions from the central government.

The question of whether or not China can begin to encourage higher-density cities has important implications for future oil use. If density can stay the same rather than fall by the amounts predicted given growth in GDP and population, oil use for transportation could be 270,000-590,000 b/d in lower in 2020 and 1.2-2.3 million b/d lower in 2035. MGI (2009) finds that urban oil use could be anywhere from 840,000 b/d to nearly 2 million b/d lower in 2025 depending on the type of urbanization if density in the cities can reach average levels in Asia.

The Future of Urban Sprawl in China

The high degree of decentralization in China makes it challenging for the central government to change course and demand smart growth be implemented in cities around the country. Yet as an authoritarian country, the central government has levers available to it that democracies rarely have. Lower-level cadres can be promoted based on how well they achieve certain targets, including those involving smart growth and TOD. The central government also has the power to change the tax structure and reduce the incentive for lower-level governments to lease land.

Now is the time for China to determine its course. Over the next couple of decades, roughly 300 million Chinese residents are expected to become urban residents, and about two-thirds of them will be moving into cities. They will dramatically affect the layout and dynamics of cities. If cities are built smart, energy use will be lower for decades. Once cities are built, it is very difficult to reshape them, so if they are built sprawling the first time, they will likely remain sprawling for generations. China could become a model for smart growth, but if it waits until its population urbanizes, it will be too late.

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Endnotes

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2. The authors speculate that the large number of cities in the same countries may cause the price of gasoline to be insignificant in this analysis.

3. McKinsey estimates loss of cultivated land loss at 15 percent between 2005 and 2025. Meanwhile, the UN expects the population to increase from 1.312 billion to 1.453 billion, or a little under 11 percent.

4. The master plan is a higher-level document, often with the twenty-year planning horizon, that determines the extent of growth in a city. In between the master and detailed plan is often the district plan, which describes the characteristics of specific parts of the city and the location of infrastructure. More information can be found in Song and Pan 2009.

5. In theory, a city could try to promote an image emphasizing smart growth, transit-oriented development, though it seems that only in the past few years have ideas like “eco-cities” blossomed.

6. The author would like to thank the peer reviewer for suggesting such a structure for this section.

7. Urban planners are also supposed to focus on other goals, including protecting cultural resources, taking local conditions into account and meeting the needs of the public, especially those who are disadvantaged. These goals are generally independent of environmental goals, though insofar as traditional Chinese cities were relatively compact, the protection of cultural resources can lead to fairly compact development.

8. The regulation appeared in the 2006 Catalog for Projects Subject to Land Use Restriction or Prohibition (Regulation 296) issued by the Ministry of Land and Resources and the National Development and Reform Commission.

The Future of Urban Sprawl in China

9. The policies included the 1994 ‘The Basic Farm Land Protection Regulation’ and the 1999 “Regulations for the Implementation of the Land Administration Law (LAL).” The Land Administrative Law was implemented in 1998 (Ding 2009).

10. In fact, the innermost road is labeled as the 2nd Ring Road, and the outmost is the 6th. The “first ring road” no longer exists.

11. The 2009 construction and investment data, respectively, come from Tables 5-13 and 5-14 of the China Statistical Yearbook. The 2004 data are from Tables 6-13 and 6-14.

12. This calculation was made using both Food and Agricultural Organization data and data of the efficiency of grain Calorie conversion from Vaclav Smil (2000).

13. The provinces are Guangdong, Liaoning, Hubei, Shaanxi and Yunnan, and the cities are Tianjin, Chongqing, Shenzhen, Xiamen, Hangzhou, Nanchang, Guiyang and Baoding.

14. These other cities do not exactly match up with the initial group of eight low-carbon cities announced in August 2010. The cities were Nanchang, Wuxi, Hangzhou, Shenyang, Sanya, Qingdao, Chongqing and Chengdu. Of this group, only Hangzhou and Chongqing were part of the initial group.

15. These conferences include at least two associated with the Shanghai Expo, the Partnership for Urban Innovation Global Conference 2010 in Shanghai (http://www.connectedurbandevlopment.org/conferences/shanghai_2010) and the conference “Towards a Low-Carbon City: Environmental Protection and Urban Responsibilities” July 3-6, 2010 in Nanjing and Shanghai (<http://en.expo2010.cn/a/20091026/000003.htm>); the 2007, 2008 and 2010 Joint U.S.-China Collaboration on Clean Energy (JUCCCE) Energy Forum, the most recent in Beijing (<http://jucce.com/forum/>); The International Conferences on China's Urban Transition and City Planning in Cardiff, Wales in 2007 and 2010 supported by “College of Urban and Environmental Sciences, Peking; Department of Urban Planning, Tsinghua; The Centre for Modern Chinese City Studies, East China Normal U.; School of Geography and Planning, Sun Yat-sen; Centre of Urban Studies and Urban Planning, Hong Kong; Urban Planning Society of China” (<http://www.cardiff.ac.uk/cplan/research/researchcentres/urbanchinaresearchcentre/index.html>); the Asian Urbanization Conference, ten of which have been held since 1985 including in Nanjing, (<http://www.hku.hk/asia2009/>); the International Association for China Planning’s annual conferences since 2007 (<http://www.chinaplanning.org/Conferences/index.htm>); and the

The Future of Urban Sprawl in China

ninth International Urban Planning and Environment Symposium in August 2010 in Guangzhou, China with special topics in China's urban planning and development (<http://en.upe9.org/info.asp?id=3>).