A SHRINKING PATH FOR BICYCLES:

A HISTORICAL REVIEW OF BICYCLE USE IN BEIJING

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Abstract

Beijing formerly had a strong tradition of cycling that exceeded many other Chinese cities in both ownership and ridership. Over the past two decades, however, this tradition has been on a shrinking path. During the mid 1980s, when China was called the "Kingdom of Bicycle", Beijing had a biking population of over eight million (Sit, 1996a), with 62.7% of all trips being made by bicycle (BTRC, 2011). By 2000, despite bicycle ownership remaining high, only 38.7% of all trips were made by bicycle, this number dropping even lower to 16.7% of all trips in 2010 (BTRC, 2011). What were the factors that made cycling so popular in the past and what deters it currently? Through a historical review and an analysis of the national and local statistical data, my research aims to (1) provide an overview of the cycling history in Beijing; (2) identify and analyze the major factors which have influenced bicycle use in different periods; and (3) propose policy recommendations based on the improved understanding about the determinants of bicycle use in Beijing.

This research covers a historical time frame of a century, which are categorized into four periods representing different stages of bicycle use in Beijing: (1) the early adoption of bicycle use from 1910 to 1949; (2) the period of steady growth in bicycle use from 1950 to 1978; (3) the period of rapid growth in bicycle use from 1979 to the 1990s; and (4) the period of decline in bicycle use from the 1990s to current day. Among various factors contributing to the rise and fall of bicycle use in Beijing, four of them have been identified as having the greatest impact: policy and regulation, built environment, the bicycle industry, and social-economic conditions. Through the investigation of these factors using a mixed method approach, the research reveals the following conclusions: (1) the historically inherited grid street network and the low height, high-density housing form contains fundamental features amenable to cycling; (2) the integration of non-motorized modes to the road network in the pre-and-early reform period, a growing bicycle industry and the moderately increased income pre-1990 were the major contributing factors to the thriving bicycle use in the 1980s and 1990s; (3) the launch of the National Automobile Industry Policy in 1994 had a detrimental impact on bicycle use and marked the beginning of a dramatic decline in bicycle use in Beijing; (4) the city's current transportation planning not only lacks a real interest in sustaining the tradition of cycling in Beijing, but also lacks a clear target and an integrated approach of reviving the bicycle use among its citizens; and (5) the strong existing bicycle industry, the remaining high level of bicycle ownership

among Beijing residents, and the generous road network in the city provide concrete grounds for a more progressive bicycle planning policy.

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Section 1: Introduction

1.1 Context

The bicycle is one of the western inventions which had made a profound impact on the lives of Chinese people. From the appearance of the first bicycle in China in 1868 (Min, 2003) soon after it was invented in Europe, bicycles were a significant part of China's modern history. During the decade of its peak use between 1980 and 1990, the country's biking population was more than 500 million, with nearly half the population commuting by bicycle on a regular basis.[1] Even today when automobiles have dominated the traffic flow in most Chinese cities, the bicycle is still an essential travel mode for millions of the working population. Being a western creation, which after a century has gained deep acceptance in Chinese society, the bicycle carries much more meaning than just as a riding vehicle. Its rise and fall symbolizes the country's persistent move towards modernization.

The exact time that the first bicycle appeared in China is still open to debate. The official record (Imperial Maritime Customs) reports that the first bicycles were imported to Shanghai in 1897 (Esfehani, 2003), but even before then, bicycles had been brought into China by Western missionaries, businessmen or colonial officers beginning in 1868 (Min, 2003). Even though Chinese people rarely rode a bicycle before 1910 (Esfehani, 2003), businesses related to bicycle use had already been developed in coastal cities like Shanghai, Nanjing and Tianjin, including repair services, import of parts and accessories, selling and rentals (Min, 2003). The frequent press coverage on various cycling races also increased public exposure to cycling. In the 1920s and 1930s, the bicycle started to be used initially by upper-class Chinese people, such as returned students from overseas, journalists, businessmen and wealthy family members, but its use was highly restricted, because the price of imported bicycles was high. In 1937, Japanese businesses opened bicycle factories in Shanghai, Tianjin and Shenyang, and the resulting cut in prices saw a wider adoption of bicycle use even in inland cities. In Shanghai and Beijing, the number of bicycle boomed in the late 1930s, and bicycles started gaining importance along with other means of transport such as the mule cart, rickshaw, bus and street car (see Table 3). By 1949, there were an estimated half a million bicycles in China[2] (Esfehani, 2003).

[1] The "peak period" here referred to is based on the national data of bicycle ownership, for example, in 1986, there were more than 523 million bicycles and a population of 1.23 billion in China (National Statistical Yearbook).
[2] China had a population of 541 million in the year of 1949.

The adoption of cycling in China in the first half of the 20th century was slow at the start but gradually picked up the pace after the 1930s. Apart from the great gains made in overall mobility, bicycles became a practical symbol, exemplifying an advanced lifestyle as the nation was striving to become modern. After the founding of the People's Republic of China in 1949, bicycle use was accelerated through a state-led industrialization process. The Japanese bicycle factories were transformed into state-owned operations, small producers and accessories suppliers were consolidated and merged into larger factories, national brands were created, and a centralized pricing and allocation system was established. Bicycles became an important part of the national economy and people's livelihood[3]. Scarcely a decade after the revolution, China was already producing one million bicycles (Esfehani, 2003), a number that increased to 8.5 million in 1978 (China Statistics Yearbooks). Ownership increased steadily as well, to 74 million in 1978, averaging 7.7 bicycles for every 100 persons (China Statistics Yearbooks). Between 1950 and 1978, as so many other basic necessities, bicycles were allocated through a rationed coupon system at a fixed price. The initial price of a bicycle set by the government was very high, however, worth almost six months of a worker's salary at the time (see Figure 3).

The "Opening-up Policy" and economic reform period initiated in 1978 marked a turning point in the bicycle history in China. Both bicycle use and bicycle ownership reached unprecedented levels in the following two decades. In 1986, China produced 36 million bicycles while ownership rose to 258 million bicycles (National Statistical Yearbook). The vast majority of daily trips in urban areas were made on bicycles. "Critical Mass", "Bicycle Fleet" and "Kingdom of Bicycle" were some of the phrases used to describe the immense waves of cyclists in Chinese cities during this period. Apart from being an essential means of transportation, bicycles had also become an important part of people's lives. In the late 1970s and through the 1980s, a bicycle, watch, sewing machine and radio, called "Three Spins, One Sound", used to be considered the four prerequisite assets to start a new family. In Beijing, cycling, skating and swimming were cited as the three must-have skills to acquire in order to be a "real" Beijing youth. Enabled by increased household income, the bicycle became an affordable and popular means of travel for most families.

[3] According to "Some Policy Regulations on the Handicrafts in the Urban and Rural Areas" issued by the Central Committee of the Chinese Community Party in 1961, commodities of great importance to the national economy and the people's livelihood, such as pigs, eggs, sewing machines, and bicycles, fell into the second category. Central ministries and commissions took charge of the procurement, allocation, and import and export quotas of these goods (Wei & Chao, 1982). The bicycle price restriction policy lasted until 1986.

In 1996, at the national level, bicycle ownership soared to its highest level of 523 million, averaging 42.7 bicycles for every 100 people, or 1.5 bicycles per household[4] (China Statistics Yearbooks). In the same year in Beijing, the number of bicycles owned also reached an historical high with 9.24 million bicycles for its 12.5 million residents[5], averaging 72.4 bikes for every 100 people, or 2.5 bicycles per household (Beijing Statistics Yearbook). However, a phenomenon that became noticeable during this time was that the high correlation that had existed between bicycle ownership and bicycle use during the pre-1990 period started to break down. Greatly increased household income now allowed people to look for alternative travel options, and the launch of the National Automobile Industry Development Policy in 1994 started an "automobile frenzy". Due to growing car ownership, some people who still had bicycles at home began driving more regularly. Moreover, as China's motorization process unfolded, both bicycle production and ownership started to decline. From the late 1990s, in contrast with rapidly growing automobile production and household car ownership, bicycle use in most cities was falling precipitously. In Guangzhou, bicycle travel fell from 33% of all trips in 1995, to less than 10.9% in 2003 (Hook, 2002; Ma, 2004). In Shanghai, it dropped from 40.3% of all trips in 1986 to 37.8% in 1995 and to 27% in 2000 (Zacharias, 2002; Hook, 2002). In Beijing, despite much higher baseline mode share numbers favouring bicycles, the mode share also decreased sharply— from 62.8% of all trips in 1986 to 38.7% in 2000, declining further to 16.7% in 2010 (see Figure 1). Another leading cycling city, Tianjin, experienced the same downward trend — with the bicycle mode share falling from 61% in 1993 to 37% today (Yang, 2011). The fast motorization process in each city serves as a common explanation why the decline in bicycle use has become widespread, though each city showed particularities. Shanghai, for example, was the leading city of cycling in the first half of the 20th century in China and a major bicycle production base after 1949, but ownership was much lower there than in Tianjin (See Table 1), which had been producing bicycles for decades. Both Beijing and Tianjin have high levels of bicycle ownership and use, but the recent decline in Beijing is more dramatic than Tianjin's. Guangzhou has taken a more aggressive approach to restricting bicycle use in its urban planning (Ma, 2004). Although each city deserves a closer look at its own history, policy and social conditions in relation to the change in bicycle use, the focus of this research is Beijing.

[4] Total ownership by urban and rural residents.
[5] Total ownership by urban and rural residents.

Table 1: Change in Bicycle Ownership per 100 Urban Households, 1995 to 2006[i]

Place	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
National	194	193	179	182	183	163	165	143	144	140	120	118
Beijing	244	249	209	221	220	231	231	201	202	192	194	191
Tianjin	231	232	225	226	232	230	239	222	229	222	202	189
Shanghai	115	124	125	133	139	126	124	124	125	126	119	123
Guangzhou	190	200	189	173	160	149	136	No Data				
Guangdong[ii]	238	225	212	204	196	181	169	143	133	121	113	104

Source: National Statistical Yearbooks

i) Ownership by urban residents

ii) Currently the above four major cities have all stopped collecting bicycle ownership data of urban residents. Guangzhou stopped in 2002, Shanghai in 2004, Beijing in 2007 and Tianjin in 2008. Only bicycle ownership data for rural residents in these cities are available.

1.2 Research Objectives

Located in the north China plain, Beijing is a flat city with the advantage that cyclists are free from strenuousness and dangers of riding on slopes. Although ring roads, flyovers and overpasses have increased the difficulty of biking, there are few barriers resulting from the city's natural topography. The weather is also pleasant: there are a couple of months in the year which are too cold or too hot to bike (July and August in summer, January and February in winter), but for most time of the year, the weather is permissible for cycling trips. Today the city still has a biking population of three to four million (Li, 2009) whose trips accounted for 16.7% of all trips in 20106. With these natural conditions still existing, some important factors that have shaped the cycling tradition in the city are being lost. The most striking change is the gradually shrinking bicycle route network. Even though dedicated bike tracks and separate lanes for bicycles still exist in many parts of the city, there is no longer a well connected circulatory system for riding your bicycle. A large amount of road space, originally designed for and being used by bicycles, has been given over to automotive traffic. Competing with cars has become a great challenge to many people contemplating cycling in the new urban environment. From 2001 to 2006, even with a consistently decreasing number of road traffic accidents each year, most casualties were still among pedestrians, cyclists and motorcyclists (Ma et.

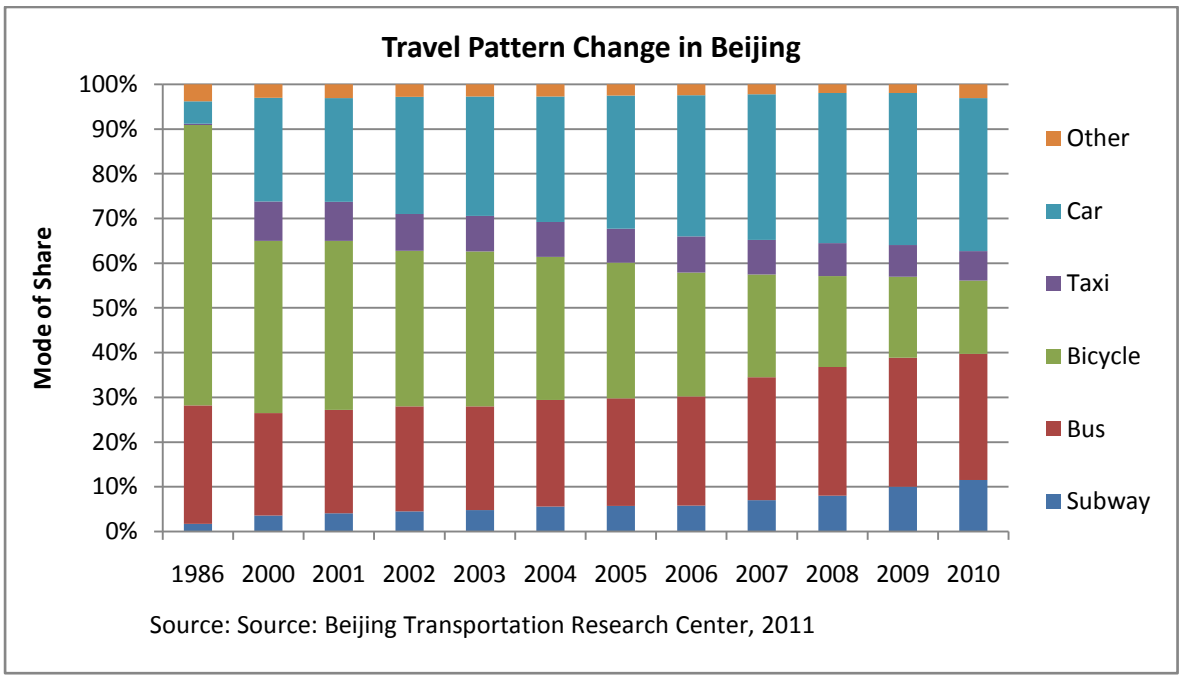
[6] Compared with 4% of commuting trips in Vancouver on bicycle, this number is still quite high. Data was retrieved the website of the City of Vancouver from www.vancouver.ca on March 12, 2012

al., 2008).[7] Air pollution, particularly the air-borne particulate pollution, has been serious (Sun et. al., 2004; Xu et. al., 1994), which poses great threats to the health of cyclists. Lung cancer in Beijing had increased from 18% of acute cancers in 1977 up to 28% in 2003 (Li 2009). Longer commuting distances are also an evident barrier to cycling, among others. By 2009, the number of car owners in Beijing[8] exceeded that of bicycle users, indicating growing space conflicts. The demographic change of the biking population is also obvious. In all, the overall physical and social environment for cycling has changed substantially.

The changes in urban form, road conditions and the demographics of the biking population are observable, but the impact of such changes on bicycle use has not been well examined. The existing research takes a micro approach, focusing on the impact of technical parameters such as road configuration, travel distance, travel time, and bicycle facilities (Miao, 1995; Niu, 2005; Zhang et al. 2007; Huang et al. 2008; Li, 2009); an in-depth analysis of the collective impact from the bicycle industry, transportation policy and changing social-economic conditions is still missing. This research has three primary aims: (1) to provide an overview of the cycling history of Beijing; (2) to identify and analyze the major factors which have influenced bicycle use in different periods; and (3) to propose policy recommendations based on this improved understanding of what made cycling so popular in the past and what deters it currently.

[7] See detailed discussion in Section 6.5.
[8] Data was retrieved from the website of Beijing Traffic Management Bureau via http://www.bjjtgl.gov.cn/publish/portal0/ on March 12, 2012

Figure 1: Travel Pattern Change in Beijing



1.3 Research Outline

The research paper consists of seven sections:

Section One provides a general introduction about the shrinking path of bicycle use in Beijing; identifies the research objectives and its relevance to policy making;

Section Two introduces the analytical framework and the methodology;

Section Three discusses the political and social conditions affecting the early adoption of bicycle use in Beijing between 1910 and 1949;

Section Four analyzes the impact of the bicycle industry, road networks, housing forms and economic factors on growing bicycle use in Beijing between 1950 and 1978;

Section Five looks at the impact of the bicycle industry, increased income on the thriving bicycle use in Beijing between 1979 and the 1990s, also discusses the separation of bicycle ownership from bicycle use beginning in the 1990s;

Section Six examines the relationships between land use, transportation policy, and social-economic conditions and bicycle decline from the 1990s and beyond. It also evaluates the current bicycle-related policies;

Section Seven summarizes the conclusions drawn from the research, the policy recommendations based on the research findings, and the issues to be addressed in future research.

Section 2: Methodology and Data

2.1 Periodization and Analytical Framework

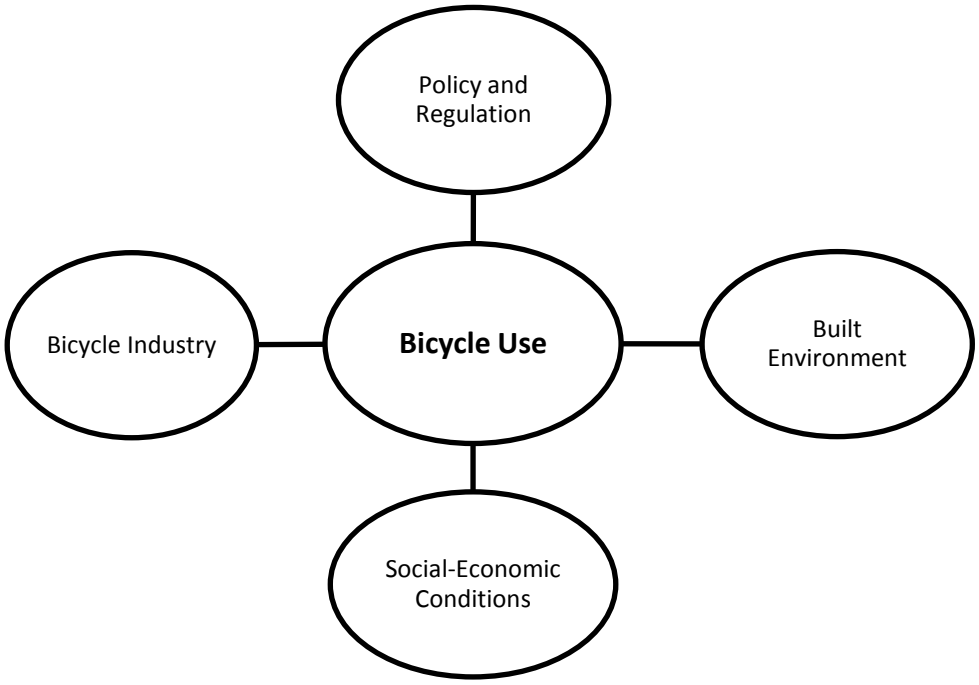
During the literature review, four periods with particular characteristics have been identified to represent the different stages of the bicycle use in Beijing: (1) the early adoption of bicycle use from 1910 to 1949; (2) the steadily growing period of bicycle use from 1950 to 1978; (3) the rapidly growing period of bicycle use from 1979 to 1990s, and (4) the declining period of bicycle use from 1990s to the present day.[9] For the first period, since there were barely any Chinese people using bicycles for commuting before 1910, my review starts from 1910, which also happens to coincide with the end of Qing Dynasty and the beginning of the Republican period in China. For the second and third periods, I follow the periodization of Chinese modern history and use the years 1949 and 1978 as two milestones to outline the history of cycling. The periodical characteristics of this history in Beijing are aligned well with the political and economic conditions in each divided period, so this periodization provides good benchmarks to compare the impact of different policies on bicycle use. The precise time frame for the most recent period is not so readily defined, however. Statistically, 1996 is the year in which bicycle ownership started to decline from its peak level both nationally and in Beijing, but overall bicycle use declined in the 1990s, which is easily seen from comparing the mode share data in 1986 (62.8%) and 2000 (38.5%). Due to lack of immediate travel data between 1990 and 1999, it is hard to tell the exact pattern of the changes and to specify a precise time point that marks the end of the third and the beginning of the final period.

Various factors have affected bicycle use across the four periods (see Fig. 2). In this paper, my analysis is focused on the four most important factors affecting bicycle use in Beijing: policy and regulation, built environment, the bicycle industry, and socio-economic conditions. Not each of these factors plays a significant role throughout all four periods. Some (such as built environment and social conditions) have an extended impact across the full timeline, while others (such as policy and regulation) are relevant only for the recent period. My analysis is

[9] Because of the unavailability of complete data on bicycle use and bicycle ownership in Beijing, it is impossible to use either of them as a single set of criteria to draw the lines between different periods; a broader consideration has thus been taken into account to determine the periodization.

structured in chronological order based on the four different periods of bicycle use and focuses on those factors that are most important during each period.

Figure 2: Analytical Framework



The following matrix (see Table 2) provides an overview of how this paper is structured and what factors are covered in each period. In the first period, I look at the political and social context in which bicycle use was adopted in Beijing; in the second period, I examine the impact of the bicycle industry, road networks, housing forms and economic factors on bicycle use; in the third period, I discuss the impact of the bicycle industry and income; in the last period, I analyze the relationships between land use pattern, transportation policy, social and economic conditions, and their collective impact on the decline of bicycle use in Beijing. For those factors which have extended impact across the four periods, the discussion of the factors is limited to the periods where they had the most impact.

Table 2: Analytical Matrix

		The Early Adoption of Bicycle Use **(1910-1949)**	The Steadily Growing Period of Bicycle Use **(1950- 1978)**	The Rapidly Growing Period of Bicycle Use **(1979 - the 1990s)**	The Declining Period of Bicycle Use **(the 1990s - Present)**
Built Environment	Urban Form	Historically planned in a concentric pattern. Condensed single-story courtyard housing walled in 25 square-mile quadrangles in a symmetrical layout along the north-south central axis. The city scale remained unchanged till1949. (Wu, 1999)	Mid-rise high density housing in work unit compounds were constructed where people lived, worked and played. The travel need was minimal. (Sit, 1996b; Gaubatz, 1999)	Breakdown of the work unit system caused separation of housing and workplaces, high rise buildings were built in the inner and outer suburban area of the city to meet the growing housing demand. Influx of migrant workers also increased travel demand.	Suburbanization resulting from a "pan-cake" style land use development generates large volume of long distance commuting trips. (Feng & Zhou, 2003)
	Road Network	A fish-bone shaped grid street network provided good neighbourhood connectivity and easy access from major streets to neighbourhood alley ways.	First *sanbanshi* main road was built in 1957 with dedicated bike tracks. A circulatory bicycle system was established, despite insufficient levels of transportation investment in road system construction. (Sit, 1996b; Yan, 2008)	The ring-road network expands with the supplementary radial arteries. Separate bike lanes on major roads were common.(Sit, 1996b; Sit, 1996a)	Massive high way construction in favour of motorized traffic, significant amount of road space originally designed for and being used by bicycles has lost to automobiles. The bicycle network has been shrinking.
Policy and Regulations	Transportation Policy	Limited transportation planning due to constrain of the city layout and shortage of funds. City wall reconfiguration and road pavement were major public works to improve intra-city mobility.(Shi, 1998)	Key Soviet urban planning standards, such as grand street width, ring-road network with radial arteries, are adopted. An integration of a non-motorized road system received strong government support.	China started to develop its modern transportation policy to support the motorization process (Guo & Zhao, 2009). A bicycle system is required in the first national urban road design standard issued in 1995 and this requirement adopted for Beijing.	The transportation planning and investment preference has been given to car-oriented infrastructure and public transit. The strategic importance of a bicycle system outlined the city's sustainable transportation plan is more symbolic rather than a commitment. A clear target and an effective scheme for reviving bicycle ridership has not been developed.
	Traffic Regulation	-	-	The fast motorization process results in mounting tensions	The Road Safety Law of PRC was revised in 2011 aiming to build

				among road users. The first Road Safety Law of PRC was issued in 1994. The legislative loophole in allowing the flexibility of changing road use leads to shrinking path for the bicycle system in the city.	road courtesy and to protect the safety of pedestrians and other non-motorized users.
	Planning Profession	Strong preservation of the traditional features of the City with limited openness to the western planning practice. (Shi, 1998)	Policy support to a bicycle system owning to the socio- economic conditions at the time.	Exposed to the different Western transportation policies and developed comprehensive policies that support the city's motorization and urbanization process.	No deliberate attention to retain the cycling tradition of the city. The level of passion and advocacy for a bicycle system among the current transportation planning profession is low.
Bicycle Industry		Three bicycle factories were established. Half a million bicycles in use in China by 1949.(Esfehani, 2003)	Bicycle factories were nationalized and the bicycle industry became an important part of the national economy and people's livelihood.	The bicycle production boomed, while bicycle ownership and use reached its peak in the period 1986 - 1996.	Export-oriented bicycle production soars, accounting for 70% of the global market.
Social-economic Context		Perceptions about the adoption of bicycles shifts as the associations with bicycle travel changes. It begins with bicycles being viewed as "disgraceful," and ends with bicycles being considered "modern" and "fashionable".	Bicycle was a scarce and expensive product allocated from a rationed ticket system at a fixed price. The initial price set by the central government was equivalent to a worker's whole-year salary.	Bicycles became the most popular means of transportation due to increased market supply and household income.	Class distinction is shaped through conspicuous consumption, including housing, mode of dressing and transport. Bicycles are perceived as low-class, used by low-income residents.

2.2 Data Collection

As this research covers a relatively long period— from the beginning of the 20th century to the present-day — many different sources were used to assemble the information needed for the analysis. For the first period, data gathering consisted largely of reviews of historic literature. For the second period, national and local statistical data, as well as relevant academic research were used. On-line sources were used on occasions when convenient to obtain historical records; for instance, the information about the major bicycle factories in China was retrieved from on-line sources. For the third and the most recent period, the analysis draws on academic papers, government regulations, policy documents, as well media reports and internet blogs. A number of interviews with a city planner and Beijing residents also round out the analysis.

Section 3: The Early Adoption of Bicycle Use (1910 to 1949)

Chinese literature on early bicycle use in China is mostly informal and disparate, and information used in various articles is repetitive and sometimes inconsistent (Min, 2003; Xu, 2006). There are a number of books covering the early urban transportation in major Chinese cities such as Shanghai and Beijing, with a particular interest in rickshaw, streetcar, and public bus (Yan et.al., 2008; Strand, 1989; Lu, 1999; Esherick, 1999). The discussion about bicycle use during this period was minimal. The only account probing the early history of cycling in China is from Amir Esfehani who presents a full analysis of the political and social conditions of integrating bicycle use in Chinese cities before 1949 (Esfehani, 2003). A comprehensive review of all-inclusive travel modes in the first half of the 20th century in China (and/or in Beijing) is still missing.

Esfehani summarized the emergence and adoption of bicycle use in China in three periods: (1) from 1870 to 1910, when the bicycle was seen by the Chinese public as an exotic technological object but only used by Western missionaries, businessmen or colonial officers; (2) from 1910 to 1930, with low-levels of bicycle use among upper-class Chinese residents; and (3) from 1930 to 1949, with increased use and a wider geographic dissemination resulting from domestic production and a reduction in price. The early domestic bicycle users in Beijing were the imperial families who had bicycles shipped from abroad as a luxury product for recreational use. Isaac Taylor Headland recorded in his 1909 book *Court Life in China* how the Guangxu Emperor had entangled his queue in the rear wheel of his bike and had to desist from further riding it. Cyclists were rarely seen in public before 1910 (Xiao, 1996) but their numbers boomed after 1930 (Lanfrance, 2008).

Looking at the means of transportation during the period between 1910 and 1949, Beijing is a dramatic mix of the old and the new, with camel, mule and horse-drawn carts, rickshaws, bicycles, streetcars, buses and taxicabs (See Table 3). As a key centre of the country's radical political transformation during this period, Beijing experienced a disruptive urban process and slow economic development (Shi, 1998). The co-existence of the mixed transport modes, from the oldest mule cart to the newest modern vehicle, reflects the circumstances of Beijing that was politically radical, socially conservative and economically poor.

After 1920, cycling emerged as a new way of transportation. Compared with other transport means at the time, there were some barriers that prevented cycling from becoming popular. First, the price of

owning a bicycle was very high. In 1907, an imported bicycle would cost 75 to 80 silver dollars (Min, 2003), which is equivalent to the price of a medium grade car in today's market. In the 1920s, most poor and working-class families made the equivalent of less than 200 dollars a year, after spending 60-70% of their earnings on food, there was not much left for transportation (Strand, 1989). Buying a bicycle was economically prohibitive for most residents in the city. For those able to afford transportation, traveling by rickshaw, street car and bus were much cheaper choices. On average, renting a bicycle would cost 20 cents per hour or $1.5 per day, whereas taking a rickshaw was 10 cents per hour or $1 per day. Street car and bus fare were even cheaper; for example, the street car was 3 cents for any distance within 10 miles, 6 cents above ten miles, and riding the bus cost 15 cents per trip (See Table 3). The high purchase price and higher rental cost made the bicycle a less affordable travel choice than any other means. Even after three bicycle factories opened in 1937, a bicycle would still cost more than $50[10], the equivalent of several months' salary of an urban worker: clearly before 1949 a bicycle was a middle to upper-class possession. Secondly, the muddy and unpaved roads in Beijing posed serious challenges to people who tried bicycles, particularly when they were mixed with traffic of other modes on narrow streets. It was not until the 1930s when major roads in the city were being paved, that the city saw booming bicycle usage (Yan, 2008). Thirdly, bicycles were not accepted by Chinese elites in the beginning (Esfehani, 2003). Pedalling a bicycle in the street was regarded as "disgraceful" by the wealthy class of people, compared to being carried in a sedan chair or pulled in a rickshaw (Esfehani, 2003) — not entirely unlike the mentality on cycling vis-a-vis driving today. In feudalistic China, the travel code was to ensure proper (ritual) behaviour among different classes. For example, *Jiaozi*, a traditional sedan-chair or carriage used by imperial families and officials, was designed to be distinguished with features based on differences in official rank. The overall appearance of the *jiaozi* used by ordinary people was inferior to those used by the ruling class. This association of a person's social status with their travel mode has historical roots. Nevertheless, as the last imperial dynasty collapsed, and new social and political movements driven by 'democracy' and 'science' prevailed, bicycles became a practical instrument, exemplifying a new lifestyle. Particularly, with the great gains in mobility enabled by bicycles and continued price cuts due to domestic production, cycling eventually became accepted among the growing middle class.

[10] Price information was retrieved from online source via http://www.douban.com/group/topic/11328196/ on March 12, 2012.

Table 3: Major Transportation Capacity and Costs in Beijing, 1900 to 1949

Transportation Mean	Start	Capacity	Average Fares (Silver Dollar)
Rickshaw	First in Beijing in 1874 as a gift to Empress Dowager Tz'u-His from a Japanese merchant	20,859 in 1917 25,877 in 1925 42,900 in 1930 37,036 in 1939	10 cents per hour $1 per day $18 per month
Street Car	First street car in operation in 1924	20 in 1924 96 in 1937 82 in 1948 daily carrying capacity: 40,000 to 50,000 people in 1947	3 cents within 10 miles, 6 cents above 10 miles
Bus	First bus in operated in 1935	30 in 1935 67 in 1941 133 in 1947	15 cents per trip or $4.5 per month
Bicycle	Appeared in public scene in 1909	97,000 in 1933 108,468 in 1939 176,970 in 1948	20 cents rental per hour, $1.5 per day
Taxicab	First in operation in 1913	200 in 1929 566 in 1931 303 in 1946	-
Mule Cart	-	5284 in 1949	-
Sources: (Yan et. al., 2008; Strand, 1989; Esherick, 1999)			

In the first half of 20th century, Shanghai was called “Paris of the East" from its prosperous trade relations with Western countries and large foreign settlements. It became a pioneer city of cycling (Esfehani, 2004; Xu, 2006), whereas the pace of using the bicycle was much slower in the old capital of Beijing (Esfehani, 2003). After the Municipal Council was established in 1914, the city government sought to modernize its urban infrastructure. Public works such as road paving and opening the royal gardens to the public provided improved conditions and spaces for bicycle users. Bicycle uses in public facilities such as post offices, the police, telecommunication offices and the city council also helped in fostering wider public acceptance of bicycle use. The story of the last Emperor Pu Yi in his biography, cutting the door step sill in the Forbidden City for cycling, is an anecdotal account of the progressive change that happened in the most conservative part of the nation.

It is clear that social and ideological evolution interacted with the adoption of the bicycle in China during its transition from a feudalistic state to a contemporary society. Bicycles were quickly introduced at the beginning, then cautiously accepted, and eventually embraced by the wider society. Domestic bicycle production and the resulting drop in price after the Japanese businessmen opened three bicycle factories in Shenyang, Tianjin, and Shanghai in 1937 further expanded its use across China. By1949, there were about half a million bicycles in China (Esfehani, 2003).

Section 4: The Period of Steady Growth in Bicycle Use (1950 to 1978)

After 1949, the urban planning for Beijing aimed to transform a "consumer" into a "productive" city; major industries such as steel making, machinery and textiles all found a home in the suburban areas of Beijing (Sit, 1996b), while the bicycle industry remained in its traditional locations of Tianjin, Shanghai and Shenyang. However, the location of the bicycle industry in other places did not prevent bicycle ownership from growing steadily in Beijing (See Table 5). By 1960, Beijing had a total of 582,148 bicycles for a population of 6.6 million, averaging 41.3 bicycles for every 100 urban households; by 1978, the total number of bicycles had increased five times to 2,546,190, an average of 1.35 bicycles per urban household. Although Beijing had lagged behind Shanghai in the Republican period, the city was catching up quickly, overtaking Shanghai as one of leading cities of cycling in China within two decades after 1949. [11]

Table 4: Bicycle Ownership in Beijing, 1960 to 1978

Year	Per 100 Urban Households	Per 100 Rural Households	Total in Urban Area	Total in Rural Area	Total
1960	41.3	38	353,198	228,950	582,148
1961	42	44	350,238	286,748	636,986
1962	42.2	46	353,636	313,490	667,126
1963	43.1	46	366,091	319,056	685,147
1964	48.5	48	417,197	335,808	753,005
1965	46.2	-	398,891	-	940,000
*1970	-	-	-	-	1,440,000
1975	-	92	-	789,268	2,230,000
1976	-	99	-	864,468	-
1977	-	106	-	946,792	-
1978	135.8	109	1,552,873	993,317	2,546,190
*Data from 1965 to 1977 was not fully available for the period of the Cultural Revolution.					

Data source: *60 Years of Beijing from 1940 to 1990*, Beijing Statistical Bureau (1999)

[11] Bicycle ownership in Shanghai in 1981 was 70 bicycles for every 100 urban households, which was significantly lower than the level in Beijing and Tianjin, whose urban residents owned 153 and 197 bicycles for every 100 households respectively in 1981. The national average of urban residents was 135.9 bicycles per 100 households in the same year (China Statistical Yearbooks).

There are a number of contributing factors to the steadily growing bicycle ownership and bicycle use during this period[12]. The strong government support in the bicycle industry and the integration of a bicycle system in the city's road network made significant impact. Sit reviewed Beijing's urban transportation development from 1949 to 1992, and pointed out that having a circulatory bicycle system in the road network was a unique feature in Beijing compared to other developing countries (Sit, 1996a). Yan also points out in his review of Beijing's transportation history that the first three-carriageway (*sanbanshi*) roads built in 1957 were aimed to support bicycle use in the city (Yan et. al., 2008). In the following section, we will take a closer look on the impact of the bicycle industry and the evolving road network on bicycle use during this period.

Urban form has a direct impact on people's travel choices (Frumkin, 2004); such an association is particularly true in Beijing. What my research indicates additionally is that different housing forms also had impact on bicycle use in Beijing, which might not be true in other cities. Minimal travel demand and short travel distance under the work unit system were viewed as major reasons favouring walking and bicycle use during the pre-reform period (Allaire, 2007), but issues related to housing density, neighbourhood connectivity, parking and safety have not been fully discussed. Another important factor to be discussed in this chapter is the pricing and allocation system of bicycles after 1950. Policies related to pricing and allocation had an extended impact on bicycle ownership and use until the mid 1980s. On the one hand, these policies ensured equitable access to bicycles when the supply of essential commodities was in a great shortage; on the other hand, it also created certain uniformity in people's travel choices.

4.1 Development of the Bicycle Industry in China

The founding of the People's Republic of China in 1949 marked a turning point in the history of the bicycle in China. In the state-led industrialization process, the bicycle industry received strong support from the government in the first Five Year Plan and accomplished a growth rate of 58.7% annually, reaching one million bicycles in 1958 (Esfehani, 2003). The former Japanese factories were transformed into state-owned operations. Small producers and accessories suppliers were consolidated into new and larger factories. National brands were created (see Table 4) and a pricing

[12] Due to the high correlation between bicycle ownership and bicycle use during this period, since there is no travel data for this period, bicycle use is considered in a similar growing pattern as bicycle ownership was.

and allocation system was set up. Even with the interruption of the Cultural Revolution between 1966 and 1976, the domestic technology of making bicycles greatly improved and production capacity steadily expanded. By 1978, China had more than five leading brands, over eighty bicycle factories and more than three hundred accessory suppliers (China Statistical Yearbooks). Annual bicycle production had grown from one million in 1958 to 8.54 million within two decades (China Statistical Yearbooks), laying a foundation for a booming bicycle industry soon after the reform period started.

Table 5: Major Bicycle Factories and the Leading Brands

Name of Factory	Location	Time of Establishment	Brand Owned
Tianjin Bicycle Factory (Previously Changcheng established in 1936)	Tianjin	1949	Feige (Flying Pigeon)
Shanghai Bicycle Factory (Previously Tongchang Chehang established in 1936)	Shanghai	1940	Yongjiu (Forever)
Shenyang Bicycle Factory (Previously Daxing established in 1936)	Shenyang	1949	Baishan/ Dongfanghong
Shanghai No. 3 Bicycle Factory	Shanghai	1958	Fenghuang (Phoenix)
Tianjing No.2 Bicycle Factory	Tianjin	1962	Hongqi (Red Flag)
Guangzhou Bicycle Factory	Guangzhou	1960	Wuyang (Five Goats)
Changzhou Bicycle Factory	Changzhou	1976	Jinshi (Golden Lion)

Date source: assembled through various internet sources

4.2 Road Network

Over the past century, Beijing's road network has evolved from an early grid to a moderately mixed-use road network favouring pedestrians and cyclists, evolving further to the current car-oriented, multi-dimensional modern road system. During the Republican period, the construction and upgrade of city roads progressed slowly due to physical constrains of the city layout and shortage of capital (Shi, 1998). Major transportation projects were limited to opening up Changan Avenue (1912), paving main roads (1915-1931) and re-configuring city walls (1914-1916) (Yan et. al., 2008), but most of the remaining city streets were left poorly maintained and unpaved (Shi, 1998). After 1949, in the

city's first master plan, the "1953 Plan"[13], key urban planning standards of the Soviet Union were adopted: a ring-road network supplemented by radial arteries and standard widths for different classes of roads were laid down in the Plan (Sit, 1996b). Although the country still suffered from a war-torn economy and extreme financial difficulties, the city government carried out a number of road construction projects to exemplify the new look of the socialist capital. Major trunk avenues were opened up and widened, Changan Avenue was widened to a 120-meter Changan Boulevard, the north-south central axis was straightened, many arterials and district streets were built and paved. In the late 1970s, the second ring-road and three flyovers were constructed. By 1978, a basic road network consisting of Changan Boulevard and the north-south central axis as its backbone and connected with the second ring road was laid out (Yan, 2008). In the decade following 1978, the city invested 4.3 billion yuan in road network construction, adding another two ring roads and 13 radiating roads to connect the new development areas with the city center (Sit, 1996a). The grid street system was then upgraded to a network of ring roads and radial sub-arteries. Despite the road network expansion during this period, road design still gave ample consideration to bicycle users, separate bike lanes were common on main roads, and road uses were kept consistent with their original design. The overall road conditions for cycling in Beijing remained agreeable.

The contribution of the traditional grid system to bicycle use is often neglected. In the early days when bicycle use was still minimal, the impact of the road system was difficult to observe. But when the city's biking population soared to over six million in the mid 1980s, the impact of these features became significant. In the old City of Beijing, a typical neighbourhood covers an area of 84 hectares with nine parallel east west lanes (*hutongs*) crossing one north south street (Wu, 1999). Each *hutong* can accommodate seven to eight courtyard houses of a plot measured about seventy by sixty meters. The distance between each *hutong* is around eight meters. Such a layout forms a fish-bone-shaped transportation network which effectively integrates neighbourhoods, blocks and lanes into a well connected system (Wu, 1999). As the majority of *hutongs* intersect with larger streets at each end, it is very easy to bike through hutongs to different neighbourhoods as well as to main streets. When *hutongs* and streets are connected in this highly ordered manner, navigation by bicycle in old neighbourhoods becomes a relatively pleasant, fun experience.

[13] The full name of the plan is "Draft Plan on Reconstructing and Expanding the Beijing Municipality" (Sit, 1996b).

Another important feature favouring bicycle use is the narrow width of *hutong* which served as a natural impediment to the intrusion of cars into neighbourhoods. *Hutongs* vary in width depending on their use — they can be as wide as nine meters for government office, schools and temples, or as narrow as three meters for residential alleyways (Wu, 1999; Sit, 1996a). In most residential neighbourhoods, *hutongs* only measure four to six meters, and driving through a *hutong* can be very difficult. Although many residents living in courtyard housing have now bought motor vehicles, it is a constant challenge to maneuver and park in *hutongs*. In fact, both *hutongs* and the neighbourhood design of old Beijing possess many features of traffic calming, which modern planners use to enhance safety and enjoyment for cyclists around neighbourhoods.

Between 1950 to 1978, owning to the economic conditions at the time, the total capital investment in the transportation system in Beijing was still low, and the provision of a quality and equitable public transit system proved to be a challenge for the city. In 1957, the first *sanbanshi* road, Sanlihe Road, was built, containing two motorized vehicular lanes of fourteen meters each, and two bicycle lanes of four meters each, with a green separation strip measuring 2.5-5.5 meters (Sit, 1996a). This marked a clear beginning of the city's approach favouring a bicycle-oriented road network. Ample road widths, adopted from the Soviet Union model, enabled *sanbanshi* design to be adopted on main roads. Some of the wide separated bike lanes are still regarded as a "luxury" in the world today. By 1991, 242 km of *sanbanshi* main roads had been built (Sit, 1996a), and the Second Ring Road and the Third Ring Road had both been constructed with dedicated bicycle tracks. The two inner city flyovers, Jianguomei Qiao and Xizhimen Qiao, built in the late 1970s, have also dedicated layers for bicycle traffic, as opposed to the ones built in recent years. There are assumptions that modern road system would prevent people from cycling, which is not true in Beijing's case. The road system of Beijing in the pre-1990 period demonstrates that as long as there are dedicated road designs for bicycles, modern road system can well support bicycle use on a large scale. In all, emergence of a circulatory system for bicycles became an outstanding feature of Beijing's road network in the pre-1990 period. During this period, there were less automobiles in Beijing and cycling was much safer compared to what it is today. In the 1980s and the early 1990s, cycling became the predominant mode of commuting for most residents in the city.

In the meantime, a clear connection between the industrial development and the urban planning policy can be found. When China produced over forty million bicycles a year and had a biking population topping 500 million in the late 1980s, urban transport planners in many Chinese cities

approached cycling as an issue of strategic importance: the city's landscape, as well as other urban policies had to respond to such scale and capacity. Even later, when motorized traffic came to the forefront of attention, the first national standard of road network design (entitled "Urban Transport Road Design Code" —UTRDC, or GB50220-95), issued in 1995, still reflects the overall importance of the bicycle network in the urban transport system. For example, according to UTRDC, separated bicycle paths are required for the road network based on the estimated volume of bicycle traffic. Thus a bicycle track is required when traffic flow exceeds 10,000/hour, and a bicycle lane is required when traffic flow exceeds 5000/hour. The width requirement of a bicycle path varies from 1.5 to 6.5 meters depending on bicycle traffic during peak hours. In Beijing, bicycle paths are somewhat wider and measure anywhere from two to seven meters on different roads, five to seven meters on the trunk roads and three to four meters on secondary roads (Li, 2009). But by now, many of these paths have been lost to the automobile.

4.3 Housing Form

The connections between the housing form and bicycle use in the city are not as visible as that with the road system. Before 1980, two main residential housing forms existed in Beijing: the traditional single-storey courtyard housing and the mid-rise apartment blocks built after 1949. High-rise buildings didn't begin to appear until 1973 (Wu, 1999). Prior to 1949, there were eleven million square meters of housing stock in the walled city (Wu, 1999), predominantly one-story courtyard housing. The scale of new housing construction was small. Among the 10 million square meters of new housing stock constructed in the city between 1949 and 1991, only one million square meters were built before 1974 in the form of three-to-four and five-to-six-storey buildings (Wu, 1999). These new apartment blocks were built in communities around places of employment (*danwei*, or work units) between the old city and industrial zones, providing work and housing, as well as healthcare, food distribution and other basic social services (Wu, 1999; Gaubatz, 1999). Many mid-rise buildings were constructed in large, walled work unit compounds; within the walls, people worked, lived and played. Consequently, the travel demands of the working population remained minimal and the travel distances tended to be shorter. Walking and cycling became compatible means of travel for daily life.

For the majority of residents who lived in courtyard housing after 1949, their travel situations were similar. The physical design of the city intentionally discouraged mobility (Shi, 1998). Except for some thoroughfares and markets, there were no compact commercial centres in the city. Schools, hospitals, shops and other services were established and scattered throughout different neighbourhoods (Strand, 1989), meaning that people's daily needs could be fulfilled by short trips to nearby adjacent destinations. If you look at the neighbourhood layout in the old city, which was connected through *hutongs*, they are exactly like what we call walkable communities today. People's daily needs could be met with minimum travel demand.

There are additional features of the traditional housing form that encouraged walking and cycling. Different from the North American single-family housing, courtyard housing is a low-height but high-density housing form, either shared by multiple families or occupied by one multi-generational family (depending on the size of the lot). The open yard in the center of the court was surrounded by dwellings, and provided a semi-public space for people living in the same court. Such features are held in high regard by Chinese architects, as an effective urban form, because ideally, it cultivates a sense of family and close neighbourly relations. This shared yard was easily adapted when bicycles became popular: people could store their bicycles inside the yard after use, or even along *hutongs*, with minimal safety concerns. The walled work unit compounds also provided a similar level of safe and convenient bicycle parking. In the peak time period between 1980 to 1990, when the city had a biking population of over eight million, a safe and convenient parking space for the bicycle was crucial for people to retain the practice, particularly when a bicycle was still a valued item for most families. In an interview with Jiang Chunfang, 53, a cycling advocate, who lived in courtyard housing for over thirty years and has written many articles urging a better cycling environment in Beijing from his own study as a resident.[14] He said that "moving from one-story housing to mid-rise and high rise buildings is an important reason why many people stopped biking." In his view, the influx of migrant workers to Beijing from 1990s onward has caused a serious bike-theft problem, so "people had to carry their bicycle home if they lived in a high rise building. It is a difficult job if you have to do that every day. I know people who stopped biking after they moved into the high rise buildings." Bike-theft problems may complicate the issue, but clearly the existence of the traditional

[14] "Please Return Bike Lanes Completely to Cyclists" is an example of his articles recently published on the website of the Chinese People's Political Consultative Conference via http://epaper.rmzxb.com.cn/2011/20110704/t20110704_398570.htm , accessed on March 12, 2012

one-story housing form, and the guarded work unit compound, accommodated cycling boom after 1980.

4.4 Pricing and Allocation System

From 1950 to 1978, the number of bicycles in Beijing increased from approximately 200,000 to over 2.5 million. The population of residents grew from 4.2 million to 8.7 million over the same period. Bicycles shared similar characteristics of other basic necessities in a planned economy: short of supply, obtainable at a fixed price along with a ration coupon, and a highly desired good by most families. The initial retail price of a 28" bicycle set by the central government in 1950 was 169 yuan[15], which was a very high price at a time when an urban worker's salary was only 445 yuan a year (China Urban Life and Price Yearbook, 2009). The price of a bicycle was more than a worker's four-month salary. In the three years between 1962 and 1964, to help the country's economic recovery from the disaster of the Great Leap Forward Policy, the withdrawal of the Soviet Unit technical assistance and a severe drought in 1960, a temporary high-price policy was adopted for some less than essential products including bicycles. The price of a bicycle was raised to 650 yuan and the profits collected went into the state treasury[16]. After 1964, the price was dropped again to the previous level with constant price adjustments for fluctuating raw material costs and production capacity. Since the range of price change was quite limited, the price of a bicycle could be said to have stayed relatively stable from 1950 to 1978 for over 30 years ranging from 150 to 200 yuan (see Figure 3). Even after 1986 when the price restriction policy was abandoned, the price of a regular bicycle only rose slightly to 250 yuan.

Similar to the stable bicycle price, urban workers' income was also relatively flat during this period, with an average annual wage that increased from 445 yuan in 1952 to only 673 yuan in 1978[17]. Despite the slow growth of family income, the bicycle ownership of urban families in Beijing increased steadily, jumping from 40 per bicycles per 100 households in 1960 to 135 bicycles per 100 households in 1978. In rural areas, the per capital ownership also reached 109 bicycles per 100

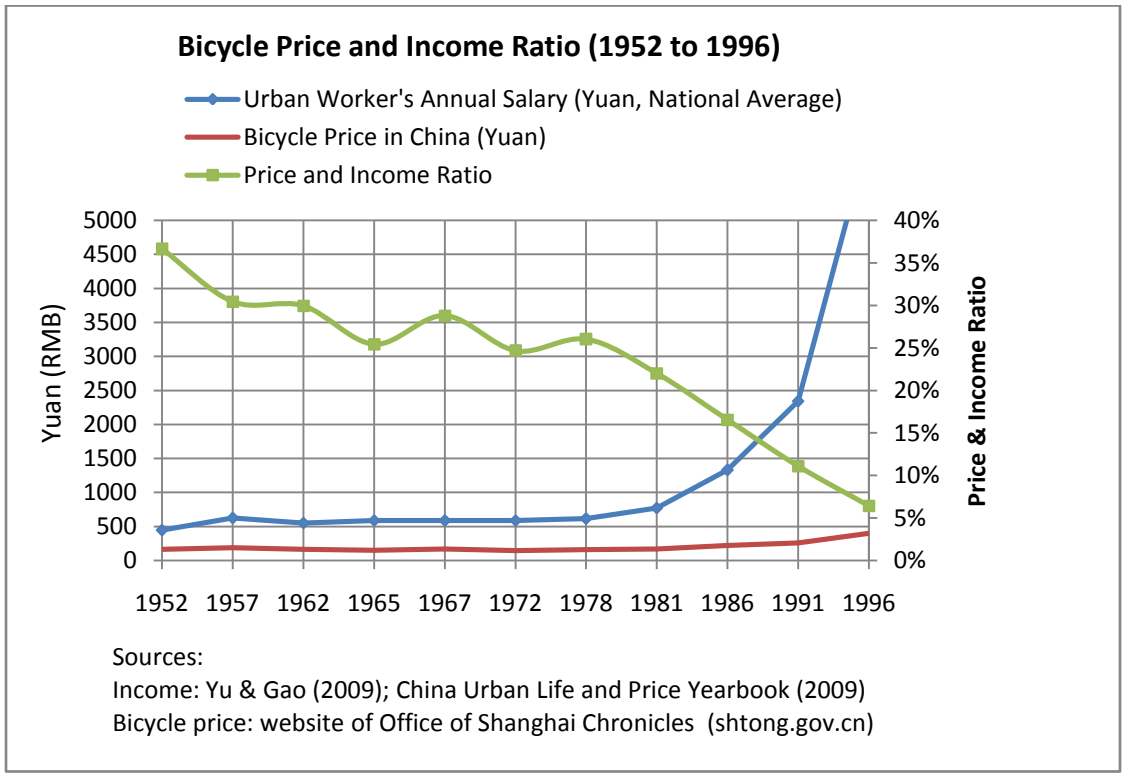
[15] Bicycle price information was retrieved from the website of Office of Shanghai Chronicles via http://www.shtong.gov.cn/node2/node82288/index.html , accessed on March 10, 2012

[16] Bicycle price information was retrieved from the website of Office of Shanghai Chronicles via http://www.shtong.gov.cn/node2/node82288/index.html , accessed on March 10, 2012

[17] Because I was unable to access the urban workers' salaries of Beijing from 1949 to 1978, I used the national average wage instead. There is a small gap between the two because of the flat salary applied in the egalitarian economic system at the time. Shanghai urban worker's annual salary was 762 in 1949 and became 672 in 1978, very close to the national average (Shanghai Social and Economic Statistics 1949 to 2000).

households in 1978, indicating that on average every household had a bicycle. In 1952, a bicycle cost more than 35% of an urban worker's annual salary, a ratio that decreased to about 25% by 1978. Even so, bicycles absorbed a large portion of an average urban family's income (see Figure 3).

Figure 3: Income and Bicycle Price Comparison



In 1953, the Chinese government launched the Unified Purchase and Sale of Grain policy to deal with a food crisis that had resulted from population increase and the large-scale industrialization process launched in Chinese cities. The policy authorized the government to control prices on materials that were important to the national economy. This policy soon expanded to livelihood necessities as well, covering eggs, meat, clothing and bicycles. All of these materials within the specified categories were put with a fixed price and distributed through ration coupons, so purchasing a bicycle would not only need money, but also require "a bicycle coupon" that was allocated as welfare for the working population through the work unit system. Coupons for food, oil, eggs and clothing were allocated monthly based on the number of family members, but a coupon for big items like a watch, a sewing machine or a bicycle was very special; the commodity supply remained

limited. Normally you had to be on a waitlist for quite a while before you could get it, and a bicycle was regarded as a valuable family asset at the time.

In all, prior to 1978, Beijing only had fewer than 130,000 motor vehicles (See Table 18), traffic was less, home and work places were close by, bicycle parking was accessible and safe, the physical environment for cycling was safe and comfortable. In short, cycling was a good fit for people's way of life.

Section 5: The Period of Rapid Growth in Bicycle Use (1979 to the 1990s)

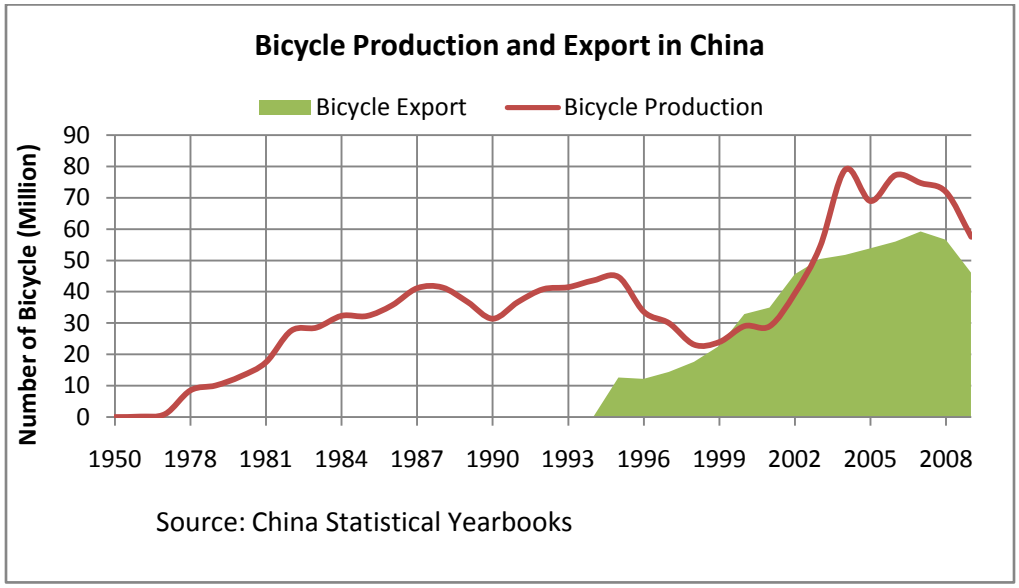
After the Opening-up of the economy in 1978, the bicycle industry enjoyed more than ten years of vigorous growth, and both bicycle ownership and bicycle use thrived. It was at this time that bicycles became essential household goods for millions of families and the most popular means of daily commuting. In addition to the continuous effect of the factors discussed earlier, sufficient market supply of bicycles and increased income were two major contributing factors to the growing bicycle use during this period.

5.1 Bicycle Production in China

The bicycle industry in China experienced three major development periods: (1) the consolidation and expansion period from 1950 to 1978 (discussed in section 4.1); (2) the domestic growth period from 1980 to 1995; and (3) the export-oriented growth period from 1996 to the present. After 1978, bicycle factories enjoyed greater independence in business operations and profit sharing, and their vitality and efficiency have been enhanced. There were 77 bicycle plants and more than 400 bicycle accessories factories in China in 1988 (China Statistical Yearbooks). Bicycle production reached its first peak period with an annual output of 41 million in 1987, compared with 17.54 million in 1981 (China Statistical Yearbooks). However, by 1990, after ten years of continuous growth, the bicycle industry faced new challenges. First, the domestic bicycle market, particularly in the cities, had become saturated. New competitors (both foreign and private) had entered the market, and the major state-owned bicycle factories all encountered difficulties in dealing with a more intense market competition, which led to the industry's first production decline in 1991 (see Figure 4). Secondly, in 1994, the central government launched the National Automobile Industry Development Policy, which had a clear impact on bicycle production. In 1996, the bicycle industry further declined and continued to slow down until 2002 (China Statistical Yearbooks). The industry then went into a new round of restructuring. After a few years of mergers, privatizing and technical upgrading, the bicycle industry regained its competitiveness in the global market. It produces a diverse range of products, including sport bicycles, folding bicycles, and electric bicycles with luxury features and high-grade lithium batteries, among others. Most of this production was for export, which grew from 12.62 million in 1995 to 57.58 million in 2009, accounting for seventy percent of world bicycle trade (Hook, 2002). Domestically, however, a similar trend to the overseas market favouring high-end

bicycles is also emerging[18]: younger people and urban adults are equipping themselves with luxury brands and fancy gears, which often cost several thousand yuan; major bicycle producers are also explicitly stating their interest in high and middle class niche market and younger generation with more expensive bicycles for recreation and sports[19]. But the question still remains, whether and to what extent these luxury bicycle users complement and ultimately expand their influence on bicycle use for commuting?

Figure 4: Bicycle Production and Bicycle Export in China[20]



5.2 Income Increase and Bicycle Ownership

Booming bicycle production and market supply during the economic reform period greatly satisfied people's longing for bicycles. In 1986 the price restriction policy was suspended. Bicycle became a real free market product. Compared to the moderate price change of bicycles during the period from

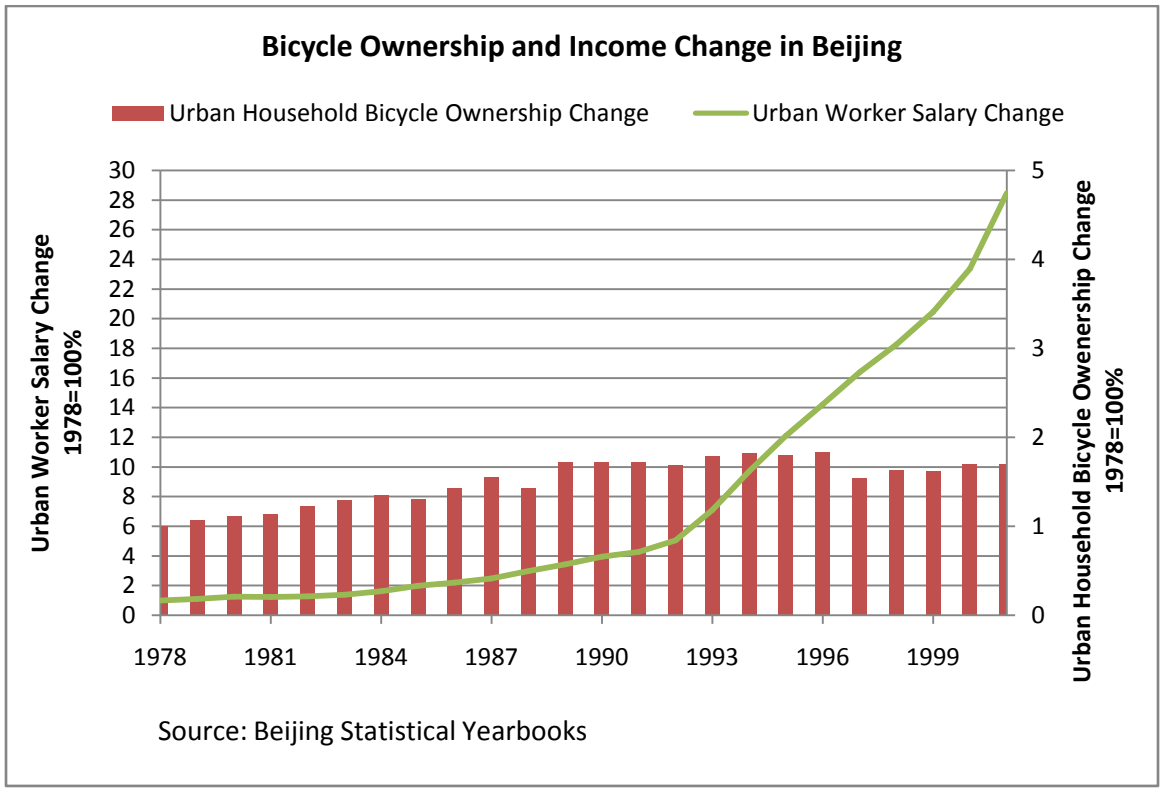
[18] Drawn from 2011 Bicycle Industry Economic Operation Analysis Report, retrieved from http://tjxh.norbicycle.cn/New.aspx?id=474 on April 7, 2012

[19] Drawn from 2012 Shanghai Phoenix Bicycle Group Sales Annual Convention Report, retrieved from http://www.phoenix-bicycle.com.cn/newbox.aspx?nid=1 on April 7, 2012. Bicycle prices displayed on the website are all above 500 yuan , ranging from 799 to 4999 yuan.

[20] In China Statistical Yearbooks (2001,2002 & 2003), the number of bicycles exported to other countries were bigger than the volume of the domestic production in the years from 2000 to 2003. The discrepancies may be caused by missing data from some private bicycle producers. According to online sources, the production data for these three years collected by China Bicycle Association are 52.22 million in 2000, 51.59 million in 2001 and 68.79 million in 2002, much higher than the data from the national statistical yearbooks. Further verifications through reliable sources need to be made.

1978 to 1999, the income of Beijing residents increased dramatically (see Figure 5). The contribution of increasing income to bicycle ownership was evident before 1990, but as the margin of income increase became greater, its contribution to bicycle ownership decreased. Between 1990 and 1995, with continuous income growth, the bicycle ownership remained rather flat. After 1995, the two variables went each their separate ways. Income increase took off steeply; bicycle ownership declined slightly and then remains stagnant at a relatively high level. At the same time, other travel options, such as driving a car, became possible. As car ownership expanded, bicycle use dropped to all-time lows.

Figure 5: Bicycle Ownership and Income Change in Beijing, 1978 to 2000

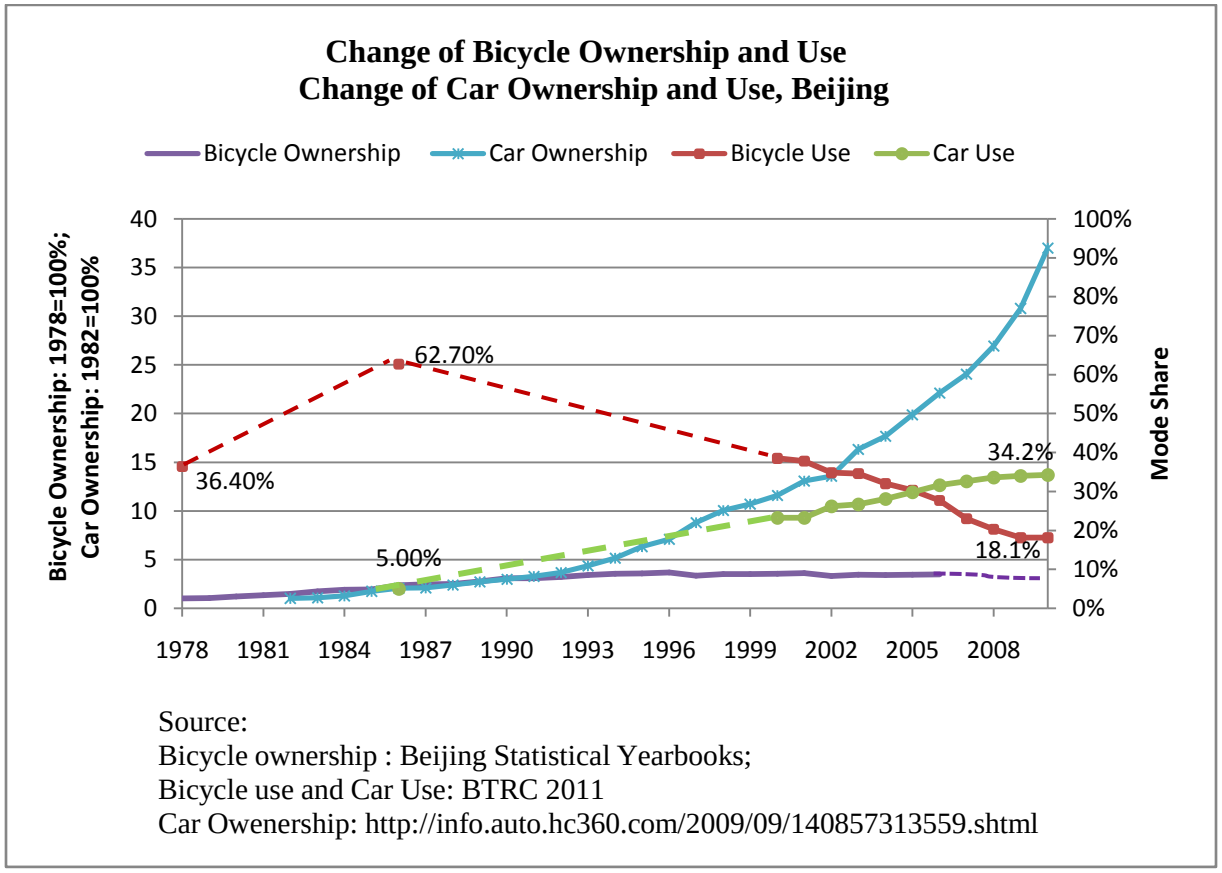


Section 6: The Declining Period in Bicycle Use (the 1990s to the Present)

6.1 Separation of Bicycle Ownership and Bicycle Use

For the period before 1990, our discussion does not specifically separate bicycle ownership from bicycle ridership for two reasons: (1) First, bicycle ownership data from 1978 is available from the statistical yearbooks, whereas travel data for Beijing residents was not available until 1986, when the first city-wide transportation survey was conducted, followed by another two in 1987 and 1988 (Qian et. al., 1999). The most recent surveys were conducted in 2000, 2005 and 2009 respectively. Therefore, reliable travel data before 1986 is unavailable, with a gap in the data between 1990 to 1999; (2) Second, due to the lack of bicycle use data, it is impossible to define the exact time when bicycle ownership separated from bicycle use. According to the available data, bicycle use was almost at its highest ever level in 1986, while ownership was at the peak level in 1996. Given the fact that auto industry started to play a role in people's travel choice since 1996, in this report I have thus designated 1996 as the year when bicycle use would no longer be correlated with bicycle ownership: before 1996, people tended to use the bicycle more regularly when they owned it; after 1996, particularly after 2000, with growing car ownership, some people still had bicycles but started to drive more regularly. In 2005, car use reached 30% of mode share and exceeded bicycle use by only a fraction (29.8%) that year (see Figure 6).

Figure 6: Comparison of Bicycle Ownership and Use in Beijing, 1978 to 2010



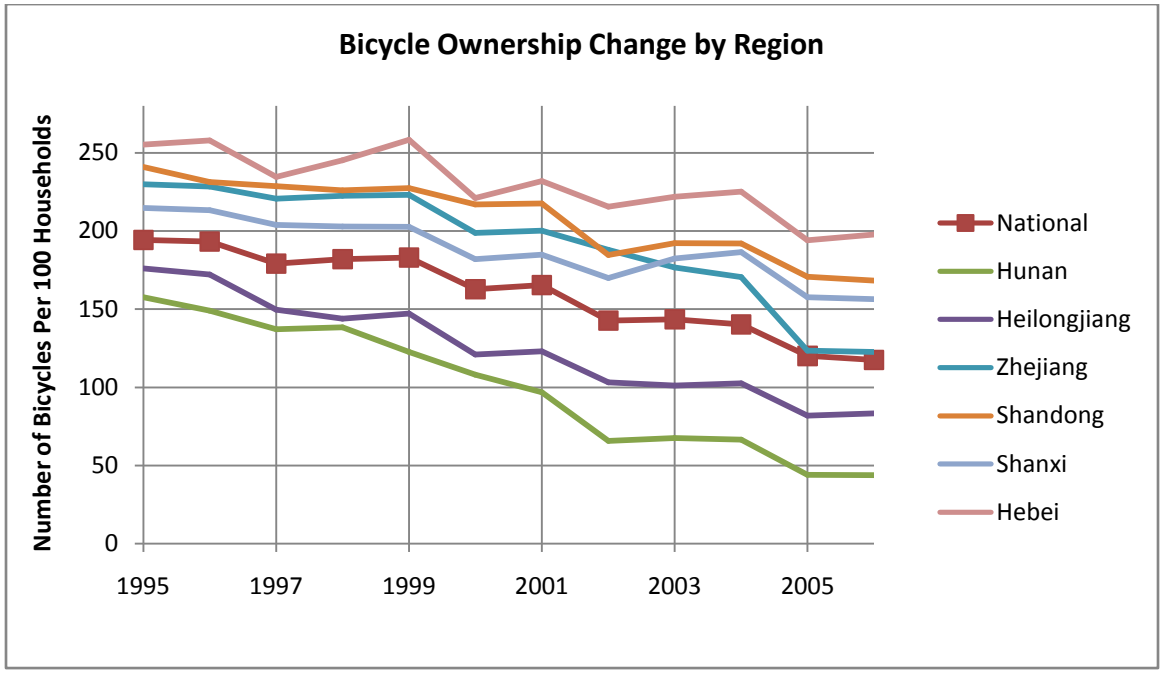
Source:
Bicycle ownership : Beijing Statistical Yearbooks;
Bicycle use and Car Use: BTRC 2011
Car Owenership: http://info.auto.hc360.com/2009/09/140857313559.shtml

6.2 Bicycle Ownership and Bicycle Use Decline

Starting in 1996, bicycle ownership in China started to decline nation-wide. The national average of bicycle ownership dropped from 1.9 bicycles per family in 1995 to 1.1 bicycles in 2006[21]. Beijing, Tianjin, Hebei, Henan, Sichuan and Shanxi all experienced a moderate loss of about 20%, while other provinces such as Qinghai, Hunan, Guangdong and Tibet saw drops of 50% to 70% (See Figure 7). Bicycle use also started to fall in many Chinese cities at an accelerated speed, replaced by the growing use of motorized vehicles such as cars, motorcycles and electric bicycles. Beijing has stayed at the forefront in this motorization process. In 2011, it already had more than six million private car owners, outnumbering the shrinking biking population of three to four million (Li, 2009).

[21] After 2006, the city no longer collected the statistical data of bicycle ownership for urban residents, suggesting a widely decreased interest in bicycles in the city. Only the data for rural households are still available.

Figure 7: Urban Bicycle Ownership Change by Region, 1995 to 2006



The reasons for such wide-spread decline of bicycle ownership and bicycle use are complex. At the macro level, automobile production became a national pillar industry, receiving full-fledged policy support since 1994. Automobile purchase and use was framed as a leading force for driving economic growth. At the city level, urban planning for land use and transportation was compelled to provide infrastructure to support a rapid motorization process. At the individual level, increased household income spurred aspirations for a comfortable and successful life. These goals were symbolized and materialized through driving, making car ownership and use the preferred choice over the bicycle. The interactions of these factors at different levels created a new cultural narrative that embraces cars and driving and gradually marginalized the bicycle in the hierarchy of urban transport. Thus the cycling environment has deteriorated, both physically and socially, leading to a consistent decline in bicycle use over the past twenty years. In the following section, we will look at how land use patterns, transportation planning, policy and regulation have impacted bicycle use in Beijing.

6.3 Land Use Pattern

Historically Beijing was a concentric city (Wu, 1999), with the Forbidden City at the centre surrounded by the Inner City and Outer City behind the wall. After the founding of People's Republic China, a new urban form similar to the socialist model city of Moscow was adopted with an industrial zone developed in the suburbs, and residential quarters located between this zone and the old city, separated by green belt (Sit, 1996b). The industrialization process in the suburbs before the Cultural Revolution caused serious problems of pollution, and the over-extended satellite townships proved to be too scattered and ineffective in relieving development pressure in the city. In 1981, near-suburban cluster developments were adopted by Beijing with the aim to form self-contained sub-centres that could transform the mono-centric pattern to a poly-nuclear development (Wu, 1999). However, this decentralized development pattern did not taken shape easily. Land use during this period has been described as a "pancake-style" pattern, referring to the constant urban land expansion around the ancient city center. From 1990 to the 2000s, the urban built-up area in Beijing increased from 397 km^2 in 1990 to 1180 km^2 in 2003, and further to 1289km^2 in 2007 (Jiang & Han, 2009). In the meantime from 1990, the work unit system was gradually abandoned accompanied by housing reform. Henceforward, housing was no longer to be treated as a welfare entitlement but as a commodity, and the promotion of homeownership became the center of housing reform policies (Shin, 2007). As a result, a large segment of the working population moved to live in these newly developed areas, which are increasingly separated from workplaces. Meanwhile, Beijing's central area as the region's economic core remains strong. Even though, in 2004, the city's master plan clearly articulated an objective to form new sub-centers in peripheral areas, evidence of Beijing changing form from a monocentric to a polycentric city is still weak (Deng & Huang, 2004). In a recent review of Beijing's overall planning, a local magazine, *Outlook,* commented that "excessive concentration of economic function, employment and building capacity in the central city has not fundamentally changed." (Wang, 2011)

The spatial imbalance between sprawling residential development and a much slower decentralisation of economic functions has had a profound impact on Beijing's transportation system. The broad spatial separation of home and workplace locations generates a large volume of long distance traffic. Travel survey data show that the average travel distance (excluding walking) of Beijing residents increased from 6 km per trip in 1986, to 8 km in 2000, climbing further up to 9.5 km in 2005, thus rising by 30% over two decades (Jia & Mao, 2008). In 2005, the average trip

distance by transit and car was 9.5 km or longer, all well in excess of the 5 km threshold considered to be the optimal distance for normal bicycles use (Li, 2009) (see Table 6). Average trips by shuttle bus increased significantly from 10.2 km in 2000 to 15.2 km in 2005, indicating increases in distance between home and workplace. Since travel distance is a primary determinant of modal choice, this increase in travel distance —which continues—is considered a major reason for the decline of bicycle use in Beijing, as many people choose either public transit or driving to cover longer distances. However, the 2005 survey data also show that despite increased average distances, 37% of the trips (excluding walking) were still shorter than 4 km, and more significantly, 44% of the car trips were for distances of 5 km or less. There is room for policy research and planning efforts to understand how to support these short trips, whether for work, shopping, or leisure activities, through more effective and sustainable modes, such as cycling.

Table 6: Travel Distance Change in Beijing, 1986 to 2005

Travel Distance (km)	Car	Taxi	Subway	Bus	Shuttle Bus	Bicycle	Walking	Average
1986	-	-	-	-	-	-	-	6
2000	10.2	9.5	15.6	11.4	10.2	4.8	-	8
2005	14	8.6	14.5	9.5	15.2	4.2	0.8	9.3

Source: BTRC, 2007; Jia & Mao, 2008).

6.4 Transportation Policy and Regulations

While travel distance has become a major barrier for bicycle travel, other physical barriers on the city's road network led people to abandon cycling: examples include reductions in separated bike lane facilities, disconnected bicycle routes, the conversion of bike lanes into driveways and car parking, ground-level pedestrian crossings replaced by underground paths and overpasses, and the absence of parking facilities for bicycles in public space, among other things. These barriers are recent, systematic products of a marginalized bicycle system in modern transportation planning in Beijing. The importance of a well-connected bicycle network in the transportation system has been largely ignored in the transportation policy, planning practice and road traffic management.

6.4.1 Development of Urban Transportation Strategy

From the early 1980s, Beijing started to develop its own modern transportation planning strategy (Guo & H. Zhao, 2009). Guo and Zhao summarize the process in three periods: (1) fundamental

research and capacity building in the 1980s, including establishing transportation research institutions, gaining exposure to Western planning theory and expanding the road network; (2) an initial phase of planning strategy development in the early 1990s, during which the conceptual framework for a comprehensive transportation system was developed; and (3) development of the city's comprehensive transportation strategy and application of the modern planning guidelines and methods from the late 1990s up to the present (Guo & Zhao, 2009). The recognition of the need for a comprehensive transportation system in Beijing was reflected in the joint statement called "The Beijing Declaration of 1995 – China Urban Transport Development Strategy"[22], prepared to coincide with the first international conference on China's urban transportation strategy in 1995 (See Table 7). In this statement, a well-balanced transportation development strategy with various sustainability principles was drafted for Beijing including a restrictive automobile use reflecting social and environment costs, and a high priority given to public transit and bicycles. Unfortunately, implementing this strategy became impracticable with the launch of the National Automobile Industry Development Policy. A few years after the 1995 Declaration, the number of automobiles in Beijing increased so fast that it outpaced the speed of road network construction. Traffic congestion was becoming a significant issue. Ever since, transportation planners have been under pressure to bridge the gap between the growing travel demand of a booming population and the existing transportation infrastructure. To handle the ever increasing congestion, the focus was on how to shift drivers to public transit. Although the bicycle system had been included in the city's comprehensive transportation framework, its role in resolving traffic congestion received little attention.

6.4.2 Marginalized Bicycle System in Transportation Strategy

In 2004, the Municipality of Beijing issued the first long-term transportation strategy of its own, known as the Transportation System Development Outline (2004-2020). As a significant planning document, it is encouraging that the bicycle system is included as an important part of a comprehensive transportation system. However, compared to statements made in support of auto traffic and public transit, the section on bicycle systems planning is quite vague and lacks specific targets for investment, the amount of completed roadway network to be added, expected ridership increases, or other important indicators. It only specifies to improve cycling routes in certain areas such as the inner city old neighbourhoods and some tourism-related locations. It does not intend to improve the bicycle system on a city-wide scale. In the 10thand 11th Five Year Plans, more than 5%

[22] The Beijing Declaration of 1995 – China Urban Transport Development Strategy was retrieved via http://www.chinautc.com/information/newsshow.asp?newsid=439 on March 12, 2012

of GDP of Beijing has been spent every year to build new roads and subway lines, while almost no figures can be gleaned on the amount of investment for improving the bicycle system or promoting the use of bicycles (City Government Work Report, various dates). The one exception is the bicycle rental system, which was operated by a couple of private enterprises and succeeded during the 2008 Olympic for a short period. It received initial government funding but failed in the long-term due to lack of continuous funding and public support (FON, 2011).

In 2009, following the green momentum of the 2008 Beijing Olympics, the City announced a five-year interim plan, known as the "2009-2015 Action Plan of Developing Human-oriented Transportation, Scientific Transportation and Green Transportation" (the Action Plan), to achieve the objectives of the City's Transportation System Development Outline (2004-2020). Promoting bicycle use as an effective way of energy saving is highlighted in the "Green Transportation" section of the Action Plan. Despite the failure of the bicycle rental system after the Olympics, the plan follows the same approach, proposing to set up a bicycle rental system consisting of 1,000 stations and 50,000 bicycles along the major subway lines by 2015. It also includes completion of three showcase zones for bicycle use in a few distinctive tourism and commercial areas. The effectiveness of such a plan in promoting cycling at the city level remains in question. Given the strong but fading tradition of cycling and the remaining high level of bicycle ownership among the Beijing residents, the current strategy seems to be limited only to bicycle sharing without considering other methods or practicalities for encouraging cycling. Ironically, in December 2009 the announcement of the Action Plan was accompanied by media coverage because of the policy goal of reviving bicycle use from the 2009 level of 18% to 23% by 2015 (Chinadaily, 2010)[23], quoting the figures released from the Beijing Transportation Commission. Only one year later, however, in January 2011, the measures announced for "Curing Traffic Congestion" (Beijing Municipal Government, 2011), made no mention of the 23% goal but stated that bicycle ridership would remain at 18%, in contrast with the progressive target of 50% of mode share for public transit and a new limit of 25 % for car use.

It is clear that the bicycle system is still in a marginalized position within the city's transportation planning. Even with 37% of trips (excluding walking) being shorter than 4km and 44% of the car trips being under 5 km (BTRC, 2011), the bicycle is still considered a separate, relatively

[23]Reported on Chinadaily at http://www.chinadaily.com.cn/china/2010-01/24/content_9368053.htm on January 24, 2010. Accessed on March 12, 2012.

insignificant, yet challenging component of the overall transportation system. Although a bicycle rental system proposed in the Action Plan has made some progress and some 5000 bicycles had been stationed in some district areas by the end of 2011, their acceptance remains an open question. According to the most recent data from the Beijing Transportation Research Center, bicycle use continues to decline, with the mode share in 2010 down to 16.4% of all trips, lower than "the remaining 18%" figure in the "Curing Traffic Congestion" document , not to mention the "disappeared" 23% of cycling mode share in the earlier Action Plan. It is clear, then, that in absence of a rigorous policy intervention in the near future, bicycle use in Beijing will continue on its downward path.

Table 7: Bicycle Related Transportation Policies in Beijing, 1995 to 2011

Year	Bicycle-Related Transportation Policies	Automobile	Public Transit	Bicycle
1995	Beijing Declaration: Urban Transportation Development Strategy in China (A joint statement made at the International Conference on China Urban Transport Development Strategy held in Beijing November 8 -10, 1995)	Proposed for a restricted development which reflections the social and environment costs, but impractical to implement because of the launch of the National Automobile Industry Policy in 1994.	Proposed to give high priority, received top attention in the transportation planning after 2000	Proposed to give high priority, but received little attention in practise
1995	Design Code for Urban Road Transportation Planning GB 50220 (Ministry of Construction)	Well covered	Well covered	Well covered
2000	Energy Saving By-law in Transportation (Ministry of Transport)	Vague	Vague; calls for using energy efficient vehicles in public transit	Not mentioned
2002	Notice on Strengthening the Use of Electric Bicycle (Industry and Commerce Administration Bureau of Beijing)	-	Supporting public transit is used as a reason to constrain electric bicycle.	New licenses are suspended; fully abandoned after Jan 1, 2006
2004	People's Republic of China Road Traffic Safety Law (National People's Congress)	Light penalties identified, but were unable to prevent aggressive driving.	-	Disadvantaged on road with relative "right of way".
2004	Transportation System Development Outline (2004-2020) (Beijing Municipal Government)	High priority with favourable conditions in road network, parking and travel speed.	50% mode share. High Priority in investment, road space, right of way and tax relief/subsidy.	Included but not as a city-wide network, no specific target and only in limited areas

2006	Bus Fare Reduction (Beijing Municipal Government)	-	Heavy subsidy	-
2008	Driving Restrictions Measures (Beijing Municipal Government)	Strong Intervention	-	-
2008	Subway Fare Reduction (Beijing Municipal Government)	-	Heavy subsidy	-
2009	City's 2009-2015 Action Plan of Developing Human-oriented Transportation, Scientific Transportation and Green Transportation (Beijing Municipal Government)	Strong emphasis on transportation management capacity, heavy investment in road network expansion	50% of mode share. High priority, length of public transit line: 2010 (300 km),2012 (420 km),2015 (561 km); use of energy-efficient vehicles	Sole focus on a bicycle rental system consisting of 1000 stations and 50,000 bicycles by 2015
2009	Regulations on Electric Bike Use (Industry and Commerce Administration Bureau of Beijing)	-	-	Restricted use, authorized manufacturer, speed limit <15km/h
2010	Notice on Further Development of Transportation Technology and Greater Efforts to Ease Traffic Congestion (Beijing Municipal Government)	Provision of 50,000 parking space in the central area and 200,000 in other parts of the city; underground fast track; heavy investment in road network expansion	Heavy investment in infrastructure construction	Public rent system with 1000 stations and 50,000 bicycles by 2015; add new parking spaces for bicycles along subway lines
2010	Notice of Parking Fee Change in non-Residential Area (Beijing Municipal Government)	Moderate intervention	-	-
2011	Temporary Regulations on Small Vehicle Quantity Control (Beijing Municipal Government)	Only 20,000 licences to issue annually. Strong Intervention	-	-
2011	Law on Road Traffic Safety (revised) (National People's Congress)	More restrictions to drivers. High penalties for breaking the rules.	More restrictions on drivers. Favourable for cultivating road courtesy	Secure "absolute" right of way. Ticket raised from $5 to $50 for cyclists who violate the rules; restricted use of electric bicycles.
2015	**2015 Target (Mode share)** (Beijing Municipal Government)	**Below 25%**	**Reach 50%**	**Remains at 18%, Public rental system with 1000 stations and 50,000 bicycles.** (2010 bicycle ridership

				dropped to 16.4%)

6.4.3 Transit Fare Reduction

Countries which in recent years have shown a substantial increases in bicycle use, such as the Netherlands, Denmark and Germany, all have an integrated policy package which include extensive pro-biking programs, as well as supportive land use planning and restrictions on car use (Pucher & Buehler, 2008; Pucher et al. 2010). Since 2008, Beijing has implemented a series of policy initiatives to promote public transit and to curb driving. The effect of these measures to promote bicycle use, however, is limited or, in some cases, even adverse.

In the past 5 years, public transit infrastructure in Beijing has greatly improvedas a result of capital investments of 105 billion yuan (Beijing Municipal Government, 2010). The subway network now covers most parts of the city, with the total length increasing from 114 km in 2005 to 336 km in 2010, and the number of buses rising from 19,872 in 2005 to 21,716 in 2009 (Beijing Municipal Government, 2010). In addition, the city has substantially reduced the transit fare since 2007. In January of that year, a one-way bus ticket was lowered to one Yuan for on-board purchase regardless of length of travel, from the previous differentiated pricing scheme based on length of travel (with a 60% discount offered on Quick Access Card and 80% discount for students and seniors using the Card). Moreover, in a bid to attract more subway users, in October 2007, a single pricing system of two Yuan was applied to the subway fare, representing a 30% reduction. The total subsidies provided to transit fare from 2008 to 2010 exceeded 10 billion Yuan annually (Beijing Municipal Government, 2010). While the new pricing scheme successfully attracted more commuters in 2010 achieving a 40% mode share of all trips, it has also led to crowded conditions and put extreme pressure on transit capacity during rush hour. A study on the impact of the subsidy policy on travel choices of Beijing residents shows that the subsidies primarily benefitted existing public transit users, but have had little impact on encouraging car users to switch to non-car modes (Wang et.al., 2009). This would suggest that the increased modal share of public transit has come at the expense of bicycle use and walking. Additionally, the failure of the pilot bicycle rental system put in place after the 2008 Olympics has been partly attributed to high fare subsidies on transit (FON, 2009). A more comprehensive transit

fare system should be developed so as to provide affordable transit service to longer distance commuters and encourage bicycling for short distance trips. If a public bicycle system were to be the main approach the city is taking to increase bicycle use, it would have to be provided free of charge in order to "compete" successfully with public transit under the existing fare subsidy structure.

6.4.4 Car Use Restriction Policy

From 2008 onwards, the city has implemented three kinds of driving restriction policies with an increasing intensity: (1) a driving restriction policy based on license plate numbers, rotating monthly from July 2008 (which has been extended to April 2013); (2) a car purchase restriction policy started in January 2011; and (3) a parking fee boost across the city from April 2011. These restriction policies have all had a certain effect on reducing car use; in particular, the lottery scheme applied to car purchase, considering the total number of over 900,000 cars sold in 2010[24], an annual cap on car plate licenses with a limit of 240,000, represents a very strong policy intervention. However, in the Notice on Further Development of Transportation Technology and Greater Efforts to Ease Traffic Congestion (issued by the city government in January 2011), the proposed package includes provision of 50,000 new parking spaces in the inner city alone and 200,000 new parking spaces in other urban parts of the city, as well as the construction of high speed underground tunnels sixty meters deep on the east and west sides of the Second Ring Road. These congestion-easing policies are essentially pro-driving in nature. What is missing from this policy package are measures that will improve the bicycle system and allow people to have an alternative to using their cars, such as riding a bicycle for short-distance travel, given the fact that 44% of car trips in Beijing are less than 5 km. In addition, according to a report released by Beijing Transportation Research Centre in 2010 (BTRC, 2010), the intensity of private car use in Beijing is much higher compared with other large cities, the average annual vehicle mileage of private cars in Beijing is 15,000 km, which, respectively, is 50% and 100% higher than private car use in London and Tokyo. Further, the proportion of private car trips in central areas is greater than 35%, which is on par with the proportion of private car trips in suburban areas, whereas in London, private car use diminishes inward from suburban to central areas.

[24] Car sales information was retrieved from http://auto.163.com/11/0129/10/6RIE2GMC00084IJO.html, April 10, 2012

6.5 Road Use and Traffic Safety

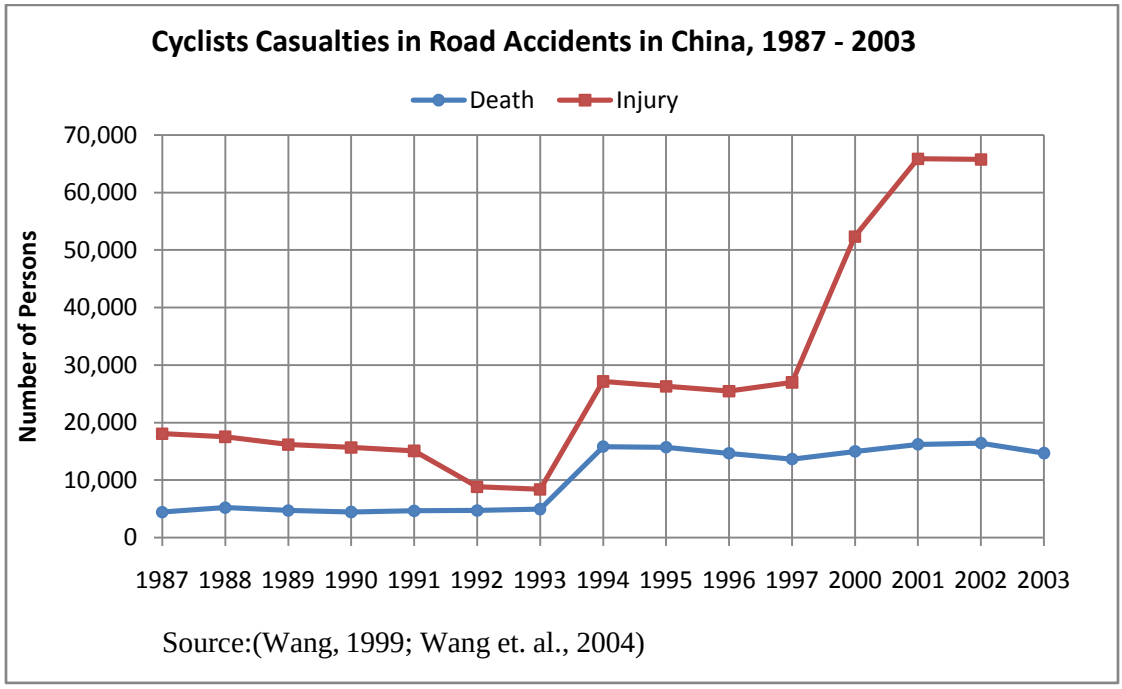
The national road design code requires the inclusion of a bicycle system in the urban transport system, but it cannot enforce proper road use on the ground. Beijing generally does well in following the Urban Transport Road Design Code (UTRDC) (Li, interview). In Beijing, bike lanes are wider, measuring two to seven meters on different roads; five to seven meters on the trunk roads and three to four meters on secondary roads when they were first designed and constructed. However, the demand for automobile-oriented space to move and park is rapidly growing. Converting to automobiles road and parking space originally designed for and used by bicycles is often the easiest and most practical solution. In Xicheng District, 76% of non-motorized road space has been converted to automobile use (Li, 2009), and along southbound of No. 2 and No. 4 subway line, 77% of road space designated for bicycles is now used by automobiles (FON, 2011). Most of these changes threaten the safety of cyclists. These changes do not happen all at once, of course; they take place in an incremental, "encroaching" style, here and there. But when these piecemeal changes are taken altogether, they have been fairly dramatic. Once the deterioration of bicycle environment becomes widespread, it has a fundamental impact on the experience of bicycle users.

Figure 8: Road Use Change (by author)

Despite the steadily declining bicycle use, cycling casualties in road accidents throughout the country increased dramatically after 1993 (see Figure 9). [25] In 1987, 4,436 cyclists were killed in road accidents and 18,087 were injured. By 2001, the numbers had risen by roughly four times to 16,190 and 65,867 respectively, reflecting severely deteriorating safety conditions for cyclists.

[25] A complete study of the cyclists' casualties in Beijing was not yet found.

Figure 9: Cyclists Casualties in Road Accidents in China, 1987 to 2003



Source:(Wang, 1999; Wang et. al., 2004)

Road accidents in the nation's capital show similar orders of magnitude (Luo et. al., 1995; Ma et. al., 2008; Wang et. al., 2011). In 2006, private car owners caused 76.9% of the road accidents in Beijing by illegal or aggressive driving, while non-motorized users were responsible for only 15.3% of the accidents (Ma et. al., 2008). Road accidents have decreased in recent years both nationally and in Beijing (see Table 8), but most casualties are still predominantly of pedestrians, cyclists and motorcyclists accounting for 60% of all killed and 50% of the injured from 2000 to 2003 (Wang et. al., 2004). Finally, nearly 40% of the motorless victims are peasants, migrant workers, small business owners and urban workers—apparently the most vulnerable groups on the street (Wang et. al., 2004; Ma et. al., 2008).

Since 1986, China has passed three pieces of major road traffic legislation. The first is the People's Republic China Road Traffic Administrative Regulations issued in 1988, which laid out basic traffic rules for a road system that was quickly turning motorized. However, in this regulation, motorists still received some preferences in the right-of-way which were abandoned in subsequent legislation. In 2004, to address the alarming rate of traffic accidents and ever-increasing traffic congestion, the first Road Traffic Safety Law of the People's Republic of China was passed. Under this law, the motorist always bears greater responsibility when an accident occurs involving pedestrians or non-

motorized vehicles. Higher penalties were put in place for drunk driving as well as driving by people who did not hold a valid driver's licence, or drove a vehicle without licence plates. The new law also enforced a compulsory vehicle insurance system to provide financial protection to the victims of traffic collisions. In 2011, further amendments were made to the 2004 Road Traffic Safety Law imposing stricter rules and harsher penalties on motorists. Even so, the penalty for non-motorized users who violate rules was raised from 5 yuan to 50 yuan. The hope is that with tightening traffic regulations and public education on road safety, a sense of courtesy will be cultivated among all road users, road conditions will continue to improve as will the safety of cyclists.

Section 7: Conclusions and Discussion

Promoting bicycle use in big cities like Beijing — with car ownership soaring under conditions of rapid urban expansion — is a great challenge. Achieving this policy objective will require an improved understanding of two things. The first concerns the cycling history of the city, the conditions and policies that have encouraged bicycle use in the past and deters it at present. The second concerns the three to four million residents who still ride bicycles in the city. Who are they? Why do they continue to use bicycles? For what purposes do they use them? How long will they continue to use them? My research has only covered the first of these concerns; a rigorous assessment of the second is of particular importance in developing policy measures that produces tangible effects on behavioural change. However, the present research can shed light on policy making for encouraging bicycle use in a more general way: it provides an overview of changing bicycle use in Beijing with baseline statistical information on bicycle ownership, use and production, and with a general analysis of the conditions and policies that have affected historical as well as current bicycle use. All this information will serve as a reference for city planners and transportation researchers to conduct further policy analysis and empirical research.

7.1 Conclusions

The review and analysis from this research indicate that the cycling tradition in Beijing can largely be attributed to the urban environment that the city used to have along with the strong government support for non-motorized modes of travel, a friendly urban form, a bicycle-oriented road network and a strong bicycle industry, all which formed a positive circular relationship favouring bicycle use. Today, some of these features no longer exist (such as the small number of automobiles) or be impossible to recover (such as human scale neighbourhoods), but others are still there and may be furthered (such as relatively high bicycle ownership, a strong bicycle industry, a restorable bicycle route network). Therefore, more policy measures are needed to recover and improve those features that still exist. For example, road widths in Beijing are comparatively large, there are many places where bike lanes can be separated or restored, and if there is a clear policy target and a firm implementation plan in place, a circulatory road network for cycling can be restored, if not in full then at least partially.

A key finding of this research is that the bicycle ownership in Beijing is still high. In 2006, on average, there were still 1.9 bicycles per household. Many of them are "sleeping" in corners and covered with dust. In the city's effort to build up a brand new bicycle rental system along the major subway lines consisting of 50,000 bicycles, a better way to utilize these non-used bicycles deserve a deeper consideration at the same time. A free community bicycle sharing system using these old stored-away bicycles of might be a good way to encourage local residents to resume bicycling for short-distance travel.

My analysis also reveals that industrial policies had profound impact on people's travel choices. The bicycle industry was a major driving force in pushing up bicycle ownership and its use in the pre-and-early reform periods, it also had a tangible impact on planning standards and road infrastructure (particularly in Beijing). The growing bicycle industry required a compatible road network to accommodate its production capacity, because a compatible road network would attract more bicycle users, and so eventually benefit the bicycle industry. The transportation strategy and urban planning in the early reform period in Beijing facilitated such reciprocal relations in a non-motorized way. Today, in contrast, we see a similar process being led by the auto industry that encourages people to shift from cycling to driving. It is important to realize that in the effort of moving towards a sustainable transportation choice, industry is a key stakeholder, and industrial policies can easily overshadow urban planning objectives. Now with two industries both performing well within their respective areas, policy making for a balanced urban transportation structure becomes more complicated. Of course, a sail boat cannot compete with a giant vessel, more policy interventions on car use are needed in order to create spaces for the return of Beijing's cycling culture. The emergence of a high-end bicycle market among the younger generation of urban dwellers, along with increasing restrictions on driving would seem to be promising developments in the right direction.

Lastly, the social and economic conditions for effective policy impact on individual behaviour have changed greatly. It was easier for government policy to promote biking in a centralized planning system where the economic development level was low and people were constrained to behave in conformity with government dictates. In the consumerist economy of today, people have greater freedom to prove their individuality by doing a variety of things, including using different transportation means. The policy effect on individual travel choices has therefore become less influential than before. An integrated transportation policy making at the city level is important, and a more detailed roadmap for promoting bicycle use is needed. For example, small scale

neighborhood experiments might work effectively, such as setting up a free neighborhood bicycle sharing system; or designing more bicycle-oriented features in the new neighbourhoods, or conduct more action-oriented research etc. These can all be promising efforts to start some small but concrete changes in reviving the old biking culture. Public engagement in the planning process is still nonexistent, but to bring about increased bicycle use or communicating with people around sustainable travel choice will soon become urgent. In recent years, cycling has drawn growing attention from the general public. Friends of Nature, a leading environment-oriented NGO, has organized three annual Car-Free-Day events and done substantial advocacy work on "Biking for a Better Beijing". So has the emergence of new slogans such as "BMW" (bus/bicycle, metro and walk) or "3510" (3km walking, 5km bicycle, 10km taking transit), all of them indicating positive social change in the city. Persistent advocacy at the policy level and public education around sustainability issues is also greatly needed.

The century-long cycling tradition is fading and reviving it is being challenged by the increasing population density, longer commuting distances, the increasing number of cars on the road, and the deteriorating air quality in Beijing. The nation's capital city needs a 'critical mass' of cycling interest to secure the city's safe and sustainable operations in the longer term. As the number of drivers in the city has already exceeded the number of bicycle users, spatial conflicts among different road users and resistance to change will continue to grow, understanding how to balance the interests of different groups and to fully engage them in making sustainable travel choices is the great challenge facing the city's planners and policy makers today.

7.2 Limitations

There are certain limitations in my research. Firstly, national policies concerning bicycle production from 1950 to 1980 needs to be further researched to provide a better understanding of the relationship between industrial policy and urban planning. My analysis looks at bicycle production, the pricing system and income levels during this period but a deeper analysis of the relations between national bicycle production policies and urban planning during the centralized planning period is still needed. Secondly, travel data on bicycle use before 1986 is non-existent, and data on bicycle ownership was found to be inconsistent from paper to paper. Even though my calculations are based on available statistical data, significant differences remain in the numbers used by other scholars. More statistical verifications should be performed. Thirdly, I did not look into the emerging

characteristics of cycling today, such as the popularity of bicycles in recreational and sports activities among the younger generations and the increased use of electric bicycles in many other cities. These may be important forces opening up physical and cultural spaces for reviving urban cycling. In all, high-quality studies of historical and current bicycle use in China remain quite limited. The questionnaire-based research we did in 2011 constitutes a small start; the space for further research in bicycle use in Beijing and other Chinese cities remains wide open.

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Appendices

Table 8: Mode Share in Beijing

Year	Bus	Subway	Taxi	Bicycle	Car	Other
1986	26.5%	1.7%	0.3%	62.7%	5.0%	3.8%
2000	22.9%	3.6%	8.8%	38.5%	23.2%	3.0%
2001	23.1%	4.1%	8.7%	37.8%	23.2%	3.1%
2002	23.5%	4.5%	8.2%	34.8%	26.2%	2.8%
2003	23.2%	4.8%	8.0%	34.6%	26.7%	2.7%
2004	23.8%	5.6%	7.8%	32.0%	28.1%	2.7%
2005	24.1%	5.7%	7.6%	30.3%	29.8%	2.5%
2006	24.4%	5.8%	8.1%	27.7%	31.6%	2.4%
2007	27.5%	7.0%	7.7%	23.0%	32.6%	2.2%
2008	28.8%	8.0%	7.4%	20.3%	33.6%	1.9%
2009	28.9%	10.0%	7.1%	18.1%	34.0%	1.9%
2010	28.2%	11.5%	6.6%	16.4%	34.2%	3.1%

Source: Beijing Transportation Research Center, 2011

Table 9: Bicycle Production and Bicycle Export in China

Year	Bicycle Production Unit of Bicycles (Million)	Bicycle Export Unit of Bicycles (Million)
1950	0.02	-
1953	0.17	-
1958	1.00	-
1978	8.54	-
1979	10.09	-
1980	13.02	-
1981	17.54	-
1982	27.58	-
1983	28.57	-
1984	32.35	-
1985	32.28	-
1986	35.68	-
1987	41.17	-
1988	41.40	-
1989	36.77	-
1990	31.42	-
1991	36.77	-
1992	40.84	-
1993	41.50	-
1994	43.65	-
1995	44.72	12.62
1996	33.61	12.17
1997	29.99	14.39
1998	23.13	17.61
1999	23.98	22.7
2000	29.07	32.86
2001	29.02	34.94
2002	39.58	45.56
2003	54.52	50.44
2004	79.06	51.75
2005	69.00	53.85
2006	77.31	56.01
2007	74.75	59.23
2008	71.85	56.59
2009	57.58	46.11

Source: China Statistical Yearbooks

Table 10: Population in Beijing

Year	Total Population (million)	Urban Population (million)	Rural Population (million)
1978	8.72	4.79	3.93
1979	8.97	5.10	3.87
1980	9.04	5.21	3.83
1981	9.19	3.86	5.33
1982	9.35	3.91	5.44
1983	9.50	3.93	5.57
1984	9.65	3.95	5.70
1985	9.81	5.86	3.95
1986	10.28	6.21	4.07
1987	10.47	6.37	4.10
1988	10.61	6.50	4.11
1989	10.75	6.64	4.31
1990	10.86	6.73	4.13
1991	10.94	6.83	4.11
1992	11.02	6.92	4.10
1993	11.12	7.07	4.05
1994	11.25	7.25	4.00
1995	12.51	8.15	4.36
1996	12.59	8.29	4.30
1997	12.40	8.26	4.14
1998	12.46	8.38	4.08
1999	12.57	8.54	4.03
2000	13.64	10.58	3.06
2001	13.83	10.80	3.03
2002	14.23	11.18	3.05
2003	14.56	11.51	3.05

Source: Beijing Statistical Yearbook (2004)

Table 11: Bicycle Ownership in Beijing

Year	Number of Bicycles Owned Per 100 Urban Households	Number of Bicycles Owned Per 100 Rural Households
1960	41.3	38
1961	42	44
1962	42.2	46
1963	43.1	46
1964	48.5	48
1965	46.2	-
1975	-	92
1976	-	99
1977	-	106
1978	135.8	109
1979	145.7	98
1980	150.9	123
1981	153.8	135
1982	166.5	141
1983	175.8	167
1984	183	187
1985	177	182
1986	193.9	191
1987	210.2	204
1988	193.7	218
1989	233	224
1990	228.3	235
1991	233.8	232
1992	229.2	245
1993	243.2	249
1994	246.8	254
1995	243.6	251
1996	249	250
1997	209.4	248
1998	221	249
1999	220.1	241
2000	230.7	220
2001	230.6	220
2002	201.15	208.3
2003	202.06	212.8

2004	191.83	208.67
2005	193.71	196
2006	191.11	186
2007	-	182.8
2008	-	185.07
2009	-	180.27

Sources:

1) 60 Years of Beijing from 1940 to 1990, Beijing Statistical Bureau (1999)

2) Beijing Statistical Yearbooks (2002, 2008, 2010)

Table 12: Number of Bicycles Owned Per 100 Urban Households by Region (1995 to 2006)

Place	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
National	**194**	**193**	**179**	**182**	**183**	**163**	**165**	**143**	**144**	**140**	**120**	**118**
Inner Mongolia	257	249	204	212	218	206	211	191	197	175	179	180
Hebei	255	258	234	245	258	221	232	216	222	225	194	198
Guangxi	245	248	216	225	231	184	189	182	187	185	124	129
Beijing	244	249	209	221	220	231	231	201	202	192	194	191
Shandong	241	231	229	226	227	217	218	185	192	192	171	168
Guangdong	238	225	212	204	196	181	169	143	133	121	113	104
Jiangsu	237	238	225	228	233	206	213	191	173	178	153	156
Henan	232	237	219	225	232	195	201	197	205	203	167	167
Tianjin	231	232	226	226	232	230	239	222	229	222	202	189
Zhejiang	230	229	221	223	223	199	200	188	177	170	123	123
Ningxia	221	230	195	207	202	181	182	172	177	180	130	132
Shanxi	215	213	204	203	203	182	185	170	182	186	158	156
Fujian	204	203	175	177	182	158	169	141	144	114	117	117
Gansu	192	195	176	182	188	179	180	164	162	165	156	135
Tibet	190	232	180	204	197	200	209	140	126	137	136	92
Yunnan	190	184	180	128	200	139	131	136	139	123	114	102
Jiangxi	185	186	165	172	176	146	153	138	140	142	107	109
Xinjiang	185	185	170	171	164	138	146	135	137	134	97	95
Jilin	181	180	173	169	172	150	151	135	139	133	104	103
Shaanxi	179	182	174	178	176	160	166	147	138	134	127	110
Heilongjiang	176	172	150	144	147	121	123	103	101	103	82	83
Hubei	172	172	153	154	154	143	143	112	116	122	94	89
Liaoning	171	163	164	169	156	156	158	132	132	130	107	103
Anhui	168	160	162	163	165	143	152	133	134	135	125	117
Hunan	158	149	137	138	123	108	97	66	68	67	44	44
Qinghai	157	164	152	129	123	104	98	68	71	68	45	35
Hainan	134	131	111	114	117	108	113	107	114	112	70	72
Shanghai	115	124	125	133	139	126	124	124	125	126	119	123
Sichuan	91	97	110	112	118	93	97	85	87	81	70	69
Guizhou	41	35	113	117	31	25	26	20	22	23	17	17

Source: China Statistical Yearbooks (1996-2008)

Table 13: Salary of Urban Worker in Beijing

Year	Average (Yuan)	State-Owned Business Unit (Yuan)	Collective-Owned Unit (Yuan)	Other Business Unit (Yuan)
1978	673	703	471	-
1979	742	778	556	-
1980	848	889	635	-
1981	837	880	685	-
1982	863	896	715	-
1983	931	964	785	-
1984	1,086	1,127	946	1,170
1985	1,343	1,367	1,231	1,768
1986	1,488	1,530	1,287	2,080
1987	1,670	1,712	1,449	2,267
1988	2,000	2,048	1,738	2,661
1989	2,312	2,366	1,992	2,761
1990	2,653	2,713	2,334	3,243
1991	2,877	2,937	2,504	3,713
1992	3,402	3,500	2,828	4,289
1993	4,780	4,920	3,834	5,469
1994	6,540	6,695	5,009	8,179
1995	8,144	8,237	6,516	10,278
1996	9,579	9,645	7,133	13,851
1997	11,019	10,917	8,259	15,370
1998	12,285	11,971	8,800	15,989
1999	13,778	13,483	8,928	17,748
2000	15,726	15,483	9,844	19,165
2001	19,155	19,776	11,063	20,594

Source: Beijing Statistical Yearbook (2002)

Table 14: Beijing Urban Resident Bicycle Ownership and Income Ratio

Year	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Bicycle Owned Per 100 Urban Households	135.8	145.7	150.9	153.8	166.5	175.8	183	177	193.9	210.2	193.7	233	233.8
Bicycle Ownership Change (1978=100%)	1.00	1.07	1.11	1.13	1.23	1.29	1.35	1.30	1.43	1.55	1.43	1.72	1.72
Beijing Urban Worker Annual Salary (yuan)	673	742	848	837	863	931	1,086	1,343	1,488	1,670	2,000	2,312	2,653
Salary Change (1978=100%)	1.00	1.10	1.26	1.24	1.28	1.38	1.61	2.00	2.21	2.48	2.97	3.44	3.94

Year	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Bicycle Owned Per 100 Urban Households	233.8	229.2	243.2	246.8	243.6	249	209.4	221	220.1	230.7	230.6
Bicycle Ownership Change (1978=100%)	1.72	1.69	1.79	1.82	1.79	1.83	1.54	1.63	1.62	1.70	1.70
Beijing Urban Worker Annual Salary (Yuan)	2,877	3,402	4,780	6,540	8,144	9,579	11,019	12,285	13,778	15,726	19,155
Salary Change (1978=100%)	4.27	5.05	7.10	9.72	12.10	14.23	16.37	18.25	20.47	23.37	28.46

Sources:

1) 60 Years of Beijing from 1940 to 1990, Beijing Statistical Bureau (1999)
2) Beijing Statistical Yearbooks (2002, 2008, 2010)

Table 15: Income and Bicycle Price Ratio

Year	1952	1957	1962	1965	1967	1972	1978	1981	1986	1991	1996
National Average of Urban Worker's Annual Salary (Yuan)	445	624	551	590	587	588	615	772	1,329	2,340	6,210
Bicycle Price in China (Yuan)	163	190	165	150	169	145	160	170	220	260	400
Price and Income Ratio	0.37	0.30	0.30	0.25	0.29	0.25	0.26	0.22	0.17	0.11	0.06

Sources:

1) Income: Yu & Gao (2009); China Urban Life and Price Yearbook (2009)
2) Bicycle price: website of Office of Shanghai Chronicles (shtong.gov.cn)

Table 16: Cyclists Casualties in Road Accidents in China, 1987-2003

Year	Death	Rate (%)[i]	Injury	Rate (%)[ii]
1987	4,436	8.3	18,087	9.65
1988	5,199	9.48	17,546	10.28
1989	4,695	9.31	16,162	10.16
1990	4,449	9.03	15,689	12.12
1991	4,633	8.69	15,094	9.31
1992	4,714	8.03	8,837	6.13
1993	4,941	7.84	8,394	5.94
1994	15,792	23.79	27,170	18.26
1995	15,694	21.94	26,303	16.51
1996	14,646	20.5	25,473	15
1997	13,627	21.1	26,994	14.2
2000	14,979	15.96	52,340	12.5
2001	16,190	15.28	65,867	12.05
2002	16,407	15.00	65,763	11.7
2003	14,664	14.05	-	-

i) % of total deaths in the road accidents of the year;
ii) % of total injuries in the road accidents of the year.
Source: Wang et. al., 1999; Wang et. al., 2004

Table 17: Road Accidents in Beijing, 2001 to 2005

Year	**Accidents**	**Death**	**Injury**
2001	17,645	1,447	10,424
2002	12,053	1,449	10,456
2003	10,842	1,641	9,877
2004	8,536	1,631	8,284
2005	6,364	1,515	6,888
2006	5,808	1,373	6,681

Source: Ma et. al., 2008

Table 18: Car Ownership In Beijing, 1982 to 2010

Year	Number of Cars (1,000 Units)
1982	130
1983	140
1984	167
1985	224
1986	267
1987	272
1988	312
1989	353
1990	389
1991	425
1992	478
1993	568
1994	669
1995	825
1996	921
1997	1,145
1998	1,307
1999	1,392
2000	1,507
2001	1,699
2002	1,765
2003	2,124
2004	2,296
2005	2,583
2006	2,876
2007	3,128
2008	3,504
2009	4,001
2010	4,809

Source: http://info.auto.hc360.com/2009/09/140857313559.shtml accessed on April 7, 2012