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Chapter

The Rise and Decline of Car Use in Beijing and Shanghai

Yuan Gao, Peter Newman and Jeffrey Kenworthy

Abstract

Chinese cities have primarily evolved around walking, bicycling and public transport with their dense, linear form and mixed land use. The recent urban growth spurt has involved private motorisation, but because of land constraints and not fearing urban density, as in Anglo-Saxon cities, the same dense urbanism has been maintained. This means that automobiles do not easily fit into this traditional fabric and especially the historic walking fabric. Issues like congestion and air quality have become major constraints to further growth. Using Beijing and Shanghai as case studies, the next phase of urban and transport development now appears to be to reduce car use with the dramatic growth in urban rail as in most developed cities in the twenty-first century. This decoupling of car use from economic growth is consistent with other developed cities but is a first for emerging cities, hence the paper aims to explain this pattern from the cultural, political and especially urban fabric perspectives. The application to other Chinese cities and emerging cities is now possible following Beijing and Shanghai's lead.

Keywords: car use, rise and decline, urban form, economic factors, cultural and political factors, Beijing, Shanghai

1. Introduction

China has undergone rapid urban development with its national urbanisation rate surging from 10.6% in 1949 to 56.1% in 2015 [1]. As a result, urban population across the nation has increased by 10.81 million per annum in the period. Personal income, the principal economic driver of private vehicle ownership [2], has remained on a double-digit[1] high-growth trajectory in most of China since 2001. Urban population growth and economic growth have thus led to growth in private ownership of passenger cars (see **Figure 1**).[2] Besides these factors, administrative guidance and political imperatives have also significantly affected the level of automobile ownership in China [3]. However the question in this paper is whether car use is continuing to rise in key cities or whether it is following the trend in developed cities to decouple this from economic growth.

Chinese cities, along with their respective provinces, have increased in car ownership over recent years and now provincially range in car ownership from a meagre 70 per 1000 persons in Gansu up to 209 per 1000 in Beijing (2017 data), with a

[1] The growth rate of personal income was actually 8.8% in 2009.

[2] It includes large, medium-, small- and mini-sized passenger cars.

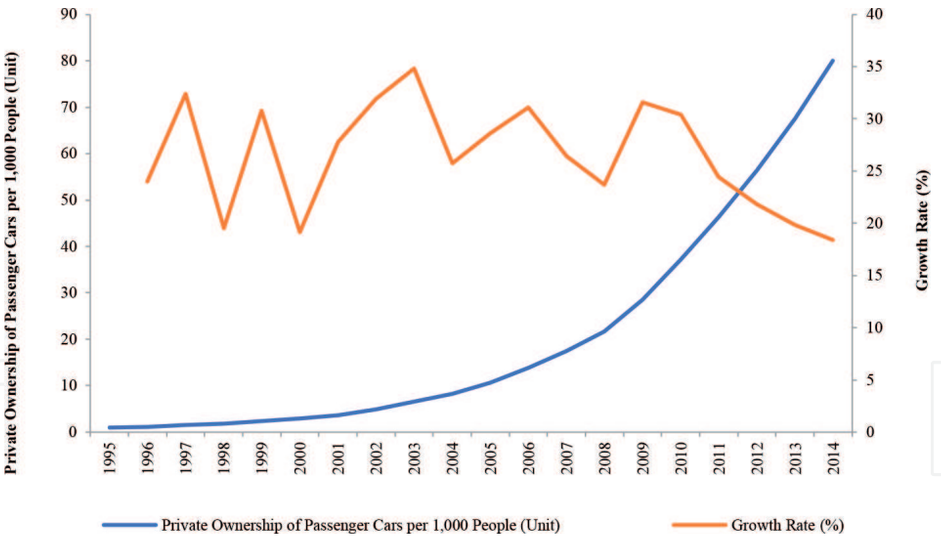

Figure 1.
Private ownership of passenger cars per 1000 people in China (unit) and its annual growth rate (%) from 1995 to 2014. Source: Compiled based on data provided by [4].

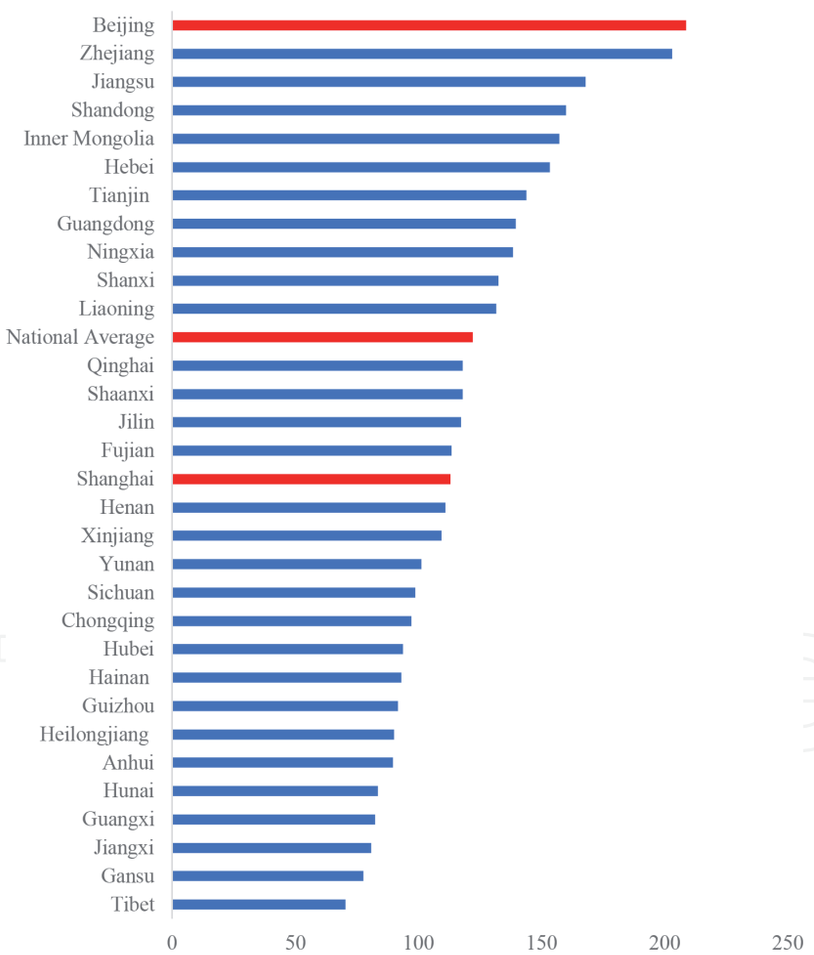

Figure 2.
Private ownership of passenger cars per 1000 people across China in 2017 (unit). Source: Compiled based on data provided by [7].

national average of 122 per 1000 persons (see **Figure 2**).[3] This national level of car ownership is less than countries such as Swaziland, El Salvador, Honduras, Guyana and Azerbaijan [5]. These levels are nowhere near the car ownership levels found

[3] Beijing and Shanghai are two of the four municipalities directly under the central government. Hence, this comparison is made with other provinces rather than cities.

in cities in more developed countries. For example, in 2005–2006, privately owned cars averaged 640, 647, 522 and 463 cars per 1000 persons in American, Australian, Canadian and European cities respectively [6]. Even between China's two most significant cities, Shanghai and Beijing, the difference is very large (113 compared to 209 cars per 1000 persons, respectively), partly due to Shanghai having implemented car management policies[4] from 1994.

Thus Chinese provinces and cities, even during what could be called a rampant period of motorisation, had by 2017 not even come close to car ownership rates in more automobile-dependent regions and were even less nationally than in some significantly less developed countries.

Added to this perspective, we now find that recent car ownership growth rates are falling. The question to be addressed in this paper is therefore whether a decline in car use and a structural change is starting to occur in Beijing and Shanghai, like in many developed cities. The paper begins by examining some trends of car use in Beijing and Shanghai. It then tries to explain the reasons why car use is beginning to decline and why this could be happening at an earlier stage of economic development than in developed cities.

2. The rise and decline of car use in Beijing and Shanghai

2.1 Beijing

Beijing, like all Chinese cities, was dominated by bicycling in the twentieth century and as shown in **Figure 3** had over 60% of daily trips by cycling in 1986, but this quickly was overtaken by a rapid growth in car use; these modes crossed in 2005, and from there a different story emerges that would have been expected in a rapidly emerging global city. Car use begins to plateau in the 2000s and starts declining since 2011. The growth trajectory that then takes over is transit as cycling continues to fall but then plateaus or rises slightly perhaps due to e-bikes as seen in the data below on Shanghai.

The Beijing transit system is shown by mode in **Figure 4**. The dramatic growth after 2007 that has impacted so strongly on modal share with cars is the role of the metro that continues to grow significantly right through to the most recent data. Beijing was the first city in China to inaugurate metro rail into its transport infrastructure, with the first line opening in 1969 [9]. This development was further pursued and received a promotional boost leading up to the 2008 Olympic Games held in Beijing [10]. The metro has been expanded ever since and has been embraced by the residents of Beijing with a daily patronage of around 9 million using the fast, high-quality system. This follows the rapid expansion of Beijing's metro system from an operational length of 142 km in 2007 to 555 km by 2015. Beijing's metro is now the second largest after Shanghai (588 km) in China [11, 12]. The metro has become a significant transport mode, though the traditional bus is still the predominant travel choice of public transport. As this is measured in boardings, it would be more favourable to the metro if passenger kilometres were used as bus trips tend to be shorter.

2.2 Shanghai

Shanghai transport data are different to Beijing as they include walking as well as e-bikes besides bicycling in the modal split as set out in **Figure 5**. But like

[4] Shanghai has adopted the Singapore-style paid auction system to limit new car registration since 1994. The number of quotas issued to public applicants is less than 10,000 every month. The average bid price soared up to 5040 US Dollars in 2008.

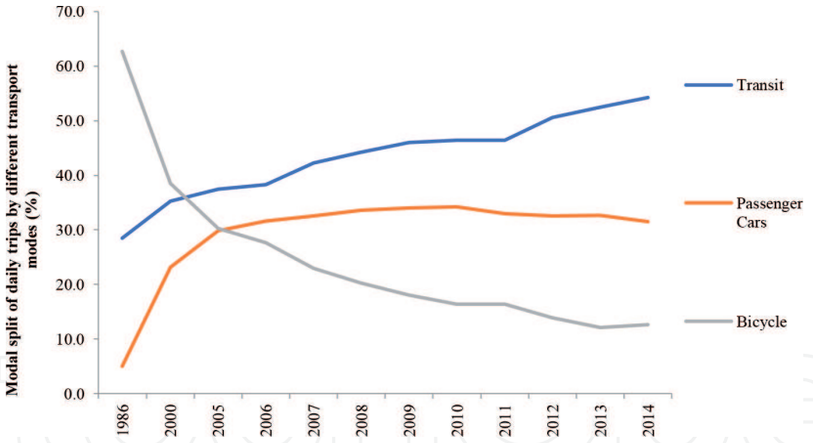

Figure 3.
Model split of daily trips (excluding walking) in Beijing (1986–2014) (%). Source: Compiled based on data provided by [8].

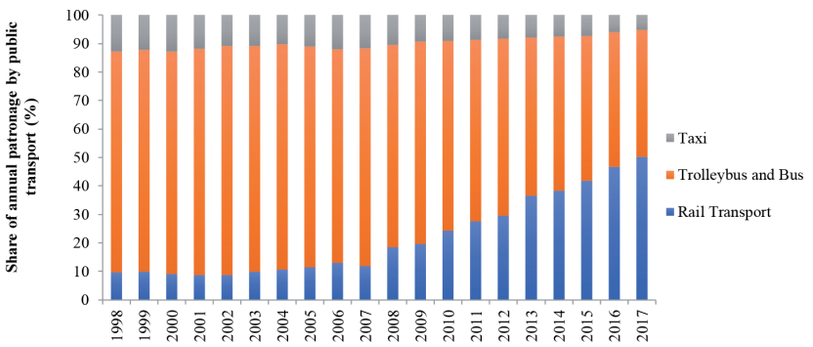

Figure 4.
Share of annual patronage by different public transit modes in Beijing from 1998 to 2017(%). Source: Compiled based on data provided by [13, 14].

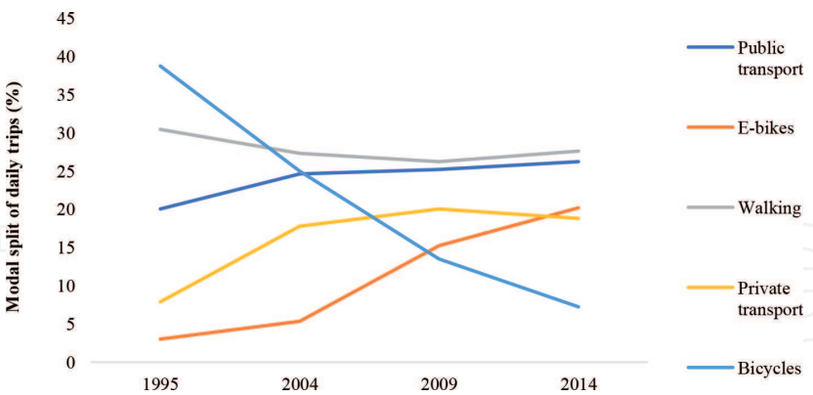

Figure 5.
Modal split of daily trips by different transport modes in the whole city of Shanghai from 1986 to 2010 (%). Source: Compiled based on data provided by [15, 16].

Beijing, Shanghai was dominated by walking and non-motorized (bicycles and e-bikes) transport in the twentieth century with over 70% of daily trips by these modes in the 1980s and 1990s. However, as in Beijing, the twenty-first century has seen a dramatic drop in these modes as car use began to grow in Shanghai. Then a plateau in car use began in the 2000s and by 2010 had peaked at less than 20% of daily trips (even lower than the 34% in Beijing). Again it would appear that transit has stemmed this car growth, though nonmotorised transport has had more growth in the latest data as well. More interesting, e-bikes have replaced bicycles as the dominant nonmotorised transport modes in China, which was well-known

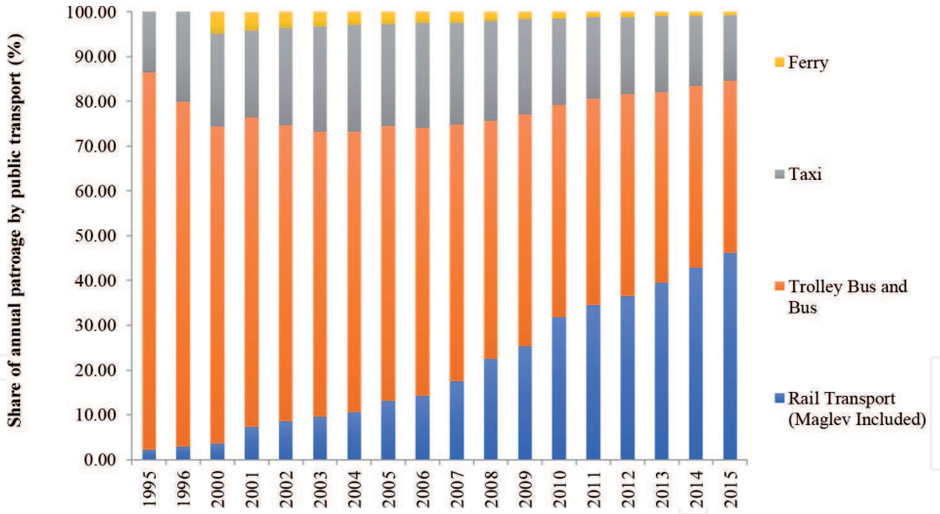

Figure 6.
Share of annual patronage by different public transit modes in Shanghai from 1995 to 2015 (%). Source: Compiled based on data provided by [17].

as the "Bicycle Kingdom" in the middle of 1980s. The actual bicycle use per day in Shanghai has decreased 70% from 2009 to 2014, while there is a sharp increase in actual use of electric bicycles by 68% during the same period.

Figure 6 sets out the transit data by mode in Shanghai; this again indicates the dramatic growth of the metro.[5] From the 1970s through to the beginning of the 1980s, the trolley bus and bus were the main transit modes in Shanghai. The Shanghai metro began in 1993 but was quite small until it was extended for the 2010 Shanghai World Expo. It is now the world's largest rapid transit system by route length and second largest by number of stations with 14 lines and 364 stations and a total length of 588 km. On an average workday, it carries 10 million passengers, while the record patronage was 11.3 million on April 1, 2016.

While private vehicle ownership in both Beijing and Shanghai is still increasing, actual automobile use as measured by modal split has in fact started declining since around 2011. Beijing went further along the automobile path than Shanghai, but both turned dramatically once a quality metro alternative was provided. Shanghai also continues to have a very high walking and nonmotorised component in its transport system (over 50% of daily trips). Both Beijing and Shanghai have much less private motorisation than would have been expected due to their rapid growth in income like other developed cities in Canada, Australia and America.

3. Contributors to the decline of car use in Beijing and Shanghai

3.1 Economic factors

Economic factors can play a more significant role in determining automobile ownership compared to actual usage due to differences in land use intensity [18]. However, most models for car use growth still assume it is driven by economic growth, especially in developing economies. Unlike automobile ownership, the actual need for automobile use has been shown to have decoupled from the financial capacity to pay for it; for example, the amount of car driving per unit of real gross domestic product (GDP) significantly declined between 1995 and 2005 in a large sample of

[5] The sharp decrease in daily patronage by trolley bus and bus in the year of 1996 is largely due to the cancellation of monthly pass in 1995 and bus system reform in 1996.

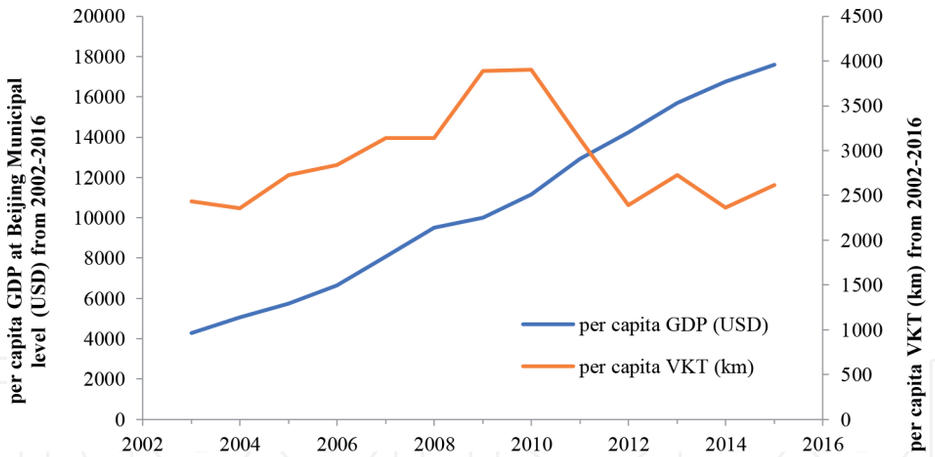

Figure 7.
Comparison of per capita GDP and per capita VKT in Beijing from 2002 to 2016. Source: Compiled based on data provided by [21, 22].

world cities [19, 20]. Taking Beijing as an example, **Figure 7**, which depicts the number of passenger cars per 1000 permanent residents, a continuous growth trend is evident in tandem with the ever-increasing per capita GDP at Beijing municipal level. However, the level of private automobile use grows to the inflexion point in 2010 and then starts dropping, despite a continuing improvement in the urban economic performance of Beijing. Furthermore in Beijing, personal income generally decreases from the city centre to the city fringe, whereas the use of the automobile increases in the opposite way. This suggests other factors than economic drivers as set out in other studies [6]. In this paper we will examine cultural, political and urban fabrics as the decoupling seems to have set in well before other cities in terms of GDP levels.

3.2 Cultural and political factors

Wealth increases have certainly led to higher levels of car use in most cities over the past 100 years, but the decline in car use setting in needs further explanation. One of the other factors would appear to be a cultural and political intervention that makes other modes more attractive. The increase in public transport in Beijing was made possible largely through the priority, which the government placed on bus and train infrastructure development. This occurred at both a local and national level in accordance with the central government's 12th Five-Year Plan (FYP) (2011–2015). As part of this shift away from the automobile, transportation demand management (TDM) initiatives were also introduced in an effort to further curb the ownership and use of private automobiles across China. These included:

- Restrictions on the operation of private automobiles on certain days throughout the 2008 Olympic Games, based on licence plate end numbers

- Limitations on the number of driving licences made available to the public, a process initiated in 2010

- Since 2011, termination of three pro-car policies designed to help overcome the 2008 global financial crisis (GFC).

As a result of these initiatives, automobile modal split in Beijing plateaued in 2010 before starting a downward trend. This is despite an increase in private automobile ownership in Beijing which would have had the potential to counteract this fall. However, research has shown that for many Chinese urban residents, the automobile

is seen more as a status symbol than an efficient means of daily transport. The new options now available would appear to be saving time compared to the highly congested road system and the decision to not build more freeways but instead to provide a better public transport option [11]

3.3 Urban form factors

Chinese cities have been historically high in density [23] and as will be shown below have been increasing in density. Urban form factors are likely therefore to be a strong explanatory factor in why both Beijing and Shanghai started declining in car use well before they were expected to do so due to usual predictions from income growth.

3.3.1 Traditional low-rise and high-density urban form and short blocks

The low-rise, high-density blocks, which characterise China's traditional way of building local neighbourhoods[6] rather than the western-style low-density and single-family detached houses, facilitate the walking-scale environments typical of Chinese cities. In particular, the mixture of residential, commercial and recreational land use within these traditional Chinese communities provides local shops, small public spaces (squares or playgrounds) and other community services. It enables these local areas to cater for their daily necessities within walking distance. The close proximity generated by the short blocks also shortens the pedestrian distance [24]. Finally, this type of urban form helps to facilitate and operate more efficient public transport for these communities. The urban density of the whole city of Beijing and Shanghai is around 50 and 70 persons per hectare in 2005, similar to some European cities and much higher than typical automobile-dependent cities in Canada, Australia and America [25].

3.3.2 Central square and linear corridor form of urban development

As well as the organic density of traditional cities, there has been a long commitment to planning the city into a central square and linear corridor. This is known as the imperial-centred and axisymmetric urban form, which is affected by the *Doctrine of the Mean*[7] [26]. The Kao Gong Ji[8] document presents a city centre based on a square or rectangular shape, a pattern that was developed during the Dynasty of Western Zhou (1046 BC–771 BC) and led to the traditional road grid. This chessboard-like urban form based on small block sizes with multiple route choices is ideally suited to walking which has dominated Chinese urban transport for thousands of years. It also laid the foundation for the later construction and development of efficient public transport corridors across many Chinese cities, and because it was dense and had relatively clear roadways, it was also suitable for the bicycle that grew rapidly in China from the end of the nineteenth century. Then when trams came, they followed these roads and took them further out into longer corridors.

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[6] Local neighbourhoods in the Chinese context evolved from a quadrangle courtyard (shaped before the establishment of New China), collective compounds (dominated during planned economy before 1978 as a part of social welfare) and commercial residential buildings with entrance guard (popular in the modern economy). It is now mostly enclosed by walls or fences for privacy, security and property rights.

[7] The *Doctrine of the Mean* is one of the *Four Books of Confucianism* and also regarded as the highest level of moral code and natural law in China.

[8] This document records the specification and technology of crafts in Ancient China, playing a significant role in urban planning of Chinese cities, especially the capital cities and political cities.

When this road structure is combined with high density and mixed land uses, as it is in China, it means that the major parts of Chinese cities were fundamentally walking and transit city fabrics [6] and became an entrenched part of how cities were built in the Chinese cultural and political landscape. Automobile fabric only develops where a new kind of urban form is sought further out from the fabric already there and at considerably lower densities. This did not happen very much in China; instead, the city fabrics from the walking and transit eras were rebuilt at much higher density and followed the same corridor-based form into new areas.

3.3.3 Traditional employment system

The socialist welfare-oriented housing within walking or cycling distances of work was provided by state-owned sectors under the traditional employment system (the so-called Dan Wei in Chinese) during the period of the planned economy in China. However, the end of this system of nearby housing provision, which came with the 1978 reform and open-up process, largely destroyed what was quite a tight job-housing balance and increased the frequency and distance of the journey to work. However, they did not at any stage build urban fabric that was automobile dependent but continued to build dense, high-rise-based corridors of urban fabric.

3.3.4 Traditional acceptance of high-density living

Chinese villages, towns and cities have always been very dense. There are various theories about why density is accepted in some cultures and not others, for example, Anglo-Saxon culture has a long history of anti-density tradition which has been passed on to New World cities [6]. The theories about density in Chinese cities suggest it is a combination of their:

- Military history: The need to have walled cities for security meant that a more urban culture became essential.

- Religion: Confucianism has a strong emphasis on community responsibilities that build networks of close dependence within and between families.

- Economy: The reality of Chinese economic history is that they have built very big centres of economic wealth based on trading textiles, handicrafts and cultural activity that could only work efficiently if it was intensively conducted.

Together these theories suggest that the Chinese economy depended on these big cities that were made of traditional walking city fabric, highly dense and mixed for many centuries, rather than being a set of low-density rural villages based around agriculture.

These various traditions and planning paradigms have resulted in the typical Chinese urban form. The central city of both Beijing and Shanghai is still a very dense urban environment of close to 250 persons per ha (characteristic of walking city fabric). The whole city, together with all its other component parts, is also getting denser despite the "urban sprawl" in outlying areas. The urban density of the whole city is more than 50 persons/ha, which is typical of European transit-oriented regions. The old walking city centres and the transit-oriented linear form of urban development together with dense land use patterns facilitate the development of public transport systems as well as walking and cycling in Beijing and Shanghai. However, especially in the superdense city centres where there is continuous

rebuilding at higher densities, these areas are becoming more and more unsuitable for cars but at the same time are beyond the affordability of most citizens.

This is not just an issue in Chinese cities as the revival of the walking and transit city fabric in most developed cities is also associated with major issues surrounding equity. The newer urban areas in outlying areas created in the last 20 years to provide more affordable housing are more automobile dependent but are still nothing like the sprawling suburbs of American and Australian cities. These areas in Chinese cities are well served now by fast metro systems as well as having considerably more local services and work; however, they are clearly going to have more car use than the traditional areas and will need to find new ways of dealing with this. For example, the lowest densities are the outer suburbs in Beijing, but even here these are above 25 persons/ha, which is the high end of auto city fabric. These areas do not go down to typical auto city densities of 7–20 persons/ha or so, but they will still need to continue to minimise such areas if they are to keep reducing their car use.

The same kind of urban fabric can be found in both cities examined; the key differences were much higher urban density in some districts of the central city and a more walkable form of urban development in Shanghai compared to Beijing. The urban density of both central cities is similarly more than 200 persons/ha. However, the urban density of the whole city and suburb areas is higher in Shanghai than in Beijing. This is perhaps due to Beijing's scattered urban areas around the ring roads. Some districts of the central city of Shanghai are superdense with more than 600 persons/ha urban density (like Huangpu, Luwan, Jing'an and Hongkou), while the highest urban density in Beijing is around 300 persons/ha. Shanghai's superdense urban form results in the dominance of walking and nonmotorised transport modes in the whole city.

4. Conclusions

Beijing and Shanghai are the two most representative cities in China in terms of their political, economic and cultural influences so it is very significant that both are now indicating a peak in car use has happened. This coincides with major investments in public transport that have provided an option surpassing many car use patterns. This has happened despite increasing economic growth and car ownership growth. To explain this needs an understanding of the fabrics that define the city and which are expressions of the cultural and political history of China. Both cities feature Chinese traditional urban fabrics of walking centres with transit linear corridors all with dense, mixed land use patterns that favour public transport and walking and cycling. They can both be termed "emerging transit metropolises" as opposed to the mature transit metropolises such as London and Paris [27]. These areas are also where the major job growth and urban activity are focused and thus private vehicle use has decoupled from wealth and has now peaked in terms of modal split. This paper suggests that this is strongly affected by their walking and transit urban fabrics, which are not built for much car use. More than likely the response will be to continue the peak car use trend and enable Chinese cities to become more and more a model for any other emerging cities that are trying to face up to a future with less automobile dominance in their cities.

Acknowledgements

This document was produced with the financial support of the Department of Education of Henan Province (Project No. 20B630021) and Zhengzhou University (Project No. 32220525).

Conflict of interest

The authors declare no conflict of interests.

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