Trapped in tremendous congestion – Can Beijing find a road towards harmonious and sustainable transport?

Felix Creutzig[*1]

Maximilian Thess[1]

Jiang Ping Zhou[2]

Michael Replogle[3]

[1] Department Economics of Climate Change, Technische Universität Berlin, Germany

[2] Institute for Transportation and Development Policy (ITDP), Beijing, China

[3] Institute for Transportation and Development Policy (ITDP), Washington, DC, USA

*Corresponding author. Email: felix.creutzig@tu-berlin.de; Address: Technische Universität Berlin, EB 4-1, Straße des 17. Juni,   10623 Berlin, Germany; Phone: 0049-30-314-78864

Abstract

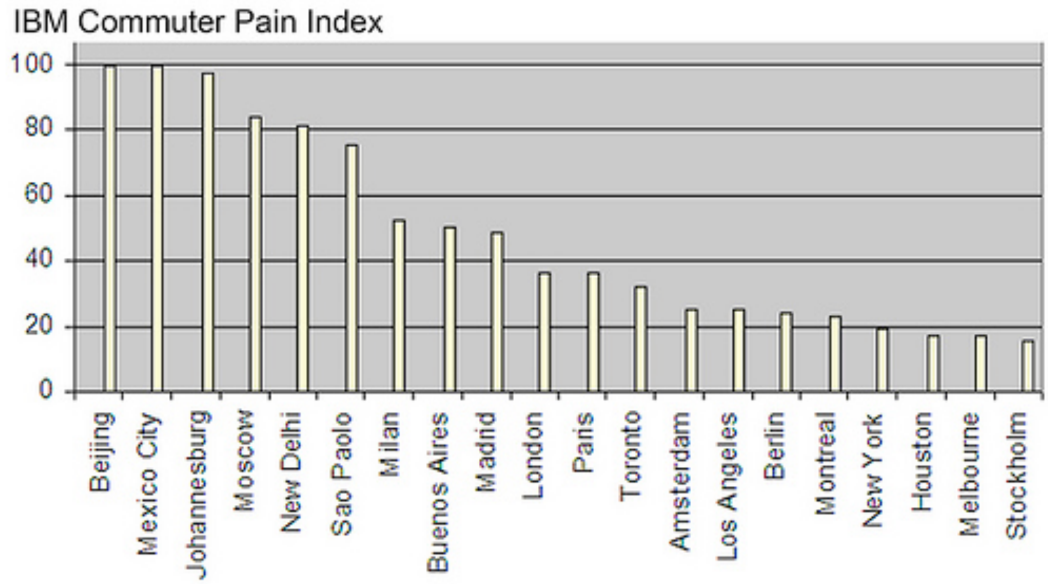
Beijing's congestion and air pollution is infamous among local residents and visitors. While rising car ownership demonstrates increased material well-being, and is a show-case of the Chinese economic miracle, car driving in the dense urban fabric of Beijing deteriorates the efficiency of transport, local public health and quality of life, and contributes to human-made global warming. The social disbenefits of significantly increased use of cars in Beijing most likely outweighs the benefits of increased driving. Beijing municipal authorities are clearly aware of this challenge, and many policy instruments are being implemented to reduce the burden of car traffic for residents and transport users alike. While partial improvements are visible, current measures have not been sufficient to manage growing transport demand. Absent further initiatives, present trends point to further deterioration in transport system efficiency and quality of life. This paper demonstrates the potential benefits of more effective transport demand management, integrated public transit provision, land-use planning and car pricing, which togethercould help make Beijing a city of harmonious and sustainable transport.

1. Motivation

Thirty years ago, Beijing had fewer than 100,000 motor vehicles on the road; in 2005 numbers exploded to 2.6 millions cars, and in 2010 more than 4.6 million fill the streets of Beijing. A global survey conducted last year said Beijing is tied with Mexico City for the world's worst commute (Figure 1; IBM, 2010). The growing difficulty of moving people and goods around the city and the impacts of traffic on the quality of life threatens to undermine Beijing's image as a world-class capital city. Nearly 70 percent of Beijing residents have at least once faced traffic congestion so bad they've turned around and gone home. While the situation is most extreme in Beijing, other Chinese cities have to meet similar challenges. Increased traffic results in economic losses due to lost time, higher operating costs of cars, poor air quality, noise pollution and increased traffic fatalities. These problems are especially acute in China. Many of its more prosperous cities are undergoing very high motorization rates that overwhelm existing infrastructure. Also, Chinese oil demand exceeds domestic supply. Hence, multiple factors – urban economic development, health concerns and energy security, as well as climate change, – impel governments to redirect urban economic development towards sustainable transportation infrastructure.

Globally, transportation was responsible for 23 % of the world's energy-related CO_2 emissions in 2006 (International Energy Agency, 2008) and this share is growing. Starting from low baseline demand, China is projected to account for 43% of additional world oil demand by 2030 (International Energy Agency, 2008), with three quarters of transportation-related emissions due to on-road motor vehicles, most notably in urban areas.

Figure 1. *A global comparative study indicates that Beijing residents suffer from congestion. Source: IBM, 2010. Reproduced with permission.*



Chinese cities exhibit high population densities, low road density (especially for secondary roads and minor roads), and rapid motorization. We argue that these attributes demand the swift development of transport demand management technologies and measures. TDM can be utilized to ensure that demand and marginal social costs of transportation are matched. A typical example is restriction and pricing of parking to reduce inner city traffic and achieve a high turnover rate of users of valuable parking space. In this chapter, we focus on a comprehensive TDM measure, a city toll addressing congestion, air pollution and climate change damage. A city toll, combined with good public transportation facilities and mixed-use land development, leads to huge benefits, amplifying the positive effects of more specific measures, as partially shown in the London, Stockholm and Singapore cases (Beevers and Carslaw, 2005; Eliasson, 2009; Wilson, 1988). The considerable co-benefits of sustainable transportation policies in Chinese cities include reduction of air pollution and congestion, traffic safety improvements for cyclists and pedestrians and improved reliability in bus service (Creutzig and He, 2009). In contrast to climate change mitigation, these co-benefits are local and relatively near short-term, as such being more relevant for policy makers (Pearce, 2000). Although these benefits have been identified, government agencies are reluctant to act, facing a set of barriers.

In this paper, we summarize the social costs of car traffic in Beijing and highlight the crucial role of transport demand management to not only alleviate Beijing's transport grid-lock, but also to establish a harmonious and sustainable transport system for Beijing citizens. In some parts, we will heavily rely on Creutzig et al. (2011).

2. Social costs of car traffic in Beijing

The scale of Beijing's gridlock encompasses more challenges than other megacities. In a recent study, Creutzig and He (2009) analysed the social costs of motorized transportation in Beijing in 2005. The analysis was restricted to the area inside the 6th ring road, corresponding to around 10 million inhabitants. The social costs of air pollution and congestion each amounts to approximately 30-40 billion RMB annually in the lower cost estimate[1]. This is significantly larger than climate change damage costs (ca. 3 billion RMB per year). However, the magnitude of uncertainty is higher for climate change damage costs than for other disbenefits. In the upper cost estimate, climate change damage is equal in magnitude to air pollution (ca. 40 billion RMB), while still being comparatively small to congestion costs (ca. 80 billion RMB). With exploding motorization, social costs of urban transport have doubled from 2005-2010 in Beijing, quantifying the tremendous gridlock of China's capital (Figure 2).

Figure 2 represents those transport and environmental social costs that can be estimated. Other social costs of car transport in Beijing are probably of similar significance but are harder to quantify. A crucial aspect of current Beijing development is an increase in urban transport inequity, which takes many forms, including gentrification with associated displacement of lower income people to areas with worse accessibility or more crowded housing conditions, and the deterioration of traffic conditions for cyclists and pedestrians.

For example, to expedite urban redevelopment, Beijing has built several big residential areas such as Tian Tong Yuan, Wang Jing, and Hui Long Guan for the relocated residents who used to live within the second- or third-ring roads in Beijing. One common problem with these residential areas is that there are only limited jobs in these areas and most residents must endure longer commutes than before to Beijing's

[1] Costs of congestion are monetized lost value-of-time as indicated by a survey of Beijing residents. Air pollution costs are based on willingness-to-pay. The low cost estimate of climate change impact is based on ~\$20/tCO_2. Results are detailed in Creutzig and He (2009). Data are updated for 2010 based on various sources and extrapolations. Note that these different scenarios corresponds to significant uncertainties in social cost estimates. Total social costs of urban transport in Beijing probably vary between 80-190 billion RMB in 2010.

downtown or elsewhere to work. The city has built subways or light rails to facilitate the commute but those subways and light rail lines are still some of the most congested in China, especially in the peak period peak direction.

Increased private cars have brought at least two problems to pedestrian and cyclists commuters in Beijing. First, a large portion of many formerly dedicated bike lanes or sidewalks are now used as parking for private cars due to both legal and illegal encroachment. Of the 1496 parking facilities in Beijing, many occupy space formerly dedicated to cyclists and pedestrians[2]. Second, Beijing's public investment, maintenance, and operational management resources in the transportation arena are overwhelmingly focused on facilities used by drivers at the expense of facilities used by cyclists and pedestrians. Since the 1980s, Beijing has built hundreds of graded interchanges and thousands of lane kilometers to facilitate motor vehicle flows. But the lane kilometers of bike and pedestrian facilities grew much more slowly and in many cases even shrank. Beijing used to have a rather complete dedicated bike lane system but now this system is broken or discrete in many parts. The replacement of *hutong* districts with less pedestrian and bicycle friendly large-scale superblock developments has contributed further to this trend. Cyclists are also most affected by increased risk of fatal car accidents, and are most affected by air pollution inhaling exhaust close to its source.

[2]More information can be found at: http://www.beijingparking.com/.

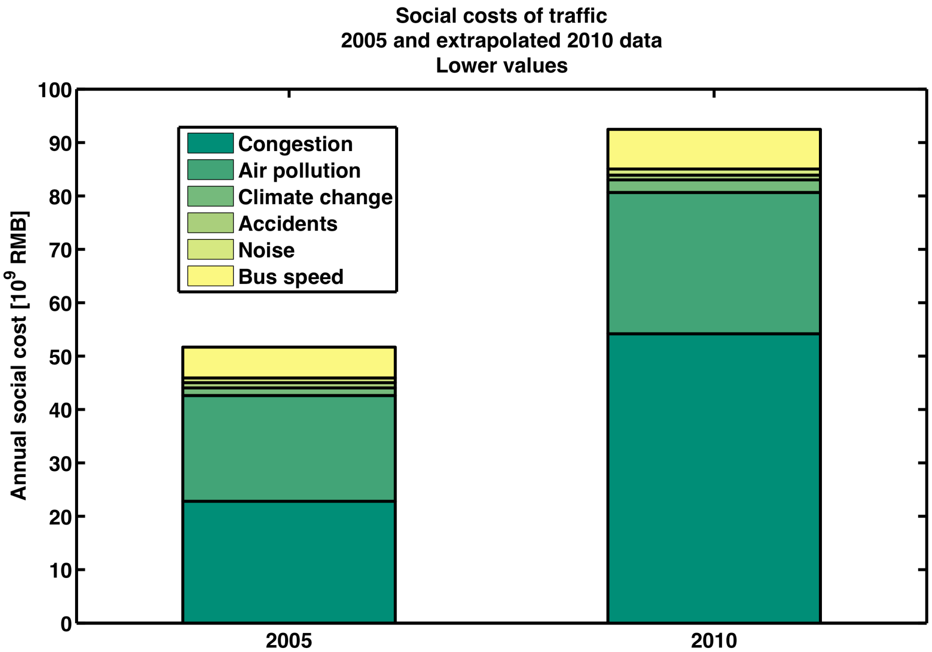


Figure 2. *Social cost of car traffic in Beijing 2005 and 2010. Due to higher car ownership, the costs of congestion have increased most. Source: Creutzig and He, (2009 and own calculations.*

3. Current policies – TDM measures in Beijing and other Chinese cities

China's automobile ownership is predicted to continue to rise 20 percent per year. In 2010, more than 700,000 vehicles were sold in Beijing, increasing overall local registered fleet to more than 4.6 million cars. A large number of cars registered outside Beijing also operate in the city. Seven percent or more of all Chinese registered motor vehicles are located in Beijing, though only one percent of the population lives there. Hence, Beijing is a focal point for investigation of urban car policies in China. The Beijing municipality has implemented a number of policies to deal with exploding urban car traffic. Huge investments in public transit are intended to meet future transport demand with rail- and bus-based transit rather than with individual motorized vehicles. On the demand side, Beijing municipality has implemented parking management in the inner city, in addition to a partial car ban starting with the Olympic Games and car ownership regulation. We discuss each policy in turn.

3.1 Public transit investments

What kind of supply-side policies can induce a sustainable modal split? A comprehensive summary of measures is given by Goodwin (2008). Here the focus is on suitable measures that are relevant for

Beijing.

For motorists, time savings trump monetary operation costs. In fact, faster public transportation can induce significant modal shift as seen in Seoul where a 10% increase in speed of public transportation induced 5% of all car drivers switching to bus and subway (Lee et al, 2003). For the Olympic Games, Beijing expanded its subway system from 56 km to 200 km in total and plans to expand it further by 2015 to a total of 560 km. When Line 5 went into operation and fares were reduced to 2 RMB per trip in 2007, ridership nearly doubled from 1.9 million trips a day in 2005-2006 to 3.4 million trips a day in 2008. The planned network would triple overall capacity and accommodate an additional 10 million trips a day, similar to the number of motor vehicle trips each day in 2005. However, the current growth in transportation demand in general and car transportation in particular suggests that additional subway capacity – as a solitary measure - only flattens growth in car transportation. Access to public transport alone is not enough to attract drivers to leave their cars at home, especially when public transport requires multiple transfers and crowded conditions (see for example He et al, 2005).

The Beijing Municipality implemented additional measures to prioritize public transit (Green Report, 2009), initiating the "Storm of Affordable Public Transit". Measures attracting car owners to public transit included: smart cards (Public Transit Electronic Card), reduced fares, new and improved buses, optimized bus routes, and dedicated bus lanes. A total of 54km in three unconnected corridors of Bus Rapid Transit have been implemented, but only corridor 1 functions satisfactorily.

Despite the increased capacity and ridership of the subway, the bus remains the backbone of Beijing's transportation system. In 2005, daily bus trips outnumbered subway trips by a ratio of 4 to 1. But buses must compete for road space with cars; dense traffic slows buses, causing more drivers to switch to cars. In Beijing, buses are plagued with extraordinary low speeds, mainly due to congestion. A comprehensive bus rapid transit (BRT) system could double operational speed from 10 to 20 km/h. This could effectively double capacity, accommodating 8 million more passengers a day without an increase in the number of vehicles. BRT can be highly cost–effective. Guangzhou's recently opened BRT shows the potential of this approach, if designed for high capacity and effectiveness. Guangzhou's 23 km BRT cost only US$4.4 million/kilometer to build, carries over 750,000 passengers a day, moves 27,000 passengers per hour per direction in the peak, and fully integrates with the metro at 4 stations (Replogle and Kodransky, 2010).

3.2 Parking management

One of the first TDM policies that Beijing implemented was parking fees. Parking, in general, is one of the less controversial policies to implement because people accept the rationale of paying for the use of a parking space. In recent years, the municipal government has also sought to restrict the number of new parking spaces available in the downtown area while simultaneously increasing parking fees (Xinhua, 2007). However, enforcement still needs considerable improvement. Many motorists have created their own parking spaces by encroaching on sidewalks (Beijing Traffic Management Bureau, 2008). Also current parking fees do not capture the costs of providing the parking and are too low to significantly influence modal choice. Since many cars are government-owned or company cars, numerous motorists get their parking fees reimbursed, as has also been documented for Shanghai (Feng and Ye, 2008). Numerous parking management best practices widely used around the world have not yet been introduced to Beijing (Replogle, et.al. 2009).

The Beijing municipality has also provided limited park-and-ride facilities. Since 2007, Line 5 has a park-and-ride center at Tiantongyuan North subway station with a parking fee (2 RMB/day). In the 11th five-year plan, Beijing plans to build 26 Park-and-Ride centers outside the 4th ring road.

3.3 Driving ban

Between July 20 and September 20, 2008, Beijing implemented a car ban, limiting road access based on license plate numbers. Once in effect, Beijing's road traffic showed significant improvements –vehicle speeds increased dramatically, particularly during the Olympics, when morning and evening peak periods traffic speeds increased by 27% and 23% respectively (Green Report, 2009). In parallel, public transit ridership rose from 35% in the first half of 2008 to 45% (Green Report, 2009). The car ban, along with other policies, lowered Beijing’s air pollution index to 36% below the average of the preceding eight years.

Seeing its success, the Beijing Municipal Government followed up with a modified driving ban, according to which drivers are not permitted to drive one day out of the work week. Despite temporary progress in congestion relief and air quality, Beijing drivers oppose these measures. Many private motorists feel entitled to drive their car daily and policies that restrict daily use of a car are considered akin to a restriction on private property rights (Qiu 2008; Economic Observer Online, 2008). The car ban currently in effect may make other alternative measures such as a city toll more attractive to drivers. Implementation of a city toll would allow to would permit the city to simultaneously eliminate the driving ban.

A comparative policy in Mexico city further points to the limitation of driving bans. The restrictions of the programs, *Hoy No Circula*, were intended to improve air quality but no such effect was observed. Evidence indicates that the restrictions led to an increase in the total number of vehicles in circulation as well as a change in composition toward high-emissions vehicles (Davis, 2008).

3.4 Car ownership regulations

In response to the success of the Olympic car ban, officials considered restricting car purchases. However, according to Wang Haiping, deputy head of the Beijing Municipal Development and Reform Commission, limiting car purchases at that time would have been irresponsible as China is trying to boost domestic consumption to offset the impacts from the global financial crisis (Xinhua, 2008). This viewpoint is reflected in national policy measures. For example, the central government has reduced car fees to ensure the automobile industry meets its sales goal (Xinhua, 2009). In December 2010, with ever-increasing pressure on the urban transport system, Beijing municipality put forward a car permit scheme which is implemented by 2011. In this document titled "Beijing Municipal Government's Opinions on Easing Traffic Congestion" car permit scheme, heavy investment into public transit, parking pricing, building of new towns, jobs/housing balance, etc. were all proposed as measures to ease traffic congestion in Beijing. The aims of all these measures, according to the document, are to a) ease traffic congestion; b) optimize the development environment; c) improve citizens' travel in Beijing. Beginning 2011, each year, only 240,000 new car licenses (each month 20,000 new car licenses) would be issued in Beijing through a lottery to lucky eligible applicants. Drivers with a valid Beijing car license are not subject to time or space restrictions that the city places on vehicles without a valid Beijing car license. More than 215,000 people rushed to buy a vehicle before December 24, 2010 before the provisions of the car permit scheme in Beijing came into effect (Xinhua, 2011). In fear of stricter car license restriction polices, 210,000 eligible applicants applied for 20,000 car licenses in Beijing in January 2011. The scheme is expected to have limited effects on congestion relief in Beijing, which already had nearly five million registered cars with a valid Beijing car license even before the scheme[3].

Shanghai is the only other province that restricts car purchases; it limits the number of automobiles through license plate auctioning. As a result of this long-standing policy, Shanghai has a significantly

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[3] Most information about Beijing's car permit scheme is based on: Beijing Municipal Government. 2010. http://www.gov.cn/gzdt/2010-12/24/content_1771947.htm;

China Car Consumer Web. 2010. http://inf.315che.com/n/2010_12/140294/, accessed January 09, 2011.

lower car ownership rate than Beijing although the city has comparable income level. In contrast to Beijing's distribution of licenses by lottery, Shanghai car owners have to bid competitively at auction for their license. Personal communication with planning officials in a few cities indicate that most feel they could not restrict car use like Shanghai, as they are historically or politically not as strong as Shanghai.

Restrictions on vehicle purchases or registration help to lower the overall number of personal cars, but not usage. For example, the Hong Kong government limits the number of drivers through high fees. Yet, these motorists have high vehicle kilometers traveled (Cullinane and Cullinane, 2003). Motorists drove their car because of the high sunk costs and comparably small marginal costs.

3.5 Evaluation of current Beijing transport policies

Beijing has demonstrated a clear understanding of the urban transport challenge, and has invested political power and money into large-scale improvements of public transit. At the same time, total travel demand is increasing at unprecedented scales. With rising incomes, cars are widely viewed as a core status symbol for affluent residents. As a result, on their own, neither affordable public transit nor partial car bans can for long hold back the tide of cars flooding of the city. More aggressive parking management is a vital and politically viable complementary immediate step that can further traffic restraint and reclaim sidewalks and street space for pedestrians and cyclists. Limitation of car permits can reduce the additional growth of cars. However, the current situation is already unsustainable and produces high social costs for the environment, for the residents, and car drivers themselves. In conclusion, the present set of policies falls short of what is needed to mitigate Beijing's gridlock. More effective measure are required (Replogle et.al. 2009). In the next chapter, we present calculations demonstrating multiple benefits of a comprehensive city toll of Beijing's roads.

4. Calculated effects and their uncertainties of a Beijing city toll

Let us first introduce the concept of a congestion charge – or more generally – a city toll. A congestion charge was introduced as a theoretical concept by Pigou (1920) to internalize transportation externalities. The major externality is congestion, i.e. the value of time lost by other road users. Time benefits differ across road users. For example, leisure traffic has much lower value of time than commuting or business trips. The main idea of a congestion charge is that the road user is charged the difference between individual and social costs, by this paying the marginal social cost of road usage. In effect, this reduces road usage to its social optimum (reducing congestion and environmental pollution). Practically the revenue can be used to compensate those affected by externalities. A detailed explanation of road pricing is presented in Newbury (1990). Road pricing can also be used to address environmental externalities as part of a mixture of approaches (Button, 1990). The economic rationale for a generalized congestion charge for Beijing – a city toll addressing congestion, air pollution and climate change - is explained in Creutzig and He (2009). A congestion charge can be regressive, neutral, or progressive, depending on location, design and mode choice (Santos and Rojey, 2004). In particular, when car drivers have income above average - as is the case in Beijing, richer people will pay the toll and poor people will not. A city toll is often regarded as the theoretical first-best solution but is afflicted with numerous barriers and constraints and often not optimal in real-world settings. Toll schemes become more feasible choosing a soft implementation path (Rouwendal and Verhoef, 2006). The driving ban measures in Beijing can be used as an intermediate step on an implementation path towards a city toll. Real-world solutions deal explicitly with institutional and behavioral constraints and understand a city toll as part of a package solution.

The role of a congestion charge or city toll in reducing social costs and creating co-benefits for Beijing was first analysed in Creutzig and He (2009). According to welfare theory, the theoretically optimal toll would maximize congestion relief at the least collective individual cost. We found that a 27% reduction in car transportation would result in 14 billion RMB per year in driving time saved. Importantly, other social benefits add up to 7.2 billion RMB per year, mostly due to cleaner air whereas climate change mitigation only corresponds to 0.4 billion RMB per year at current carbon prices. An overview of the benefits is displayed in the right column of Table 1. For the average car driver, such a city toll would mean a toll of 35-45 RMB per day. One possible implementation scheme would charge 1 RMB per km inside the 4^{th} ring road and increase to 3 RMB per km inside the 2^{nd} ring road. As a result, the average speed would increase from 21.5 km/h to 27.8 km/h. In Figure 2, the co-benefits of a city toll based on 2005 and 2010 data are displayed. A city toll would now even generate greater benefits than in 2005 because the transport situation has further degenerated. Benefits are most significant for congestion relief but also very relevant for the reduction of air pollution.

Figure 3 lists the magnitude of the effect of a city toll on the various sustainability dimensions, and specifies the uncertainties. Uncertainties are significant, and mostly rely on uncertainty in social costs estimates. While some of the uncertainty could certainly be reduced by more precise data on Beijing congestion, the significant uncertainty in social costs is likely to remain because its non-monetary nature.

The transformation to monetary values, used here to provide a common level for comparison, depends on a number of additional socio-demographic data, and heterogeneous preference, and is here based on expert judgment. While Figure 3 makes transparent the degree of uncertainty related to social cost estimates, the figure also reveals that benefits of a city toll will certainly be significant, and data is good enough to justify strong action.

City tolling would be highly beneficial not only for the local economy but also for overall quality of life. However a city toll alone is insufficient; motorists cannot switch when no competitive alternatives are available. Together with a city toll, improved public transportation service, bicycle networks, and safer, pedestrian-friendly streets make it easier for drivers to use their cars less. Practically, car owners can more easily switch to other modes. Technically, these measures increase demand elasticity and reduce opportunity costs for car drivers while scaling up the benefits of city tolling. Additionally, the increased availability of rapid public transit allows the reduction of the city toll and thus the burden for car drivers while achieving the same traffic reduction. In London, expanded bus services and the congestion charging scheme resulted in increased bus use (Transport for London 2007). The combination of measures acts synergistically and can significantly reduce vehicle miles traveled. With the recent expansion of the subway system and BRT, the city is in good position to supplement some car traffic with fast rapid transit. In fact, the high quality public transit system is a precondition for a city toll, enabling commuters to switch to public transit. However, even subways experience congestion. To alleviate this situation, a comprehensive high-quality Bus Rapid System integrated with the metro and modeled on Guangzhou, could further help to alleviate the situation. A more formal study of the interaction of charging and supply-side measures via demand elasticity can be found in Creutzig and He (2009).

In addition, the Beijing municipality needs to reevaluate its land use planning and urban design standards. Jobs are very much centered in the inner city, and non-radial transport infrastructure is in short supply in outer districts and suburbs, where large superblock development patterns also suppress opportunities for convenient and attractive walking, cycling, and public transport use. A polycentric approach with transit-oriented development, mixed-use planning characteristics, and small block sizes specifically designed for pedestrians and cyclists can avoid many future problems. A complete list of various urban transport policy recommendations for Beijing can be found in Replogle et al. (2009).

However, only a city toll can appropriately address congestion and local air pollution, thus creating significant co-benefits. In fact, the municipal government has discussed congestion charging measures for several years. What are the barriers that have prevented implementation?

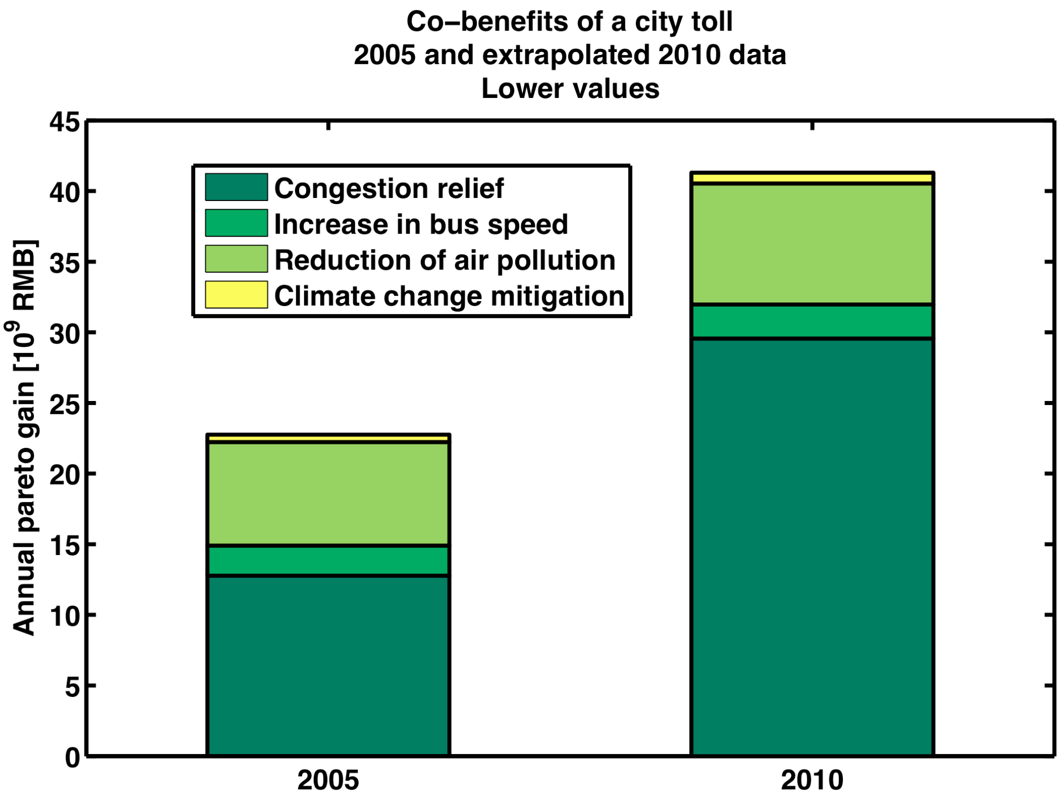

Figure 3. *Co-benefits of a city toll.. Source: Creutzig and He (2009) and updated calculations for 2010. The situation from 2005 to 2010 detoriated because of a doubling of motorization – mostly with respect to congestion.*

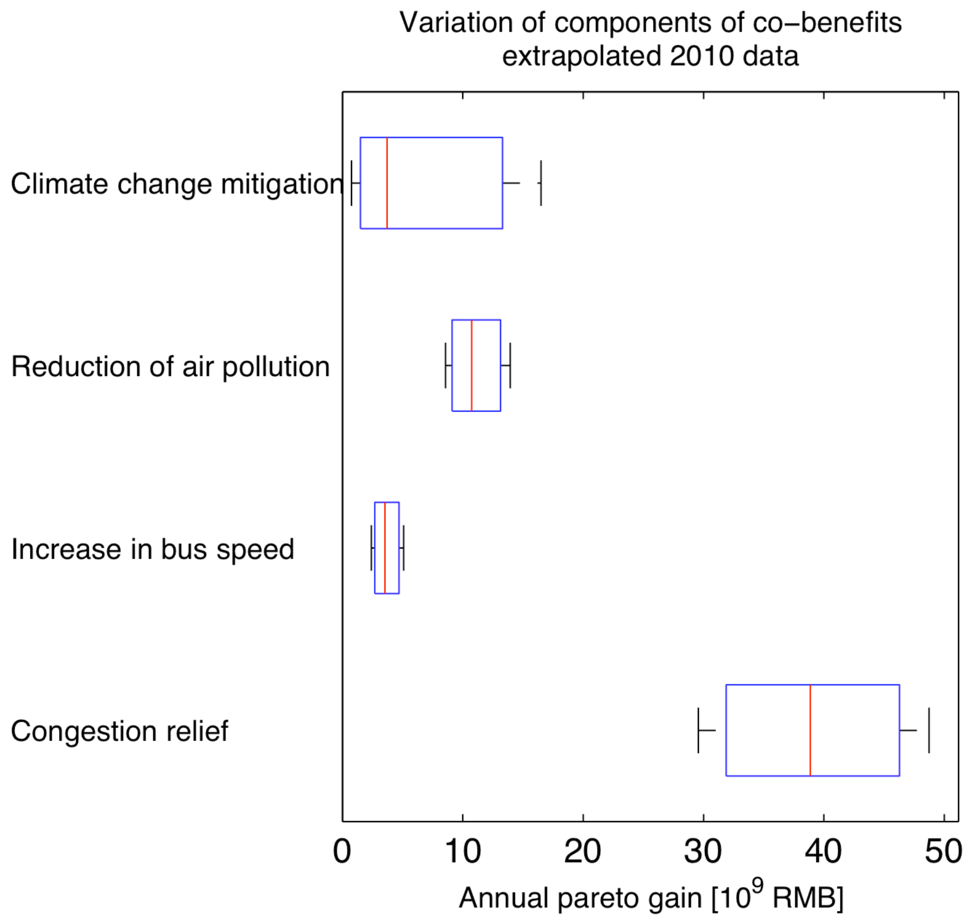

Figure 4. *Uncertainty in co-benefits is significant but is probably higher than previously estimated. The exact effect of a city toll and the social benefits cannot be exactly predicted, but it is likely that benefits are widely appreciated.*

Any pricing measure is met with fierce resistance of commuters – or so goes the story. The examples of Singapore, London, and Stockholm, however, have demonstrated that a congestion charge is not only accepted, but even welcomed by many residents. Beijing residents suffer far more from current transport system shortcomings and many of them are likely to welcome a well-communicated measure providing relief from massive congestion delay with improved transport system options. Creutzig and colleagues (2011) have analyzed barriers to congestion pricing, and how to overcome them in the specific case of Beijing. The results are summarized in the following table.

Table 1. *Barriers, solution strategies and stakeholders.*

Barrier	Solution strategy	Stakeholders
Inequitable distribution of impacts	• Careful design to mitigate harmful effects • low transaction costs (smart card) • up-front benefits (e.g., BRT) • expert support from, e.g., Singapore and London	• Urban and transportation planners • Beijing Transportation Research Center (BJTRC) • NGOs
Perception that policy is all costs, no benefits (loss aversion)	• Information campaign on benefits, focusing on air pollution and congestion reduction • Promote BRT and NMT improvements	• Beijing Municipal Office Bureau (public relation department) • NGOs
Land-use policies that worsen congestion (single use development, etc.)	• Transit-oriented development regulations • Retain and increase mixed-used developments	• National government • Municipal agencies • NGOs
Institutions and capacity for implementation are undeveloped	• Mandate for integrated transportation agencies • Capacity building • Knowledge distribution	• NDRC • BMLR, BMCHURD, BMCT, BMCDR, BMEPB • NGOs, think tanks
Indicators of success and inventives to reduce use	• Re-evaluation of economic growth concept and car ownership strategy • Promote auto ownership for off peak use • Increasing emphasis on additional indicators, such as air quality and accessibility	• NDRC and ministries • International community

5 Beyond Beijing – policy harmonization across Chinese cities

The London congestion charge has initiated public discussion in smaller British cities such as Manchester and Cambridge. The need for a congestion charge in these cities is not clear as the urban areas are much smaller than London. The situation is different in China. Thirty urban areas have more than three million inhabitants, and many of these cities are already significantly congested. Projected rapid motorization, relatively high population density, and serious air pollution suggest that aggressive transport demand management is an issue beyond Beijing. What is the prospect of effective transport demand management in Chinese cities?

China's tendency toward isomorphic development (Chien, 2008) indicates that if an influential city such as Beijing successfully implements sustainable transportation policies, other cities are more inclined to follow. Though individual cities will still confront barriers to congestion pricing, the pattern of isomorphic development suggests that introduction of stronger TDM measures in Beijing faces many challenges. Of course the implementation of new TDM policies in Beijing has the potential to become a potent role model for other Chinese cities. As the capital city, policies implemented in Beijing have greater significance and influence. Other possible cities that may be first movers on such TDM measures include Shanghai, Shenzhen and Guangzhou.

Shanghai has over twice the population density of Beijing but a similar population (>17 million). However, because of its license plate auctioning, Shanghai has managed to keep overall car ownership significantly below Beijing numbers. In fact, auctioning license plates was explicitly been introduced to curb congestion and air pollution. Indeed, congestion charging is currently being discussed within the Shanghai municipality (Reuters, 2007; Feng and Ye, 2008).

Shenzhen is a rapidly developing city in Guangdong Province located at the mouth of the Pearl River Delta close to Hong Kong and one of the original special economic zones. Shenzhen attracted foreign capital and as a result became the 4th richest city in the country, experienced the fastest population growth of all Chinese cities between 1990 and 2000 as well as high growth in per capita income. This development also led to an explosion of car ownership and worsening air pollution (Güneralp and Seto, 2008). At the same time, Shenzhen is a laboratory for innovative policies in China. Currently, the Shenzhen municipality is in the initial planning phase of a city toll.

Guangzhou has 2.15 million automobiles, including 1.61 million cars. The number of private cars increased by 22 percent annually over the last five years, a rate exceeding even Beijing's and Shanghai's. About 300,000 new vehicles were licensed last year. Guangzhou has already taking encouraging steps forward, implementing a Bus Rapid Transit System that exceeds expectations, and seriously discussing the introduction of a congestion charge. The government of Guangzhou may raise parking fees this year. Guangzhou City Government has also recently announced that it would consider congestion pricing if local congestion situations continued to deteriorate. A draft document lists 30 new measures to curb downtown traffic in the post-Asian Games period. The city had ruled out following the Beijing policy of restricting the issuance of new license plates (Xinhua, 2010).

6. Conclusions

There are a number of reasonable actions that could reduce political barriers to the implementation of a city toll, or more generally, sustainable TDM policies in Chinese cities, discussed below.

6 .1 Local solutions and measures

Implementation of a city toll is conditional on leadership and good management practices. A city toll implies a huge redistribution of revenue. Redistribution must be clarified from the beginning through extensive public education campaigns. Addressing distributional concerns, a toll must take into account equity effects from a fairness perspective and relative benefits of individuals across time; authorities must communicate these benefits actively and avoid getting into a defensive posture from the start over such concerns. Uncertainty about potential costs and benefits must be reduced to dampen loss-aversion caveats.

One way to address equity concerns would be to provide every citizen with a charged smart card – valid for at least public transportation and city tolling – upon the introduction of the city toll. Especially in Beijing, company cars represent a high share of all automobiles in the city center. Transport system management would be enhanced if car benefits for government and business cars were replaced with mobility benefits on *Yikatong* smart cards which could be used for any transport mode (Creutzig and He, 2009; Replogle et.al, 2009).

Both economic theory (Creutzig and He, 2009) as well as the insight from the London and Singapore experience clearly demonstrate that pricing measures work best and possibly only in combination with a set of other instruments, most notably improved supply of rapid public transit. Package solutions can overcome the substantial barriers to sustainable TDM measures. With the 2008-2011 opening of new subway lines and planned aggressive extension to 560 km by 2015, improved bus service and current bicycling habits, Beijing municipality is in a good position to introduce a city toll. Moreover, Beijing's extensive network of traffic cameras with automated license-plate recognition technology and enforcement systems tied to license plate number restrictions provides a strong technological backbone for implementation of a city toll system.

However, Beijing's government agencies are not ideally positioned to handle transportation and environmental/ social costs and benefits within the same framework. A mandate for integrated transportation management, also addressing public health and environmental consequences, is necessary. The government of Madrid, which created an integrated planning agency in 1986, provides a possible model. Other model cities include London, Singapore, and Hong Kong.

6.2 National support

Incentive structures for mayors in China that focus on economic growth but not on social and environmental well-being are clearly counterproductive. The central government should shift its evaluation of party members from GDP indicators to a more integrated indicator set that includes environmental, accessibility and equity measures. Evaluation should also be not purely indicator driven so that leaders will focus on more than improving their statistics. Similarly at the municipal level, integrated planning of environment and transportation should be facilitated by institutional reorganization. The Chinese government has indicated its growing concern about climate change, energy security, and air pollution; it may be willing to support TDM measures to achieve all of these goals. As one crucial measure, nationally increased fuel price would support energy security and climate change mitigation, and would alleviate local gridlocks to some degree.

6.3 International support

Lacking capacity and knowledge hinders many promising TDM measures, including city toll implementation. International agencies and NGOs play an important role in changing the normative structure and building crucial capacity building. Normative involvement, such as the promotion of sustainability concepts, by professional consultants is still relatively weak. However, the Institute for Transportation and Development Policy (ITDP), the Energy Foundation's China Sustainable Energy Program, the Clean Air Initiative for Asian Cities, the Sustainable Urban Transport Project and other organizations put considerable effort into transforming the normative structure and building capacity.

Though Beijing citizens will mostly be concerned with congestion relief and clean air, international agents may also be motivated by GHG mitigation. There are opportunities for international support through various existing and new climate instruments for the transport sector (Huizenga, C. and Bakker, S. 2010). Capacity building for comprehensive TDM measures is highly cost-effective and can produce larger environmental benefits than technology-targeted measures. With combined effort and good management practices TDM measures for sustainable cities can be successfully implemented in China.

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References

Beevers, S.D. and Carslaw, D.C. (2005) 'The impact of congestion charging on vehicle emissions in London'. *Atmospheric Environment*, vol 39, no1, pp1-5

Beijing Statistical Yearbook (2007), China Statistics Press, Beijing

Button, K. (1990) 'Environmental externalities and transport policy', *Oxford Review of Economic Policy* vol 6, no 2, pp61-75

Chien, S. (2008) 'The isomorphism of local development policy: a case study of the formation and transformation of national development zones in post-Mao Jiangsu, China', *Urban Studies* vol 45, pp273-294

Cullinane, S. and Cullinane, K. (2003) Car dependence in a public transport dominated city: evidence from Hong Kong' Transportation Research Part D, vol 8, pp129-138

Creutzig, F. and He, D. (2009) 'Climate change mitigation and co-benefits of feasible transport demand policies in Beijing', *Transportation Research Part D,* vol 14, no 2, pp120-131

Creutzig, F, Thomas, A., Kammen, D. M. , Deakin, E. (2011) 'Transport Demand Management in Beijing, China: Progress and Challenges' In Low Carbon Transport in Asia: Capturing Climate and Development Co-benefits, edited by E. Zusman, A. Srinivasan, and S. Dhakal (Earthscan, London, 2011) ISBN 9781844079148.

Davis, L. W. (2008) 'The Effect of Driving Restrictions on Air Quality in Mexico City' Journal of Political Economy, vol 116, pp 38-81

Eliasson, J. (2009) 'A cost–benefit analysis of the Stockholm congestion charging system'. *Transportation Research Part A: Policy and Practice*, vol 43, no 4,pp 468-480

Feng, S.W. and Ye, J.J. (2008) 'A Comparative Study of Parking and Congestion Charge Policies based on Transport Mode Choice Estimation', Paper read at Conference on Intelligent Transportation Systems, 12-15 October, Beijing, China

Goodwin, P. (2008) 'Policy incentives to change behaviour in passenger transport' in *OECD International Transport Forum,* Leipzig

Green Report (2009) 'Green Trips in Beijing, 2008', report, http://www.cleanair.net.cn/cleanair/2008GreenReportAbstract.pdf, accessed May 25, 2009

Güneralp, B. and Seto, K.C. (2009) 'Environmental impacts of urban growth from an integrated dynamic perspective: A case study of Shenzhen, South China', *Global Environmental Change*, vol 18, pp720-735

He, B., Chen, J., and Wang, W. (2005) 'Survey and analysis of trip characteristics of private cars with Nanjing as an example', (in Chinese), *Chengshi guihua xuekan* (*Urban Planning Forum*), vol 4, no 158, pp83-87

Huizenga, C. and Bakker, S. (2010) *Climate Instruments for the Transport Sector: Considerations for the Post-2010 Climate Regime: Consultants' Report*, Asian Development Bank and Inter-American Development Bank, Manila.

IBM (2010) 'IBM Global Commuter Pain Study Reveals Traffic Crisis in Key International Cities' http://www-03.ibm.com/press/us/en/pressrelease/32017.wss#release

International Energy Agency (2008) *World Energy Outlook*, ISBN: 978-92-64-04560-6, Paris

Lee, S., Lee, Y.H., and Park, J.H. (2003) 'Estimating price and service elasticity of urban transportation demand with stated preference technique: a case in Korea', *Transportation Research Record*, no1839, pp167-172

Newbury, D.M. (1990) 'Pricing and Congestion: Economic principles relevant to pricing roads', *Oxford Review of Economic Policy*, vol 6, no 2, pp22-38

Oi, Jean C. (1995) 'The role of the local state in China's transitional economy', *China Quarterly* vol 144, pp1132-1149

Pearce, D. (2000) 'Policy frameworks for the ancillary benefits of climate change policies', in *Global Environmental Change Working Papers*, Center for Social and Economic Research on the Global Environment (CSERGE), London

Pigou, A.C. (1920) *Wealth and Welfare*, MacMillan, London

Qian, Y. and Stiglitz, J. (1996) 'Institutional innovations and the role of learning government in transition economies: the case of Guangdong province of China', in J. McMillan and B. Naughton (eds) *Reforming Asian*

Qiu, L. (2008) 'Beijing's car restrictions drive people mad', *China Daily Online*, 30 October

Replogle, M., Kondransky, M., Daizong, L., Liu, Y. Yao Wen, W., Weinberger, R., Kaehny, J., Rufo, M., Creutzig, F. (2009) *Travel Demand Management in Beijing: Opportunities for Green, High-Tech, Equitable Transport,* Institute for Transportation and Development Policy and China Sustainable Energy Program. Beijing. www.user.tu-berlin.de/creutzig/TDMBeijing_Replogleetal2010.pdf

Replogle, M. and Kodransky, M. (2010) 'Urban Leaders Find Path to Global Green Growth', *Journeys,* Land Transport Authority, Singapore, Issue 4, May 2010, pp. 16-25.

Reuters (2007)'Shanghai mulls traffic 'congestion fee', *Drive.com.au*, 26 November

Rouwendal, J. and Verhoef, E.T. (2006) 'Basic economic principles of road pricing: From theory to application', *Transport policy,* vol 13, no 2, pp106-114

Santos, G. and Rojey, L. (2004) 'Distributional impact of road pricing: The truth behing the myth', *Transportation*, vol 31, no1, pp21-42

Transport for London (2007), *Fifth Annual Report*, Transport for London, London

Walcott, S.M. (2002) 'Chinese industrial and science parks: bridging the gap', *The Professional Geographer,* vol 53, pp349–364

Wilson, P.W. (1988). Welfare effects of congestion pricing in Singapore. *Transportation*, vol 15, no3. pp.191-210

Xinhua (2007) 'Beijing's parking fees to be increased' *China Daily Online*, 9 July

Xinhua (2008) 'Official: Beijing won't restrict private car purchase to ease traffic, pollution', *Sina English (online)*, 19 November 19

Xinhua (2009) 'China's policy stimulus to spur car sales in Year of Ox', *Xinhuanet.com*, 28 January

Xinhua (2010) 'Southern China city releases proposals against traffic congestion: report, *Xinhuanet.com*, 1 October 2010 http://news.xinhuanet.com/english2010/china/2011-01/10/c_13683402.htm

Xinhua (2011) 'Beijing's new car license applications hit 215,425 in January', *Xinhuanet.com*, 10 January, 2011 http://news.xinhuanet.com/english2010/china/2011-01/09/c_13682583.htm