# IMPROVING THE EFFICIENCY OF URBAN BUS SERVICES IN INDIA

by

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ABSTRACT OF THE DISSERTATION

Improving the Efficiency of Urban Bus Services in India

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This dissertation analyzed the performance of public bus services in Indian cities and explored factors that affect their efficiency. Following the Road Transport Corporation Act of 1950, most states in India established State Road Transport Corporations to provide public bus services in their respective states. By early 1990s, most of the State Transport Undertakings (STUs) had become large monopolistic operations that incurred huge losses. The government of India started to encourage the STUs to resort to privatization to expand their services and stopped providing funds for purchase of new vehicles. Delhi and Bangalore privatized part of their urban bus services to increase the supply of buses in the city.

The analysis involved quantitative analysis of the performance of urban transport companies, the efficiency of their operations and a comparison of the privatization experience of Delhi and Bangalore to understand the differences in their experience. Data Envelopment Analysis (DEA) was used to estimate the relative efficiencies of

public bus companies.  Then, tobit regression and truncated regression were performed on the estimated efficiencies to explore the exogenous factors that influence efficiency.

Results from the multivariate analysis showed that privatization significantly affects service efficiency.  Privatization led to an increase in the supply of buses, a decrease in crowding on buses and overall improvements in the quality of service. However, its impact on production efficiency was insignificant.  The results from regression analyses indicated that factors other than privatization, such as higher population density and regular revisions of fares influence efficiency.  Higher traffic speeds can also improve efficiency of bus systems.  While some these factors can be directly controlled by the bus operator, others are beyond their control and have to be addressed though overall planning for land use and traffic management.

The research also offers several practical implications to cities that are planning to privatize their operations. The comparison of the privatization experiences of Delhi and Bangalore does not support the theory that competition between operators improves efficiency.  Regardless of the method of privatization chosen, the nature of regulations imposed on the private operators determines the outcome from privatization.

## Dedication

To my husband Jairam, who encouraged me when I despaired, pushed me when I dawdled, and steadied me when I faltered.

And to my sons, Arjun and Nikhil, who have made me a better person than I ever was.

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My father, Damodaran Nayanar read all the chapters, provided feedback and helped with editing. My friend Carole Ryder's editing greatly improved the quality of the writing.

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# 1 Introduction

When my friends and I waited at the bus-stop near our college in Calicut, we would always pass up an empty Kerala State Road Transport Corporation (KSRTC) bus and wait instead for a more crowded private bus. We did not mind having to stand for the entire 40 minutes of the trip to the city. It was not because we enjoyed balancing on one foot while holding on to the railing on the ceiling of the bus, trying not to fly out the window every time the bus made sharp turns at high speed. It was because the public sector buses were old, often rusty, with leaking roofs and uncomfortable seats. They also took a different route to the city and had fewer services on those roads. So if the bus had a breakdown, we would have to wait longer before getting another ride. The trip on the private bus, while presenting its fair share of adventures, was nevertheless more reliable.

In this dissertation, I studied the performance of bus services in India. There are cities and towns in India that are served exclusively by public bus companies, some of which enjoy the services of both public and private companies and many that do not have any local bus service at all. My research compared in detail, the experience of Delhi and Bangalore, two large cities that pursued planned privatization of public bus services. Their approaches were different from each other, with different impacts on service and performance. My research analyzed the performance of urban State Transport Undertakings (STUs) in India comparing the performance of systems that have privatized and those that have not and explored the factors that contribute to inefficiency. The reasons for the differences in the privatization experiences of Delhi and Bangalore were also explored.

## 1.1 The problem of bus transport in Indian cities

India has a population of about 1.2 billion (CIA 2008), with an urban population of about 300 million (The Registrar General of India 2008). Of the urban population about 108 million live in urban agglomerations with populations larger than a million. Urban population in India has been growing at a much higher rate than the total population in the country. While the total population grew 2.5 times since 1947, the urban population grew 5 times (Chakrabarti 2001). Almost all cities in India are served only by bus services for the daily commute, the exceptions being, Mumbai, Kolkata, Chennai to a small extent, and recently Delhi. There are 31 other cities and urban agglomerations with populations more than a million and have no urban rail service. The public bus service is thus responsible for providing affordable and efficient means of travel in most parts of India.

Urban areas in India were historically served by piecemeal private bus services, such as the services in Kolkata, or small scale operations by public transport companies started during the British rule (Phanikumar and Maitra 2006). It was only in the 1950s following the Road Transport Corporations Act of 1950, that considerable efforts and resources were allocated toward starting and maintaining public bus services in cities. After a period of gradual growth, the state transport undertakings (STUs) eventually became a source of employment generation, especially during the economic crisis of the 1970s. Though the state's transport sector is not the only public company responsible, there are states such as Kerala where, in the 1990s, the government employees' salary expenses exceeded the state's revenue and the state found it increasingly difficult to pay employees on time (World Bank 2002). Kapur and Ramamurthy (2002) explain that of all state level public sector undertakings in India, the power sector and the state transport undertaking are the ones that drain the most resources from the state exchequer.

The government's inability to improve the public transport system partly stems from the fact that lay-offs in the public sector are very rare (Kapur and Ramamurthy 2002). No employee is held responsible for poor service. Employee performance does not affect job security or promotions. Promotions are based solely on seniority. So when a vacancy presents itself, the person who started the job earlier gets promoted regardless of performance.

Apart from the high staff to bus ratio, the public transport companies operate older, ill-maintained vehicles. The financial constraints make fleet renewal unaffordable for many public companies (TERI 2002). Vehicles that are poorly maintained are prone to service disruptions, consume more fuel and are more polluting than newer, well-maintained vehicles (DTC 2008, APSRTC 2008, MTC 2008).

The poor financial condition of most of the public bus companies in India is so grave that they have been trapped in a vicious cycle, from which they can escape only with the help of careful proactive planning. Once in debt, the bus companies are forced to continue operating the older vehicles because there aren't enough resources for fleet replenishment and augmentation. Older vehicles consume more fuel and are prone to service interruptions, rendering the service inefficient and unreliable, and leading to further loss of revenue. Thus the public company is left with even less money and drawn deeper into a financial crisis.

The Indian economy has grown steadily since the 1990s (The CIA 2008, Reddy 2008, Chaitanya 2004), increasing the purchasing power of its citizens and their travel demand. Most of the economic opportunities are concentrated in the large cities, making them the center of transportation problems as well (Chaitanya 2004). Lack of adequate financing has made it challenging for improvements in transport services to keep up with the growing demand (TERI 2002). Every person who can afford at least a two-wheeler motor-cycle abandons the overcrowded and unreliable public transport for a more personal and on-demand mode of travel.

However, Indian roads do not have the capacity to accommodate the increasing number of vehicles. In most large cities, traffic speeds are only 10-12 km/hour during the peak hours (World Bank 2002). Before the liberalization in the early 1990s and the economic growth in the years that followed, private vehicle ownership in India was quite low. As the economy improved and personal incomes increased, the demand for private and faster means of travel increased. The average annual vehicle growth rate in India for 1991-2001 was 9.9% (Ministry of Road Transport and Highways 2005). It was much higher than the population growth rate, which was only 1.51% (The Central Intelligence Agency 2002). The absolute number of registered motor vehicles in India more than doubled[1] during the ten-year period from 1991 to 2001, growing from 21,374,000 in 1991 to 54,991,000 in 2001(Ministry of Road Transport and Highways 2005). By 2003, the number had reached 67,033,000. Vehicle count is expected to double again by 2010.

In spite of the economic growth, a large percentage of Indians are poor. Almost 70 million urban residents in India are poor with limited access to affordable transportation and other urban amenities (World Bank 2002). For the economic condition

[1] The number of registered motor vehicles in India grew 2.6 times in the 10 years from 1991 to 2001

of the poor to improve, it is essential that they have affordable access to jobs, markets and education. Ensuring affordable transportation is thus crucial to the amelioration of poverty.

Privatization is being discussed as one of the best options to be incorporated into a restructuring and has already been attempted in some of the cities. But none of the privatizations in India are complete privatizations where one or more private services replace the public services. They are all partial privatizations with private buses adding to the services offered by the public buses. Literature on privatization does lay out its list of cautions, and privatization may not be a miracle solution that will solve all the ills of the public bus service in India. Indians have been traditionally suspicious of the private sector, presuming that they will be extremely profit-conscious and even greedy. However, there are several benefits that can be accrued from a privatization process that is carefully planned to mitigate all or most of the possible problems.

## 1.2 Privatization and Liberalization of Public Services – The Issue

When many developing countries became independent from colonial rule after World War II, cities were already large enough to warrant some means of public transportation (Satyanarayana, 2000). Sometimes, these cities had services that were provided by private companies. As the countries became independent, the governments took an active interest in providing public transport services in the form of bus services. The reasoning was manifold.

It was recognized that public transportation served an important social purpose. To improve the economy and reduce poverty, people needed to have access to markets and jobs (World Bank, 1996). To ensure a secure future, the children and youth had to have affordable access to education and schools.  To ensure public well being, everyone had to have access to health-care facilities and other services.  Governments recognized that access to services cannot be improved without improving access to affordable transportation.  Thus, the governments of many newly independent and less developed countries took upon themselves the responsibility of providing affordable bus services for their citizens.

The advantages of having publicly owned and operated systems were considered important (Singh 2000).  It was expected that the governments would have a better perspective of the social obligations of a public transport service than a private company driven by profit-margins.  The government would be willing to provide reduced fares to deserving passengers, keeping the service affordable and ensuring access to the millions of poor people in their cities (Asian Development Bank 2002).

Second, it allows the government to channel development to designated areas (Singh 2000).  Since transportation and economic growth are intricately related, the government can choose areas or parts of their city that need to developed, or has the potential to be centers of economic growth, and introduce new transportation services to such regions.  It will then improve the accessibility of the area, and increase the commercial and economic opportunity for that region.

Third, a government operated service makes it easier to provide coordinated services using different modes (Singh 2000).  It helps to avoid costly duplication of services and the limiting of operations to selected corridors with high ridership.  It was also expected that a government controlled operation would use better equipment and more qualified personnel than a private company.  Overall, it was expected that a government operated service would provide coordinated services at affordable rates, serve all parts of the city and provide better access to everyone, especially the poor and disadvantaged populations.

However, over years of operation most public sector companies became very bureaucratic. Their operations became inefficient. With the job security of the public sector employment and lack of accountability there was no motivation for employees to perform well (Marwah, Sibal and Sawant 2000). The system as a whole became corrupt, inefficient, losing patronage and revenue, resulting in the accumulation of huge debts. Old vehicles were no longer replaced or even maintained at an optimum condition, adding to the inefficiency.

When public bus companies become a financial burden for the government, privatization is often seen as a means to escape the financial responsibility of providing transport infrastructure and services (Gomez-Ibanez and Meyer 1993; Estache and deRus 2000; Kulkarni 1999). It allows an increase in the quantity of service as there is new capital that can be used to increase supply. The new vehicles can also be ones that use new technology and be less polluting. The private sector is more profit-oriented and inherently motivated to minimize costs (Gomez-Ibanez and Meyer 1993).

However, in the absence of careful supervision, the privatized sector may continue to be monopolistic and may compete on the road with other buses for passengers. They may ignore speed limits and carry more passengers than their vehicle's capacity. They may fail to update vehicle's emission standards and inspections, fail to serve on assigned routes and even cancel trips (Marwah, Sibal and Sawant, 2001). The private operator may refuse to honor the government's promises to provide subsidized and affordable travel for deserving citizens. They may relegate persons who are eligible for subsidized travel privileges to second class status[2].

Privatization, once chosen as a suitable solution, has to be carefully planned and appropriately regulated. It is possible to address most of the potential problems of privatization effectively through careful drafting of the contract and regulations. Achieving a balance between regulating the industry to ensure an appropriate level of service at affordable costs to the public and allowing the private sector to be innovative enough to make reasonable profits is the biggest challenge in all attempts to privatize bus transport services.

## 1.3 Research Approach

The primary inquiry is into the nature of bus services in Indian cities, in an attempt to understand the financial and social factors that motivate and guide them. Since their operations are different across the country, the study lends itself to one based on case studies and the lessons learned from the experiences of the various cities.

### 1.3.1 Research Questions

The goal of the dissertation is to understand the problems faced by the urban bus transportation companies in India and to explore the extent to which those problems can be solved through privatization. So the first research question is regarding the nature of bus services in Indian cites.

- What have been trends in the performance of urban STUs?
- Have the bus supply kept up with growth in population?

[2] Some private bus operators in Kerala, India refuse to allow students - who pay a fourth of the regular price for tickets - to board the bus until other passengers who pay full price have boarded, allow only a few, fixed number of students to board, and force students to give up seats for other passengers.

- Are the operations of the urban STUs cost-efficient?
- How efficiently are the STUs using the available resources?

Since public transport has social functions as well, efficiency also needs to be assessed in non-financial terms. So part of performance assessment will evaluate the operational efficiency of public transport systems in terms of the services produced with respect to the resources used. Efficiency assessments are useful if the sources of inefficiency can be identified and possibly addressed. A related research question is regarding the sources of inefficiency.

- What are the factors that affect the efficiency of bus operations in Indian cities?
- Is privatization an important factor that affects efficiency?

Finally, the research explores the differences in the approaches adopted by Delhi and Bangalore towards privatization of bus services in their cities.

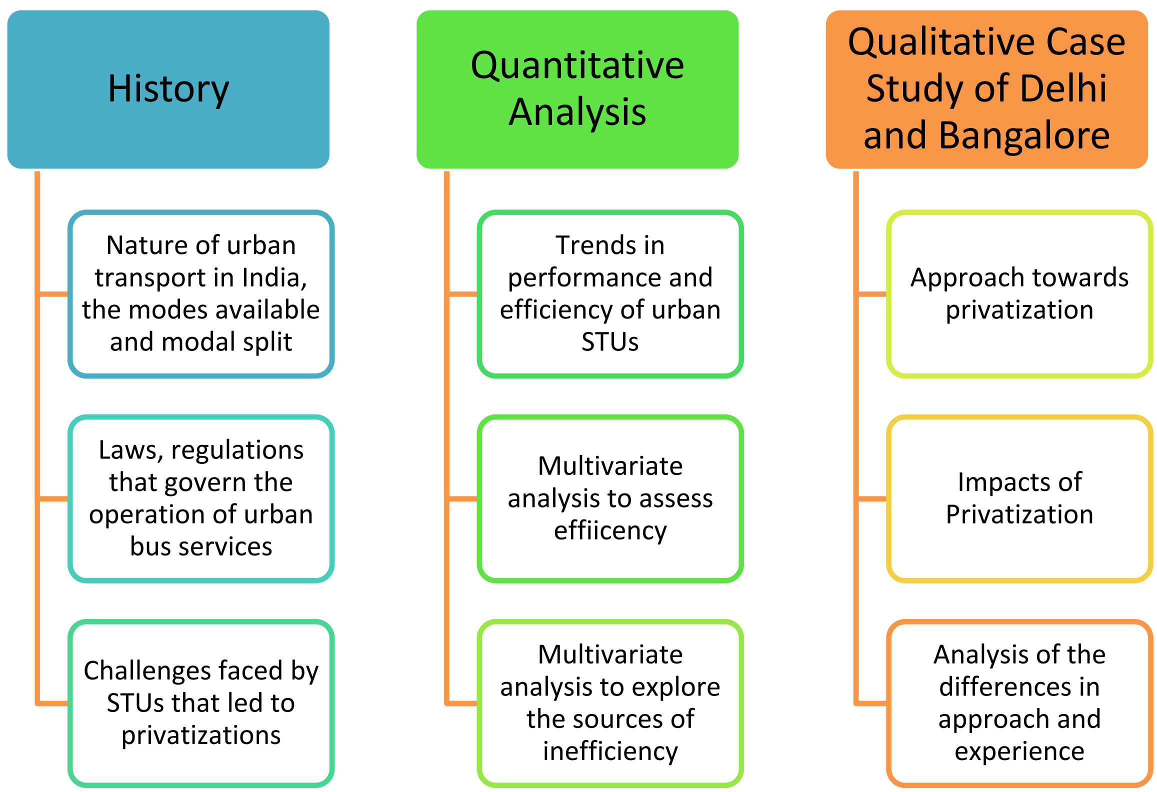
- What impacts did the privatization efforts in Delhi and Bangalore have on the public bus services in those cities?
- What are the differences in the methods of privatization and the nature of regulations adopted by Delhi and Bangalore?
- How have these affected the outcomes of privatization in these cities?
- What lessons can be learned from the privatization experiences of Delhi and Bangalore?

### 1.3.2 Research Organization

The research is broadly organized into three parts. The first stage studies the nature of urban transport in India and the evolution of urban bus transportation in cities.

The second part involves quantitative analysis of the performance of urban transport companies and efficiency of their operations. The third part compares the restructuring experience of Delhi and Bangalore to understand the differences in their experience. The organization of research is graphically presented in figure 1.1

*Figure 1.1 Organization of Research*



## 1.4 Organization of the Dissertation

The dissertation is organized into chapters as described below.

*Chapter 2* provides an overview of urban transport in India. It describes the various modes available in the urban areas and the extent to which they are used in meeting the travel demand. The chapter concludes by observing that buses are the most important means of public transport in India, because they are affordable and can be flexible in terms of routing and scheduling to meet changes in demand.

*Chapter 3* describes the history and evolution of the urban bus companies in the public sector. It describes the laws that allowed the creation of State Road Transport Corporations and some of the challenges faced by the urban STUs that compelled them to consider various options for restructuring including privatization. The chapter concludes by discussing some of the concerns that have been raised against privatization of public bus companies.

*Chapter 4* reviews the arguments made for privatization of urban bus services and the possible problems that may arise from privatization. It discusses the possible methods of privatization, and the experiences of cities in developed and developing countries that have privatized their bus operations.

*Chapter 5* describes the nature of data available regarding bus services in Indian cities. The limitations of the data available and the subsequent limitations that it imposes on the research are also discussed. The chapter concludes with a discussion of how the research questions outlined in chapter 1 can be addressed using available data.

*Chapter 6* explores the nature of bus transportation in 10 cities in India. It discusses the trends in bus supply and use, financial performance and operational efficiency of urban STUs.

*Chapter 7* assesses production and service efficiencies of urban STUs using data envelopment analysis (DEA). A Tobit regression is then performed to examine the exogenous sources of inefficiency.

*Chapter 8* discusses the experiences of Delhi and Bangalore in privatizing their bus operations. These two cities adopted different methods of privatization and experienced different impacts. The chapter explores the reasons for their dissimilar experience and the extent to which the method of privatization and the regulations adopted during privatization impacted the outcome.

*Chapter 9* summarizes the findings from the research and the limitations of the research. It describes the theoretical contribution that the research makes to the expected benefits of privatization. The practical implications of the research in terms how it could inform and influence future efforts to restructure urban bus services in India and other developing countries are also discussed. The chapter concludes by outlining possible directions for future research.

# 2 Urban Transport in India – An Overview

This chapter provides an overview of urban transport in India. It describes the various modes that are available in the urban areas and the extent to which they are used to meet the travel demand.

India is a largely rural country, with only about 30% of the population living in urban areas. But the total urban population of India has tripled since 1971. The urban population grew from 109 million in 1971 to 160 million in 1981, 217 million in 1991, and 285 million in 2001 (Office of the Registrar General, 2001a; Padam and Singh, 2001). Another feature of the growth is that it has been concentrated in large cities. By 2001, Mumbai (Bombay) had a population of 16.4 million, Kolkata (Calcutta) had a population of 13.2 million, and Delhi had a population of 12.8 million. Chennai (Madras), Hyderabad, and Bangalore each had more than 5 million residents. Thirty-five metropolitan areas had populations exceeding one million, almost twice as many as in 1991 (Office of the General Registrar, 2001b).

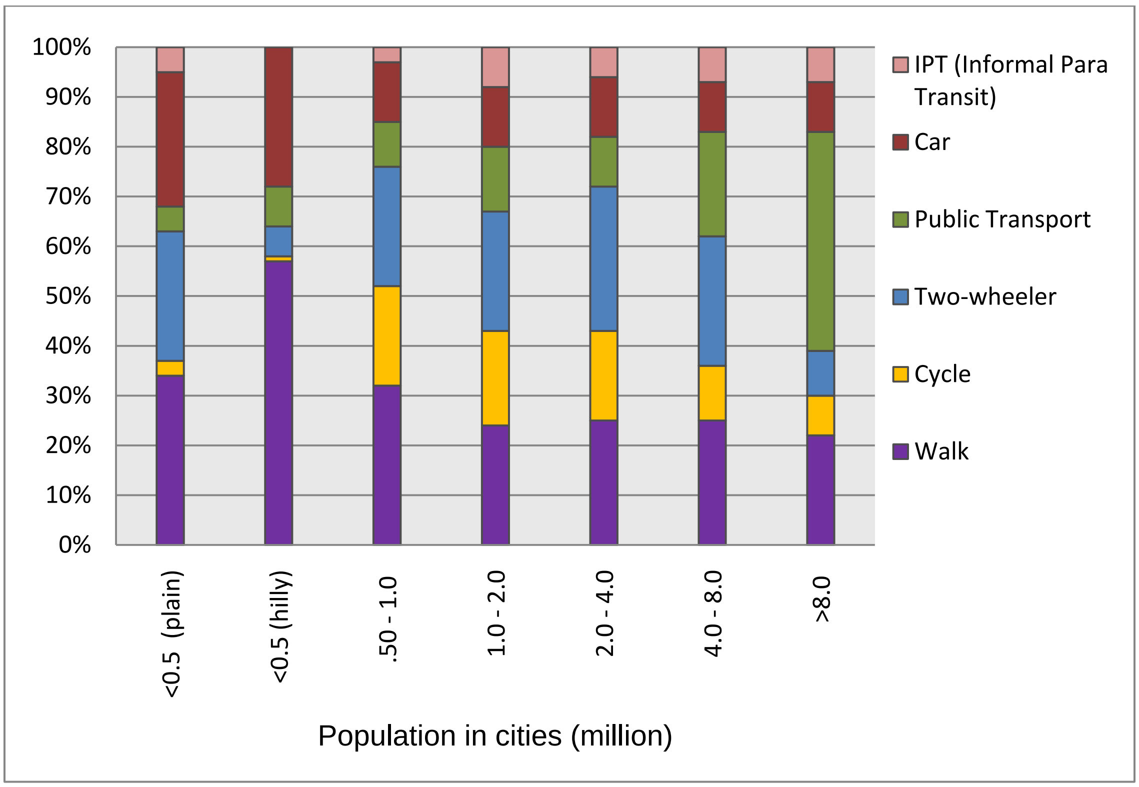
A large percentage of urban residents live in poverty. In 2008, the per-capita income in India was the equivalent of only US $2,600, less than a tenth of average incomes in countries in North America and Western Europe (Central Intelligence Agency, 2008). While poverty is still a major problem for much of the population, real per-capita income in India grew by 37% from 1980-81 to 1990-91 (in excess of inflation) and by 40% from 1990-91 to 2000-01 (Ministry of Finance, 2004). That economic growth was fuelled by a growth in the service industry led by the information technology industry. The groups that benefited the most from this growth were thus the middle and upper classes who had access and opportunity for higher education. Over the entire period from 1980 to 2000, overall purchasing power of the average Indian almost doubled. This increase contributed to a growth in motor vehicle ownership. Lower-income classes have benefited as well and the portion of India's urban population living in poverty fell by half during the last quarter of the 20th Century, from 49% in 1974 to 24% in 2000 (Ministry of Finance, 2004).

With 24% of the population living below the poverty line, roughly a fourth of urban residents cannot afford almost any form of motorized transport. Car ownership was only 12 vehicles per 1000 people and motorcycle ownership was about 60 per 1000 people in 2006 (MORTH 2007), which are much lower than China where car ownership was 18 vehicles per 1000 people and motorcycle ownership was about 95 per 1000 people in 2006 (Pucher et.al. 2007). In India, it was only 3.5 cars per 1000 persons and 16.3 motorcycles per 1000 persons in 1991, and has been steadily increasing (MORTH 2007). However, millions of Indians still cannot and do not own private vehicles. They rely on walking, biking and public transport for their daily travel needs.

## 2.1 Modal Options in Public Transport

Many small Indian cities are served only by bus or paratransit services for intracity travel. Many medium and small cities with populations less than 2 million and some larger cities with more than 2 million residents do not have any bus service. They are served only by paratransit modes such as the auto-rickshaws[3], cycle-rickshaws, jeeps, tempos[4], etc. As can be seen from figure 2.1, the modal share of public transport is very small for small cities and increases with increase in the size of cities. On the other hand, the modal share of walking and biking decrease with increase in city sizes.

*Figure 2.1 Modal Split in Indian Cities in 2007 (in percentage)*




Source: Ministry of Urban Development, 2008

[3] motorized 3-wheelers
[4] Tempos are similar to minivans, but can seat about 12-15 people

### 2.1.1 Buses

Buses are the most important means of public transport in India. Buses have been an attractive choice for investments in public transport, because it is less capital intensive than rail. It can be feasible in smaller cities where travel demand does not justify a rail system. It is also possible to modify routes and schedules in a bus transport system, unlike in a railway system. It is easier and less expensive to add services when compared to rail. The most important advantage of bus transportation is that it is the cheapest among all the public transport modes available in India.

There are 58 State Road Transport Undertakings in India, which are public companies or corporations that provide bus services within their cities and states. They operate approximately 115,000 buses serving about 65 million passengers per day (CIRT 2008). State governments control the operation of private buses through licensing policies. Sometimes, the state declares some routes as nationalized routes and do not grant permits to any private buses to operate on those routes. In other states, public and private buses operate side-by-side on the same routes. The involvement of private operators varies from state to state[5].

The modal share of bus transport varies from zero in some small and medium cities to about 40% in large cities such Delhi. Buses in Delhi enjoyed a modal share of 60% in the 1990s which has declined to about 40% in 2008 (DIMTS 2009). In general, buses enjoy a higher modal share in larger cities and are less prevalent in smaller cities. But there are exceptions, and buses in some small cities such as Kochi and Coimbatore serve about 50% of the total travel demand.

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[5] The history and evolution bus services in India are discussed in more detail in chapter 3.

### 2.1.2 Railways

The Indian Railways were expanded to serve almost every part of India during the British rule. Today, they offer a variety of services, including subways, commuter trains, long-distance trains, freight trains, and trains that move petroleum products (Ministry of Railways 2002). For passengers, it offers a few options for comfort depending on how much fare one is able to afford. The general car charges a very small fare, but there are no assigned seats. So the passenger may have to sit with five other passengers in a seat meant for three. The 2$^{nd}$ class sleeper car charges slightly higher fares but is a more comfortable ride and the seats can be converted to sleeping berths at night. It offers no privacy at all, and often local passengers are allowed to board during the local peak hours. The other option is to pay much more and travel in the first class car, which have small coupes with doors offering privacy, and do not allow local passengers to board at all. Most trains also have 2 or 3 air-conditioned cars, which are comfortable in the hot summer months (Ministry of Railways 2006a).

The railways in India are owned and operated by the Indian Railways which operates under the central government. The first train traveled from Mumbai station to Thane covering 21 km in 1853. About a year after that first trip, the rail was introduced in Kolkata in Eastern India and two years later the Madras Railway Company opened its service in the Southern city of Chennai. By 1880, the Indian Railway system had a route mileage of about 9000 miles. Today, they operate about 11000 trains every day, 8250 of them being passenger trains, covering 63028 km (Ministry of Railways 2006). This extensive network is the largest in the world under a single management (Indian Railways 2002). The Indian Railways carries 475 million tons in freight traffic and about

5000 million passengers annually. However, 60% of the originating passengers traveling by rail are suburban commuters in Mumbai, Kolkata and Chennai. Commuters in other cities constitute 13% and long distance travelers constitute 27% of the total number of rail passengers. The passengers who travel in the first class and air-conditioned cars, while constituting only 1% of the volume, contribute about 20% of the revenue. Suburban commuters, though 60% in volume contribute only 10% of the revenue (Ministry of Railways 2002).

Most of the financial concerns of the Indian Railways can be attributed to the failure of the increase in fares to keep up with the increase in the cost of operation (Indian Railways 2002). Mumbai suburban trains are the only ones that break even in terms of cost. They are able to do that only because they are always crowded and carry at least 5 times more people than the trains' capacity during the peak hours (Western Railway, 2004). In cities other than Mumbai, Chennai, Delhi and Kolkata, only a small percentage of commuters use the train. In those cities, like Kanpur, Coimbatore etc. trains are infrequent. In many medium-sized cities, like Mangalore, there are only two or three trains coming in during the peak hour.

### *Suburban Rail and Subway Systems*

Mumbai, Delhi, Kolkata and Chennai are the only cities in India that have either a surface or underground urban rail network. In cities other than Mumbai, the urban rail systems are not extensive enough to be the most important mode of transport. In those cities the road remains the most popular means for transport.

Indian Railways is divided into various zones for the purposes of management and operations. The suburban rail in Mumbai is owned and operated by the Western

Railways, which is the zone that operates in the western states (Ministry of Railways 2007). The suburban trains run at a 3-minute interval during the peak hours. Despite the high frequency, the trains in Mumbai are always filled beyond capacity. Kolkata was the first city to build an underground rail network in India under the Eastern Railways. However, the tracks run for only 16.45 km stopping at 17 stations. So it serves only a small percentage of the travel demand in the city. They have begun the construction of an above-ground expansion of 8.7 km (Metro Railway 2008).

In Chennai, the Southern Railway operates suburban services along three corridors originating in the Central Business District and branching in the southeast, western and northeast direction. Two of these lines, the Arrakonam line and the Gudur line are broad gauge lines and the third, which is the Tambaram line, is a meter gauge line under conversion to broad gauge. The two broad gauge lines operate 276 services per day and the meter gauge line operates 230 services a day. The system carries approximately 630,000 passengers a day but this constitutes only 10% of the total bus and rail trips (Southern Railway 2005). Southern Railway also operates the Mass rapid Transport Service (MRTS) service from Madras Beach to Thirumailai, which is a 9 km length of elevated track running through the city. It operates 118 services a day. This system is being extended to the suburban area of Velachery (Southern Railway 2005).

The urban rail network in Delhi, known as “the Delhi Metro” is the most extensive of all with 65.11 route km, of which 13.01 km is underground. The underground section is called the Metro corridor (Delhi Metro Rail Corporation 2008). The 52.10 km surface/elevated part is called the Rail Corridor. The trains are equipped with the most modern communication and control systems and have state-of-the-art air conditioned cars. The system's share of passenger traffic was only 2% in 2008 and has been a bit disappointing. Delhi Metro rail Corporation is proceeding with Phase-II of the project, which will add 121 km of rail to the network (Delhi Metro Rail Corporation 2008).

Hyderabad does not have a separate urban rail network, but has local trains operating during peak hours, sharing tracks with the long-distance trains and serving the daily commute. This system was introduced in August 9, 2003 and is used by about 65000 people every day (Government of Andhra Pradesh 2008). The Andhra Pradesh State Road Transport Corporation which is the public sector company that operates buses in Hyderabad, issues passes which can be used on buses as well as the local trains. The city is working on coordinating transfers and developing a multimodal transport system.

### 2.1.3 Trams

Before the 1940s, the cities of Kolkata, Mumbai, Chennai, and Delhi had trams. Kolkata is the only city which has a tram service today. However, the trams in Kolkata serve no purpose other than to maintain an old-world-charm. Its ridership has declined drastically, from about 0.75 million per day in the early 1980s to about 0.16 million per day in the early 2000s (Calcutta Tramways Corporation 2008). Lack of investments in the maintenance of tracks and cars has led to deterioration of infrastructure and unreliable service. Only about 25 km out of the 68 km of tracks have reserved right of way. In effect, it operates in mixed traffic and competes for road space with all the other vehicles on the road.

### 2.1.4 Intermediate Public Transport and Paratransit

Most of the smaller cities are not served by buses at all. They rely on a combination of paratransit modes like auto-rickshaws, cycle rickshaws, jeeps and tempos. Autorickshaws and cycle rickshaws operate as taxis offering their passengers a personalized mode of transport and taking them door to door (Tiwari 1999). In the 1990s an important source of air pollution was the large and mostly old fleet of auto rickshaws with highly inefficient, poorly maintained, very polluting 2-stroke engines (Tata Energy Research Institute 1997). Since many autorickshaw drivers illegally adulterated their gasoline fuel with up to 30% kerosene and 10% lubricating oil, the pollution they generated was further increased (Kandlikar and Ramachandran 2000). Two-stroke engines were banned first in Delhi in 2001 and then in the whole country and the old vehicles are being phased out. However, autorickshaws are not affordable to the poor, as autorickshaw fares are about 20 to 25 times more than the bus fare. Passengers also often have to negotiate fares with the autorickshaw drivers who demand more fare than what the meter shows, citing peak-hour traffic or other problems.

Jeeps and tempos, on the other hand, often operate illegally as stage carriages as well. They are however unregulated and fix their own fares. They can be seen at crowded intersections near market places or movie theaters and will usually have a hustler who calls out the direction in which the vehicle is going. Once they have enough passengers, they leave. So there is no schedule or rules to their operations and can be very confusing to non-residents.

Auto-rickshaws and cycle rickshaws are slow moving vehicles and are often accused of being the major cause of the congestion in Indian cities, where there are no separate lanes for fast and slow vehicles. Such diversity of roadway users also causes a range of safety issues (Tiwari 1999). The modes have very different sizes, maneuverability, capacities, speeds, and other operating characteristics, generating a range of conflicts and accidents.

### 2.1.5 Walking and Biking

Since much of the population is too poor to afford any form of motorized transport, the highest percentage of travel in many Indian cities is walking and biking. However, there are differences between small and large cities. Walking and biking are more common in smaller cities where they account for over two-thirds of all trips (Pucher et. al. 2004). In larger cities, the distances between origins and destinations are longer and walking and biking become less feasible. The modal share of walking and biking is only about half of all trips in medium sized cities and about one third of all trips in large cities.

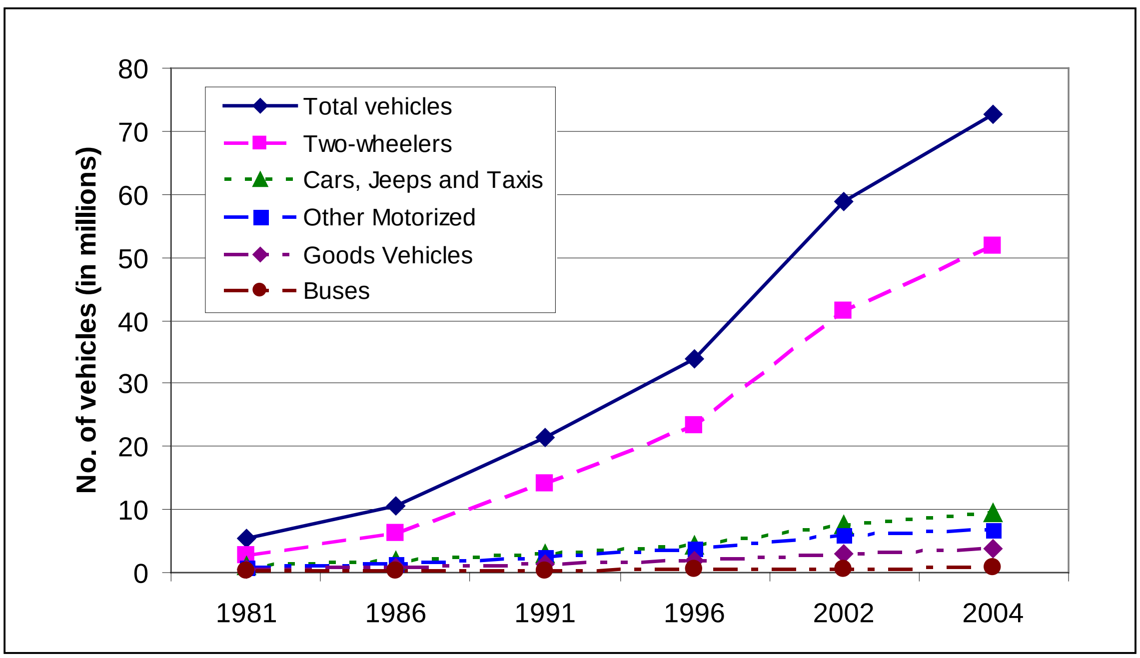
There are differences in the modal share of walking and biking even among comparably sized cities, probably due to differences in income and availability of public transport (Pucher et. al. 2004). Kanpur, Lucknow and Pune are three medium sized cities. But the percentage of walking and biking trips in Lucknow and Kanpur are much higher than in Pune. Kanpur and Lucknow do not have any mass transportation system and people have to rely on rickshaw and taxi services, while Pune has a public bus service. Also Pune has a higher level of motorcycle ownership when compared to Lucknow and Kanpur because of a larger middle class in that city.

Since walking and biking are mostly the modes of choice of the poor, who lack political and economic power, these are modes that are largely ignored by the government (Vasconcellos 2001; Low and Banerjee-Guha 2003). Indian cities lack bike lanes and sidewalks even in cities where walking and biking are important modes of transport. Pedestrians and cyclists are often forced to use the shoulder or the roadway itself adding to the congestion, reducing speed of travel and causing safety problems.

## 2.2 The Condition of Road Transport Infrastructure

Eighty percent of land passenger requirements in India are met by road transport (Singh 2006). So the condition of road transport infrastructure is an important factor affecting the quality and efficiency of transportation.

*Figure 2.2 Growth of Motor Vehicle Fleet in India by Type of Vehicle*




*Source:* Ministry of Road Transport and Highways (1999, 2000, 2003)
*Note*: 'others' includes tractors, trailers, motorized three-wheelers such as auto rickshaws and other miscellaneous vehicles that are not separately classified.

Road length per unit land area in India is quite high. Indian roads have a geographic coverage of 0.66 km of highway per square km of land (World Bank 2002). This is comparable to USA, where there is 0.65 km of highway per square km of land and is far higher than China, where there is only 0.16 km of highway per square km of land (World Bank 2002). However, most of these highways in India are only 2-lane. Only 3000 km is 4-lane and negligible length is access-controlled (Department of Road Transport and Highways 2006). So road area per square km of land is low in most urban areas in India. The availability of roads as a percentage of urbanized area varies from only 6% in Kolkata (Phanikumar and Maitra 2006) to 21% in Delhi (Somayajulu and Mukherji 2007), which is almost comparable to cities such as New York with 23 % (Vasconcellos 2001). Delhi being the capital city of India has enjoyed more central government investments in transport infrastructure than other cities.

## 2.3 Summary

Despite the very extensive network that the Indian Railways boasts about, it only caters to about 20% of the total land passenger travel demand. Bus is the prevalent mode of public transport in India. For a growing city that is considering a public transport system, buses are more attractive than rail, because it involves less capital investment and is flexible in terms of routing and network planning. It is much easier to add schedules and routes to a bus service than to a rail service.

It is easier to privatize bus transport than rail transport. A private bus owner has a much smaller investment to make than a possible private rail operator. Besides, rail involves substantial fixed infrastructure and considerably more detailed planning. A railway system is usually a monopolistic operation and there is no room for multiple rail providers or for competition in the market that is possible in a bus system.

The next chapter discusses the history of bus transportation in India and the challenges that forced some cities to consider privatization of their services.

# 3 Bus Transportation in India – History and Challenges

Buses are the most popular form of public transport in India. This chapter describes the history and evolution of bus transport systems in India, and examines the challenges that prompted some cities to privatize their bus services.

Indian cities began to grow in size in the early 1900s. Since then, many cities like Mumbai and Kolkata have had various forms of public transportation. In Mumbai, permits to operate buses were given to a private company. In Kolkata, small private operators organized piecemeal operations. Upon gaining independence in 1947, the government decided that it was its responsibility to provide the people with affordable means of transportation and nationalized most public transport operations. Since then, the various transport corporations have gone through periods of growth and high ridership, and periods marred by financial loss and poor performance.

## 3.1 Institutions Involved in the Provision of Public Transport

In India, all modes of transportation except the Railways and the Airways are the responsibility of the state government. All urban and rural planning and development were also the responsibility of the respective state legislature till 1992. In 1992, the legislature passed the 74th Constitutional Amendment which mandated devolution of power from state legislatures to local (urban and rural) governments. Thus local governments now have considerable discretion in economic and other development planning including maintenance of roads, bus stops etc (Tata Energy Research Institute 2002).

There are several institutions concerned with urban transport in India, at the top of which is the Ministry of Urban Development which has the overall responsibility for urban transport policy and planning. The licensing, inspection and taxation of motor vehicles are the responsibility of the Transport Department of the respective state government and are subject to the provisions in the Motor Vehicles Act of 1988 (Deb 2002). The administration of the Motor Vehicles Act is itself the responsibility of the Ministry of Surface Transport (MOST). That ministry also issues guidelines about vehicle specifications and emission standards. The State government, through its Public Works Department is responsible for the construction and maintenance of roads and bridges and through its State Transport Undertaking is responsible for the operation of bus services (Tata Energy Research Institute 2002). The construction and maintenance of smaller roads, traffic signs, street lights, sidewalks, etc are to be managed by the local urban or rural government. Finally, the police department is responsible for the enforcement of traffic laws (Tata Energy Research Institute 2002).

## 3.2 Bus Transport in India before 1947

Before 1947, only four cities in India, Mumbai, Kolkata, Delhi and Chennai, had populations large enough to sustain a public transport system. All of these cities had various forms of transportation serving the people. They had tramcars, of which Kolkata still maintains a namesake service, and bus services provided by private companies existed in all four cities. In all these cities except Kolkata, the State government acquired the assets and operating permits after 1947, ending private sector bus services in Delhi, Chennai and Mumbai. The service in Mumbai was probably the best in terms of organization and service. Mumbai started with a fleet size of 24, grew 10 times in 10 years and had a fleet size of 243 in 1947 (Brihanmumbai Electric Supply and Transport Undertaking 2008). Kolkata had private operations as well, which eventually grew in size. But unlike Mumbai where one company was responsible for the entire bus services in the city, Kolkata had several small bus owners operating 2 or 3 vehicles. They formed unions and self-regulated in their own way, by imposing fines on buses that did not operate on schedule or cancelled trips (Phanikumar and Maitra 2006).

Public buses in Delhi were operated by the Gwalior and Northern India Transport Company until 1947. In 1948, bus services were nationalized and a government owned company named Delhi Transport Service was constituted (Delhi Transport Corporation 2007a). Later, after the Road Transport Corporation Act was passed into law in 1950, the Delhi Transport Service was reconstituted as the Delhi Road Transport Authority (Delhi Transport Corporation 2007a). This company was under the Delhi Municipal Corporation for about 20 years. During that time, transport demand in Delhi increased manifold. It was alleged that the Delhi Road Transport Authority was inefficient and was providing the people of Delhi with inferior service (Delhi Transport Corporation 2007a). So in 1971, the Government of India took over control of the Delhi Road Transport Authority and renamed it as Delhi Transport Corporation. Later, the control of Delhi Transport Corporation was handed over to the government of the National Capital Territory of Delhi (Delhi Transport Corporation 2007a).

Chennai, which used to be called Madras, had several buses operated by private operators before India's independence in August 1947. In 1947, the government of

Madras introduced 30 publicly owned buses in the city and acquired private buses, nationalizing the bus services in the state. These services were operated by the Madras State transport Department (MTC Chennai 2009). In 1972, the operation of buses was placed under a corporation, the Pallavan Transport Corporation Ltd, to incorporate a commercial approach. The Pallavan Transport Corporation had 1029 buses at that time. In 1994, the corporation was split into two, the Pallavan Transport Corporation for the southern part of the city and the Dr. Ambedkar Transport Corporation for the northern parts of the city (MTC Chennai 2009). After about 7 years, the two corporations were merged for better planning and operational efficiency and the new company, named the Metropolitan Transport Corporation (Chennai) Ltd (MTC) was constituted in 2001. The public bus supply by the transport corporations in Chennai expanded from 1029 buses in 1972 to 2773 in 2006, increasing the number of passengers carried per day from approximately 1.2 million in 1972 to 4.73 million in 2008 (MTC Chennai 2009).

## 3.3 The Nationalization of Bus Services – post-1947

After India gained independence in 1947, considerable importance was placed on improving bus transportation (Deb 2002). The Road Transport Corporations Act was passed in 1950. It allowed municipalities and state governments to get directly involved in providing public transport. For the first time in Indian history, it became the responsibility of the respective state and local governments to provide their citizens with adequate, efficient, affordable and properly coordinated passenger transport network (Government of India, 1950).

### 3.3.1 The Road Transport Corporations Act, 1950

The Road Transport Corporations Act was passed in 1950 with the aim of encouraging and providing appropriate institutional set-up for individual states to operate road transport services in their state. The goal was to offer significant advantages to the public, trade and industry through the development of road transport (Government of India 1950). It was expected that if the state government was responsible for the provision of road transport, it would allow coordination of road transport with any other form of transport that may be available. The state could also use its discretion to decide which areas needed expanded services and improvements in road transport facilities.

The Act specifies the procedures for constituting a road transport corporation, and the details about its administration, funding, etc. Section 18 of the Act clearly states that "it shall be the general duty of the corporation to provide, or secure, or promote the provision of, an efficient, adequate, economical and properly coordinated system of road transport services in the State or part of the State for which it is established..." (Government of India 1950).

Following the guidelines set forth by the Road Transport Corporations Act of 1950, the states constituted their own State Road Transport Corporations.

## 3.4 State Road Transport Undertakings

Even though there are only 28 states in India, there are 58 State Transport Undertakings, some of which serve entire states and some of which serve only one city or region. Some State Transport Undertakings are very large corporations like the Andhra Pradesh State Road Transport Corporation which owns and operates about 19000 buses and the Maharashtra State Road Transport Corporation which owns about 17000 buses

(CIRT 2008). Others like the Orissa State Road Transport Corporation, which operates about 400 buses and Meghalaya Transport Corporation which operates about 130 buses offer only nominal services (CIRT 2008). Most of the transport needs in such states are met by private operators often operating mini-buses with a seating capacity of 15 to 20 passengers.

There are vast differences in the organization and management of transport services in various states. Most of the larger STUs offer a variety of services, such as ordinary buses, limited stop buses, air-conditioned buses, etc (Deb 2002). Some STUs such as the Kerala State Road Transport Corporation offer a town-to-town service during peak hours, where the buses will not make any stops between the origin and destination towns. It is feasible in Kerala which is a small urbanized State with numerous small towns, and may not be feasible in other States.

Some states have separate STUs for the large cities in their states. The state of Maharashtra has municipal transport companies in several of its municipalities. Some of these municipalities, such as Kolhapur, Pimpri-Chinchwad, Pune etc. are geographically and economically close to each other and to Mumbai. These municipal transport corporations operate several buses between these towns as well (Agarwal 2006).

Many States do not have separate STUs operating in their cities. For example, the city of Hyderabad in Andhra Pradesh is served by about 3800 public buses operated by the Andhra Pradesh State Road Transport Corporation (Andhra Pradesh State Road Transport Corporation 2008). But unlike other cities of comparable size, such as Bangalore, Hyderabad does not have a dedicated urban STU. Many other states such as Kerala, Orissa, Bihar, and Uttar Pradesh have medium and large cities but do not have any dedicated urban STUs. They only have State Road Transport Corporations which operate state-wide and sometimes operate local buses in their cities. They often do not maintain separate data for individual cities. Some states, such as Tamil Nadu divided their state into geographic zones and incorporated separate STUs for each zone. Some cities, such as Delhi, have granted permits to private owners to operate buses in their city, while others such as Mumbai are prohibited by law from allowing any kind of private participation in the provision of public transport.

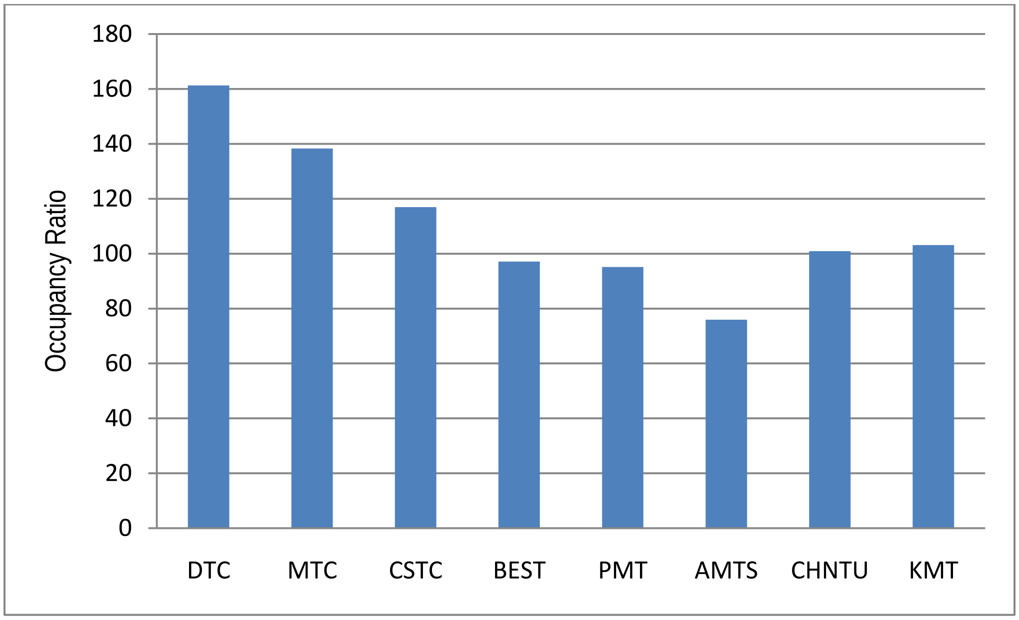
## 3.5 Financial Challenges Faced by STUs

Lack of funds is perhaps the biggest challenge faced by the STUs. Starting 1992, the central government stopped providing funds to the State Road Transport Corporations. In 1992 and 1993, the legislature also passed the $74^{th}$ and $75^{th}$ Amendments to the constitution which decentralized government and gave more power to municipal and village governments. One of the negative effects of such policies of devolution was that State Road Transport Corporations no longer had access to central government funds to improve or augment their transport supply.

On the other hand, the liberalization of markets and the considerable foreign investment that India received since the 1990s, especially in the service industries, led to a sustained economic growth. Most of this growth was concentrated in the large cities and led to increasing urbanization and growth in urban population. Such growth increased travel demand in cities.

However, since State Transport Corporations no longer had access to sufficient funds, they were unable to expand their services. The quality of service suffered. Many State Road Transport Corporations did increase their supply of buses with the help of borrowings. But, these increases were not proportional to the increase in population and were not sufficient to meet the growth in demand. Almost all cities suffered a decline in per capita provision of bus services.

*Figure 3.1 Average Occupancy Ratio of public STUs in India in 1991*




*Sources* ASRTU 2002; CIRT 2005

*Acronyms*: DTC-Delhi Transport Corporation; MTC-Metropolitan Transport Corporation, Chennai; CSTC-Calcutta State Transport Corporation, Kolkata; BEST-Brihanmumbai Electric Supply and Transport Company, Mumbai; PMT- Pune Municipal Transport; AMTS – Ahmedabad Municipal Transport Service; CHNTU – Chandigarh Transport Undertaking; KMT – Kolhapur Municipal Transport

Insufficient supply of buses led to increased waiting times and crowding on buses. In 1992, buses in Delhi had an occupancy ratio of about 160%, where occupancy ratio is the ratio of total passenger-km to total seat-km (see fig 3.1). The insufficient supply led to a decline in the quality of buses which in turn led to a decline in the modal share of buses (Ministry of Urban Development, 2008). Many middle-class Indians responded to the insufficient public transport supply by choosing private modes of travel.

*Table 3.1 Comparison of Modal Share of Public and Private modes in Indian Cities (1994 and 2007)*

| City Category | City Population Range (millions) | Share of Public Transport (%) | | Share of Private Modes (%) (Cars and Motorcycles) | |
|---|---|---|---|---|---|
| | | 1994 | 2007 | 1994 | 2007 |
| 1 | <0.5 | 16.4 | 6.5 | 27.4 | 43.5 |
| 2 | 0.5 – 1.0 | 20.6 | 9 | 32.4 | 36 |
| 3 | 1.0 – 2.0 | 25.4 | 13 | 38.6 | 36 |
| 4 | 2.0 – 4.0 | 30.6 | 10 | 42.9 | 41 |
| 5 | 4.0 – 8.0 | 42.3 | 21 | 33.9 | 36 |
| 6 | >8.0 | 62.8 | 44 | 20.9 | 19 |

*Source*: Ministry of Urban Development, 1995; Ministry of Urban Development, 2008

Modal share of public transport has fallen in cities of all sizes. Since these numbers are not for individual cities, but for city categories, it is not very useful in drawing detailed conclusions. The 1994 study had only 21 cities, while the 2007 study had 30 cities. Many cities have moved from one category to the next with increase in population. For example, in 1994, Kochi was a category 2 city with a population of 0.75 million (Ministry of Urban Development 1995). For the 2007 study, Kochi was included in category 3 (Ministry of Urban Development 2008). Such changes make direct comparison of categories erroneous. Kochi, for example, is a city where the modal share of public transportation is around 50% (Ministry of Urban Development 2008). The decline in the share of private modes for category 3 between 1994 and 2007 is probably because Kochi moved into category 3 and caused an overall decline in the modal share of cars and motorcycles. Despite such changes, however, it is possible to observe the general decline in the modal share of public transport and the increase in the use of private vehicles.

Indian cities have become increasingly congested. Improvements in road infrastructure have not kept up with increase in the use of vehicles. As discussed in chapter 2, most roads in India are narrow, with only one lane in each direction. Speed of travel in many cities is only 8-12 km/hour during the peak hours (Agarwal 2006; Deb 2002).

Thus funding constraints and the consequent inability of STUs to provide necessary public bus services led to not just a crowded bus system with poor quality of service, but also to an increase in the use of private vehicles, increasing congestion and pollution.

For public transport companies that wanted to increase and improve their fleet, privatization seemed to be an attractive option.

### 3.5.1. Encouragement of Privatization by the Government of India

Starting early 1990s, India has liberalized its markets, allowed foreign investments and generally moved away from its previous policies of "license raj[6]". International organizations such as the World Bank encouraged and supported the creation of free markets, elimination of subsidies, reduction of state interference and control, privatization of state-run services and deregulation of industries (TERI 2002). They promoted the idea that the state should serve only as a facilitator and regulator of services and monitor the performance of the private service provider (World Bank 2002). The government of India accepted the merits of such arguments and the plan documents of the central government have been urging the States Transport Undertakings to privatize in ways that they find suitable (Government of India 2008a).

[6] License raj refers to the Indian government's policy before 1990, which included rigorous government approval (licensing) requirements for industries and constant and vigilant monitoring of operations.

The government of India allows the use of private buses by the State Transport Corporations according to the Motor Vehicles Amendment Act of 1988.

### 3.5.2 The Motor Vehicles Act, 1988

The Motor Vehicles Act of 1988 allowed the State Transport Authority or the Regional Transport Authority in every state to grant permits to private vehicles to operate as either a stage carriage or a contract carriage (Government of India 1988). A stage carriage has various stops along the routes and is allowed to pick up and drop off passengers at these stops. Contract carriages are required to run a point to point service.

The Transport Authority can attach route specifications, the number of trips per day, a time table for operation, bus stops where passengers may be picked up and dropped off, maximum number of passengers and weight of luggage that may be carried at any time, vehicle conditions and standards, fares, etc to a permit issued for a vehicle to be used as a stage carriage (Government of India 1988).

While the Motor Vehicle Act makes a provision for the State Transport Authority (STA) to allow private investments in public transport, it also allows the STA to revoke such a permit upon paying them appropriate compensation (Government of India 1988).

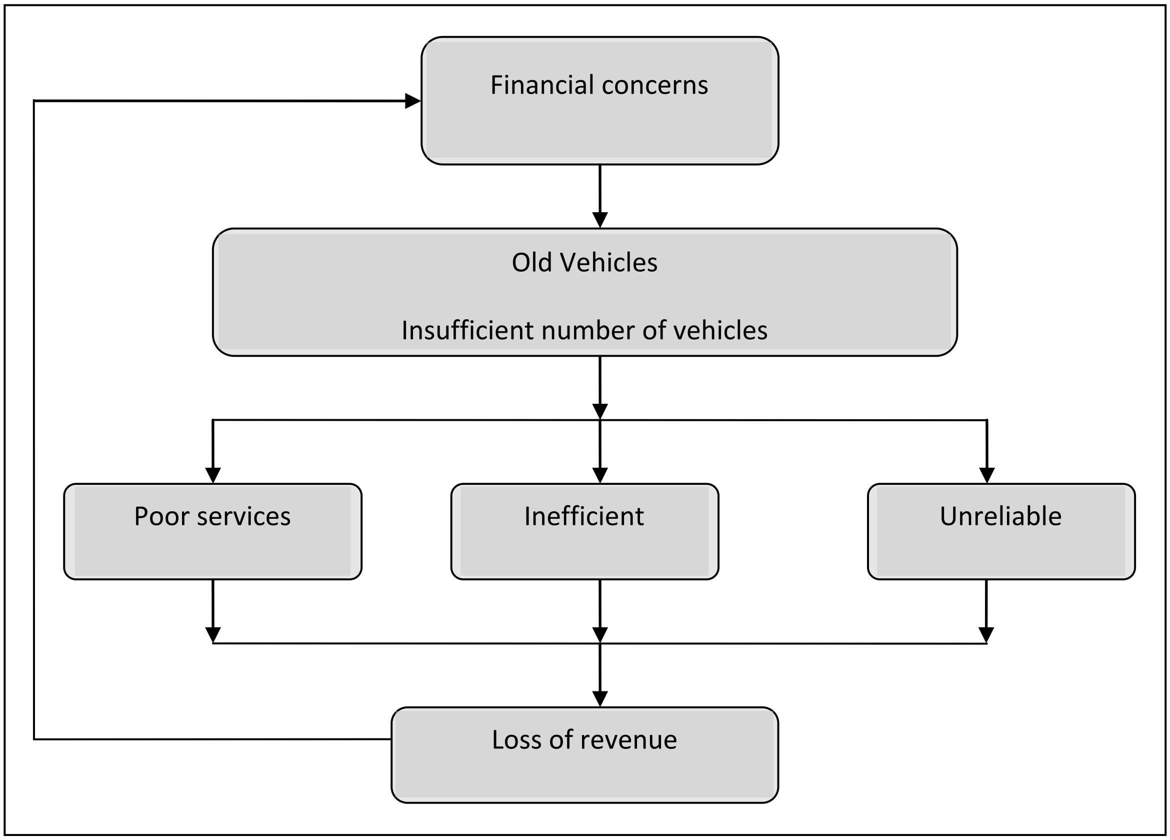
## 3.6 Is Privatization a Possible Solution?

Lack of capital is a serious problem facing public bus transportation industry in India. A company that has financial concerns to start with is unable to augment or maintain its services to keep up with the increasing demand. The company is forced to operate an insufficient number of old vehicles. Then the services become unreliable due to frequent breakdowns of vehicles. The costs of operations increase due to poor fuel efficiency. The overall service becomes sub-standard with increased waiting times and uncoordinated transfers. All of these, coupled with the improved economy, push people away from public transport and toward private transport. Then it leads to further loss of revenue. The vicious cycle of financial downfall is shown in figure 3.2.

The infusion of capital can allow more investment increasing the quantity of service. So there could be more buses. There could be new routes and increased services on all routes. That could reduce overcrowding and waiting times at the bus stops. Increased frequency could also improve transfers between the different routes and modes.

More capital can also help the bus companies to purchase new vehicles. These would be fuel efficient, would be able to use new technology like low-floor buses with wider doors etc which will allow faster boarding and disembarking. That could translate into shorter stops at bus stops and saved time. So the buses may be able to keep the schedules more often. New vehicles could be required meet the new and stricter emission standards to maintain better environmental quality. Thus, theoretically increased investments can increase the quantity and improve the quality of bus services in Indian cities.

*Figure 3.2 The cycle of financial downfall of public transport companies*




However, privatization may not solve all of the problems faced by the STUs. Many of the problems are inherent to the nature of traffic in Indian cities and literature on privatization warns that privatization may generate other problems.

Several of the problems facing State Road Transport Corporations in India are due to employment practices. Employees are hardly ever terminated, even when there is evidence of lack of performance. Most of the employees are unionized. When threatened of downsizing, they organize strikes and hold up services. Terminations of employees or lay-offs involve significant political risks (Agarwal 2006). The state road transport corporations are usually under the State Ministry of Road Transport and the minister of transportation is an elected member of the State Legislature. Restructuring of the State Transportation by terminating employees is rarely a serious consideration (Tata Energy Research Institute 2002). The only criterion for promotions is seniority. So the person who joined the service first is always the first to get promoted, regardless of performance or skills. There is usually no monetary or professional motivation to perform well.

A private operator may reduce employment rates and terminate inefficient employees to make the company more cost-efficient. But the benefits of such savings may be offset by other problems created due to higher unemployment rates.

Bus services also face other challenges which are beyond the control of the operator. Delays are a major problem that both increase waiting times and affect efficiency of transfers. Most of the reasons for delays, such as congestion and low speed of travel would affect everyone, independent of ownership. Urban roads in India are predictably congested, especially during peak hours, because road infrastructure has failed to keep up with the increase in vehicle ownership and use in all cities (World Bank 2002).

Buses have to compete for road space with cars, trucks, autorickshaws, motorcycles and bicycles (Pucher et. al 2005). Dedicated bus lanes are not available in any Indian city. Bus-priority at intersections and traffic lights are also unavailable. Such unfavorable road conditions affect efficiency regardless of the nature of ownership of the vehicles. Private buses may not be able to operate more efficiently in such conditions either.

While privatization will probably provide some financial relief to the State government, the public transport sector has a social service obligation as well and there is a possibility that those obligations will not be honored by the private operator. Several cities like Hyderabad faced strong opposition from employee unions and even the public when they considered privatization.

Nevertheless, the most serious among the numerous problems faced by bus services in India is lack of funds. The next chapter looks at the theoretical framework of privatization and deregulation and discusses the advantages and possible problems from privatization.

# 4 Arguments for Privatization of Urban Bus Transport Services

Since the 1980s, global institutions like the World Bank and the International Monetary Fund have encouraged states to minimize or eliminate subsidies, and allow market forces to control the supply of public services (Amin 1994). These recommendations were intended to improve the efficiency of loss-making public sector enterprises that operated in several countries. Among the many industries and various public services that the states were encouraged to privatize were public transportation systems including urban bus services.

Bus services involve capital investments and significant operating expenses. When the state owns and operates the bus services, they are often subsidized using tax revenue. For public transport companies in many developing countries, privatization is an attractive option as a source of financing when public companies have been making losses and need increasing assistance from the state in the form of subsidies. To attract private investors, the state has to ensure that they will have the opportunity to make profits (Gomez-Ibanez and Meyer 1993). Therefore privatizations are often accompanied by deregulation of the industry to allow the private investor the freedom to make business decisions that will make the company efficient and profitable (Sheshinski and López-Calva 2000).

However, there are challenges to treating the public bus industry as a purely commercial enterprise, the supply and price of which may be left entirely to market forces. A bus service has important social functions which include providing people with access to education, health care, jobs and markets. Providing affordable and efficient transportation is crucial to improving public welfare. Many governments seek to keep public transportation affordable to people living in poverty by keeping the fares low.

Thus public transport services have social, environmental, financial and welfare objectives. While allowing the private operator the deregulated environment to pursue their financial goals, the state needs to ensure that the private operators serve the social, environmental and welfare objectives of the government.

## 4.1 The Public Bus Industry: A Social Service or a Business Enterprise?

The biggest financial challenge facing a bus company is ensuring its financial viability. In addition to the capital investment which is often made using borrowings from financial institutions, a bus operation has operating expenses such as labor, fuel, maintenance, taxes etc. The bus service has to be able to generate sufficient revenue to pay for its expenses and minimize the need for subsidies. The most obvious way to ensure the financial viability is to maximize revenue and minimize cost (Gomez-Ibanez and Meyer 1993; Halcrow 2000; Gwilliam 2007). But the various social and welfare policies of the government often conflict with the ability of bus services to make profits.

Revenue can be classified into farebox revenue and revenue from other sources such as advertisements and rents. Farebox revenue depends on patronage and the fare structure (Gwilliam 2000). One of the financial objectives is to increase patronage leading to an increase in fare revenue.

Increasing patronage is not an objective that creates a conflict between financial and social functions, because increased use of public transport serves environmental and social goals of the government. The environmental objectives of public transport are related to lowering air pollution and lowering fuel consumption (Hensher 2007; Allen 2007). Environmental objectives can be served by increasing patronage, because increased patronage would probably mean that fewer people are using private cars. An increase in the quantity of services, either by increasing the frequency of service or by expanding the area that is covered by bus services result in higher patronage (Parry and Small 2009). But increase in services also leads to an increase in costs.

Fare increases, on the other hand, are a more debated issue. An increase in fares could lead to higher revenue (Gwilliam 2000). But, providing public transport at low fares is a social objective of the government aimed at providing equitable access to transportation. There are millions of poor people even in the wealthiest countries (Hagen and Kjorstad 2007). Ensuring low-income citizens the opportunity for education and access to jobs, markets and social events is the best way to help them out of poverty (World Bank 1996). Governments try to keep their promise to provide equitable transport by keeping fares as low as possible and by issuing subsidized travel passes for senior citizens, veterans, students etc. Increasing fares to allow profit-generation from public transport may not be a politically feasible option, especially in developing countries with high incidences of poverty (Shaw, Gwilliam and Thompson 1996; Sheshinski and Lopez-Calva 2000). So the government may regulate fares, thus reducing the opportunity for the private operator to make profits.

It is argued that low fares on public transport systems can also be used as an incentive to reduce the use of private cars for the daily commute (Parry and Small 2009). There are benefits that can be derived from more people choosing to use public transport instead of private cars. One of the advantages is that it reduces congestion. Easing of congestion reduces the external costs from delays, reduces pollution and could also reduce traffic accidents (Parry and Small 2009). However, congestion can also be reduced by appropriate road pricing. Reduction of public transit fares is not the only way to curb congestion (Transport for London 2004).

Other government regulations regarding networks, schedules and vehicle quality can also affect profitability. Social objectives of public transport are usually concerned with accessibility and affordability (Walker 2007). The government may regulate the network and schedules and force the private operator to serve low-density areas and serve during off-peak hours, reducing efficiency (Walker 2007, Allen 2007).

Ensuring the quality of vehicles is an important component of attempting to meet environmental objectives like decreased pollution. Many governments regulate the age of vehicles by not allowing vehicles older than a certain number of years to be used for public transport. The government often also imposes emission standards and fuel standards, forcing the vehicles to be well-maintained and requiring the use of clean fuels. Several governments also require public transport vehicles to be accessible to disabled passengers. Complying with some of these regulations may require purchasing new vehicles, thus increasing the cost of production.

The average public bus company in both developed and developing countries spends about 60% of its operating budget on personnel costs (ITDP 1997). Upon privatization, most companies reduce costs by reducing the number of employees. The benefits of cost efficiency and profits earned by the privatization may be offset by the increase in unemployment, the social unrest that could follow mass layoffs in the public sector and the increased burden that high unemployment would impose on the State's welfare programs.

The second source of revenue is advertisements and rentals. Many bus companies rent the space on the body of their buses to businesses that wish to place their advertisements on the buses. Advertisements may also be allowed on tickets and ticket stubs. Often bus companies own terminals which have space that are suitable for commercial uses such as restaurants, coffee shops, fast food stalls, newsstands, book stores etc. Rent from such commercial spaces can be a source of revenue for the bus company. However, terminals are often owned and operated by the public sector or a private real estate business, and may not provide any revenue to the private bus operator.

Thus there are several means to increase revenue and minimize costs. But many of those conflict with the social or environmental objectives of the government. To ensure the financial viability of the transport service while maintaining affordability is a challenging task for many governments.

## 4.2 The Benefits of Privatization

The primary motivation for privatization in most developing countries is often the government's need for financial relief (Gomez-Ibanez and Meyer 1993). Privatization is seen as a means to ease the financial burden of providing transport infrastructure and services and as a means of debt relief (Gomez-Ibanez and Meyer 1993; Estache and deRus 2000). Growth of population and improvement of economy increase the demands for transportation. Inviting the private sector to invest in new transport services is then resorted to, when the government cannot afford to make new investments. Second, funds for public sector projects are raised through borrowings from various financial institutions (Kulkarni 1999). When the public sector undertakings do not make profits, the debt accumulates and then privatization is seen as a means of debt relief.

With the private sector funds that are infused into the industry, it may become possible to increase the quantity of service. New routes and new services may be added to meet the growing demand. Uzbekistan, Sri Lanka, New Delhi, and Santiago experienced an increase in the supply of buses immediately following privatization (Gwilliam 2001). However, these were all net cost systems and were adding on to the existing public bus supply. So the total bus supply in these cities increased. All these cities also had private operators engaging in dangerous driving practices, due to overprovision of capacity leading to too much competition on the road. On the other hand, following privatization in Britain, the supply increased only on some routes and decreased on others.

The quality of service is expected to improve with the infusion of new capital (Vasconcellos 2001). New vehicles with better fuel efficiency can be purchased. The fleet can be updated with new vehicles that use cleaner fuel and new technology like low-floors and wider doors for easier boarding. The new vehicles can be less noisy and less polluting. All these improvements could lead to increased ridership, which could translate to more profit and even more private investments (Vasconcellos 2001).

Public managers report to politicians and have political ambitions for themselves. So decision making in public sector enterprises is often influenced by vested political interests. Such distortions adversely affect efficiency. Privatization is expected to eliminate political interference in the decision-making process (Sheshinski and López-Calva 2000). Besides, bankruptcy of the public company may involve high political costs. It may also involve larger political cost to distribute the burden of the loss-making company on the possibly unionized employees than to distribute it over the population of tax-payers who are not unionized (Sheshinski and López-Calva 2000).

It is expected that privatization will improve the production efficiency by reducing the cost of production and the private operator will be able to provide more vehicle miles per input cost (Gomez-Ibanez and Meyer 1993; Sheshinski and López-Calva 2000; Cavallo 1997; Hibbs and Bradley 1997). The private sector is more profit-oriented than the public sector and more cost-conscious (Gomez-Ibanez and Meyer 1993).

When a city is served only by public sector services, the public company enjoys a monopolistic access to the market. Absent competition, there is no motivation to improve services. However, fares are usually low. Low fares are maintained as a matter of policy to uphold the promise of providing affordable transportation and is not a response to the market forces. Privatization can break the monopoly and allow market forces to motivate the bus operators to provide efficient services while keeping the fares low (Gomez-Ibanez and Meyer 1993; Sheshinski and Lopez-Calva 2000; Gwilliam 2007; Hibbs and Bradley 1997).

To ensure that the cost-minimizing attitude of the private operator does not compromise quality of service and that the profit-mindedness of the private operator does not raise the cost of travel for citizens, competition is introduced. Competition is expected to provide the incentive to improve services at lower fares (Gomez-Ibanez and Meyer 1993; Estache and deRus 2000). For a successful privatization, it is usually important to deregulate the industry as well. Deregulation will allow the private operator sufficient freedom to be innovative in terms of minimizing the cost of operations. However, if the deregulation is not carefully planned it can lead to excessive regulation, demoralizing the private investor, or to insufficient regulation, leading to unsatisfied passengers (Gwilliam 2007).

## 4.3 The Concerns of Privatization and Deregulation

The private owner/operator needs to recover the cost of capital, which is often raised through borrowings from commercial banks at high interest rates (Parry and Small 2008). So the private operator may only serve areas with high density of population, where the occupancy rates of the buses are likely to be high. The off-peak services and routes serving low-density areas may be ignored and cancelled.

Private operators also need to maintain high fares, to maximize traffic revenue. So they may not uphold social service pledges of the government to provide subsidized fares to deserving citizens. If the State wishes to maintain low fares and ensure services during off-peak hours and to low density areas, the private operations will need to be regulated accordingly (ITDP 1997). Strict regulation of fares, routes and schedule will not allow the private operator much freedom to increase revenue or to minimize costs. The State may then have to provide subsidies to the private bus operators (Parry and Small 2008).

Sometimes, regulations allow several private companies to operate on the same routes. In such cases, it could lead to competition on the road, which will result in dangerous driving practices (Marwah, Sibal and Sawant 2001). It is not uncommon for private buses to race each other to the next bus stop, so that they can carry more passengers. They may overload their buses and make undesignated stops to allow passengers to board.

A significant share of the cost of operation is personnel costs (ITDP 1997; Gwilliam 2007; Ramanayya, Nagadevara and Roy 2007) and the private operator may exploit their employees by not paying for overtime and having them work long hours with fewer or shorter breaks. The owner-operators may also reduce the size of the workforce, reduce the number of work hours, reduce frequency of service, and refuse to pay drivers for down time. The employees of private corporations in many developing countries are not unionized and are unable to collectively negotiate better wages and contracts.

Privatization may not improve the efficiency as much as expected, because efficiency also depends on many external factors that are independent of ownership (ITDP 1997). Urban roads in many developing countries are congested with poor street design. The streets are narrow and there is insufficient road space to accommodate the increasing traffic. The speed of travel is low, especially during the peak hours. Many developing countries have mixed modes of traffic that do not have separate rights-of-way. It is not uncommon to find animal-drawn vehicles, bicycles, cycle-rickshaws, motorcycles, cars, jeeps, buses and trucks sharing the street and moving at the speed of the slowest vehicle (Whitelegg and Williams 2000; Pucher et.al. 2005).

Even on those urban roads where human and animal-drawn vehicles are banned, buses may not enjoy exclusive lanes or signal privileges at intersections (Tiwari 1999).

Such inadequacies in transport infrastructure increase the cost of operation. Even if the private operator is motivated to purchase and use newer articulated buses which will reduce costs by carrying more passengers per driver, the streets in a developing country may not be wide enough to accommodate the turning radius for larger buses (Vasconcellos 2001).

Several experts believe that privatization is a means of raising private capital for a public purpose and it should only be treated as one possible financing option among many (ITDP 1997). Further, in theory, there should be no difference in the operating efficiency between a well-regulated private system and a public system.

Table 4.1 compares the expected benefits from privatization with the possible problems from privatization and deregulation.

*Table 4.1 Comparison of Benefits and Problems of Privatization and Deregulation*

| **Expected Benefits from Privatization** | **Criticism of Privatization** | **Issues that are analyzed in this dissertation** |
|---|---|---|
| Increases supply; new routes and services added; reduces overcrowding; reduces waiting times; | Supply is increased only on main routes; supply decreases in suburban and other routes affecting network connectivity. Not motivated to reduce overcrowding, as that reduces the earning per driver and reduces the profits. | The changes in the supply of buses are examined in chapter 6. The effects of supply and crowding on efficiency are analyzed using multivariate analysis in chapter 7. |
| | | |
| Improves quality of service, through the purchase of new and better vehicles | New purchases have to be made with borrowings at high interest rates. So the private operator is highly motivated to maximize profits, usually by decreasing service on low-patronage routes and increasing fares. | In chapter 8, the impacts of the mandated conversion of all buses to CNG engines are discussed. |
| | | |
| Decreases political influence on decision making | The private operators often have strong lobbyists and do influence political decision making. | |
| | | |
| Improves cost efficiency of operation | The cost efficiency is achieved through increasing fares and decreasing services. There is usually also a reduction in employment and reduction of labor hours. | Chapter 8 discusses the measures adopted by private operators in Delhi to improve cost efficiency. |
| | | |
| Competition motivates bus operators to maintain low fares | Competition has often led to dangerous driving practices and road race. Requires careful monitoring to ensure quality of service. If monopoly routes exist, fares will increase on those routes. | The issue of competition and dangerous driving practices is discussed in chapter 8. |
| | | |
| Use flexible/part time labor leading to savings on operating costs | Will lower the quality of labor. Will lower wages, benefits etc. Will increase unemployment and the net benefits to society may be offset by the poverty resulting from unemployment. | Any effect on unemployment cannot be assessed for Delhi or Bangalore, because the public company was not taken over by a private corporation in either of these cities. Private buses added to the existing supply of public buses. |

### 4.3.1 The Cycles of Privatization and Nationalization of Public Bus Services

Experiences of several cities in developing countries tend to suggest that there is indeed a cyclical nature to the regulation of bus transport services (Gwilliam 2007; Vasconcellos 2001). When many developing countries in Asia and Africa were decolonized after World War II, they formed quasi-socialist governments which nationalized the bus services that existed in their cities. In the few cases where they did not nationalize the bus services, they imposed heavy regulations regarding fares and networks (Gwilliam 2007). The public bus companies in the developing countries were required to keep their fares very low eventually leading to heavy dependence on subsidies and sometimes bankruptcies. When the developing countries resorted to privatization to replace their bankrupt public bus companies, they faced important questions regarding the nature of regulations to be imposed on the private company. They did not want to abandon their social service pledges of providing affordable transportation, but had to allow the private operator the opportunity to make reasonable profits.

With the fares decided by the state, many private companies were unable to operate a profitable business. They either quit the business venture or resorted to illegal and sometimes dangerous practices such as racing on the roads and operating only on profitable routes. Eventually the criticism from the public who demanded a safer service led to nationalization of the bus industry (Gwilliam 2007).

Vasconcellos (2001) explains in detail how the provision of public transport can go through a cycle of public sector operations, get converted to private sector services and then due to unacceptable services get reverted to public sector operations. Vasconcellos (2001) also explains another possible cycle where the individual private operators start an unregulated service which becomes unacceptable due to declining levels of service and increasing fares. Then the services get taken over by the public sector company, which gradually becomes heavily indebted, monopolistic and inefficient and is eventually privatized.

The challenge facing cities with bus services is to decide the appropriate nature of regulation and the role of the state in the operation of the bus industry, so that the cyclical regime changes can be avoided.

## 4.4 Options Regarding the Nature of Privatization and the Degree of Deregulation

Privatization of public transport services can be achieved in different ways - by outright sale of a publicly owned company to a private owner, by inviting and accepting private investments for a public venture, or by outsourcing – contracting out – of some parts of the operation to the private sector (Gomez-Ibanez and Meyer 1993).

A public service system can be completely privately owned or publicly owned and leased out to the private operator. Deregulation could be total deregulation giving the private company complete freedom to decide on routes, frequency of service and fares. A minimum set of regulations regarding safety, vehicular and operational, and driver licensing are almost universally required. At the other extreme, the system could be very heavily regulated with the government prescribing the routes, the hours of operation and the fares. Another decision to be taken while implementing privatization is regarding the extent to which the service will be subsidized by the government, if at all.

Table 4.2 *Types of privatization and degrees of deregulation*

| | **Owner of Buses** | **Operator of Buses** | **Agency that plans Routes** | **Agency that sets schedules** | **Agency that decides the Fare Structure** | **Agency that bears Revenue Risks** | **Agency that bears Costs Risks** | **Comments** |
|---|---|---|---|---|---|---|---|---|
| **Corporatization** | Public | Public | Public | Public | Public | Public | Public | The agency is corporatized to impose accountability |
| **Management Contract** | Public | Private managers | Public | Public | Public | Public | Public | Private managers with experience in private sector recruited to manage operations |
| **System Concession** | Public | Private | Public | Public | Public | Private | Private | Smallest form of privatization – public assets operated by private company who bears operating costs. |
| **Franchises** | | | | | | | | |
| Gross Cost Franchise (kilometer scheme in India) | Private | Private | Public | Public | Public | Public | Private | Revenue risk taken by the public agency. Costs of operation borne by the private company. |
| Net Cost Franchise | Private | Private | Public | Public | Public | Private | Private | Private company carries the risks of both cost and revenue |
| **Free Entry** | Private | Private | Private | Private | Private | Private | Private | The most complete form of privatization |

Sources: Gwilliam 2004; Fox 2000

Table 4.2 describes the different types of privatizations and degrees of deregulations that are possible. At one end of the spectrum is corporatization where the agency responsible for operations is corporatized in an effort to impose accountability and financial and operational efficiency (Gwilliam 2004; Fox 2000). However, both parties to the contract have the same parent company and the agencies may not be appropriately rewarded for their good performance or penalized for a bad performance.

A slightly bigger step towards privatization is the involvement of private managers for the operation of the public sector company (Gwilliam 2004; Fox 2000; Deb 2002). It brings in more expertise and sets standards for managers in terms of required qualification and experience. But the managers have no control over the public sector employment practices, and the sector remains public and monopolistic (Agarwal 2006).

An actual step toward privatization takes place in the smallest form only when there is at least a leasing of public equipment (buses) to private operators to run the services (Gwilliam 2004; Fox 2000). The lessee bears all the costs other than the purchase of the vehicle and keeps all the revenue. So there is a high motivation for success. However, if there is only one lessee, the system will remain monopolistic and if there are several lessees there is the risk of competition on the road (Mathur 1999; Agarwal 2006). The contract has to be carefully detailed to avoid such possible problems.

The most common type of privatization seen in developing countries is franchising where the private franchisees provide a service as specified by the public agency (Gwilliam 2004; Fox 2000; Deb 2002; Estache and de Rus 2000). The private company carries some commercial risk, depending on the type of contract and covers investment costs. Franchises can be primarily of two types, net cost and gross cost. Each of these can further be route based, or area based, and this distinction is made based on whether the rights are given to serve a specific route, or whether the rights are given to serve an entire section of the city.

*a) Gross cost franchises:* In this system of franchising, all revenue accrues to the government, which then pays the franchisee a fee for operating the service (Gwilliam 2004; Fox 2000; Deb 2002; Agarwal 2006). The contract is awarded to the lowest bidder (least total cost supplier). The franchisees carry only cost risk and no revenue risk. Gross cost franchises could be made to work even with a large number of small operators. The government can have its own conductor on every bus where all the revenue is directly collected by the government. Or there could be a system of revenue clearinghouse, where the farebox revenue from all trips is pooled and then divided among the operators according to the terms of the agreement, usually based on kilometers run (Gwilliam 2004; Fox 2000). A possible problem of gross-cost franchising is that the private operator may not be motivated to improve services and increase patronage, as their revenue does not depend on patronage at all.

*b) Net cost franchises* In net cost systems, the franchisee keeps all the revenue. The franchise is granted to the most attractive bid which can be either positive or negative[7] (Gwilliam 2004; Fox 2000; Deb 2002; Agarwal 2006). The franchisee carries cost as well as revenue risk. This is closer to free entry and requires less supervision than in a gross cost operation. However, it also has a high chance of encouraging competition

[7] A positive bid is when the private operators pay the government for the rights to operate a bus service in the city. A negative bid is when the government offers remuneration to the private operator in return for operating bus services in the city.

on the road, especially if the service is operated by a large number of small private operators (Deb 2002; Agarwal 2006).

The most complete form of privatization is when free entry of private operators is allowed (Gwilliam 2004; Fox 2000). The private operator enjoys complete freedom with regards to entry into the sector, ownership of assets, and commercial decisions and carries all risks. It would be the best choice for industries where there is no role for economies of scale or scope and no social obligations and objectives to be met. It is thus suitable for road-based freight movements, intercity bus operations and taxi operation.

Most cities choose a franchising system, either net cost or gross cost. The choice depends on the aspects of the sector that the government wants to or is willing to privatize. A bus transport service comprises various functions like planning and maintaining infrastructure such as streets, signals, lanes, stations and stops; owning and maintaining garages; planning of routes, schedules and networks; owning and maintaining the buses; operating the buses; and running services such as ticketing, and information. There also have to be bus repair shops and an agency that will collect data and maintain databases. Of these numerous tasks that have to be coordinated to operate an efficient bus service, Gwilliam (2004) argues that only maintenance of streets and signals are always maintained in public hands. The others are all subjective and private sector involvement in those areas will be determined by the aim and nature of the concessions.

## 4.5 The International Experience

Cities worldwide have privatized their public bus services during various periods. They have adopted various approaches to privatization. Several studies have been undertaken in many of these cities to understand the impacts of privatization.

The United States of America has more than 500 public transit agencies and at least half of them contract part of their services. In 1983, Pucher et. al. found that private firms were more cost effective than public firms, but those efficiencies were achieved through an increase in fares and reduction in services. Teal (1985) examined six cases of contracted out services and found that the average cost savings for contracted services was 39%. In 1988, Teal studied 800 transit agencies and found that those who contracted their services to private firms saved at least 10% on costs. Some firms were able to reduce their costs by almost 50%. Karlaftis and McCarthy (1999) studied the bus transportation system in Indianapolis and found that the contracting of bus services resulted in an annual reduction of 2.5% in operating costs. They also found that those savings could be attributed to savings in labor costs. Simmons et. al. (2003) found that private management is more cost effective than public management, but that public management is more effective at service provision than private management.

Privatization of bus operations in Britain was sudden and complete privatization and deregulation of all bus services except those in the Greater London metropolitan area through the British Transport Act of 1985 (Gomez-Ibanez and Meyer 1993). It allowed free entry of private operators with 42 days notice. In London, a controlled competition regime was introduced. In 1990, White examined the impacts of deregulation in metropolitan areas of the UK and found that productivity increased by 11% and operating costs decreased by 23.6% between 1985 and 1989. However, White (1990) also found that the ridership decreased by 16.2% in areas outside London and increased by 5.6% in London. In an independent study, Banister and Pickup (1990) also found that ridership decreased in areas outside of London, while increasing in London. Gomez-Ibanez and Meyer (1993) found that following the reform, services improved in some areas but deteriorated in others; and fares increased on some routes but decreased in others. There was an increase in the number of employees, but the new employees were paid less while the older employees enjoyed wage protection. Savage (1933) also found that while operating costs and the need for subsidies decreased after privatization, use of public transit declined as a result of service changes and lack of integration of networks. Services improved only on the major routes.

Jorgensen et. al. (1995) studied public and private bus operators in Norway and found that they did not have any differences in cost efficiency. But Alexandersson et. al (1998) who studied the effects of competition in Swedish bus operations, found that costs fell by 13.4% following the introduction of a competitive regime. In 1996, Kerstens studied the effects of privatization of bus operations in France, and found that there was a small increase in technical efficiency following privatization. However, risk-sharing and contract duration also had small positive effects on technical efficiency. Transport efficiency in cities such as Copenhagen and Stockholm, which had established a controlled competition regime (a highly regulated privatization regime), experienced maximum increase in social welfare (Karlaftis 2008).

Gwilliam (2005) evaluated privatization of the bus industry in Bishkek, Kyrgyzstan; Bangkok, Thailand; Santiago, Chile and Ceylon, Sri Lanka. In all cities, implementation of privatization and introduction of competition confronted a variety of problems. In Bishkek, Kyrgyzstan there was a lack of commitment from the regulatory authorities which continued to reserve its role as the provider of "social" services and allowed subsidized travel for certain categories of citizens (students, senior citizens etc.) only on public buses. In Bangkok, Thailand, the regulatory authority provided a part of the bus services creating a conflict of interests and leading to protection of vested interests. In Sri Lanka the regulatory reforms lacked clear guidelines and many original operating licenses were granted based on political clout leading to overprovision of services. Then it was necessary to strictly restrict schedules resulting in many buses operating only about 125km per day.

In Santiago, Chile, privatization led to increased supply, decreasing waiting times and reducing the walking distance to bus-stops. However, there was also a 100% increase in fares and increased pollution and congestion. Bus capacity utilization fell to 55% (Estache and Gomez-Lobo 2004). The source of inefficiency was an inefficient industry structure (Gwilliam 2005). They had a large number of small operators making it difficult to supervise. Later Santiago, Chile revised its regulatory structure from a net cost system to a gross cost system with regulated fares and networks. They reduced the number of buses in service, increasing occupancy rates. New quality standards were also imposed on all vehicles used for public transport. In Bogota, a competitive regime for bus services was introduced in the 1990s. Estache and Gomez-Lobo (2004) found that following the introduction of competition in Bogota, average speeds increased by 50%, travel times reduced by 32% and fare increases were minimal at 6%.

In developing countries, there is an abundance of net cost systems, fewer gross cost systems and almost no city that allowed free entry under completely deregulated conditions as in Britain. Bangkok, Sao Paulo, Sri Lanka, Bishkek, Uzbekistan, and Delhi have net cost systems. Sri Lanka, Bishkek, Uzbekistan and Jordan give route based permits. All of them regulate fares. Some regulate routes as well. In Sao Paulo and Bangkok, network plans and expansions are not decided by the government but have to be approved by the state. Table 4.3 summarizes the types of privatization adopted by various cities in developing countries.

The abundance of the net cost systems can probably be attributed to the fact that it requires less monitoring and management by the State. It is also very similar to the unregulated operations that it often replaces (Gwilliam 2005). Gross cost systems work better for cities that already have strongly administered bus infrastructure systems, and where the government is committed to and is working on integrating different modes of transport.

*Table 4.3 Types of Privatization adopted by selected cities in various developing countries*

| City | Government Agency | Type of Privatization | Regulations | Impacts |
|---|---|---|---|---|
| Bangkok, Thailand | BMTA | net cost, positive | fares, network, expansions | exclusive licensing - anti-competitive; government monopoly over some routes not eliminated; no agency to integrate public and private transport; poorly coordinated network; |
| Sao Paulo, Busway, Brazil | Sao Paulo State | net cost, positive | fares; operations plan to be approved by the State | trolley bus corridor, incentives for electrification and replacing of diesel buses; |
| Sri Lanka | CTB | net cost, route based | fares, route, frequency | too many buses - had to restrict operations - nationalized the government buses |
| Santiago, Chile (earlier) | | net cost, route based | Network | massive overprovision of capacity; increased urban congestion; environmental degradation due to use of old vehicles; increased fares to compensate for low occupancy. |
| Bishkek, Kyrgyzstan | BPTA | net cost, route based | network and fares | private sector did not carry subsidized passengers, did not invest in bigger vehicles; dangerous and aggressive driving practices |
| Jordan | Public Transport Corporation | net cost; route based, positive | fares, network | increased supply of buses; increased ridership; increased employment |
| Uzbekistan | Uzavtotrans | net cost; route based | fares, routes | increased supply of buses; dangerous driving practices |
| Delhi, India | DTC | Net cost | Fares | increased supply of buses; dangerous driving practices; increased accidents and fatalities; |
| Bangalore, India | BMTC | Gross cost, route based, negative | Network, age of vehicles | increased supply of buses; |
| Curitiba, Brazil | URBS | gross cost, negative km-based | route, frequency, | 16 private companies; eliminated subsidies; revenue from transportation can only be used to pay for the system; average age of buses - 5 years; 75% of commuters use the bus service; city's fuel consumption is 30% lower than 8 other comparable Brazilian cities. |
| Santiago, Chile (present) | Transantiago | gross cost, negative km-based | fares, network | increased safety on roads; improved services |

*Sources*: Poapongsakorn and Nikomborirak 2003; Rebelo and Machado 2000; Estache and Gomez-Lobo 2004; Kumarage 2002; Rebelo 1999; Rebelo and Benvenuto 1997; Kumarage 2004;

## 4.6 Conclusions

Privatization of bus services is an attractive option for cities that are unable to meet the demands for public transport due to lack of financing options. It is also an option when the public company is unable to generate sufficient revenue and requires increasing financial aid from the government in the form of subsidies.

Many cities in developed countries that have privatized their bus services have experienced an overall improvement in service. The privatized services in many cities were more efficient both in terms of cost efficiency and technical efficiency.

Cities in developing countries, however, have experienced more mixed results. Many cities that have privatized experienced an immediate increase in service supply (Table 4.3) resulting in decreased waiting times and improved access to public transport. However, privatization of bus services in developing countries also led to several problems. Sometimes the cities resorted to privatization in response to pressure from international organizations such as the World Bank, which often require introduction of competition in the market as a precondition for access to aid. Governments in such cities were sometimes an unwilling participant and continued to preserve their roles as the providers of public and social services. Such actions distorted the market and adversely affected the impacts of the reforms.

In cities where privatization was to be gradual, there were services provided by a public company as well as one or more private companies during the same period. In those cities, the regulating agency was often the same as the public company that operated the service. In such situations (Bangkok, Thailand; Ceylon, Sri Lanka) the regulations tended to be unfair towards the private operators and protected some monopolistic privileges for the public company. An example of such protectionist attitudes would be cases when governments declare some routes as ‘nationalized’ where private companies would not be allowed to operate.

Another problem experienced in developing countries is sub-contracting. The private operator often sub-contracted a route to a smaller bus owner, which made it difficult to hold any party responsible for poor services.

Most of these problems can be resolved through appropriate regulations. Once a city has decided to privatize, the important task is to draft the regulations carefully, allowing the private operator some room to be innovative and cost efficient, while ensuring the safety, quality and service standards.

The following chapters analyze the performance and evaluate the efficiency of urban bus services in India and examine the factors that affect their performance.

# 5 Data: Requirements, Sources and Limitations

The goal of this dissertation is to study the performance of public bus companies in India and assess whether privatization improves efficiency of bus operations. Ideally, the dissertation should be able to analyze the performance of bus operators in India before and after privatization and explore whether privatization has led to any gains in efficiency. However, the traditional comparison done in previous studies as discussed in chapter 4, are not feasible in the case of India. This is partly due to the nature of the privatizations that have been attempted and partly due to the nature of data that is available. This chapter discusses these two factors and the limitations that they impose on the research.

## 5.1 Data about Public Operators

All State Transport Undertakings (STUs) in India report their annual operating statistics and performance measurements to the Association of State Road Transport Undertaking (ASRTU) and the Central Institute of Road Transport (CIRT) in Pune. CIRT has a data repository for all the State Road Transport Undertakings in the country. They publish the data annually as a book "STUs – Profile and Performance", which is available for purchase from CIRT. CIRT sometimes publishes parts of the data or a summary of the data from STUs online. CIRT also publishes a journal called "Indian Journal of Transport Management", the May issue of which usually has an excerpt of the profile and performance for the previous year[8]. The data compiled by CIRT is comparable between STUs because CIRT defines each variable and has a standard form that the STUs are required to use when reporting data.

This dissertation uses data for Delhi, Kolkata, Chennai, Mumbai, Bangalore, Pune, Ahmedabad, Chandigarh, Pimpri-Chinchwad and Kolhapur (see figure 5.1). Of these ten cities, Delhi, Kolkata, Mumbai, Chennai and Bangalore are large cities with populations over 5 million and Pune, Ahmedabad, Chandigarh, Pimpri-Chinchwad and Kolhapur are medium cities with populations between 1 and 5 million (Office of the Registrar General, India 2001a).

The most notable omission among the cities chosen is Hyderabad. Hyderabad has a population of about 7 million (Datta 2006) and about 3800 public buses serving the city (APSRTC 2008). However, the city does not have an exclusive urban STU. Bus services in Hyderabad are provided by the Andhra Pradesh State Road Transport Corporation (APSRTC) which operates bus services in the entire state of Andhra Pradesh. APSRTC maintains separate data for their urban and rural operations, but their data for urban operations include operations in other urban areas in the state as well (Agarwal 2006; Badami and Haider 2007).

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[8] In India, the financial year starts on April 1st of a year and ends on March 31st of the following year. So data for 1989-90 would have the period of data collection as April 1st 1989 to March 31st 1990.

*Figure 5.1 Cities chosen for the research*


The cities chosen for the study are not a good geographic representation of the country (see figure 5.1). The large cities are from different states in the country and different parts of India. However, the medium cities are all from the western and northern parts of the country. Chandigarh is in the northern part and closer to Delhi. Ahmedabad is in the western state of Gujarat. All the other three medium cities are from the State of Maharashtra which also has the city of Mumbai. This skewed selection of cities is because of the varied nature of bus operations in India.

Many cities in the state of Maharashtra have dedicated municipal transport undertakings. So there is separate data available for each city in Maharashtra (Badami and Haider 2007). Many medium cities, especially those in the northern parts of India such as Lucknow and Kanpur are not served by urban bus services at all. Most medium and small cities in the Eastern States such as Orissa and West Bengal are also not served by urban bus services (Badami and Haider 2007).

Several small cities, especially those in the southern states are served by both private and public buses. Southern states such as Kerala have a higher travel demand due to the higher rate of education, higher levels of urbanization and more women entering the workforce. There are many medium sized towns such as Coimbatore and Madurai in Tamil Nadu and Thiruvananthapuram in Kerala which are served by large number of public buses. The modal share of bus services is also higher in smaller cities in southern India, when compared to medium and small cities in northern India (Ministry of Urban Development 2008). But data on the private buses or even city-wide data on public buses is not available for these cities, because data for those cities are not separately maintained by their respective State Transport Corporations. So it was not possible to include these cities in the research.

## 5.2 Nature of Privatization

In most developed countries that have privatized their bus services, the private systems replaced a publicly owned and operated system. Such a complete transfer of operation from public to private operators, allow ‘before and after’ comparisons between public and private systems. It enables the comparison of changes in fare structure, employment practices, production efficiency, routes and networks, etc.

In India, however, privatization did not replace public systems in any city (Kapur and Ramamurthy 2002). They merely added to the supply of public bus service. There is often an environment of competition between the public and private operators in a city. The fares are regulated by the government, and the routes and schedules are set by the government for both the public and private operators. The nature of privatization is thus different from that observed in developed countries. So it is not possible to compare a public and private system the way it has been done in previous studies in developed countries.

What is possible to do is to analyze whether the use of private investments to augment the supply of public buses has helped to improve the efficiency of public bus companies. It is possible to compare public bus companies in various Indian cities with each other and analyze whether the systems that have used private franchisees to increase their supply of transport or those that have competition from private buses are more efficient that the ones that did not privatize.

## 5.3 Data about Private Operators

Another problem is that very limited information is available on private bus operators. Data regarding the operations of private buses is not systematically collected by any agency. Most private companies are small and own only 2-5 buses, their companies are not publicly traded and there is no data available on their cost structure, employment structure, etc (Deb 2002). In Bangalore, BMTC uses a franchise system and hires private buses to operate according to terms set by the BMTC (BMTC 2006). There is information regarding the performance of private buses in Bangalore. But private operators in Bangalore do not have any freedom to decide their routes and schedules or to collect fares, and only augments the supply of BMTC buses. So it is not very useful to compare the performance of private and public buses in Bangalore. In Delhi, there is an atmosphere of competition between public and private buses and it might allow more direct comparison between public and private buses, but there is no reliable data available regarding the performance of private buses (Government of India and Government of National Capital Territory of Delhi 2001; Sahai and Bishop 2008). One of the reasons is that private operators in Delhi were only allowed to own a maximum of 5 buses and 80% of them only owned 1 or 2 buses, their companies are not publicly traded and they are very reluctant to divulge any business information (Sahai and Bishop 2008).

Many small cities in Southern India such as Kochi, Coimbatore and Mangalore are served by a large number of private and public buses (Ministry of Urban Development 2008). But private bus owners in these cities are also small scale operators like those in Delhi, and their financial and performance data are not available.

Kolkata is a city that was served by private buses well before India's independence in 1947. After the formation of the state of West Bengal, the CSTC (Calcutta State Transport Corporation) started public bus services in the city. But the private services were never phased out or bought over by the public company. So Kolkata is a city where public and private buses have been in operation for a long time. CSTC operates around 1200 buses across the city of Kolkata, and the number of private buses serving the city is estimated to be around 5000 (Phanikumar and Maitra 2006). But, the city offers very little in terms of a case study on privatization, because there is no data available on the private operators. The 5000 private buses that serve Kolkata are owned and operated by small companies or individual owners grouped into a number of route associations. They charge the same fares as CSTC, have high labor productivity and high fleet availability. Route associations are very strong. They regulate services and even impose fines on those that don’t run on schedule (Phanikumar and Maitra 2006).

## 5.4 Policy Data and Documents

All STUs publish their own ‘Annual Administrative Report’, which sometimes includes some of the more detailed information that may not be required to be reported to the CIRT. However, since the annual reports are for their own internal use, the nature and quality of information are different for different STUs. Even for the same STU, the issues discussed are sometimes different from year to year. Often, the reports are not used to present data, but more as a vision statement or a policy statement and are useful for the researcher as a policy document.

All current policy documents of various state governments and ministries are available electronically and many can be accessed online through libraries of Indian Universities or research institutions.

## 5.5 Other Data

### 5.5.1 Traffic Data

Traffic data provides important information regarding congestion, modal split, number of vehicles in an urban area, speed of travel etc. Traffic data in terms of number of passenger car units are only available through data sharing from research organizations. Other data such as road length, width, and number of vehicles registered are available through the local transport departments of cities. The Ministry of Urban Development has conducted two studies on travel patterns since 1990. The first study was published in 1995 and the second was published in 2008[9].

### 5.5.2 Demographic Information

An urban bus service needs to have the demographic information of the area that is being served to assess travel demand. Using too many buses will result in low occupancy rates on buses leading to inefficiency and financial losses and using too few will lead to crowded buses and possible loss of ridership to motorcycle and car.

The Registrar General of India conducts a decennial survey of all territories under its control. The last census was conducted in 2001. Many cities update their local demographic information in their own socio-economic surveys for their state and local budgets. So city or state-wide demographic data is available through the state economic surveys though all the information may not be comparable across different States.

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[9] The first study published in 1995 is only available in hard copy; the author obtained a copy from the Ministry of Urban Development. The second study (2008) is available electronically and can be downloaded from the website of the Ministry of Urban Development.

### 5.5.3 Economic Data

Economic surveys are done both by the central government and by state governments to aid in the preparation of their central and state budgets (Ministry of Finance 2008a). Since budgets are prepared and presented every year, an economic survey is available for every year. The recent economic surveys are all available electronically and some can be accessed online. However, the data available through the economic survey is broad and useful only as data by sector.

An important factor that affects the comparison of cities is the difference in cost of living among the cities. The dissertation uses the national consumer price index published by the Labor Bureau of India to convert all Rupee figures to constant 1990 prices. However, the center-wise index shows that the inflation rates in various cities are different affecting the cost of living and the cost of operation in the cities. But center-wise data was not available for every year and so it was not used (Labour Bureau 2009).

### 5.5.4 Land-Use Data

Urban transport is influenced by the geography of the city, the distribution of population in the city and the distribution of land-uses in the city. For example a city such as Mumbai which is geographically confined and has high density of population will often have a high density traffic corridor which is easy to identify and serve. A city such as Delhi, which is not confined by any natural geographic feature like mountain range or water body can grow outwards almost unlimitedly. Such cities tend to be more spread out with traffic moving in several directions without any one defined high traffic corridor. Cost of operation of public transport can be higher in such cities.

Indian cities have land use data on large rolls of paper. Broad land-use maps are available in electronic format, but cities are not geo-coded in detail and geographic analyses are difficult to do.

### 5.5.5 Environmental and Pollution data

Environmental and Pollution data are available for Delhi through The Energy and Resources Institute. However, the data was not used in the dissertation since it was available only for Delhi. Also Delhi is the only city that has enforced the use of Compressed Natural Gas (CNG), the transition to which affected the supply of buses for a period of time.

With increasing vehicle ownership rates and increasing congestion, pollution is a major problem affecting Indian cities. Unfortunately, pollution data is only available for Delhi and cannot be used in an analysis involving several cities. So any possible improvement in air quality resulting from increased use of public transport and decrease in the use of personal modes cannot be assessed.

## 5.6 Summary

Several bus companies consider privatization to be a suitable solution to improve their bus services. But a comparison of the performance of bus operations before and after privatization is not suitable for this research because of the nature of privatizations in India. A comparison of public and private buses operating in the same city is also not feasible because of a lack of reliable data on private buses.

The approach used in this research is to analyze the efficiency of selected urban STUs using data envelopment analysis. By analyzing the exogenous factors that affect efficiency, the research attempts to identify the sources of inefficiency and the factors that can improve efficiency. The inclusion of ‘use of private buses’ as an exogenous factor allows to examine whether privatization has a significant effect on efficiency. A qualitative examination of the privatization experiences of Delhi and Bangalore is also done to understand institutional and regulatory factors that affected the outcome in those two cities.

# 6 Nature of Bus Services in Indian Cities

The Road Transport Corporation Act of 1950 required states in India to take a proactive role in planning and implementing a bus service system for their state. It also allowed the State Road Transport Corporations to manage the bus services in their State in ways that they found suitable. Some states incorporated urban STUs to plan and operate bus services in their cities. This chapter examines the nature of bus services in 10 cities in India, explores the trends in their performance and evaluates the efficiency of their operations. The goal is to examine whether there has been a decline in the performance of bus systems and whether the efficiency of their operations has improved or declined during the study period.

Large cities in India, such as Mumbai, Delhi, Chennai, Bangalore and Kolkata are served by a large number of buses, sometimes all publicly owned and operated such as the services in Mumbai and sometimes by both public and private services such as Delhi (CIRT 2008). The populations in the five large cities chosen for the study ranged from about 6 million in Bangalore to 18 million in Mumbai in 2004 (Datta 2006). Mumbai, Kolkata, Delhi and Chennai have an urban rail network serving the city in addition to the bus services, while Bangalore has only bus services.

The medium cities chosen for the study had populations ranging from about 4.9 million in Ahmedabad to 1.2 million in Chandigarh in 2004 (Datta 2006). Ahmedabad could be categorized as a large city, but since its bus operations are small in scale with a fleet strength of only 551 in 2004 (CIRT 2005), it is studied as a medium-sized city.

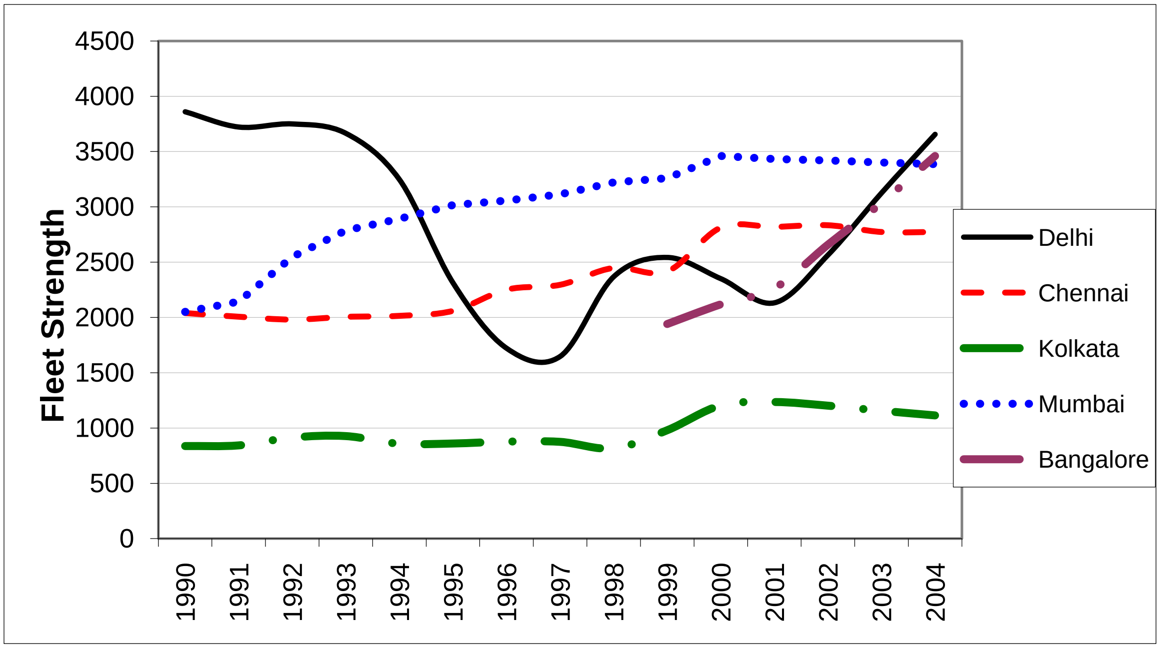
In this chapter, the performance of STUs is evaluated in three categories. First, the services are evaluated in terms of the quantity of service, examining whether provision of bus services has kept pace with changes in population. Second, the financial performance of STUs is assessed to examine whether the services are cost efficient. Third, efficiency of production and service are analyzed in terms of efficiency in the use of available capital (vehicles), labor and fuel.

## 6.1 Quantity of Service

Analysis of the quantity of service is useful for assessing the extent to which bus services are available to the public and the extent to which the available services are used. Data indicating quantity of service that are available from CIRT or ASRTU are fleet strength, kilometers operated, passenger-km, seat-km and occupancy ratio.

### 6.1.1 Number of Buses

*Figure 6.1 Number of Buses Owned by the Bus Services in Large Cities (1990-2004)*




*Source*: ASRTU 2001, CIRT 2005

In all large cities except Delhi, the number of buses owned by the respective STUs increased between 1990 and 2004 (fig 6.1). Delhi Transport Corporation (DTC) reduced their fleet initially in the mid-1990s after the State Transport Authority issued permits to private operators. Later they increased their fleet because of the public's complaints against the private operators (Marwah, Sibal and Sawant 2001; Mathur 1999). In 2000 and 2001, they reduced their service again following the Supreme Court directive banning older vehicles from service[10] (Agarwal 2006). Since 2003, DTC has started to increase their fleet strength again (CIRT 2008).

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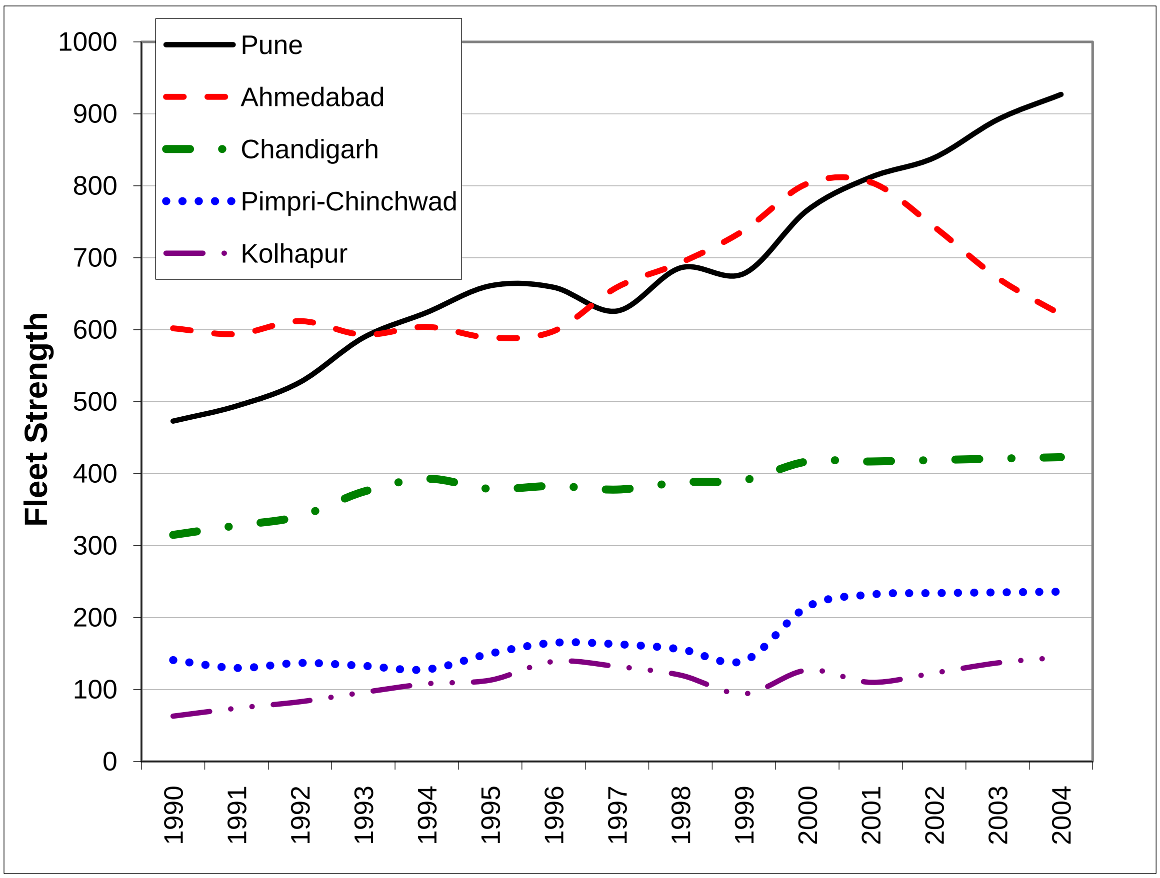
[10] In 2000 a Supreme Court directive ordered that vehicles older than 8 years may not be used for public transport in Delhi unless they were converted to be compatible with compressed natural gas (CNG), which is less polluting than diesel. This is discussed more in chapter 8.

Fleet strength for all transport companies in medium cities except Ahmedabad shows an increasing trend (fig 6.2). The Ahmedabad Municipal Transport Service (AMTS) has been decreasing their fleet strength since 2001, when they started to pull older vehicles from service, but were unable to purchase new vehicles to replace the buses that were being discarded (Singh 2006).

*Figure 6.2 Number of Buses Owned by Bus Services in Medium Cities (1990-2004)*

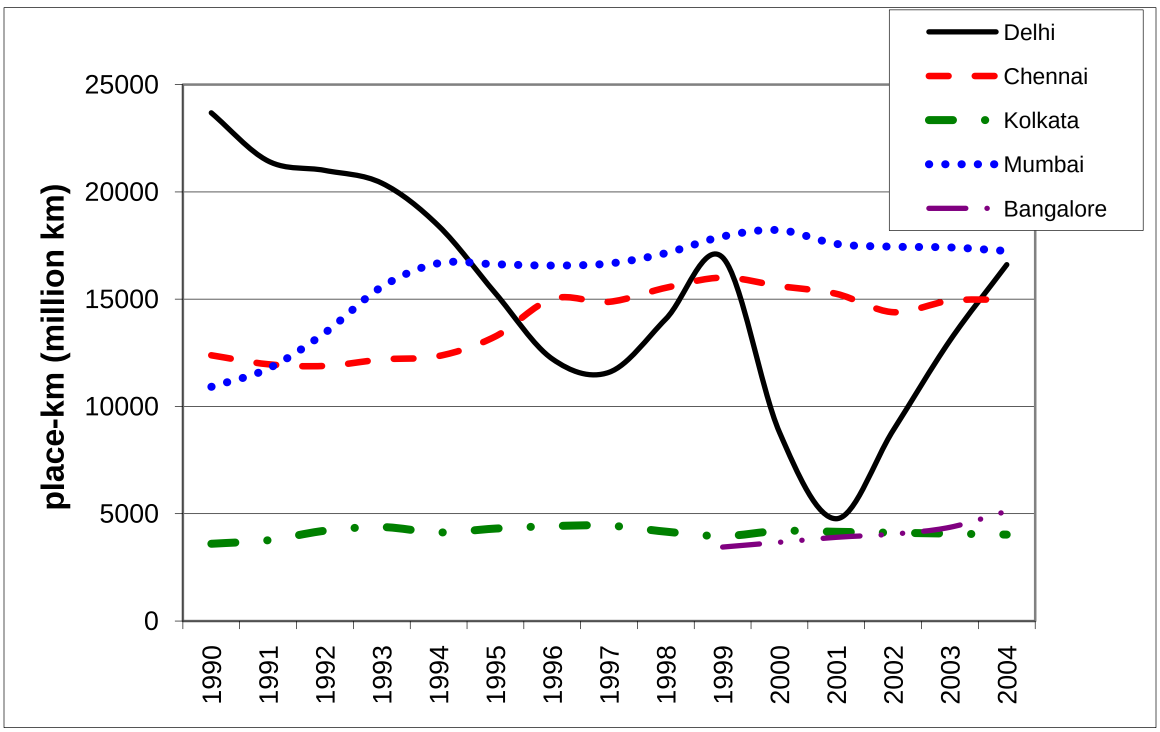



*Source*: ASRTU 2001, CIRT 2005

### 6.1.2 Capacity of Services

Fleet strength by itself is not a reliable indicator of the quantity of service because it does not account for the size of buses, the number of kilometers operated or the frequency of service (Badami and Haider 2007). Seat-km, the indicator of capacity that is reported by the STUs in India, is obtained by multiplying the total kilometers operated annually by the number of seats on a bus (CIRT 2004). Since buses in most cities are crowded, place-km, which is obtained by multiplying total number of places in a bus (seating and standing capacity) by total kilometers operated, is probably a better indicator of total capacity of services offered than seat-km (Badami and Haider 2007). Figure 6.3 and figure 6.4 show the trend in place-km for large and medium cities respectively.

*Figure 6.3 Passenger-Carrying Capacities of Bus Services in Large Cities (1990-2004)*

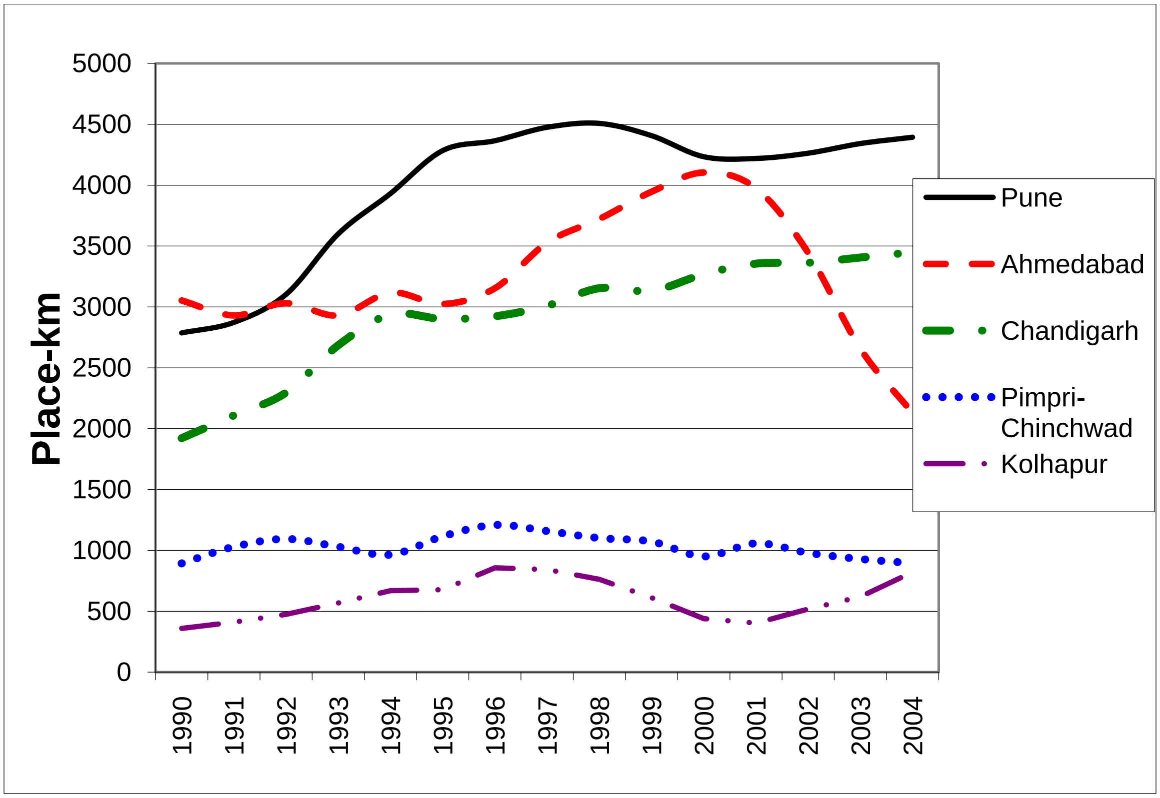



*Source*: ASRTU 2001, CIRT 2005

Among the large cities, place-km had an overall increasing trend for Brihan Mumbai Electric and Transportation Services, Mumbai (BEST) and Metropolitan Transport Corporation, Chennai (MTC) between 1990 and 2004 (fig 6.3). Calcutta State

Transport Corporation , Kolkata ( CSTC) and Bangalore Metropolitan Transport Corporation , Bangalore (BMTC) had an overall steady supply of bus capacity and the place-km provided by DTC followed the trend of its increases and decreases of fleet strength (fig 6.3).

*Figure 6.4 Passenger Carrying Capacity of Bus Services in Medium Cities (1990-2004)*




*Source*: ASRTU 2001, CIRT 2005

In the medium cities, place-km had an overall increasing trend for Pune Municipal Transport, Pune (PMT) and Chandigarh Transport Undertakings, Chandigarh (CHNTU) (fig 6.4). Pimpri-Chinchwad Municipal Transport, Pimpri-Chinchwad (PCMT) and Kolhapur Municipal Transport Undertaking, Kolhapur (KMT) had an overall steady supply of bus capacity. AMTS, Ahmedabad had an increasing trend till

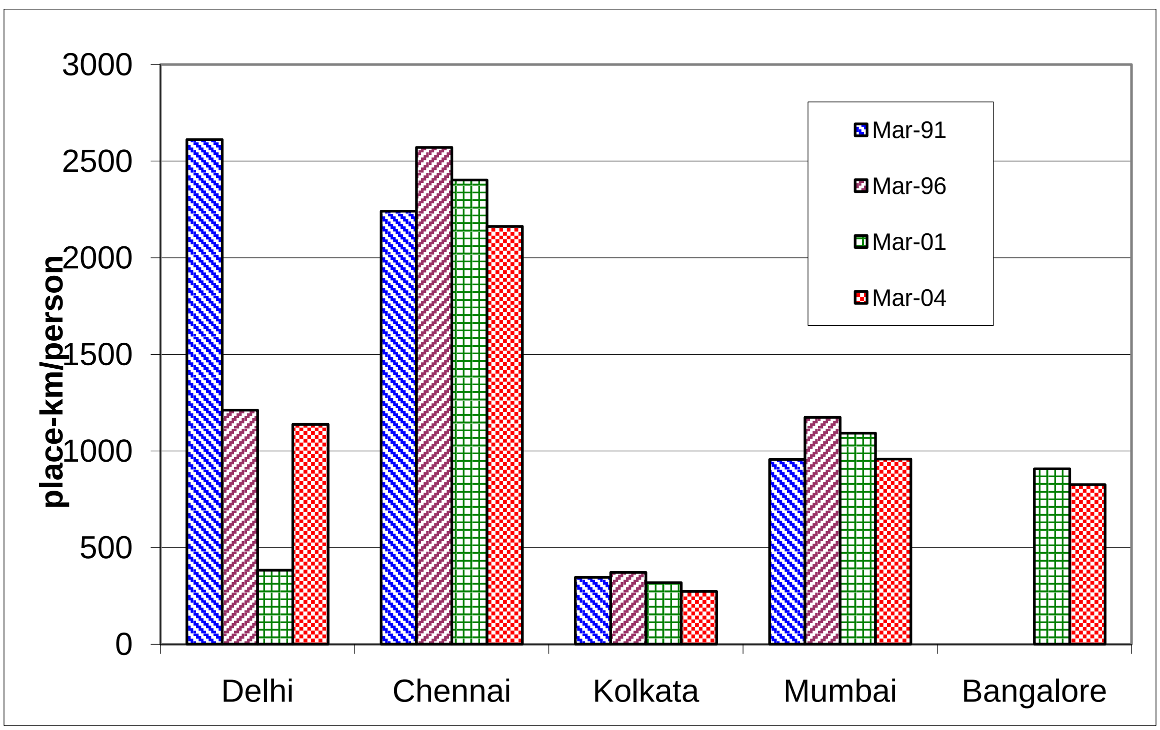
2001. In 2001, AMTS started eliminating older buses from service. But they were unable to replace those buses with new vehicles because of funding constraints, and its supply of services started to decrease (Singh 2006).

### 6.1.3 Capacity per capita

Place-km does not take into account the population that is served by the transport company. Quantity of service is a better indicator of performance if it is compared with the population in the city, thus enabling the measurement of per capita capacity (Agarwal 2006). Place-km per person is calculated as total place-km offered annually divided by population in the area served to obtain an indicator of per capita supply of bus services.

Figures 6.5 and 6.6 show changes in the capacity of bus services in large and medium cities between the years 1991 and 2004.

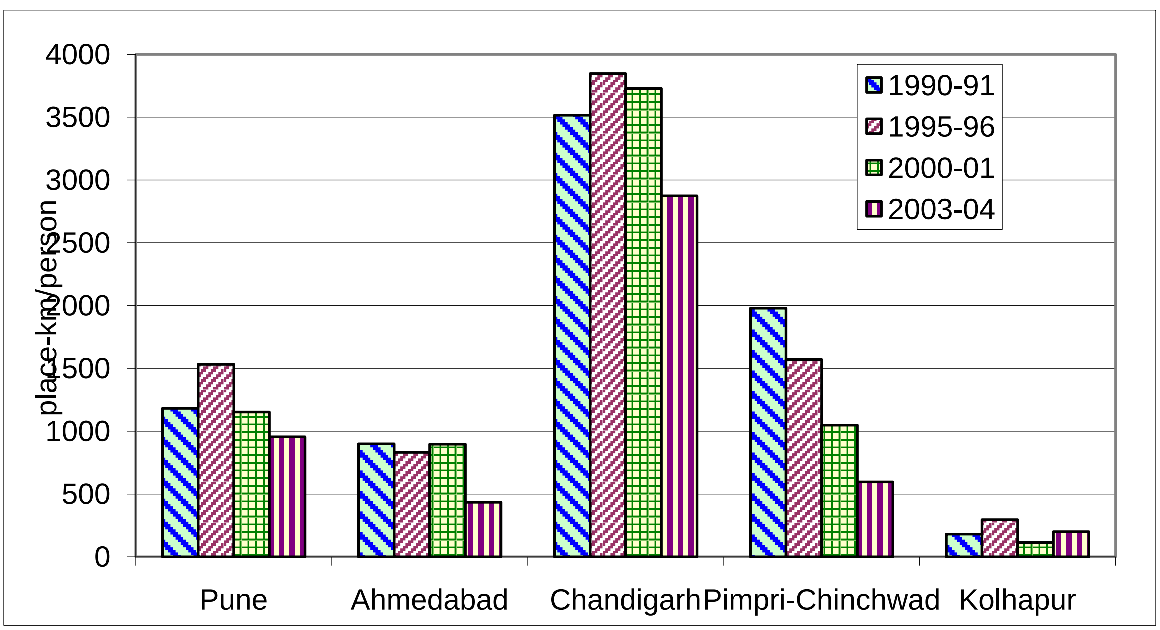
*Figure 6.5 Quantity of Service Provided per Capita in Large Cities*




*Source*: ASRTU 2001, CIRT 2005

Among the large cities, Chennai had the largest supply of bus services per capita in 2004 (fig 6.5). Even though BEST, Mumbai provided higher total capacity of services than MTC, Chennai (fig 6.3), it provided less than half the capacity per capita compared to Chennai. One of the reasons for the lower capacity offered by BEST, Mumbai is that Mumbai also has an urban rail network, which caters to 60% of the travel demand in the city (Singh 2006). Place-km per person for DTC, Delhi fell by more than half between 1991 and 1996. However, the city has since issued permits to about 5000 private buses to operate stage carriage services in Delhi (Mathur 1999). So the overall bus supply in Delhi is about double that in figure 6.5. The decreasing trend of place-km per capita shows that public bus supply has not been keeping up with the increase in population.

*Figure 6.6 Quantity of Service Provided per Capita for Small and Medium Cities*




*Source*: ASRTU 2001, CIRT 2005

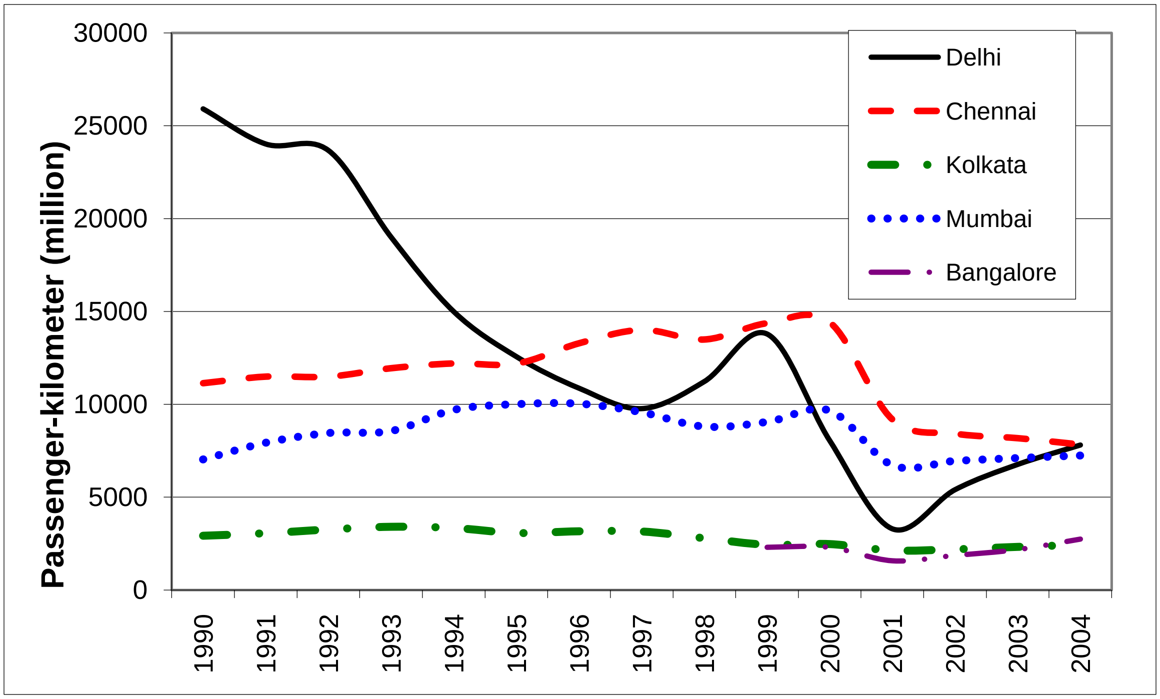
Chandigarh is an outlier in terms of per capita services among medium sized cities and provided at least 3 times the capacity per capita when compared to any other medium city (fig 6.6). In fact, the per capita capacity provided by CHNTU was higher than even the large cities included in the study. Even though PMT, Pune provided the highest capacity among medium cities, it provided only less than half the capacity per capita compared to Chandigarh.

All medium sized cities have experienced a decline in quantity of bus service available per capita. Most STUs operating in medium sized cities incur losses and are unable to increase their vehicle supplies in response to the growth in population (Deb 2002; Agarwal 2006). Often, they are also unable to replace old vehicles that are discarded with new ones (Deb 2002; Singh 2006).

### 6.1.4 Ridership and Occupancy

All cities have experienced an increase in population and travel demand. So it can be expected that bus ridership data for all cities would also show an increasing trend. Since most cities have also experienced a decline in per capita supply of bus services, it can be expected that crowding will show an increasing trend.

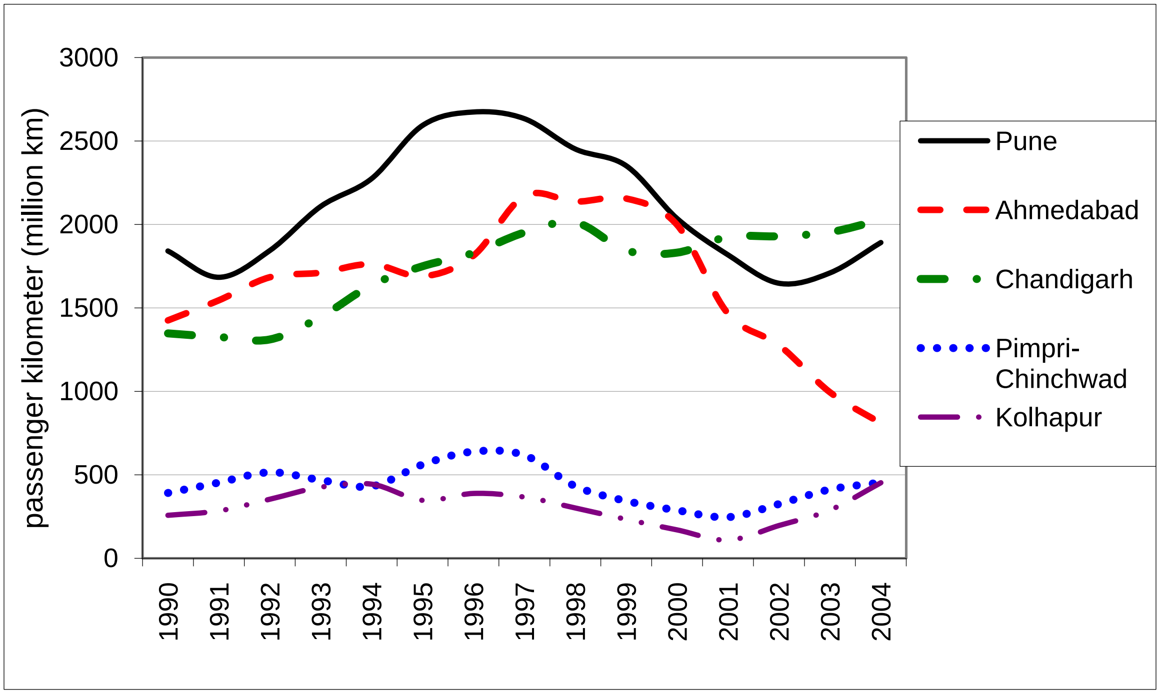
*Figure 6.7 Trend in the Public Bus Ridership in Large Cities (1990-2004)*




*Source*: ASRTU 2001, CIRT 2005

Ridership increased for BEST, Mumbai and MTC, Chennai between 1990 and 2000, and then fell to 1991 levels or below (fig 6.7). For CSTC, Kolkata and BMTC, Bangalore, passenger-km has been almost consistent with no considerable change. However, the population in these cities increased during the study period (Chaitanya 2004). So even in cities where passenger-km did not decrease between 1990 and 2000, there has been a decline in the modal share of buses.

*Figure 6.8  Trend in Use of Buses for Small and Medium Cities (1990-2004)*



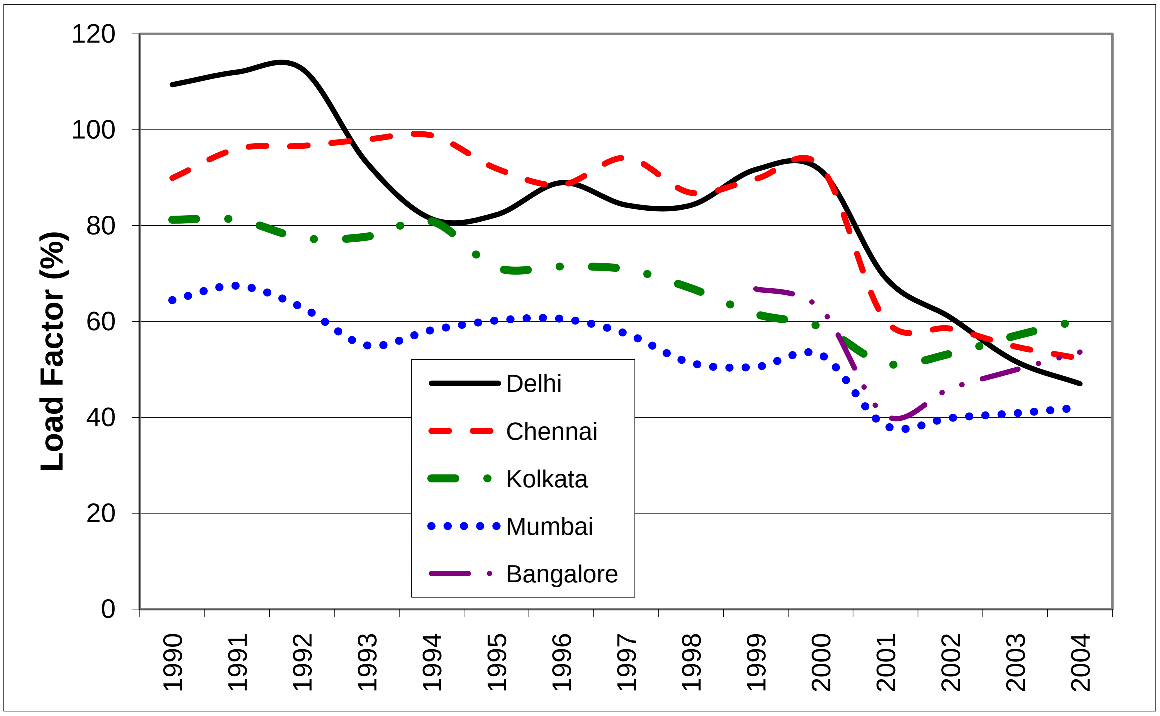

*Source*: ASRTU 2001, CIRT 2005

Ridership increased overall for all 5 medium cities till 1997 (fig 6.8). After 1997, all medium cities, except Chandigarh experienced a decline in ridership till 2001. Since 2001, passenger-km has been gradually increasing in Pune, Pimpri-Chinchwad and Kolhapur. In Ahmedabad, it continued to decrease. AMTC, Ahmedabad also decreased their fleet strength since 2001 (CIRT 2005; Agarwal 2006), which could have contributed to the decrease in patronage. It has been observed that when the public transport services offered are meager in comparison to the demand, people tend to rely on alternative means of transport. An increase in the quantity of service offered often increases ridership because of the attraction of reduced waiting times and less crowded buses (Parry and Small 2008).

Ridership on public buses decreased in all cities between 1990 and 2001 (fig 6.7 and fig 6.8). There has been a corresponding increase in the use of private vehicles. The economy of India has grown at rates of 4-7% during the period between 1990 and 2004 (Panagariya 2004; Reddy 2008), and has increased the rate of ownership and use of private vehicles (Sahai and Bishop 2008). So it is possible that the reduction in capacity per capita has led to increased use of motorcycle or car. Officials of MTC Chennai and DTC Delhi, concur that their cities do need more buses, and that if they are able to offer more comfortable rides on less crowded buses operating at higher frequencies, they would be able to attract more passengers.

Another way to analyze usage is to examine percentage load factor (fig 6.9). A load factor of 100% would mean that the bus is filled to seating and standing capacity.

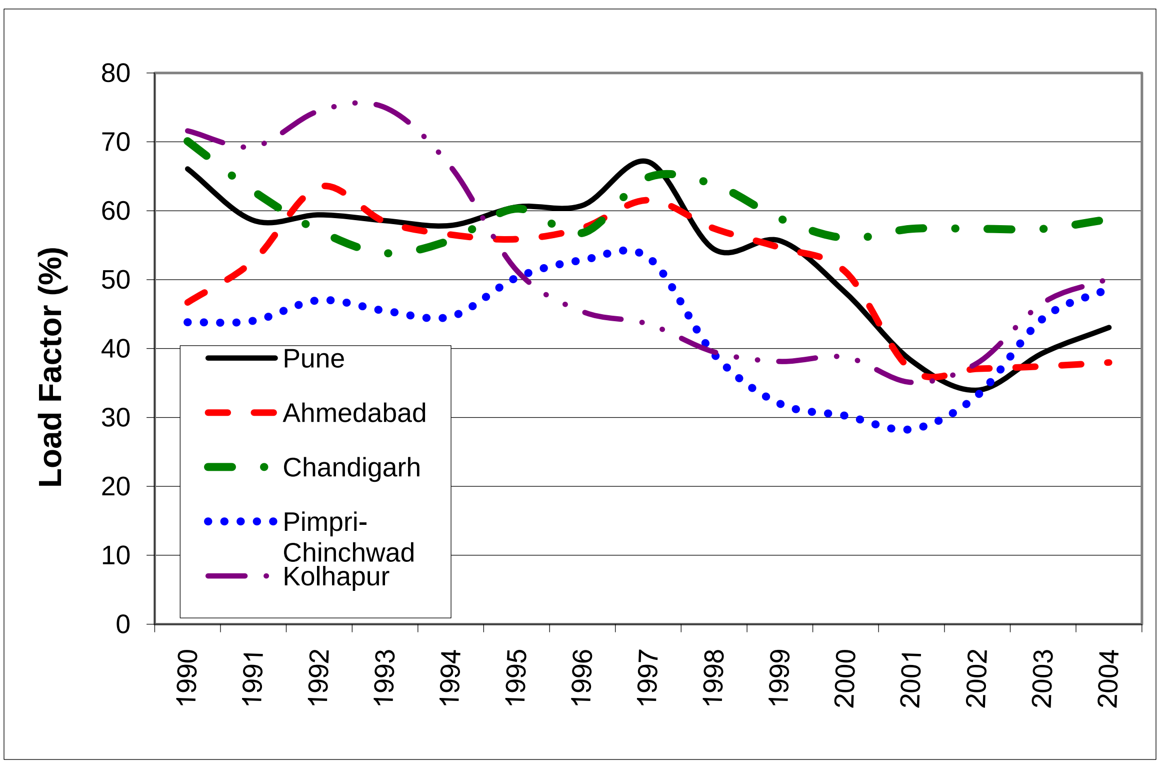
*Figure 6.9 Rate of Crowding on Buses in Large Cities (1990-2004)*




*Source*: ASRTU 2001, CIRT 2005

With a load factor of more than 80%, buses in Delhi and Chennai were crowded till 2000, when their buses began to be less crowded (fig 6.9). Since this reduction in crowding happened despite decreases in capacity per capita, it can be inferred that patronage of public buses has decreased in large cities. This inference is also supported by the fact that passenger-kilometer in these cities have fallen since 1999 despite increase in population (fig 6.7). Studies conducted by the Ministry of Urban Development in 1995 and 2008 also show that modal share of buses have decreased since 1995. (Ministry of Urban Development 1995; Ministry of Urban Development 2008).

*Figure 6.10 Percentage Load-Factor for Medium Cities (1990-2004)*




*Source*: ASRTU 2001, CIRT 2005

Buses in medium cities seem to be less crowded than those in large cities. The highest average load factor for all five medium cities was reported in 1993 and was only 75% (fig 6.10). The year 2000-01 recorded the lowest average load factor for medium cities at only 35%. These load factors indicate that buses in medium sized cities do not get filled to capacity. It is possible that the shorter distances in smaller cities encourage more biking and walking than in large cities (Singh 2006).

The quantity of service in most cities has increased over time. However, capacity of service provided has not kept pace with the increases in population and per capita provision of services has declined. Even with a reduction in capacity offered per capita, buses have not become more crowded. Load factors on buses have fallen between 1990 and 2004 showing that buses are less crowded. Ridership has not increased in the large cities and has even decreased in some between 1990 and 2004. These indicate that there has been a decline in the modal share of buses (Ministry of Urban Development 1995; Ministry of Urban Development 2008).

## 6.2 Financial Performance

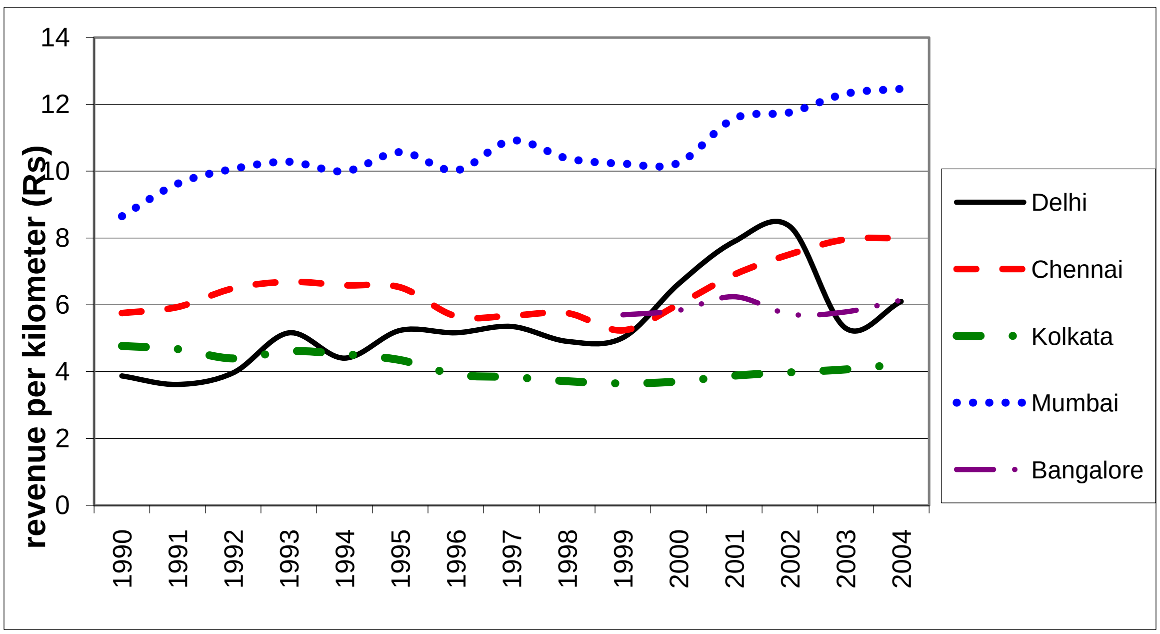
Financial trends are analyzed based on earnings and cost at constant 1990 prices controlling for inflation. The Consumer Price Index for Industrial Workers (CPI (IW))[11] as reported by the Labour Bureau of the Government of India is used for conversion of all financial data to constant 1990 prices.

[11] Though the Labour Bureau also publishes CPI for agricultural laborers and rural laborers, CPI (IW) is recommended for conversion of all urban data.

### 6.2.1 Revenue and Cost

At current prices, revenue and costs have increased for all STUs. Since the increase in passenger-km was small till 2000 and declined since then for all large cities, an increase in fares is the best explanation for the increase in revenue. However, the increase in fleet size led to increase in operating costs as well (Agarwal 2006). Figure 6.11 shows the revenue per kilometer for large cities at constant 1990 prices controlling for inflation.

*Figure 6.11 Revenue per kilometer for Bus Companies in Large Cities at Constant 1990 Prices (1990-2004)*



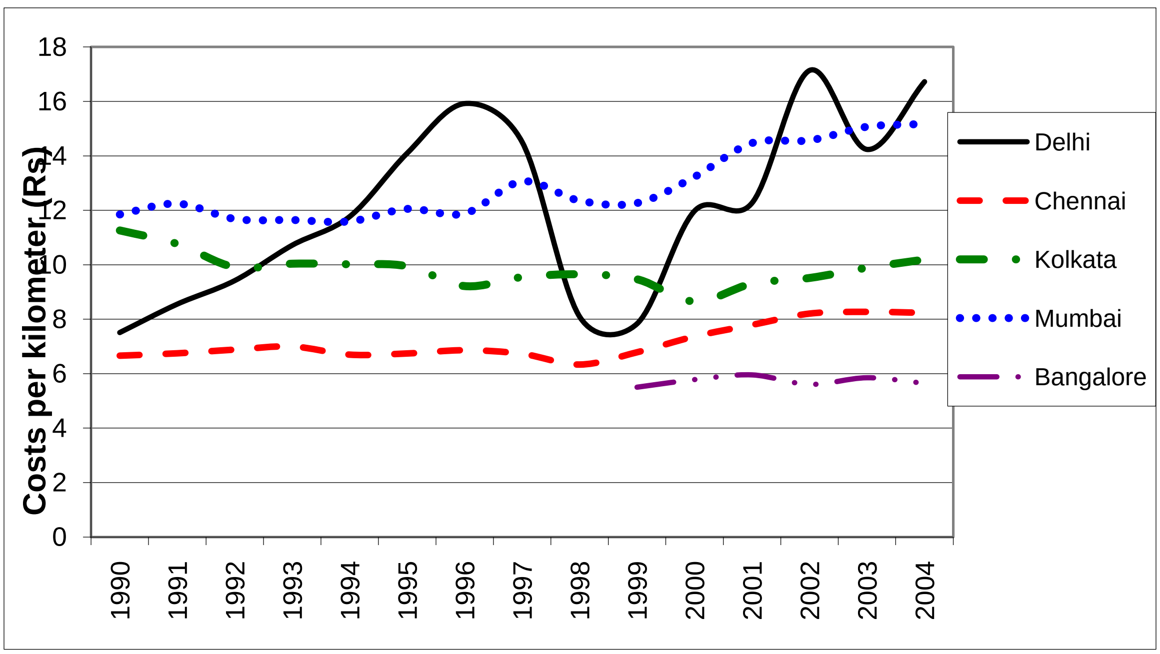

*Source*: ASRTU 2001, CIRT 2005
*Acronyms*: DTC-Delhi; MTC- Chennai; CSTC- Kolkata; BEST- Mumbai; BMTC- Bangalore

BEST, Mumbai earned the highest revenue per kilometer and their earnings per km increased between 1990 and 2004 (fig 6.11). MTC, Chennai also had an overall increasing trend for revenue per kilometer between 1990 and 2004. For BMTC

Bangalore and CSTC Kolkata, the revenue generated per kilometer has been almost constant (fig 6.11). DTC, Delhi which experienced periodic declines in fleet utilization and passenger-km per bus also experienced corresponding declines in revenue (ASRTU 2002; CIRT 2005). Rate of earnings for AMTS Ahmedabad, PCMT Pimpri-Chinchwad, KMTU Kolhapur and CHNTU Chandigarh has increased even when controlling for inflation (ASRTU 2002; CIRT 2005).

However, costs per kilometer are higher than revenue per kilometer for most cities (fig 6.12 and fig 6.13).

*Figure 6.12 Costs per kilometer for Large Cities at Constant 1990 Prices (1990-2004)*

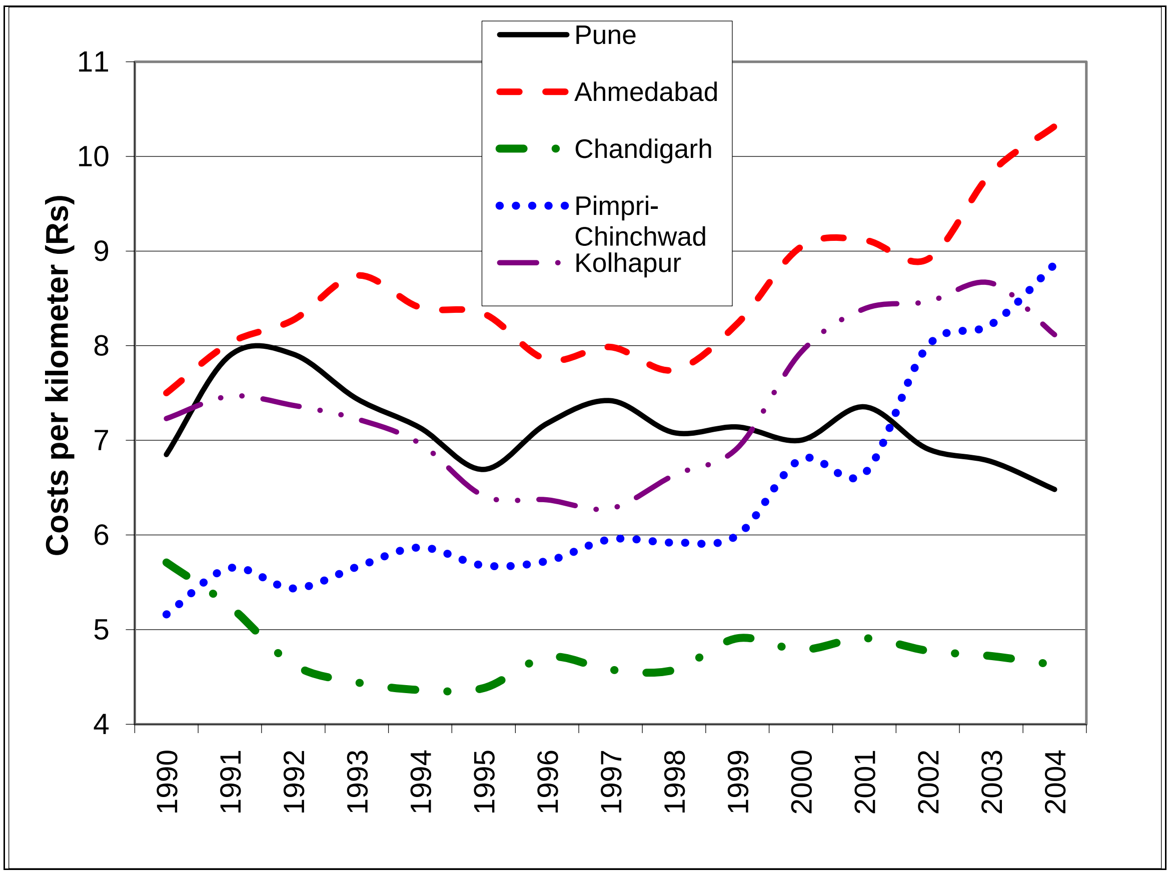



*Source*: ASRTU 2001, CIRT 2005

When controlled for inflation, only CSTC Kolkata and BMTC Bangalore have been able to reduce or even stabilize their costs of operations (fig 6.12). However, for Kolkata, costs per kilometer was almost double that of revenue per kilometer. For DTC

Delhi, MTC Chennai and BEST Mumbai, costs of operation have increased. For DTC Delhi, costs doubled between 1991 and 2004, even when compared at constant 1990 prices (fig 6.12). One of the reasons for increasing cost of operations is that employee benefits and salaries are regularly negotiated by the employee unions and revised to reflect inflation and increases in cost-of-living (Agarwal 2006). But fare increases are more politically charged and fares are not revised as regularly as employee benefits (Deb 2002; Agarwal 2006).

*Figure 6.13 Costs per kilometer for Medium Cities at Constant 1990 Prices (1990-2004)*



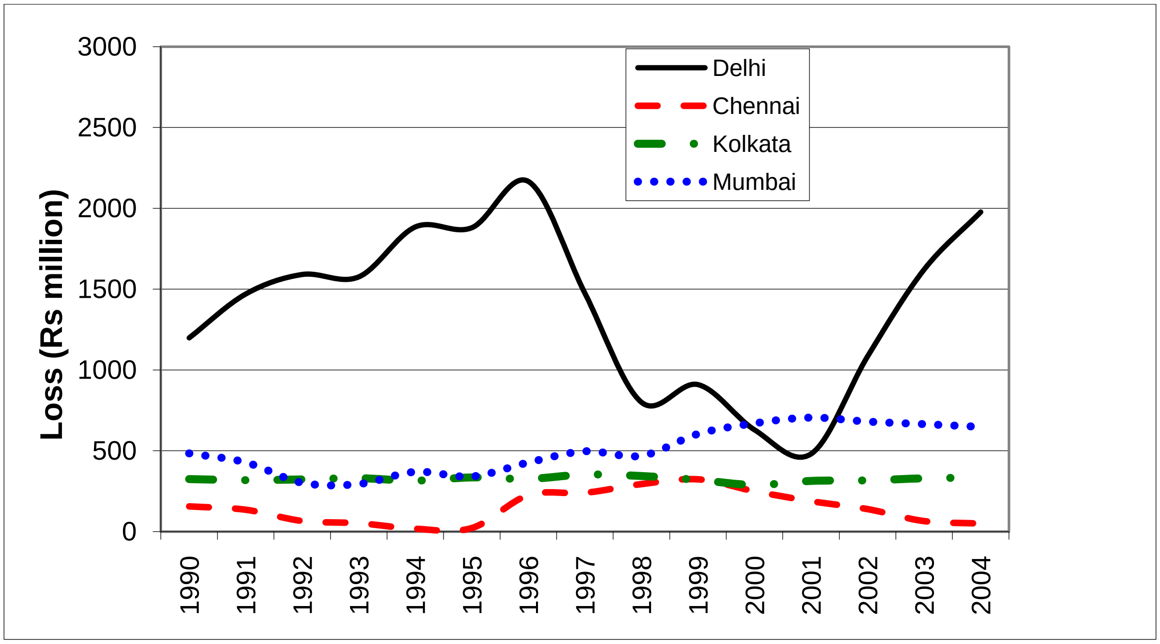

*Source*: ASRTU 2001, CIRT 2005

When controlled for inflation, only CHNTU, Chandigarh has been able to reduce or even stabilize their costs of operations. For all other medium cities, costs of operation have increased. For AMTS and PCMT, costs have doubled since 1991, even when the figures are compared at constant 1990 prices (fig 6.13).

### 6.2.2 Loss Trend

Public bus services in all large cities, except Bangalore, have been incurring losses since 1991 (fig 6.14 and fig 6.15). Losses suffered by DTC Delhi had decreased when they reduced their fleet size in the late 1990s (ASRTU 2002). However, as they started to increase the scale of their operations starting 2000, their losses started to increase (Agarwal 2006). Despite being the STU to generate the highest revenue per kilometer, BEST Mumbai had an overall increasing trend for losses (ASRTU 2002; CIRT 2005). When compared at constant 1990 prices, the losses of CSTC Kolkata did not increase over the years. For MTC Chennai, losses decreased from 1990 to 1994, but increased from 1995 to 1999 and then started to decrease again. But all these comparisons are at constant 1990 prices, and at current prices, the losses incurred by the STUs have been increasing.

*Figure 6.14 Loss at Constant 1990 Prices for Large Cities Cities at Constant 1990 Prices (1990-2004)*

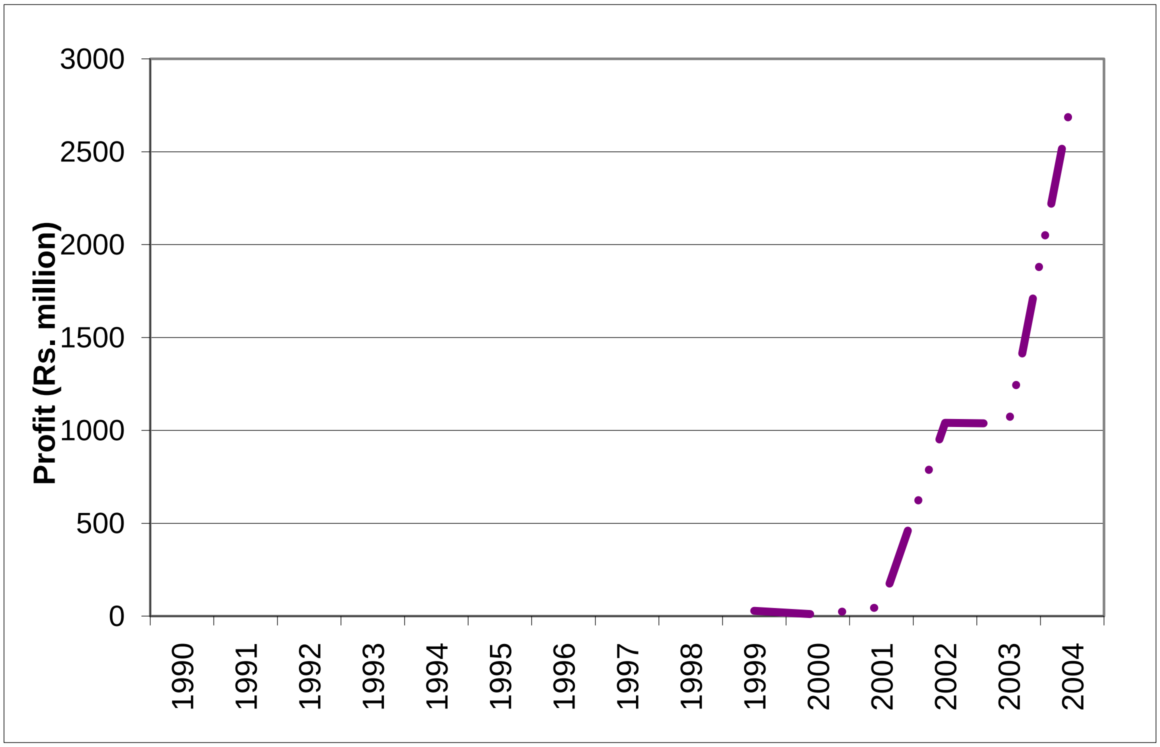



*Source*: ASRTU 2001, CIRT 2005

PMT Pune and KMT Kolhapur have been more stable regarding their losses. Their losses have never exceeded Rs.12 million (at 1990 prices). Since 2001, AMTS Ahmedabad and PCMT Pimpri-Chinchwad have been experiencing increasing losses. One of the reasons for the increase in losses could be the increase in cost of operation due to the increase in capacity and fleet strength, which unfortunately did not increase passenger-km sufficiently to reduce losses (Singh 2006).

BMTC Bangalore has been able to make profits almost every year since its inception in 1997-98. Their profits have increased even when compared at 1990 prices (fig 6.15).

*Figure 6.15: Profits at Constant 1990 Prices for BMTC, Bangalore (1999-2004)*




*Source*: ASRTU 2001, CIRT 2005

However, Bangalore has higher fares than most other cities. It is especially interesting to compare bus fares in Bangalore with those in Chennai, because Chennai has one of the most efficient bus systems in India, after Bangalore. Chennai has high employee productivity, lower rate of employment than all cities except Bangalore, and high rate of production efficiency for vehicles (ASRTU 2002; CIRT 2005). But Chennai still incurs losses, while Bangalore makes profits. This could be because Chennai has one of the lowest fares in India. The fare per stage is only Rs 2.00 for both Chennai and Bangalore. But in Bangalore the fare increases rapidly for longer trips when compared to Chennai. For example a trip that is about 10-12 km and goes through about 7 stages, will cost only Rs. 4.00 in Chennai, but nearly 3 times more in Bangalore at Rs. 11.00. (BMTC

2008; MTC 2008). Overall, most urban STUs except BMTC Bangalore have been unable to control their losses. When the STUs increased the size of their operations in response to the growth in travel demand, their cost of operations increased. But the revenue did not increase as much as the costs leading to increasing losses (ASRTU 2002; CIRT 2005). Many cities also experienced loss of ridership as indicated by the decrease in passenger-km. So an increase in cost of operations resulting from expansion of services combined with a decrease in patronage seems to be one of the major reasons for the increase in losses incurred by many STUs.

However, an urban bus service has social and welfare objectives as well, and it is useful to examine the efficiency of bus services in non-financial terms. The next section examines the production and service efficiency of urban STUs in India.

## 6.3 Efficiency

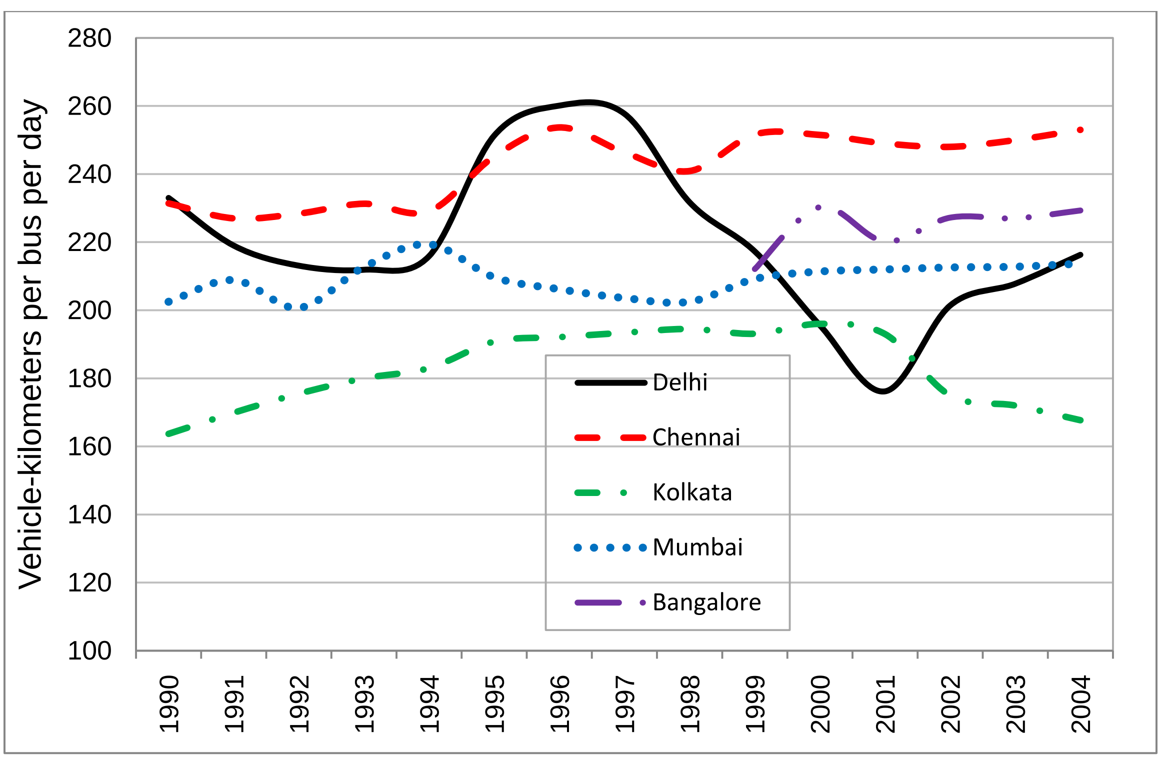
Efficiency can be defined as the rate of use of resources to produce a certain output and can be quantified as the ratio of output to input (Karlaftis 2004). For bus transport, efficiency can be assessed as vehicle efficiency, labor efficiency and fuel efficiency (Nolan et. al. 2001; Karlaftis, 2004; Barnum et. al. 2007). Vehicle efficiency can be measured as vehicle-kilometers per bus or as passenger-km per bus. These would indicate the production efficiency and service efficiency of buses. Labor efficiency is reported by the STUs to the ASRTU and CIRT as employees per bus. But, it is more useful to use passenger-km per employee and vehicle-km per employee to measure labor efficiency following the definition of efficiency as the ratio of output to input. Similarly, both vehicle-kilometers per liter of fuel and passenger-km per liter of fuel can be used as indicators of fuel efficiency.

### 6.3.1 Vehicle Efficiency

Efficient use of vehicles can be assessed as production efficiency, by examining the number of kilometers operated per day by the buses. High vehicle–km per day would indicate low peak to base ratio and high fleet utilization, both of which are indicative of efficient use of available buses (Karlaftis 2004).

A second indicator of vehicle efficiency measures passenger-km per vehicle and is an indicator of the effectiveness of service. A well planned network with appropriate routing and scheduling of buses based on travel demand will probably generate the maximum passenger-km per bus (Cho and Fan 2007). However, interpretation of service effectiveness of buses must be done carefully because very high numbers might indicate crowding.

*Figure 6.16 Production Efficiency for Public Buses in Large Cities (1990-2004)*



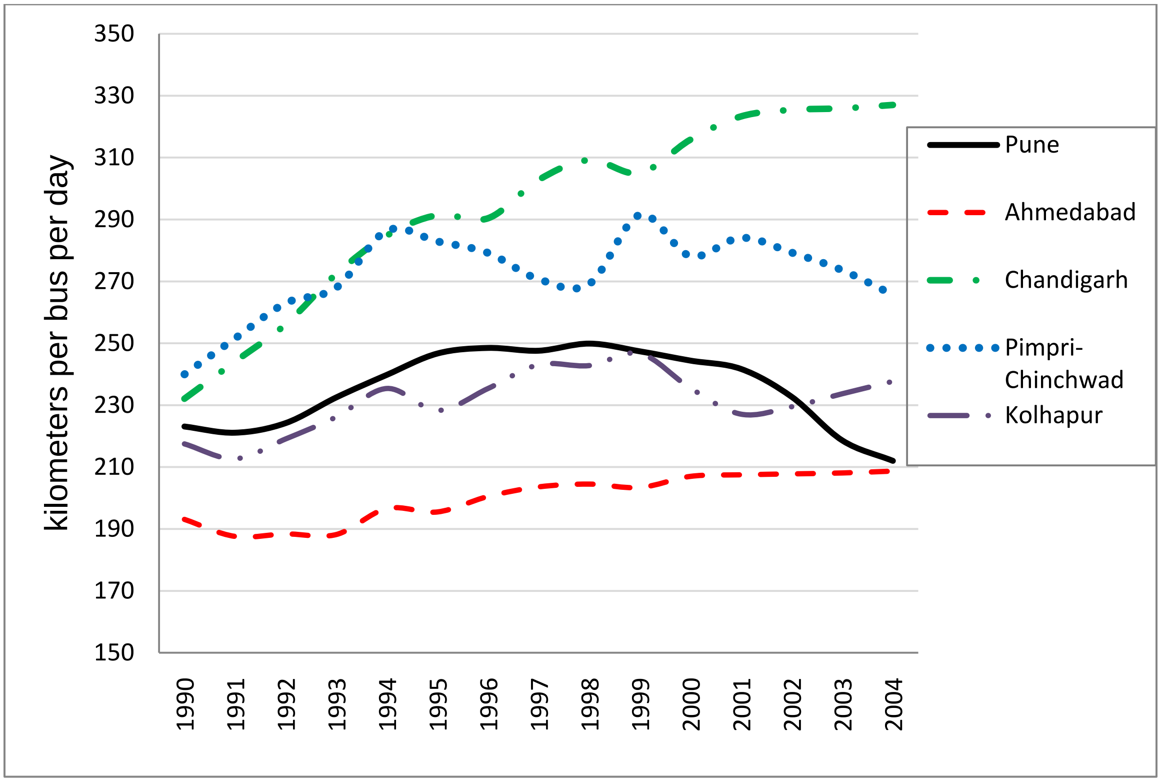

*Source*: ASRTU 2001, CIRT 2005

Vehicle- kilometers per bus per day has mostly been within a range of about 200 to 235 km for BEST, Mumbai and BMTC, Bangalore (fig 6.16). For MTC, Chennai, veh-km per bus per day has ranged from about 225 to 248 km and for CSTC, Kolkata, the overall production efficiency is lower, ranging from about 160km to about 195 km per bus per day (ASRTU 2002; CIRT 2005). DTC, Delhi had more fluctuations and their vehicle efficiency has ranged from 175 km per bus per day to 260 km per bus per day (ASRTU 2002; CIRT 2005). The pattern of variation is related to the changes in fleet utilization and peak to base ratio because vehicle-km per bus per day is calculated as the ratio of total revenue vehicle kilometers to total fleet held.

One of the reasons for the low production efficiency of Kolkata is that it is the most congested city in India, with a peak hour traffic speed of only 6 km/hr. Traffic speeds in Kolkata are also affected by the large number of non-motorized traffic such as bicycles and rickshaws[12].

[12] Kolkata used to have large number of human-pulled rickshaws and not just cycle-rickshaws. Now there are more cycle-rickshaws than the kind of rickshaws where rickshaw-puller pulls the rickshaw by hand.

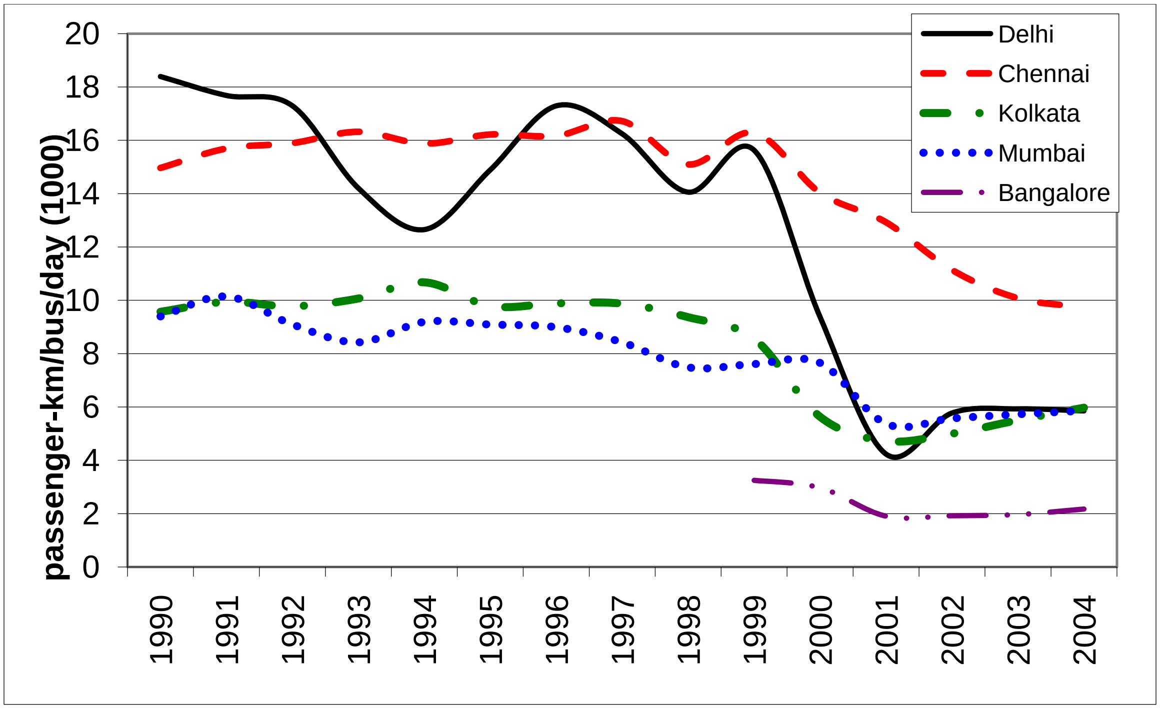
*Figure 6.17 Production Efficiency for Public Buses in Medium Cities (1990-2004)*




*Source*: ASRTU 2001, CIRT 2005

Among the medium sized cities, CHNTU improved their vehicle efficiency from about 280 km per bus per day in 1990 to about 320 km per bus per day in 2004. (CIRT 2005). PCMT, Pimpri-Chinchwad improved its vehicle efficiency from 230 km per bus per day to 290 km per bus per day between 1990 and 1994 and then stayed within a range of 270 to 290 km per bus per day till 2004 (ASRTU 2002; CIRT 2005). PMT, Pune and KMT, Kolhapur had vehicle efficiency ranging from about 210 to 250 km per bus per day and AMTS, Ahmedabad had vehicle efficiency ranging from about 190 to 210 km per bus per day (fig 6.17).

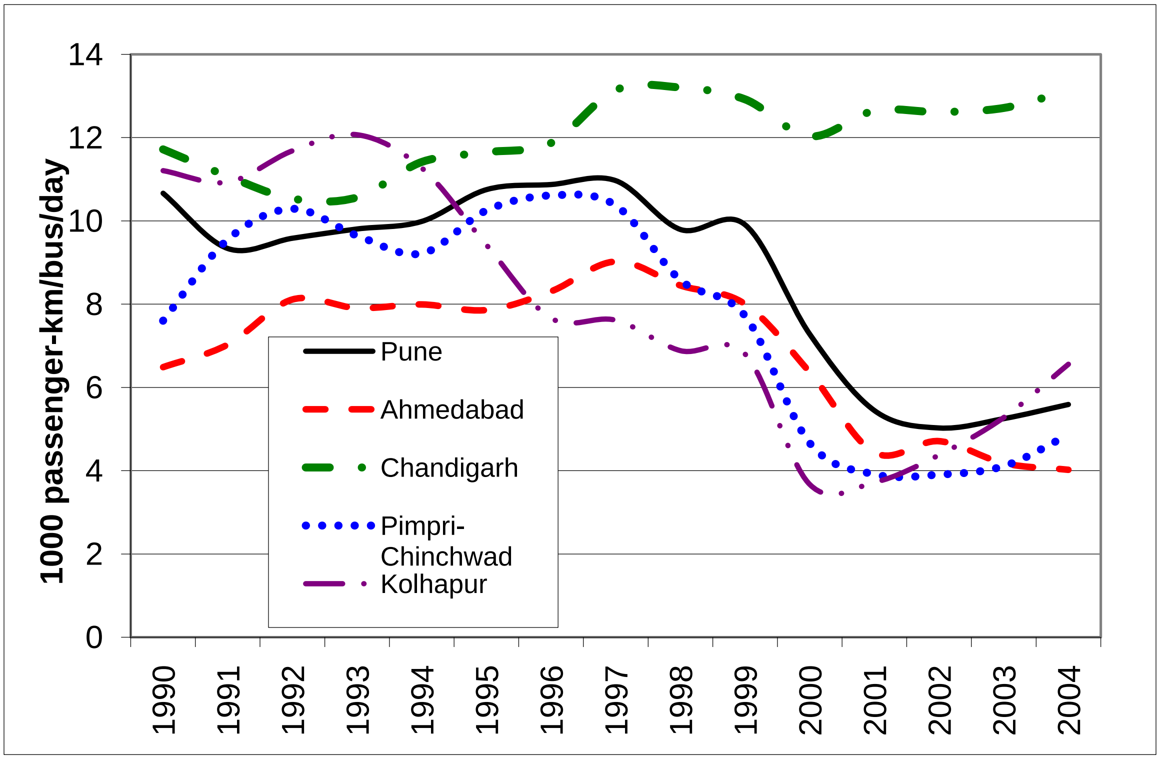
*Figure 6.18* *Service Efficiency for Public Buses in Large Cities (1990-2004)*




*Source*: ASRTU 2001, CIRT 2005
*Acronyms*: DTC-Delhi; MTC- Chennai; CSTC- Kolkata; BEST- Mumbai; BMTC- Bangalore

Figure 6.18 shows the trend in the service efficiency of buses in large cities. Passenger-km carried per bus has decreased for all large cities between 1990 and 2004 (ASRTU 2002; CIRT 2005). From 1990 to 2000 it had remained almost stable with only small fluctuations from year to year for BEST, Mumbai, MTC, Chennai and CSTC, Kolkata. DTC, Delhi experienced a decline in vehicle efficiency in 1994, improved for the next three years, then declined in 1998, improved slightly in 2000 and has since declined gradually. In Bangalore, passenger-km per bus is lower than other large cities indicating less crowding (Agarwal 2006).

*Figure 6.19* *Service Efficiency for Public Buses in Medium Cities (1990-2004)*




*Source*: ASRTU 2001, CIRT 2005

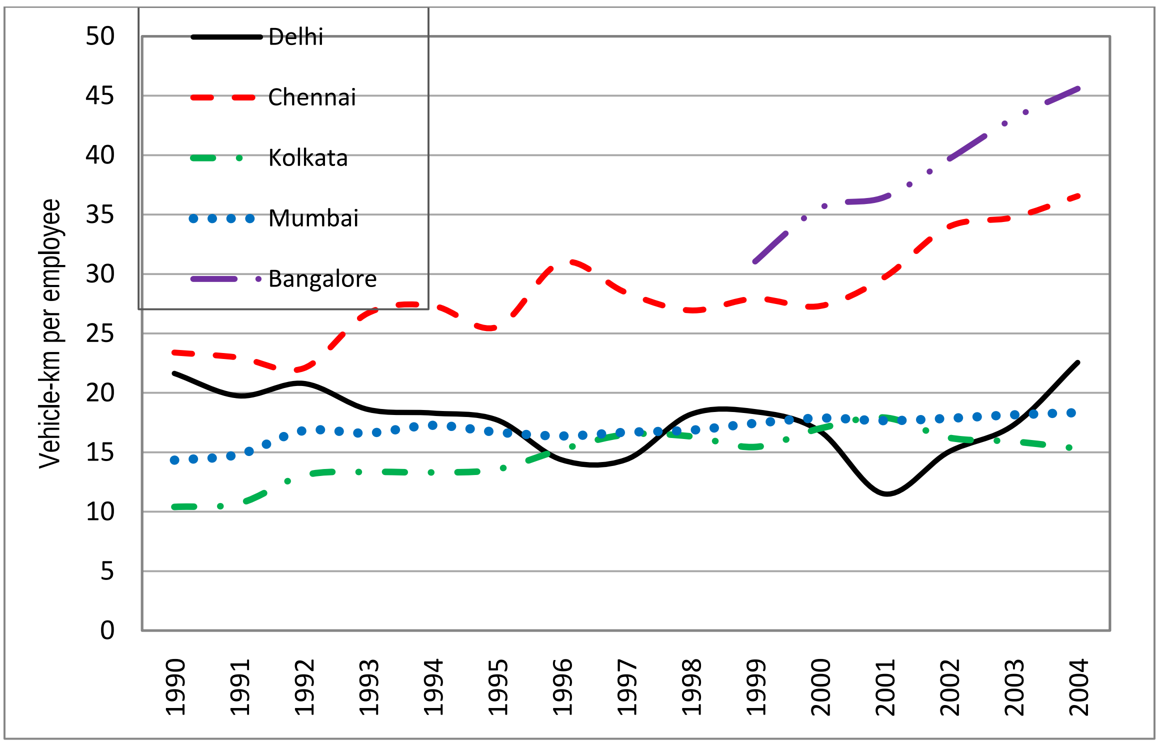
Figure 6.19 shows the trend in the service efficiency of buses in medium cities. Chandigarh is the only medium city where passenger-km per bus increased between 1990 and 2004 (ASRTU 2002; CIRT 2005). The other four cities had an improving productivity in the early 1990s, but declined from the mid-1990s to 2001 (CIRT 2005). Since 2001, KMT, Kolhapur, PCMT, Pimpri-Cinchwad and PMT, Pune have shown improvements in service efficiency of buses, but AMTS, Ahmedabad has not.

Over all, production efficiencies of buses have improved in most cities, probably owing to better technology, and fewer interruptions in service. However, service efficiency measured as passenger-km per bus has declined, and it indicates less crowding on buses, as buses in most large cities were very crowded in the early 1990s.

### 6.3.2 Labor Efficiency

Labor efficiency is measured as vehicle-km per employee and as passenger-km per employee. Since cost of labor is a major component of the cost of operations, efficient use of labor also indicate a more cost efficient operation.

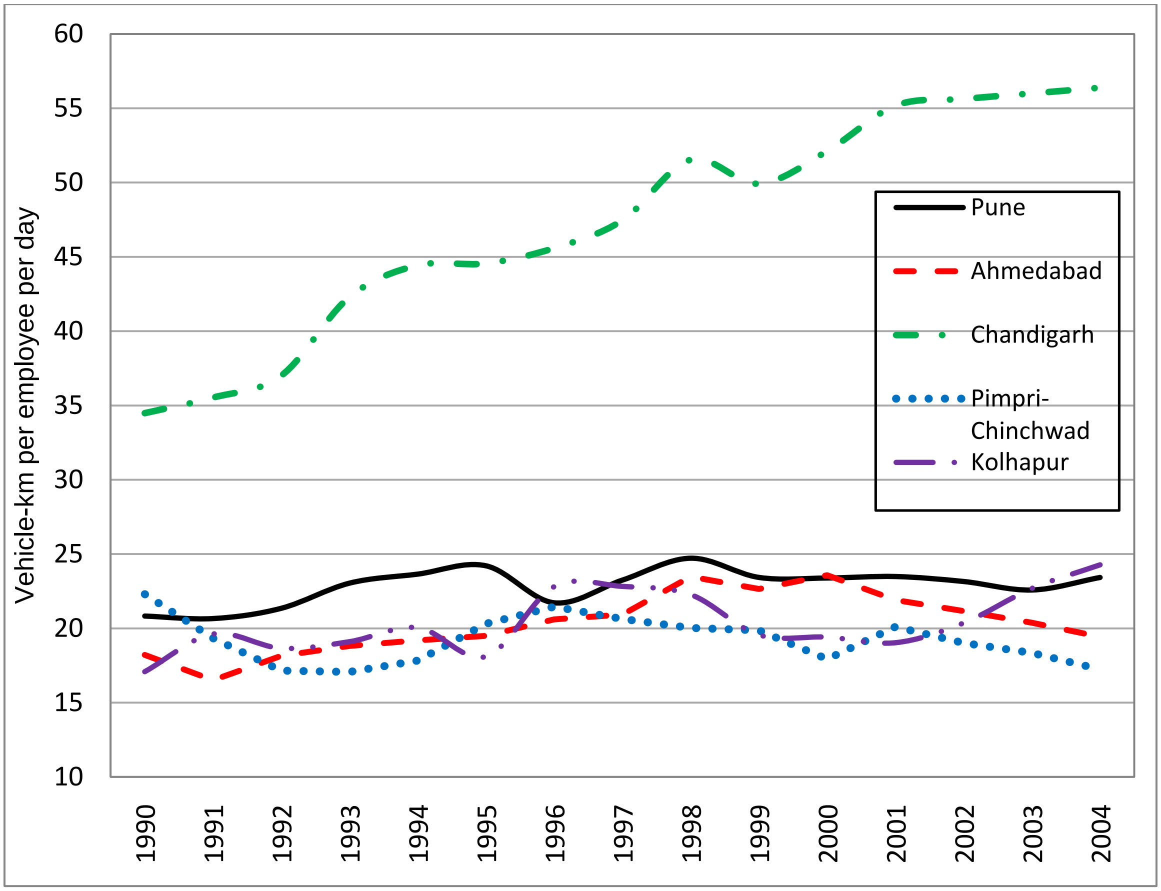
*Figure 6.20 Efficiency of Employees for Bus Companies in Large Cities (1990-2004)*




*Source*: ASRTU 2001, CIRT 2005

BMTC, Bangalore and MTC, Chennai are two companies that are able to produce the most vehicle-km per employee (fig 6.20). These are also the cities that have fewer employees per bus when compared to other large cities.

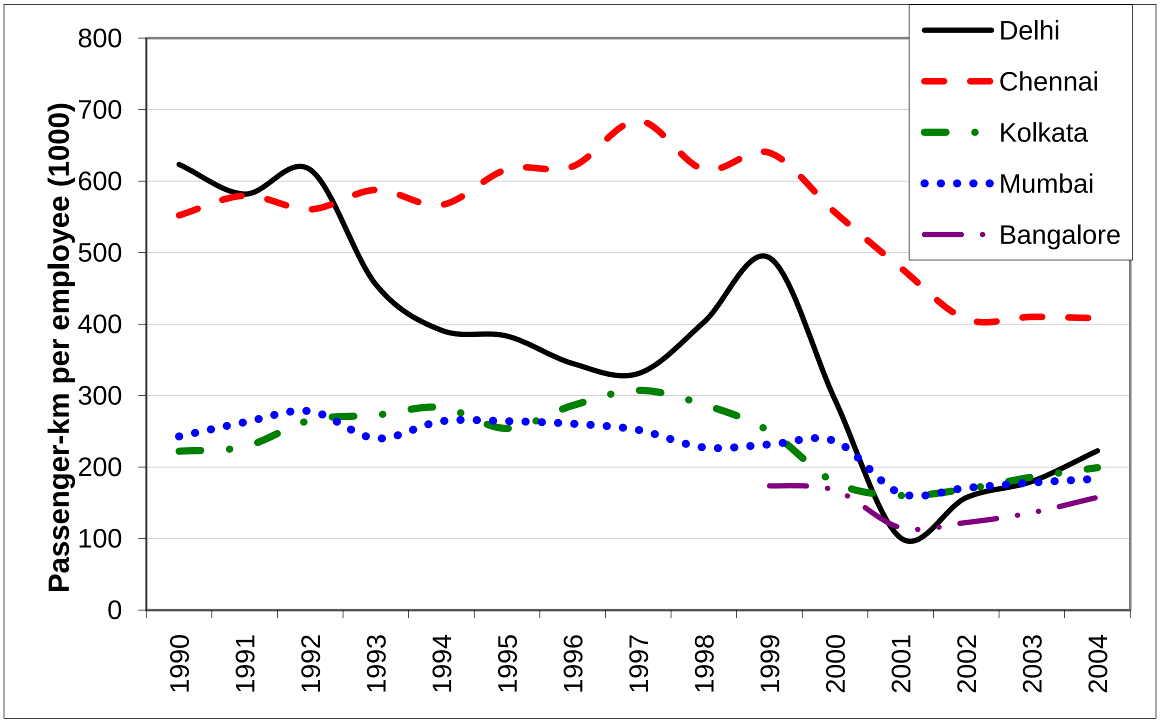
*Figure 6.21 Efficiency of employees for Bus Companies in Medium Cities (1990-2004)*




*Source*: ASRTU 2001, CIRT 2005

CHNTU, Chandigarh is an outlier in terms of employee efficiency compared to other medium sized cities (fig 6.21). Cities other than Bangalore, Chennai and Chandigarh have high employment rates that affect efficiency of production and increases cost of operations (CIRT 2005).

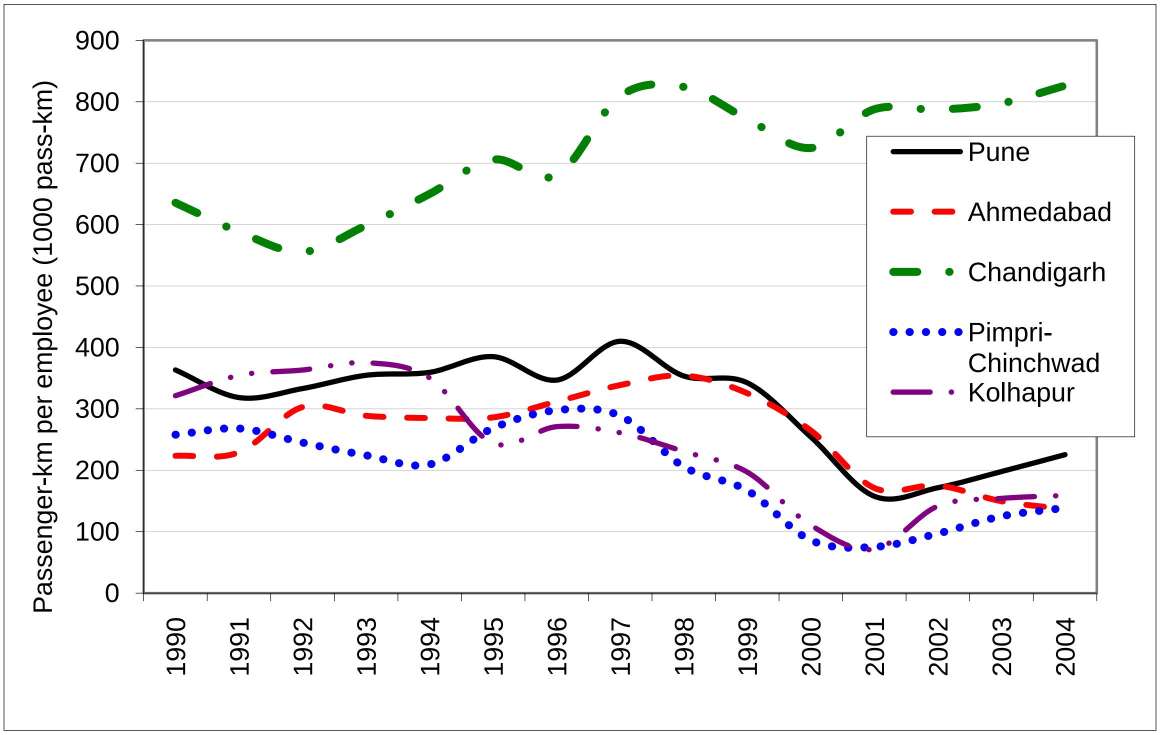
*Figure 6.22 Service Efficiency of Employees for Bus Companies in Large Cities (1990-2004)*




*Source*: ASRTU 2001, CIRT 2005

MTC Chennai has the highest labor efficiency in terms of passenger-km per employee (fig 6.22). MTC Chennai also has fewer employees per bus than DTC Delhi, BEST Mumbai, and CSTC Kolkata. BMTC Bangalore has the lowest employee productivity in terms of passenger-km per employee among the large cites. It is probably because BMTC, Bangalore has a lower passenger-km than Chennai and Mumbai and implies that buses in Bangalore are not as crowded as buses in other cities.

*Figure 6.23 Service Efficiency of Employees for Bus Companies in Medium Cities (1990-2004)*



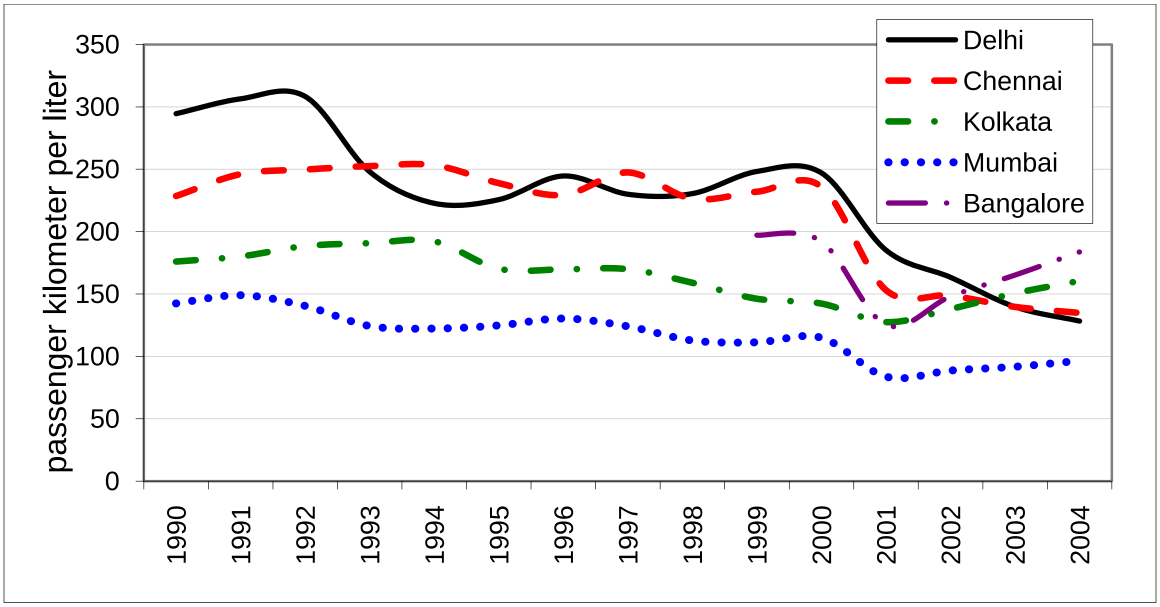

*Source*: ASRTU 2001, CIRT 2005

CHNTU, Chandigarh had higher service efficiency of employees compared to other medium sized cities (fig 6.23). Overall, service efficiency of medium sized cities have declined between 1990 and 2004. But most cites have seen an improvement since 2001 (ASRTU 2001, CIRT 2005).

### 6.3.3 Fuel Efficiency

Fuel efficiency is reported by the STUs to ASRTU and CIRT as kilometers per liter. The quality of fuel is monitored by the government and various government regulations have stipulated Euro-III and Euro-IV standards for fuel and emission. The improvement in the quality of the fuel itself has probably led to better fuel efficiency. BMTC, Bangalore and CHNTU, Chandigarh have achieved higher fuel efficiency than bus companies in other cities and it is probably because these cities have invested in newer vehicles and schedules regular maintenance for their vehicles.

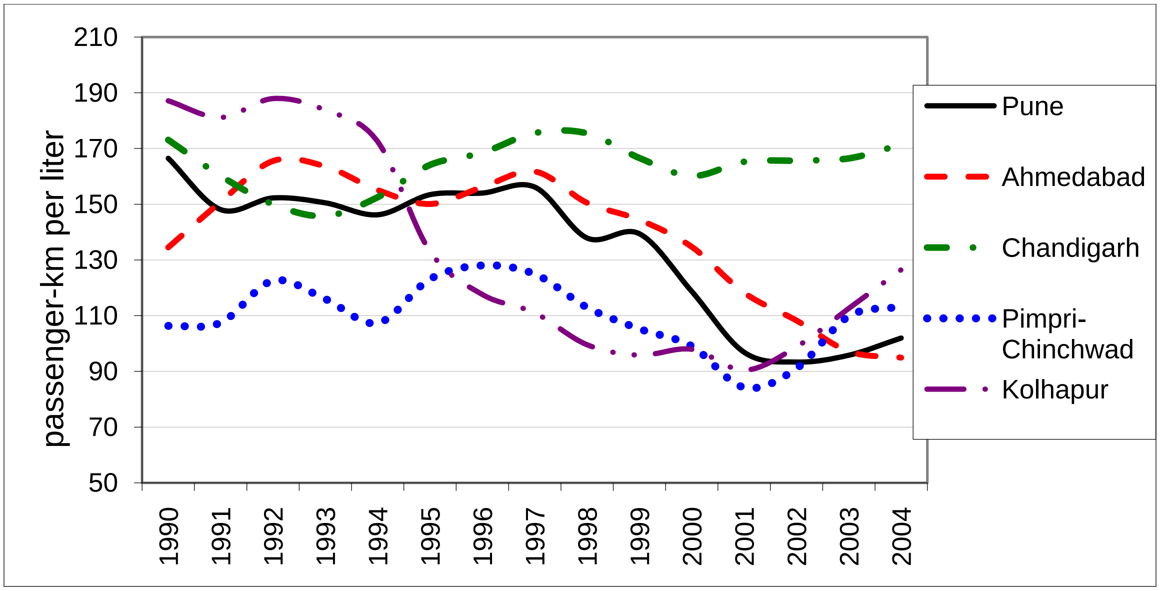
*Figure 6.24: Fuel Productivity for Bus Companies in Large Cities (1990-2004)*




*Source*: ASRTU 2001, CIRT 2005

The large cities experienced a small decline in passenger-km per liter of fuel till 2001 (ASRTU 2002) which is the result of lower ridership. Since 2001, however, the fuel efficiency has begun to improve in Bangalore, Mumbai and Kolkata (fig 6.24) due to an increase in ridership and in the case of Bangalore, an improvement in vehicle quality and maintenance. Fuel efficiency can also be measured as passenger-km per liter of fuel. As can be seen from figure 6.25, despite decreasing fuel efficiency in terms of kilometers per liter in Pune and Pimpri-Chinchwad since 2001, they have been able to generate more passenger-km per liter of fuel, which implies improved fuel productivity. .

*Figure 6.25 Fuel Productivity for Bus Companies in Medium Cities (1990-2004)*




*Source*: ASRTU 2001, CIRT 2005

## 6.4 Summary of Performance

The change in the service and financial performance of the cities studied are presented in table 6.1. All cities in India experienced a growth in population between 1990 and 2004, increased travel demand in the cities. So many cities expanded their bus services by increasing the number of vehicles that they operated, expanding the area that they served and adding new routes to their schedule. However, populations in these cities increased at a faster rate than the increase in bus capacity. So the quantity of service offered per capita decreased in most cities between 1990 and 2004.

*Table 6.1 Summary of performance change for large and medium cities between 1990 and 2004*

| | Quantity of Service | | | Financial Performance | | | Efficiency | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Number of buses | Capacity per capita | Load Factor | Revenue per km | Costs per km | Losses per year | Vehicle Efficiency | | Fuel Efficiency | | Labor Efficiency | |
| | | | | | | | PE | SE | PE | SE | PE | SE |
| **Large Cities** | | | | | | | | | | | | |
| Delhi | -/+/-/+ | - | - | + | + | + | - | - | + | - | - /+ | - |
| Mumbai | + | 0 | - | + | + | + | + | - /+ | + | - | + | - |
| Kolkata | + | - | - | 0 | 0 | 0 | - | - | + | - | + | - |
| Chennai | + | - | - / + | + | + | 0 | + | - /+ | + | - | + | - |
| Bangalore | + | - | - /+ | 0 | 0 | + $$ | + | -/+ | + | -/+ | + | + |
| **Medium Cities** | | | | | | | | | | | | |
| Ahmedabad | +/- | - | - | + | ++ | + | + / - | - | + | - | 0 | - |
| Chandigarh | + | - | - | + | 0 | - | + | + | + | 0 | + | + |
| Pimpri-Chinchwad | + | - | -/+ | + | ++ | + | + | - | + | - | 0 | - |
| Pune | + | - | -/+ | + | + | 0 | - | - | + | - | 0 | - |
| Kolhapur | + | 0 | -/ + | + | + | 0 | + | - | + | - | 0 | - |

*Legend*: **-** Decreased; **+** Increased; ++ Large increase; 0 No change;
+/- Increased, then decreased; **- /+** Decreased, then increased; **+ $$** Increasing profits

But even with a decrease in bus service provided per capita, crowding in buses did not increase. The load factor fell in both large and medium cities. This shows the modal share of bus transit is decreasing in Indian cities.

One of the reasons for the decrease in modal share is the improved economy. In India, GDP has grown at annual rates of 4-7% since 1990. Cities have been the center of this growth and most of the jobs and resultant income have been generated in the cities. Thus, people living in cities have more disposable income and higher car and motorcycle ownership rates. Chennai and Bangalore are two cities where load factors started to increase after an initial decline. They have been able to attract more passengers by offering better services such as air-conditioned buses and limited stop buses. These improvements targeted the middle class passengers who are able to afford personal modes, but will use buses if the services are attractive.

In most cities, revenue per km has increased even at constant 1990 prices. Revenue increased despite a decline in passenger-km, because fares have increased as well. However, costs have increased more than revenues resulting in increasing losses.

The most important component of operating costs is personnel costs (ITDP 1997). While labor efficiency is higher in large cities when compared with medium cities, the employees in larger bus companies receive better salaries and benefits increasing the cost of labor for large cities (Badami and Haider 2005). Cities such as Chandigarh and Bangalore which have better operating ratios also have lower employment rates in their STUs compared to other cities.

Production efficiency of vehicles has improved over time in most cities implying better fleet utilization and fewer service interruptions. However, service efficiency has declined in many cities. It is probably due to the decline in ridership and a decline in the modal share of bus transit. Employment rates in bus companies are high in many cities and it is probably a significant source of inefficiency. One of the limitations of the service efficiency analysis done here is that it shows a decrease in crowding as a decline in service efficiency. But most bus services in India had average occupancy rates at close to standing capacity and peak-hour occupancy much higher than standing capacity in the early 1990s. Less crowding on buses is a positive change for bus users in India. The problem that most cities face is that they are unable to provide sufficient supply of services to assure their passengers of a comfortable trip. The overcrowding on buses is an important factor that encourages passengers to purchase and use a motorcycle or a car.

Fuel efficiency has improved owing to general improvement in technology and quality of fuel, and has decreased the cost of fuel per kilometer. But since most cities expanded their operations since 1990, their total expenditure on fuel increased.

The performance indicators examined in this chapter provide an overview of the changes in service quality and efficiency, but it does not allow the determination of the overall efficiency of a bus company. Each of the performance indicators describes only one component of efficiency. Since some cities are efficient in the use of vehicles while others have better ridership, it is difficult to make any general conclusions by examining each performance indicator separately. So in the next chapter a data envelopment analysis is done to generate a single measure of efficiency for every STU selected for the study for every year from 1990 to 2004. Such a multivariate analysis would help to draw more general conclusions about the performance of STUs. Following efficiency analysis, a tobit regression is performed using the calculated efficiency as the dependent variable and various exogenous factors as independent variables to examine the factors that affect efficiency.

Delhi and Bangalore have private buses in addition to the public buses serving their cities, but have experienced dissimilar trends in service efficiency, vehicle efficiency, labor efficiency and financial performance (see table 6.1). So these two cities will be studied qualitatively in chapter 8 exploring the institutional and regulatory differences that may have influenced their outcome from privatization.

# 7 Efficiency Analysis of Urban State Transport Undertakings

Performance measurements of public transport systems on the sole basis of financial performance has been questioned by authors who have argued that public transport serves a social function as well, and it is useful to assess its efficiency in non-financial terms (Tsamboulas 2006; Karlaftis 2008). Most of the performance measurements that attempt to assess efficiency in non-financial terms measure efficiency as a ratio of outputs to inputs by using the services produced as outputs and the resources consumed as inputs (De Borger et. al. 2002, Karlaftis 2004, Nolan et.al. 2001). In this chapter the method Data Envelopment Analysis (DEA) is used to perform an efficiency analysis.

## 7.1 Data Envelopment Analysis (DEA) – The Method

DEA is a non-parametric method of efficiency measurement, which measures the relative efficiency of decision making units by comparing them to similar units (Charnes, Cooper and Rhodes 1978). The method calculates an agency's efficiency based on the maximum outputs that a decision making unit is able to produce with a given set of inputs or based on its ability to produce a given set of outputs using the least amount of inputs. The method is useful in assessing the performance of decision making units such as transit systems, schools, and hospitals for whom performance may not be measured only in terms of financial performance or profits earned. DEA can thus be used to ascertain a benchmark performance against which the performance of other similar agencies can be compared.

Efficiency is defined as the ratio of output to input.

Efficiency = output/input

However, since different outputs and inputs may not be equally important, appropriate weights may be assigned to the various output and input variables.

Efficiency = sum of weighted outputs/sum of weighted inputs

In DEA, the assessment of efficiency is done by maximizing the sum of weighted outputs for a given sum of weighted inputs.

$$\max_{A_i, B_k} \sum_{i=1,}^{m} A_i * Y_{ji} \qquad (1)$$

Such that

$$\sum_{k=1}^{n} B_k * X_{jk} = 1 \qquad (2)$$

$$\sum_{i=1}^{m} A_i * Y_{ji} - \sum_{k=1}^{n} B_k * X_{jk} \leq 0 \qquad (3)$$

$$B_k, A_i \geq \theta \qquad (4)$$

where, $\theta$ is a very small positive number;

$A_i$ is the weight of the $i^{th}$ output;

$B_k$ is the weight of the $k^{th}$ input;

$Y_{ji}$ is the quantity of the $i^{th}$ output of the $j^{th}$ agency;

$X_{jk}$ is the quantity of the $k^{th}$ input of the $j^{th}$ agency;

m is the total number of outputs; and

n is the total number if inputs used in the analysis.

Equation (1) maximizes the weighted output of company j, such that its weighted input is 1 (as constrained by equation 2). This constraint is added under the assumption that the resources available to a transit agency are limited and that the objective of the transit agency is to maximize its output given the limited resources. Equation (3) is added as a constraint to ensure that the efficiency is a number between 0 and 1. If output is always smaller than or equal to the input, the efficiency is always between 0 and 1.

Equation (4) ensures that all inputs and outputs have at least a small positive weight. This is essential because an agency j is allowed to manipulate the weights such that its efficiency indicator is maximized. For example, if equation 4 is not used in the DEA calculation, then an input such as fuel may be assigned a weight of zero while the number of vehicles is assigned the maximum weight. So equation 4 ensures that an unfavorable variable is not completely ignored. The fact that the weights can be manipulated by each agency allows each transit agency to assign weights to various inputs and outputs according to its priorities[13].

## 7.2 DEA as a method of performance measurement

Several studies have been done using performance indicators to examine the effects of subsidies and privatization on transit system performance. However, a problem faced by many of the earlier works (Bly and Oldfield 1986; Cervero 1986) is that they used a large variety of performance indicators that did not yield consistent results. So it was difficult to make any generalizations (Karlaftis 2004). Over the years, various studies have used factor analysis (Fielding et. al. 1985) and combination of factor analysis and cluster analysis to reduce the number of indicators. In 1992, Chu et. al. used

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[13] An example of how to calculate efficiencies using DEA using the MS excel solver- add on is presented in Appendix 7.1

data envelopment analysis (DEA) to develop a single measure of efficiency for a transit system relative to other transit systems in a peer group. Since then several studies have been done (Karlaftis and Sinha 1997; Mizutani and Nakamura 1997; Alexandersson et. al. 1998; Yeh et. al. 2000; Barnum et.al. 2007; Cho and Fan 2007) to study the performance of transit systems using DEA.

Viton (1998) studied the efficiencies (defined as a ratio of outputs to inputs) of bus transit systems in the USA using DEA, using the number of employees, the number of vehicles and the quantity of fuel consumed as inputs and the vehicle-miles and passenger-miles as outputs and found that 80% of the systems scored higher than 90%. Karlaftis and McCarthy (1997) also studied bus transit in the USA using DEA. They used three measures of efficiency - efficiency, effectiveness and combined performance - and found that a system that scored high on any one of the measures usually performed well on the other measures as well. Efficiency was defined as the production efficiency and measured using fuel used, number of employees and number of vehicles as inputs and vehicle-miles as output. Effectiveness was defined as service-effectiveness and measured using fuel used, number of employees and number of vehicles as inputs and passenger-miles as the outputs. Combined efficiency was measured using the same inputs but with both vehicle-miles and passenger-miles as output. Karlaftis and McCarthy (1997) found an inverse relationship between subsidy and transit performance. Transit systems that received more subsidies were less efficient compared to those agencies that received fewer subsidies.

Karlaftis (2004) studied the production efficiency and service effectiveness of 256 US transit agencies using DEA and found that efficiency (defined as the ratio of produced outputs to inputs) and effectiveness (defined as the ratio of rate of consumption of outputs to inputs) are positively related. The inputs used were quantity of fuel used, number of employees and number of vehicles. Three measures of efficiency were calculated using various output measures for the same inputs. Production efficiency had vehicle-miles as the output, service effectiveness had passenger-miles as the output and the combined efficiency had both vehicle-miles and passenger-miles as outputs. Piacenza (2006) studied the effects of subsidization mechanisms on the cost-efficiency of public transit systems by comparing the performance efficiencies of 44 Italian municipal bus companies during a seven year period from 1993 to 1999. The companies were subsidized either based on a cost-plus scheme or a fixed-price scheme[14]. The study used fuel, labor and number of vehicles as inputs and number of seat-kilometers as the output and found that companies under the fixed-cost scheme were more efficient in production of services. Margari et.al. (2006) studied 42 Italian public transit companies, comparing their efficiencies using DEA. They used number of drivers, number of other employees, quantity of fuel consumed per year, costs of other material and services as inputs. They calculated the annual seat-kilometers as the total number of vehicles times the average seating capacity of vehicles times the average distance covered by a vehicle in a year and used it as the output measure. The study found that the urban systems have an average efficiency of 93% against a mean efficiency of only 86% for the mixed and intercity systems.

Cho and Fan (2007) studied the effect of privatization of Taiwan Motor Transport Company on the efficiency of transit services in Taiwan. They used data from 1997

[14] The cost-plus scheme is where the local authorities enjoyed a full recovery of budget losses through subsidies. A fixed-cost scheme is where the local authorities receive a fixed amount as the subsidy.

through 2002. The data from 1997 to 2000 are those of the Taiwan Motor Transport Company which is a public undertaking. The data for 2002 is that of the private company Guo Gwang Bus Company who is the new owner. The data from the transition year 2001 was not included. Data prior to 1997 was not used due to inconsistencies in measurement. They developed three set of efficiency indicators for each of the years - cost-efficiency, service effectiveness and cost effectiveness using total number of employees, total number of vehicles and total fuel used as inputs and vehicle-kilometers and passenger-kilometers as outputs. All efficiency indicators showed statistically significant improvement following privatization.

Some studies took the calculation of efficiencies a step further and tried to analyze the sources of the inefficiencies. Boame (2004) examined the technical efficiency of Canadian transit systems using a bootstrap DEA method. The efficiency scores for thirty transit systems in Canada were calculated using the fleet size (number of buses in the active fleet), liters of fuel (diesel/gasoline) used, and labor (the total number of paid employee hours) as inputs and revenue vehicle kilometers as the output. After calculating DEA efficiency scores for the systems, Boame then used tobit regression to assess the sources of inefficiency. The independent exogenous variables included in the regression were average speed (a proxy for congestion costs), peak to base ratio, average fleet age, and time trend. The results showed that average speed had a positive and statistically significant effect on efficiency, the peak to base ratio was negatively correlated to efficiency and significant, the average age of fleet was negatively correlated to efficiency, but insignificant, the time trend variable was positively correlated to efficiency and significant indicating that there were system-wide improvements in efficiency probably due to technological advances.

Tsamboulas (2006) studied the performance of 15 transit systems in Europe using DEA to assess efficiency scores and performed a tobit regression on the efficiency scores with exogenous factors to determine the sources of inefficiency. Three inputs were used, *labor* measured as the number of employees, *fuel*, measured as the amount of fuel used annually, and *capital*, measured as the number of vehicles operated by each system. Three models were calculated, all of which used the same inputs, but with different outputs. The first efficiency model used annual vehicle kilometers as the output; the second, effectiveness model used annual number of passengers as the output; and the third combined model used both annual vehicle kilometers and the number of passengers as the outputs. To determine the sources of inefficiency, Tsamboulas regressed selected exogenous variables on the efficiency scores using tobit regression. The independent variables used were the density of each city, the total subsidy to total cost ratio, the total ticket revenue to total cost ratio, two dummy variables, publicly owned operator and open entry and finally a time trend variable. The variable *open entry* is an indicator of the competition that was introduced in some cities by allowing open entry to private operators. The results indicate that the only two variables that significantly affect efficiency are time trend and open entry, both of which are positively correlated to efficiency. All variables except public ownership have a statistically significant effect on service efficiency and all of the significant variables except subsidies to cost ratio have a positive effect. Subsidies to cost ratio seems to have a negative effect on service effectiveness indicating that increase in subsidies reduces service effectiveness. Overall effectiveness was significantly affected by all the variables used in the regression. The variables time trend, open entry, the population density of the city and the revenue by cost ratio had positive effects on overall efficiency. Public ownership and subsidies to cost ratio had negative effects on overall efficiency.

Reviews of the studies that have used Data Envelopment Analysis to compare the efficiencies of bus companies indicate that this is a useful method. It allows the calculation on an efficiency indicator which can be used to compare the performance of a transit agency to other similar agencies. Most of the studies indicate that privatization increases efficiency. The efficiency scores are useful when the sources of inefficiencies can be identified and possibly rectified. So it is also useful to do a regression on the efficiency indicators following the DEA, to identify the sources of inefficiency.

## 7.3 Efficiency of Urban Transport Companies in India

### 7.3.1 Data

For this study, the data used is from 10 urban transport agencies in India. The data is for 15 years 1989 – 2004 for each of the cities. Annual data was collected for each of the cities regarding their operating characteristics such as number of vehicles, number of employees, vehicle-kilometers, passenger-kilometers, fuel used, subsidies available, cost of operation, revenue from fares, etc. Data regarding possible exogenous factors, such as population of the area served, population density, private vehicle ownership rates, per capita incomes etc were also collected. These information were used to calculate production and service efficiencies and then to analyze the exogenous sources of inefficiency using tobit and truncated regressions.

### 7.3.2 Definitions of Inputs and Outputs

Production processes involve the use of inputs to produce outputs. In the case of bus transit, the inputs are generally in the three categories of labor, capital and energy (Karlaftis 2004). Accordingly, the most commonly used inputs are number of employees (proxy for labor), number of vehicles (proxy for capital) and quantity of fuel used annually (proxy for energy used). The outputs used to measure efficiency in the transit industry are usually vehicle-kilometers (produced output) and passenger-km or passenger boardings (consumed output) (Karlaftis, 2004, Cho and Fan 2007).

In this study, the inputs used are total number of employees, total number of buses, and total amount of fuel used per year. The outputs used are vehicle kilometers per year and passenger-kilometer per year. The first model is a *production efficiency* model with only vehicle kilometers as output and total number of employees, total number of buses, and total amount of fuel used per year as inputs. The second model is a *service efficiency* model with only passenger-km as output and total number of employees, total number of buses, and total amount of fuel used per year as inputs. A third *combined efficiency* model was run with both vehicle kilometers per year and passenger-kilometer per year as outputs and total number of employees, total number of buses, and total amount of fuel used per year as inputs.

On examination of data it was observed that for the years 1990, 1991 and 1992, Delhi had load factors that were above 100%. Load factor is calculated as the ratio of passenger-km to place–km where place-km is obtained by multiplying the total capacity of a bus including seating and standing capacity, by the total number of kilometers operated per year. This indicates that buses in Delhi were overcrowded during those years. If occupancy is analyzed using seating capacity of buses as the capacity and having standees as indicative of crowding, there are 33 cases where buses are crowded. High passenger-km will skew the results of service efficiency and combined efficiency and probably assign 100% efficiency to very crowded systems. This is conflicting because, as occupancy increases and buses are filled to capacity, it decreases comfort. Crowding decreases quality of service, increases waiting times and implies that the system is not offering sufficient quantity of service to meet the demand. It may also discourage passengers from using the bus, decreasing the effectiveness of service. The effectiveness of service as measured using passenger-kilometer as the only output is therefore an incomplete assessment of efficiency.

One possible way to resolve the conflict is to reduce the passenger-km for the years during which load factor was above 100% to reflect a load factor of only 100%, which is the maximum desirable load factor. However, even 100% load factor implies crowding. So another approach to dealing with the crowding on buses is to include a variable that indicates the level of crowding. This can be done by using the number of standees as an undesirable output. So if the occupancy ratio is 100% (equal to about 70% load factor), there would be no standees on the bus. Bus companies in India use 50 as the seating capacity of their buses. So an occupancy ratio of 150% implies that there are 25 standees.

However, DEA calculates efficiency by maximizing the outputs for a given set of inputs. So even though an undesirable output decreases efficiency as it is maximized, the DEA results would indicate otherwise. One possible approach is to transform the undesirable output into an input variable (Rheinhard et.al. 1999).

Another method is to transform the undesirable output by using a reciprocal of the undesirable output as the DEA output, thus making it a desirable output (Dyckhoff and Allen 2001; Gomes and Lins 2008). Variables with a value of ‘0’ can also be a problem for DEA calculations because it affects ratios.

So in this analysis, instead of using the number of standees as an output, a comfort variable is used.

Comfort = 100, when there are no standees, and

Comfort = 0.001, when there are 23 or more standees (22 is the standing capacity of buses)

Another possible problem was that the cities chosen for the study were not comparable in their size of operation. So each of the models discussed above were run twice, once with all cities combined into one group and then a second time with the cities grouped into large cities and medium cities.

The ten models run were the following.

***Production Efficiency***

Inputs: number of vehicles, number of employees, amount of fuel used per year

Output: vehicle-kilometers per year

1. Efficiencies of cities when grouped into large and medium cities over the study period of 1990-2004
2. Efficiencies of cities when **not** grouped into large and medium cities over the study period of 1990-2004

***Service Efficiency***

Inputs: number of vehicles, number of employees, amount of fuel used per year

Outputs: passenger-km per year, level of comfort

3. Efficiencies of cities when grouped into large and medium cities over the study period of 1990-2004 (with pass-km adjusted to reflect a maximum load factor of 100% and level of comfort not included as output)
4. Efficiencies of cities when grouped into large and medium cities over the study period of 1990-2004 (with pass-km not adjusted to reflect a maximum load factor of 100% , but with level of comfort included as output)
5. Efficiencies of cities when **not** grouped into large and medium cities over the study period of 1990-2004 (with pass-km adjusted to reflect a maximum load factor of 100% and level of comfort not included as a variable )
6. Efficiencies of cities when **not** grouped into large and medium cities over the study period of 1990-2004 (with pass-km not adjusted to reflect a maximum load factor of 100%, but with level of comfort included as output)

***Combined Efficiency***

Inputs: number of vehicles, number of employees, amount of fuel used per year

Output: passenger-km per year, level of comfort

7. Efficiencies of cities when grouped into large and medium cities over the study period of 1990-2004 (with pass-km adjusted to reflect a maximum load factor of 100% and level of comfort not included as an output)
8. Efficiencies of cities when grouped into large and medium cities over the study period of 1990-2004 (with pass-km not adjusted to reflect a maximum load factor of 100%, but with level of comfort included as output)

9. Efficiencies of cities when **not** grouped into large and medium cities over the study period of 1990-2004 (with pass-km adjusted to reflect a maximum load factor of 100% and level of comfort not included as an output)
10. Efficiencies of cities when **not** grouped into large and medium cities over the study period of 1990-2004 (with pass-km not adjusted to reflect a maximum load factor of 100%, but with level of comfort included as output)

### 7.3.2 Results from DEA

The measures of efficiency were calculated using DEA. The solver add-in on MS-Excel was used to solve the equations. The results presented in tables 7.1, 7.2 and 7.3 are average efficiencies for each city over the study period. The results for Delhi and Bangalore are presented for every year, to examine the effect of privatization on efficiency.

*Table 7.1: Average Production efficiencies of cities when grouped into large and medium cities over the study period of 1990-2004*

| | **City** | **Production Efficiency (when grouped into large and medium cities)** | **Production Efficiency (when not grouped into large and medium cities)** |
|---|---|---|---|
| Large cities | Delhi | 78.28 | 83.8 |
| | Chennai | 92.35 | 95.61 |
| | Kolkata | 69.63 | 65.72 |
| | Bangalore | 98.25 | 99.36 |
| | Mumbai | 73.89 | 77.81 |
| Medium cities | Chandigarh | 97.39 | 94.32 |
| | Pune | 89.47 | 85.63 |
| | Ahmedabad | 85.31 | 79.25 |
| | Kolhapur | 79.27 | 72.67 |
| | Pimpri-Chinchwad | 72.58 | 67.34 |

Average production efficiency is lower for the medium sized cities when they are compared with larger cities than when they are compared with similar sized cities, which shows that there is an element of scale efficiency involved (see table 1). Among the large cities, production efficiency is highest for Bangalore and Chennai. These are also cities where the STU has lower employment rates and higher fleet utilization compared to other STUs. Among the medium cities, Chandigarh is the most efficient. Similar to BMTC Bangalore and MTC Chennai, CHNTU, Chandigarh has low employment rates and high fleet utilization.

*Table 7.2 Average Service efficiencies of cities over the study period of 1990-2004*

| | | **Cities Grouped into Large and Medium cities** | | **Cities Not Grouped into Large and Medium cities** | |
|---|---|---|---|---|---|
| | **City** | **Service Efficiency (with level of comfort included)** | **Service Efficiency (without level of comfort)** | **Service Efficiency (with level of comfort included)** | **Service Efficiency (without level of comfort)** |
| Large cities | Delhi | 81.54 | 92.01 | 80.3 | 94.82 |
| | Chennai | 83.65 | 98.35 | 89.43 | 98.53 |
| | Kolkata | 93.47 | 88.29 | 90.21 | 89.58 |
| | Bangalore | 97.26 | 78.31 | 97.35 | 82.21 |
| | Mumbai | 95.27 | 84.73 | 95.43 | 88.72 |
| Medium cities | Chandigarh | 96.31 | 96.34 | 95.32 | 80.34 |
| | Pune | 91.51 | 91.62 | 81.42 | 72.53 |
| | Ahmedabad | 80.43 | 80.31 | 76.35 | 69.47 |
| | Kolhapur | 84.81 | 86.28 | 80.96 | 70.29 |
| | Pimpri-Chinchwad | 78.01 | 79.52 | 72.43 | 62.42 |

In table 7.2, when level of comfort is included as an output, the passenger-km is not adjusted to reflect 100% load factor. But, when level of comfort is not included as an output, the passenger-km are adjusted to reflect a maximum load factor of 100%[15]. There addition of level of comfort as an output, does affect the service efficiency. Crowded systems such as those in Delhi and Chennai have lower service efficiency when level of comfort is included. Systems with lower passenger-km per vehicle, such as Bangalore and Mumbai appear to be more efficient when comfort is considered as an important output.

*Table 7.3 Average Combined efficiencies of cities over the study period of 1990-2004*

| | | **Cities Grouped into Large and Medium cities** | | **Cities Not Grouped into Large and Medium cities** | |
|---|---|---|---|---|---|
| | **City** | **Combined Efficiency (with level of comfort included)** | **Combined Efficiency (without level of comfort)** | **Combined Efficiency (with level of comfort included)** | **Combined Efficiency (without level of comfort)** |
| Large cities | Delhi | 80.65 | 88.09 | 81.8 | 90.43 |
| | Chennai | 88.41 | 97.42 | 90.23 | 97.29 |
| | Kolkata | 87.52 | 83.35 | 88.92 | 82.49 |
| | Bangalore | 99.14 | 98.37 | 98.32 | 96.68 |
| | Mumbai | 92.47 | 85.28 | 91.25 | 83.54 |
| Medium cities | Chandigarh | 96.42 | 96.2 | 96.59 | 90.74 |
| | Pune | 90.79 | 90.47 | 86.27 | 81.46 |
| | Ahmedabad | 83.78 | 84.28 | 82.46 | 72.93 |
| | Kolhapur | 82.48 | 84.64 | 84.82 | 76.38 |
| | Pimpri-Chinchwad | 76.98 | 78.83 | 75.39 | 66.17 |

Combined efficiency is less affected by the scale of operations when level of comfort is included as an output variable. STUs in smaller cities in India have lower

[15] As discussed in the previous section, passenger-km is adjusted such that the maximum load factor would be only 100%. This is because ridership above 100% indicates a very crowded condition, but the DEA will calculate efficiency considering any increase in passenger-km as a positive factor.

ridership rates than most of the large cities and are less crowded. When level of comfort is not used as an indicator of crowding, crowded systems are rated as more efficient and this reflects adversely on STUs in smaller cities. But, when crowding is addressed as an important factor that reduces efficiency, less crowded systems are rated higher. Since crowding indicates that the city does not have sufficient number of buses operating, the efficiencies which include level of comfort are more suitable for further analysis.

The efficiency of bus systems in Chennai and Delhi increases by almost 9 points when the level of comfort is not used as an output variable. This shows that buses in these cities are crowded. On the other hand the efficiency of BEST Mumbai decreases by about 7 points when level of comfort is not used as an output, which shows that buses in Mumbai are not as crowded as those in Delhi and Chennai.

Since crowding is an important factor that affects service quality and efficiency calculations, the efficiencies calculated using crowding factor will be used for further analyses.

Bangalore and Delhi are two cities that used private buses to increase their supply of public transport. Both cities privatized only partially and private buses did not replace public buses in either city. The efficiencies of these two cities are presented separately to analyze whether their use of private buses have had an impact on the efficiency of their bus services. The efficiencies for BMTC Bangalore are presented in Table 7.4.

*Table 7.4: Efficiencies for Bangalore Metropolitan Transport Corporation for various years when compared against all other cities included in the study (comfort variable included as output)*

| | Year | Production Efficiency | Rank | Service Efficiency | Rank | Combined Efficiency | Rank |
|---|---|---|---|---|---|---|---|
| Pre-privatization | 1999 | 96.23 | 10 | 90.29 | 10 | 96.93 | 10 |
| Post-privatization | 2000 | 96.96 | 9 | 96.62 | 7 | 97.73 | 6 |
| | 2001 | 97.48 | 8 | 95.82 | 9 | 97.17 | 9 |
| | 2002 | 98.73 | 6 | 96.43 | 8 | 97.73 | 7 |
| | 2003 | 98.14 | 7 | 97.69 | 6 | 97.59 | 8 |
| | 2004 | 98.99 | 5 | 98.17 | 5 | 98.53 | 5 |
| | 2005 | 99.15 | 4 | 98.83 | 4 | 98.90 | 4 |
| | 2006 | 99.56 | 3 | 100.00 | 1 | 100.00 | 1 |
| | 2007 | 100 | 1 | 99.72 | 3 | 99.04 | 3 |
| | 2008 | 99.82 | 2 | 99.89 | 2 | 99.62 | 2 |

All three measures of efficiency have increased for BMTC, Bangalore following privatization, even though it is only a small increase for production efficiency and combined efficiency.  There is more increase in service efficiency showing an improvement in quality of service.  Bangalore has increased its supply of buses, decreasing crowding and offers more attractive services targeting middle class passengers.

The efficiencies for DTC Delhi are presented in tables 7.5.

*Table 7.5: Efficiencies for Delhi Transport Corporation for various years when compared against all other cities included in the study (comfort variable included as an output variable)*

| | Year | Production Efficiency | Rank | Service Efficiency | Rank | Combined Efficiency | Rank |
|---|---|---|---|---|---|---|---|
| Pre-privatization | 1990 | 92.42 | 3 | 71.14 | 19 | 78.26 | 17 |
| | 1991 | 87.92 | 5 | 72.93 | 16 | 77.82 | 18 |
| | 1992 | 95.19 | 2 | 71.48 | 17 | 79.42 | 14 |
| | 1993 | 85.93 | 6 | 71.43 | 18 | 76.81 | 19 |
| Post-privatization | 1994 | 81.26 | 9 | 74.38 | 14 | 79.12 | 16 |
| | 1995 | 71.91 | 15 | 76.89 | 12 | 80.52 | 11 |
| | 1996 | 64.21 | 19 | 76.68 | 13 | 80.94 | 10 |
| | 1997 | 65.27 | 18 | 73.27 | 15 | 81.37 | 9 |
| | 1998 | 74.83 | 12 | 81.4 | 11 | 79.25 | 15 |
| | 1999 | 83.11 | 8 | 84.17 | 9 | 80.18 | 12 |
| | 2000 | 83.84 | 7 | 88.93 | 2 | 79.43 | 13 |
| | 2001 | 67.68 | 17 | 86.53 | 5 | 86.91 | 3 |
| | 2002 | 74.82 | 13 | 87.31 | 4 | 87.39 | 1 |
| | 2003 | 78.92 | 10 | 89.43 | 1 | 83.58 | 6 |
| | 2004 | 78.56 | 11 | 84.78 | 8 | 82.96 | 7 |
| | 2005 | 71.9 | 16 | 82.73 | 10 | 87.24 | 2 |
| | 2006 | 74.28 | 14 | 85.67 | 6 | 86.31 | 4 |
| | 2007 | 92.12 | 4 | 85.29 | 7 | 82.94 | 8 |
| | 2008 | 96.67 | 1 | 87.61 | 3 | 83.92 | 5 |

Privatization seems to have improved service and combined efficiency when comfort level is used as an output, even though the improvement in efficiency is not consistent[16]. The lowest efficiencies were before privatization. It shows that DTC buses were more crowded before privatization and comfort levels improved after privatization.

[16] Trend analyses described in chapter 6 showed that DTC had several fluctuations in all variables over the course of the study period.

On the other hand, when level of comfort is not used as a variable, the years before privatization have relatively high service efficiency indicating high ridership[17].

One of the findings from the DEA results is that crowding on buses decreased in both Bangalore and Delhi following privatization. Efficiencies have also improved in Bangalore following privatization, but there have been periodic improvements and declines in efficiency in Delhi. The efficiencies calculated using DEA provides an understanding of how the overall efficiencies have changed over time. But it is not possible to explore the reasons for such changes in efficiency using DEA. The results from DEA indicates that having competition from private buses helped improve services in Bangalore, while the outcome was more ambiguous for Delhi. But there could be several other exogenous factors that affect efficiency.

Further analysis using regression will help identify such exogenous factors. The next section discusses the regression analyses that were performed to explore the causes of inefficiency.

## 7.4 Identifying Exogenous Factors that Affect Efficiency

The results from the DEA are a set of efficiency scores for each of the transit agencies for each year. Regression of these efficiency scores on the various external factors that could affect efficiency, but were not included in the DEA can be used to understand the influence of those factors on the efficiency scores. This will help identify the sources of inefficiency, some of which may be environmental factors such as congestion, while others may be policy factors such as fare per km, and yet others may be

[17] During those years the average load factor for DTC buses were about 110 % (ASRTU 2002).

demographic factors such as population density or average income. It might be possible for the transport company to address some of these sources of inefficiency and improve performance, but others such as the demographic factors may be beyond their control.

Ordinary least squares (OLS) regression is not appropriate for this analysis because OLS assumes that the dependent variable can assume any value and would give biased parameter estimates (Tsamboulas 2006). In this case, the dependent variable is the efficiency score calculated using DEA, and these scores are always between 0 and 100. For such dependent variable with truncated or limited values, tobit regression (Tobin 1958) or truncated regression is more appropriate. In this data set all observations have efficiencies between 64 and 100. So it implies that a truncated model might be more appropriate than a tobit model. So both models are used and compared in this analysis. The tobit model is shown in equation 5 and the truncated model is shown in equation 6.

$$y_{it} = x_{it}(\beta) + u_{it}, \quad u_{it} \sim N(0, \sigma^2) \quad \ldots\ldots..(5)$$

$$y_{it} = y_{it}^*, \text{ if } y_{it}^* > 64 \text{ and } <100$$
$$y_{it} = 64, \quad \text{if } y_{it}^* \leq 64$$
$$y_{it} = 100, \quad \text{if } y_{it}^* \geq 100$$

where,

$y_{it}^*$ = efficiency score (from DEA) for city i in time t
$x_{it}$ = vector of independent variable
$(\beta)$ = vector of estimated parameter
$u_{it}$ = error term

$$y_{it} = x_{it}(\beta) + u_{it}, \quad u_{it} \sim N(0, \sigma^2) \quad \ldots\ldots..(6)$$

$$y_{it} = y_{it}^*, \text{ for } y_{it}^* > 64 \text{ and } \leq 100$$

where,

$y_{it}^*$ = efficiency score (from DEA) for city i in time t
$x_{it}$ = vector of independent variable
$(\beta)$ = vector of estimated parameter
$u_{it}$ = error term

The summary statistics for the dependent variables are presented in table 7.6

*Table 7.6 Summary Statistics for Dependent Variables*

| Variables | Mean | Std. Dev | Min | Max |
|---|---|---|---|---|
| **Production Efficiency** | 83.12 | 10.423 | 64.21 | 100 |
| **Service Efficiency** | 87.75 | 7.696 | 71.14 | 100 |
| **Combined Efficiency** | 87.29 | 7.257 | 70.22 | 100 |

The models shown in equations 5 and 6 are used for production efficiency. For service efficiency and combined efficiency, the lower limits for truncation and censoring are set at 71 and 70 respectively.

### 7.4.1. Independent Variables Used and Hypotheses

The exogenous independent variables used in the regression models are those that can influence the efficiency of transit systems. These variables can be broadly classified into demographic factors, traffic conditions and policy variables. In addition to the various exogenous factors, there can also be city-specific effects on efficiency due to various unmeasured factors. Some such factors would be the city's cultural attitude towards mass transit, the landuse patterns in the city, the institutional arrangement for public transport management and operation, the management of privatization and even corruption. The use of dummy variables for cities will allow to test whether such unmeasured factors significantly affect efficiency. These unmeasured city fixed effects are assumed to be time invariant. Dummy variables are used for each of the cities, except Kolkata and Ahmedabad. The data for Kolkata was excluded because Kolkata always had private buses, the key variable of interest which was correlated with the city dummy variable. The dummy for Ahmedabad was omitted and serves as the reference case. The variables are presented in table 7.7.

*Table 7.7 Independent variables*

| Variable group | Variable | Description |
|---|---|---|
| **Demographic factors** | Popdnsty | Population density |
| | incmpcpt | Income per capita |
| **Traffic Conditions** | avgtrfsp | Average traffic speed |
| **Policy Variables** | avgagebs | Average bus age |
| | farepkm | Fare per km |
| | pvtbus | Competition from private buses |

***Demographic Factors:*** The demographic variables used are *population density* and *income per capita.* Population density is the population per land area and is obtained by dividing the total population by total land area of the city. It is expected that higher population density will lead to higher occupancy of buses resulting in higher passenger-km. So population density is expected to have a positive effect on service efficiency. Average population density for the cities chosen was 12046.46 persons per square kilometer, and Mumbai had the highest density with 29484.28 persons per square kilometer.

According to the literature, income per capita is expected to affect the efficiency negatively, the argument being that higher incomes lead to higher ownership and use of private vehicles and reduced use of public transport (Boame 2004). So efficiency of public transport is expected to be negatively correlated to average income. However, in developing countries, a small increase in per capita income may increase the use of public transport, because a large number of urban poor cannot afford even the low fares of public transport. In the case of Indian cities, higher average incomes probably will not have any significant influence on ridership because regardless of the increase in the number of people who are able to afford private automobiles, there will still be a large number of captive riders who will continue to use public transport.

***Traffic Conditions***: A variable used to reflect external influences from traffic, such as congestion, is the *average speed of traffic.* Higher average speeds have been shown to increase efficiency and therefore the variable is expected to have a positive influence on efficiency (Boame 2004).

***Policy variables***: The policy variables that can affect efficiency of public transport are *fare per km, average age of buses,* and *competition from private buses.*

Fare per km is the fare that is charged per kilometer on ordinary buses in the city. Express buses and luxury buses, such as air-conditioned buses charge more per kilometer. High fares are expected to discourage some patrons from using public transport, reducing ridership. So the variable is expected to have a negative effect on efficiency. Public buses in India operate as 'stage carriages' and fares are scheduled per stage. A stage is about 2 km, and fare per stage is not very different for each city. However, the fare structure varies more from city to city. For example, in Chennai, 5 stages (10 km) cost Rs 3.50 and in Bangalore, a 10 km trip costs about Rs. 10.00. Highest fares for 10 km are in Bangalore and Delhi and the lowest are in Chennai. Average trip length for Indian cities is about 10km (Ministry of Urban Development 2008). So to calculate fare per km, the fare for 10 km was divided by 10. This is possibly a better indicator of fare differences between cities than fare per stage.

Average age of vehicles is a variable that can be controlled directly by the operator who may choose to purchase new vehicles. It is often a matter of policy and is sometimes enforced by laws on private operators. Older buses are expected to experience more breakdowns, causing disruptions of service negatively affecting efficiency. So as the age of buses increases, efficiency decreases and the variable is expected to have a negative effect on efficiency (Boame 2004).

A dummy variable that indicates whether or not the system has competition from private buses is also included. According to privatization theory, competition is expected to have a positive impact on efficiency.

Finally, a *time trend* is included in the model as well. The variable *time trend* would capture any linear trend in efficiency during the 15 years from 1990 to 2004 (Boame 2004; Tsamboulas 2006). The variable is expected to have a positive influence on efficiency owing to advances in technology and management practices. In addition to modeling time as a linear trend, it is also modeled by using dummy variables for years to detect discontinuities.

The summary statistics for the independent variables are presented in table 7.8.

*Table 7.8 Summary Statistics for Independent Variables*

| **Variables** | **Mean** | **Std. Dev** | **Min** | **Max** |
|---|---|---|---|---|
| Competition from private buses (dummy) | 0.295302 | | | |
| Population density (persons per square km) | 12046.46 | 7617.808 | 2194.67 | 29484.28 |
| Income per capita (Rupees) | 26029.5 | 13538.7 | 10337.56 | 99262.65 |
| Average traffic speed (km per hour) | 21.90604 | 4.700981 | 12 | 30 |
| Average bus age (years) | 9.053691 | 3.077348 | 4 | 15 |
| Fare per km (Rupees) | 0.536175 | 0.346443 | 0.25 | 1.6 |

The correlations between the independent variables were examined using pair-wise correlations and variance inflation factors (VIF). Variance inflation factors are a measure of multi-collinearity among the independent variables. Multi-collinearity results when there is significant interdependence between the independent variables. VIF diagnostics were performed and the results are presented in table 7.9. The VIF is calculated as $1/(1-R^2_k)$, where $R^2_k$ is the $R^2$ calculated by regressing each independent variable k on all other independent variables. Higher values of VIF indicate higher levels of multicollinearity, and represent the factor by which the variance of eth estimators is inflated. 1/VIF is called the *tolerance* and since it is the reciprocal of VIF, lower values (less than 0.05) indicate high levels of multicollinearity. The pair-wise correlations are presented in table 7.10.

*Table 7.9 Variance Inflation Factors*

| Variable | VIF | 1/VIF |
|---|---|---|
| Fare per km | 6.16 | 0.162404 |
| Population density | 3.98 | 0.251009 |
| Average Speed of traffic | 3.84 | 0.260119 |
| Income per capita | 3.53 | 0.283533 |
| Average age of buses | 2.9 | 0.344661 |
| Competition from private buses | 2.69 | 0.37211 |
| Mean VIF | 3.85 | |

The VIF for all variables are below 10 and indicates low levels of interdependence between the independent variables.

*Table 7.10 Pair-wise Correlations for Independent Variables used in Regression Analysis*

| | Competition from private buses | Population density | Income per capita | Average speed of traffic | Average age of buses | Fare per km |
|---|---|---|---|---|---|---|
| Competition from private buses | 1.0000 | | | | | |
| Population density | 0.1893 | 1.0000 | | | | |
| Income per capita | 0.1723 | 0.1545 | 1.0000 | | | |
| Average speed of traffic | -0.3230 | -0.3908 | -0.3662 | 1.0000 | | |
| Average age of buses | -0.0401 | -0.0252 | -0.3020 | 0.2198 | 1.0000 | |
| Fare per km | 0.2857 | -0.1565 | 0.3351 | -0.3770 | -0.3023 | 1.0000 |

It would have been reasonable to expect average speed to have a significant correlation with population density and income per capita. But it is perhaps not significant because average speed of traffic is low in all cities. The medium cities have narrower streets and more biking and walking trips, which add to congestion because pedestrians and cyclists use the roads due to the absence of sidewalks. In the large cities road congestion is due to the high volume of motorized vehicles.

### 7.4.2 Modeling the Efficiency of Transport Systems

Tobit regressions and truncated regressions were performed for all three sets of dependent variables, production efficiency, service efficiency and combined efficiency. The data set is for 10 cities for 1990-2008. But the data is not uniformly available for all cities for all years creating an unbalanced panel. Data for Delhi is available from 1990-2008, data for Bangalore is available from 1999 to 2008 and data for all the other cities

(Ahmedabad, Chandigarh, Chennai, Kolkata, Kolhapur, Mumbai, Pimpri-Chinchwad and Pune) are available for 1990-2004.

The following 4 models were run for the years 1990-2004 with 126 observations, for each of the dependent variables. The panel is still unbalanced because the data for Bangalore is unavailable for 1990-1998[18].

1. Tobit regression with dummy variables for cities and dummy variables for years
2. Truncated regression with dummy variables for cities and dummy variables for years
3. Tobit regression with dummy variables for cities and a time trend variable
4. Truncated regression with dummy variables for cities and a time trend variable

***Production Efficiency***

The year dummies were insignificant in both the tobit and truncated models indicating that no particular year had any significant effect on efficiency. If there was a nation-wide policy change which affected all STUs the dummy variable for that year may have been significant. Also the values of the coefficients and the significance of the other variables are almost the same regardless of whether the time trend or year dummies are used in the model. So the results from the models using the 'time trend' variable, which assumes a linear time effect are used for further discussion[19].

Table 7.11 presents the results for production efficiency.

[18] Regression models were also done by excluding Bangalore for 1990-2004 data, to ensure a balanced panel. The signs of the coefficients and their significance were similar to the results presented which were obtained by including Bangalore in the analysis.
[19] The results from regression models with year-dummies are presented in the Appendix.

*Table 7.11 Regression results for production efficiency*

| Variables | Tobit regression | | Truncated regression | |
|---|---|---|---|---|
| | **Coefficient** | **t** | **Coefficient** | **z** |
| Competition from private buses | 5.182322 | 1.82 | 6.14322 | 1.88 |
| Population density | -.0002158 | -2.07 | -.0001981 | -2.13 |
| Income per capita | .0002425 | 0.28 | .0002409 | 1.08 |
| Average traffic speed | .1126814 | 2.31 | .1154666 | 3.40 |
| Average age of buses | -.0554155 | -3.25 | -.0787514 | -2.68 |
| Fare per km | 11.93066 | 3.33 | 12.38122 | 3.27 |
| Time trend | .155327 | 3.04 | .1560417 | 4.38 |
| Bangalore | 20.89307 | 6.78 | 20.7106 | 6.03 |
| Chandigarh | 19.37725 | 5.67 | 20.68532 | 5.25 |
| Chennai | 3.86844 | 3.18 | 3.991728 | 3.09 |
| Delhi | -16.39565 | -7.41 | -15.31195 | -7.24 |
| Kolhapur | -.8296678 | -0.24 | -.5154113 | -0.14 |
| Mumbai | -14.73506 | -5.44 | -15.64729 | -5.29 |
| Pimpri-Chinchwad | -7.746538 | -2.46 | -7.206248 | -2.15 |
| Pune | 8.020621 | 1.89 | 8.131615 | 1.73 |
| Constant | 84.41546 | 7.66 | 86.98128 | 6.91 |
| | | | | |
| Log likelihood | -328.68016 | | -315.65805 | |
| Wald $chi^2$ | | | 604.03 | |
| LR $chi^2$ | 266.67 | | | |
| Prob > $chi^2$ | 0.0000 | | 0.0000 | |

The results from both tobit and truncated models are very similar. The variables that have a significant positive effect on production efficiency are average traffic speed, fare per km and time trend. Higher traffic speeds leads to better efficiency indicating that reduction in congestion and overall reduction in use of private vehicles will benefit efficiency of buses. An increase in average traffic speed by 1km/hr can increase the efficiency of bus services by 0.11%. Cities that charge higher fares are more efficient. Higher revenues will help cities invest in better vehicles and in regular maintenance of vehicles which will in turn improve efficiency. An increase in fare by 1 rupee/km can increase the efficiency of public buses by 11.9% to 12.3%[20]. The variables that have a negative effect on production efficiency are population density and average age of buses. Production efficiency is calculated by maximizing vehicle kilometers, which is higher in less dense cities than in densely populated cities. So higher population density has a small negative effect on production efficiency. Older buses cause a decline in production efficiency as well. Production efficiency can decline by about 0.05% to 0.08% for every year that a bus has been in service.

Competition from private buses has a significant effect on the production efficiency of STUs at the 90% level. The city dummy variables of several cities are significant showing that unmeasured factors are significant[21]. Bangalore, Chennai and Chandigarh show significant positive effects and Delhi, Mumbai and Pimpri-Chinchwad show significant negative effects. This implies that it was probably factors other than competition from private buses that helped Bangalore improve its efficiency[22].

***Service Efficiency***

Similar to production efficiency, year dummy variables were insignificant and the models using the 'time trend' variable are used for discussion[23]. Table 7.12 presents the results for service efficiency. The values of service efficiency used for regression analysis are those calculated with 'comfort' factor included as a variable.

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[20] The average distance travelled by commuters in most cities is about 10km, and the fare for a 10 km trip ranges from about Rs. 3.00 to about Rs. 12.00. So an increase in fares by 1 rupee per km will result in at least a doubling of fares. In some cities the fare will become 4 times higher than current fares.

[21] Examples of such factors are the city's culture towards public transport and the number of workers per family.

[22] Regression models were also done with the entire dataset from 1990-2008. The results showed that competition from private buses had a significant negative effect on production efficiency. City effects were similar but with Bangalore and Chandigarh showing higher positive coefficients with stronger significance.

[23] The results from regression models with year-dummies are presented in the Appendix.

*Table 7.12 Regression results for service efficiency*

| Variables | Tobit regression | | Truncated regression | |
|---|---|---|---|---|
| | **Coefficient** | **t** | **Coefficient** | **z** |
| Competition from private buses | 4.323947 | 2.73 | 3.757766 | 2.19 |
| Population density | .0002659 | 3.07 | .0002887 | 3.09 |
| Income per capita | -.000178 | -3.54 | -.000192 | -3.18 |
| Average traffic speed | .0948774 | 2.50 | .0463948 | 2.23 |
| Average age of buses | -.1070572 | -0.86 | -.0976506 | -0.50 |
| Fare per km | 10.89022 | 5.32 | 12.57584 | 5.38 |
| Time trend | .6669024 | 3.62 | .731144 | 3.70 |
| Bangalore | 13.01687 | 12.33 | 13.77223 | 11.70 |
| Chandigarh | 10.25466 | 5.85 | 10.03096 | 5.43 |
| Chennai | 3.792542 | 2.26 | 4.390075 | 2.44 |
| Delhi | -12.91916 | -11.40 | -13.65928 | -10.49 |
| Kolhapur | 1.34489 | 0.75 | 1.00847 | 0.53 |
| Mumbai | 15.83759 | 1.39 | 16.37506 | 1.03 |
| Pimpri-Chinchwad | -5.219577 | -3.24 | -5.546077 | -3.22 |
| Pune | 9.042232 | 1.34 | 8.938897 | 1.39 |
| Constant | 82.76786 | 14.64 | 80.72097 | 13.30 |
| | | | | |
| Log likelihood | -246.44083 | | -241.90648 | |
| Wald $chi^2$ | | | 1873.07 | |
| LR $chi^2$ | 380.34 | | | |
| Prob > $chi^2$ | 0.0000 | | 0.0000 | |

The variables that have a significant positive effect on service efficiency are competition from private buses, population density, average speed of traffic, fare per km and time trend. The addition of private buses increases the supply of buses and decreases crowding on buses, which improves the quality of service. Service efficiency can increase by 3.75% to 4.32% with the introduction of private buses. High population densities help to increase ridership on buses, increasing service efficiency. Similar to production efficiency, increasing the average speed of traffic and increasing fares will have a positive effect on service efficiency. An increase in fares by 1 rupee per km could increase the efficiency by 10.89% to 12.58%. An increase in fares could theoretically decrease ridership, but fare increases in India are usually very small and do not tend to affect ridership. Increases in per capita income have negative effects of service efficiency. As more people are able to afford private vehicles, they will choose to ride the bus only if the services are attractive. The marginal effect of increase in personal incomes on the service efficiency is very small and is probably because of the large number of captive riders.

The dummy variables for Bangalore, Chandigarh and Chennai are positive and significant and that for Delhi and Pimpri-Chinchwad are negative and significant. Other cities do not have any city effects. It shows that unmeasured factors, perhaps the service improvements that Bangalore and Chennai implemented targeting the middle class, also have an effect on service efficiency.

***Combined Efficiency***

Similar to production and service efficiency, year dummy variables were insignificant for combined efficiency and the models using the 'time trend' variable are used for discussion[24]. Table 7.13 presents the results for combined efficiency.

[24] The results from regression models with year-dummies are presented in the Appendix.

*Table 7.13 Regression results for combined efficiency*

| Variables | Tobit regression | | Truncated regression | |
|---|---|---|---|---|
| | Coefficient | t | Coefficient | z |
| Competition from private buses | .94856 | 2.05 | 1.156741 | 2.10 |
| Population density | .0001257 | 2.11 | .0001349 | 2.27 |
| Income per capita | -.0001075 | -3.18 | -.0001155 | -3.06 |
| Average traffic speed | .1282438 | 2.58 | .1984993 | 2.85 |
| Average age of buses | -.198981 | -2.52 | -.2087139 | -2.95 |
| Fare per km | .4034169 | 4.19 | .6709075 | 3.44 |
| Time trend | .9696475 | 4.44 | 1.034815 | 4.48 |
| Bangalore | 14.64752 | 10.61 | 16.33485 | 9.68 |
| Chandigarh | 16.57455 | 7.78 | 16.52124 | 7.41 |
| Chennai | 6.095411 | 2.99 | 6.972583 | 3.20 |
| Delhi | -14.46362 | -10.51 | -14.12749 | -10.03 |
| Kolhapur | -.6019688 | -0.28 | -.9067162 | -0.40 |
| Mumbai | 9.761821 | 1.78 | 10.31528 | 1.78 |
| Pimpri-Chinchwad | -6.580098 | -3.35 | -6.68967 | -3.18 |
| Pune | 8.507004 | 1.19 | 8.513292 | 1.27 |
| Constant | 76.4844 | 15.15 | 73.56917 | 13.24 |
| | | | | |
| Log likelihood | -320.94155 | | -313.27982 | |
| Wald chi$^2$ | | | 1027.21 | |
| LR chi$^2$ | 368.16 | | | |
| Prob > chi$^2$ | 0.0000 | | 0.0000 | |

The variables that have a positive and significant effect on combined efficiency are competition from private buses, population density, average speed of traffic, fare per km and time trend. The variables that have a negative effect on combined efficiency are per capita income and the average age of buses. However, it is important to note that there are significant city effects as well. Bangalore, Chennai and Chandigarh have significant positive effects and Delhi and Pimpri-Chinchwad have significant negative effects.

## 7.5 Overview of findings

DEA is a useful method to calculate relative efficiencies of transit systems. The method has not been used to analyze the efficiency of urban bus operations in India to the best of the author's knowledge. The use of *level of comfort* as an indicator of crowding while analyzing the efficiency of transit systems is also a new application. Since most of the studies of transit systems using DEA have been done in developed countries, crowding was perhaps not an issue of relevance. It is however, a significant issue in India and the use of the comfort variable changed efficiencies considerably.

Several factors affect efficiency of bus services. Some of those can be controlled by the STU while others may be controlled through overall planning. Some of the factors that can be controlled by the STU are fare per km and the average age of buses. Higher fares do not seem to affect ridership negatively, probably because the increased revenue can be used to improve services. Even though the marginal effect of a unit increase in fares is large at 10-12 %, it is not realistic to expect a fare increase of 1 rupee per km. It will lead to doubling and even tripling of fares for commuters in most cities and may induce a negative effect by losing ridership. Older buses decrease efficiency and the investments made to purchase new vehicles and to improve the quality of buses will lead to higher overall efficiency.

Factors that cannot be controlled directly by the STU are population density and average traffic speed. High population density can be encouraged through land use and zoning regulations. Average traffic speed is affected by the nature of traffic, such as lack of separation of slow and fast modes. Cities in India do not offer separate lanes for motorized and non-motorized modes. Average traffic speed also decreases when the volume of traffic is high which depends on the rate of use of private vehicles. So it is important to encourage use of public transport by improving service and to discourage use of private modes using various policy measures. These policy measures could include increasing the cost of using a private vehicle and decreased availability of parking. Results from regression analysis showed that competition from private buses has a positive and significant effect on service efficiency.

The city effects were also significant for many cities, indicating that unmeasured factors are affecting efficiency. Bangalore, Chennai and Chandigarh have a positive city effect, implying that these cities have unique factors that improve their efficiency. One such factor that has been discussed in chapter 6 is that these cities have taken measures to make their service more attractive to the middle-class passenger who is not a *captive rider*, and can afford to use a private mode.

The second interesting factor is that the two cities, Delhi and Bangalore, which did use private buses to augment their city bus service, had different city effects on efficiency, relative to the control city, Ahmedabad. This implies that the use of private buses does not guarantee an improvement in efficiency. At the same time, privatization is being considered by several cities as a means to improve the efficiency of their public transport systems. So it is crucial to understand the factors that contribute to a successful privatization. The next chapter compares the privatization experiences of Delhi and Bangalore and explores the reasons for their dissimilar outcomes.

# 8 Restructuring Experience in Delhi and Bangalore

The examination of trends in performance done in chapter 6 and the efficiency scores estimated using data envelopment analysis (DEA) in chapter 7 showed that the performance of public buses in Bangalore has improved over time while that of public buses in Delhi had periods of improvement and periods of decline. Delhi and Bangalore are two cities that have used private buses to augment their supply of public bus services. However, they adopted different methods of privatization. Delhi chose a net cost system which allowed private operators to operate buses on assigned routes and collect the appropriate fare. Bangalore adopted a gross-cost system and contracted out parts of their services to private operators who were paid for every kilometer of service. Regression analyses (results presented in chapter 7) showed that unmeasured factors in Delhi and Bangalore had a significant influence on the efficiency of public bus operations. Some such factors could be institutional difference or the management of privatization. This chapter analyzes the differences between the approaches of Delhi and Bangalore to explore how those differences affected the outcomes from privatization in these cities.

## 8.1 Bus Transportation in Delhi

Delhi is the capital city of India and was home to 13.85 million people in 2001 (Office of the Registrar General of India 2001a). In 10 years, the population of Delhi increased by about 4 million from its 1991 population of 9.42 million (Office of the Registrar General of India 2001a). The estimated population for 2009 is about 17 million

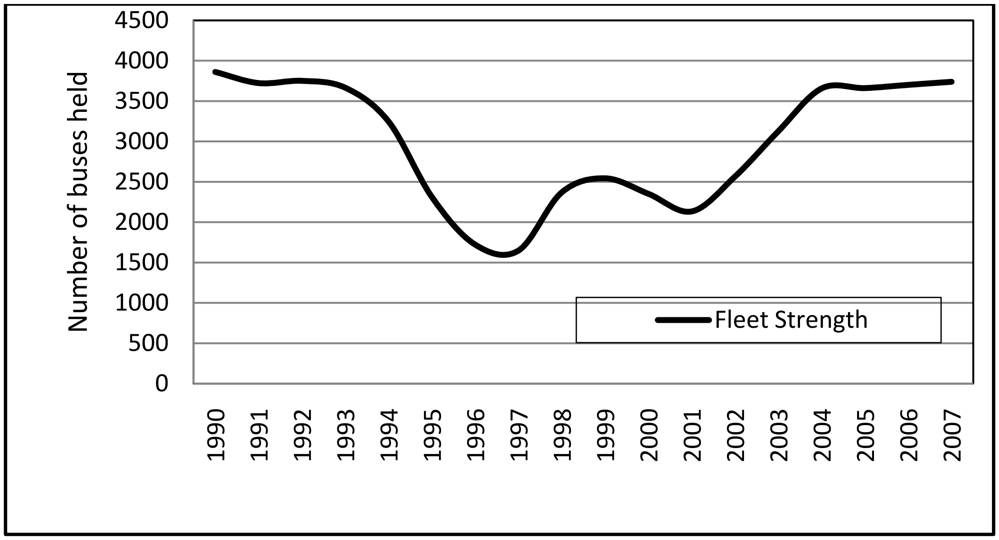
(Government of Delhi 2008). Total travel demand in Delhi has been growing at a rate of about 5% per year and had reached 70 billion passenger km by 2007 (Government of Delhi 2008). Delhi has the highest per capita car ownership in India at 75 cars per 1000 people compared to 7 cars per 1000 people for the country as a whole (Singh 2006).

Buses are the most popular mode of public transport in Delhi. They serve about 60% of the city's total travel demand (Tiwari 1999; Agarwal 2006). Bus services in Delhi are provided by public and private companies. The Delhi Transport Corporation (DTC), which is a public sector undertaking currently under the government of the National Capital Territory of Delhi, owns and operates public buses in the city and suburbs. The State Transport Authority of the State of Delhi issues permits to private buses to operate in the city under a net cost franchise scheme known as the Blue Line Scheme (Government of Delhi 2008). There were about 3200 DTC buses and about 2000 private buses in operation in 2008 (Government of Delhi 2008). In addition to the DTC and Blue Line buses, there are also numerous buses that provide chartered services, such as school buses. Furthermore, several large financial and research institutions and most large companies in the information technology sector provide chartered bus services for their employees (Agarwal 2006).

### 8.1.1 Performance Trends of DTC

Between 1990 and 2005, Delhi Transport Corporation went through many fluctuations in its service provision and performance. Since 1990 the number of buses owned by Delhi Transport Corporation first decreased for seven years, then increased marginally for two years, decreased again for the following two years and then started to increase again (Fig 8.1).

*Figure 8.1 Number of buses Owned by Delhi Transport Corporation (1990-2007)*




*Source*: ASRTU 2002; CIRT 2008

The decline in the number of buses owned by DTC in the early 1990s was due to the poor financial condition of the corporation. Delhi Transport Corporation could not afford to buy any new vehicles to replace the old vehicles (Deb 2002; Agarwal 2006). In 1997, DTC started to use private buses under a gross-cost scheme[25], which was called the kilometer scheme. That led to a small increase in fleet strength (Agarwal 2006). But the kilometer scheme was phased out over the next two years. In 2002, the state government allotted funds to DTC to purchase new vehicles in an effort to revive the corporation, leading to an increase in the number of vehicles owned by DTC from 2002 (Agarwal 2006).

Since the 1990s, a number of studies conducted on the air quality in Delhi concluded that Delhi is one of the most polluted cities in the world (Tata Energy

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[25] The gross-cost scheme implemented in Delhi and Bangalore is known in India as the kilometer scheme. The public corporation hired private buses which operated buses under the banner of the public company, the public company collected the fares and the private operator was paid a fixed amount per kilometer operated.

Research Institute 1997). In 1995, up to 60% of buses plying in Delhi's streets were more than 8 years old (Deb 2002; Agarwal 2006). In an effort to improve the air quality in Delhi, the Supreme Court ordered that all buses, autorickshaws and taxis that were more than 8 years old had to be pulled out of service or converted to CNG by 2000. That caused the decrease in the fleet strength in 2000-01 (Deb 2002; Agarwal 2006).

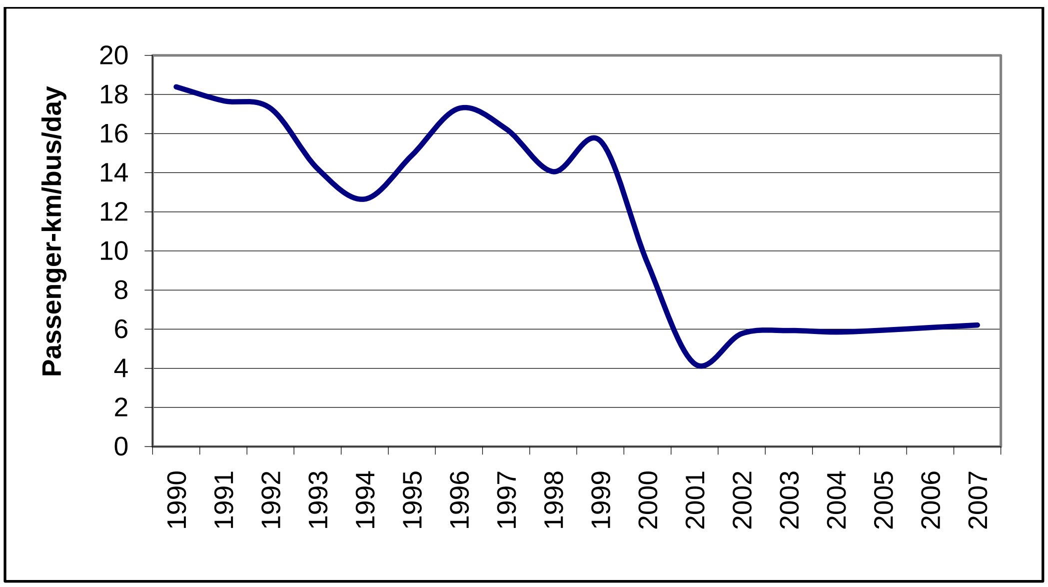
The deadlines for conversion to CNG had to be extended a few times. First, there were only two manufacturers who could retrofit the buses with new CNG-compatible engines, and they were slow in completing orders (Agarwal 2006). Second, the infrastructure was slow to get set up and there were an insufficient number of CNG refueling stations. Finally, by December 2003, all buses operating in Delhi had been converted to CNG. However, a negative impact of the conversion to CNG was that for a few years, Delhi was not served by a sufficient number of buses (Agarwal 2006). The fleet strength of DTC revived to about 3700 by 2007 and they secured funds to increase their fleet size to 6000 by 2010 (Government of Delhi 2008).

*Fleet Utilization* of DTC has been poor overall (Agarwal 2006). Even during its best year since 1990 only 89.6% of DTC's total fleet was in service (ASRTU 2002; CIRT 2007) and the average fleet utilization between 1990 and 2005 was only 75.9%. It was at its worst in 2000-2001, when only 43.1 % of buses owned by DTC were in service (ASRTU 2002).

During the period from 1991 to 2001, the population of Delhi grew by about 4 million (Office of the Registrar General of India 2001) and the supply of public buses did not keep up with the increase in population. However, these numbers do not include the private buses that have been serving Delhi since 1993. Since that time about 5000 private buses have served Delhi in addition to the DTC buses (Deb 2002; Agarwal 2006; Badami and Haider 2007). Since 2002, DTC has been increasing their fleet size and bus supply with the help of external funds and borrowings despite increasing losses.

Passenger-km per bus can be used as an indicator of the rate of use of buses (Badami and Haider 2007). It is not a perfect indicator because it does not reflect the number of trips or the length of trips, but it is useful as a primary indicator of the rate at which the services offered are used by the public.

*Figure 8.2* *Bus Productivity – Delhi Transport Corporation*

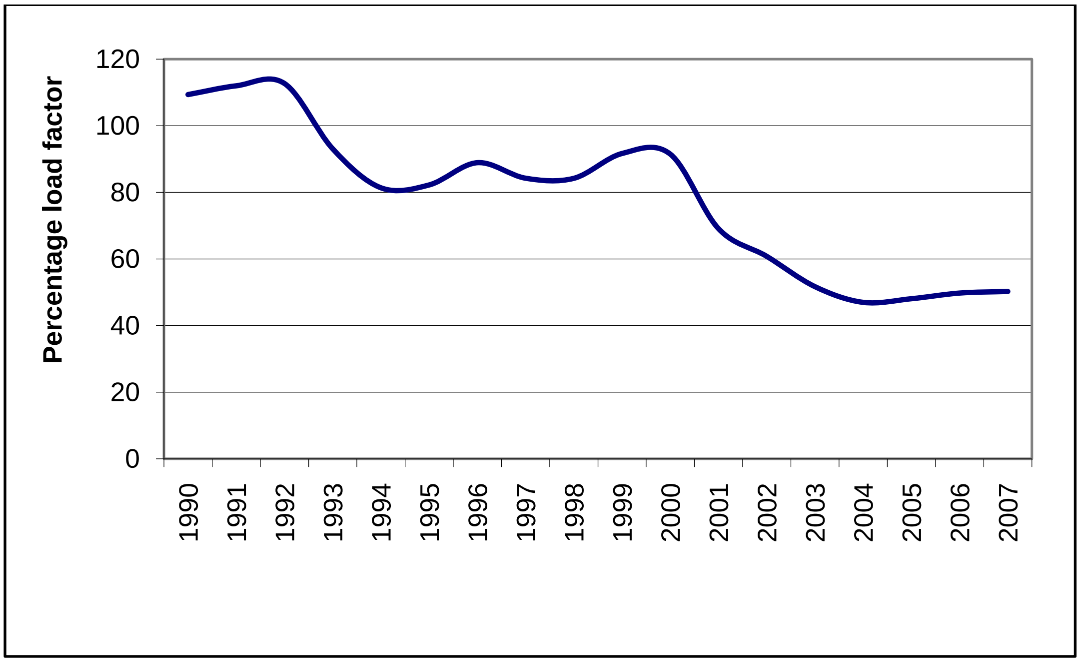



*Source*: ASRTU 2002; CIRT 2005; CIRT 2006; CIRT 2007; CIRT 2008

Use of DTC buses has been following a largely decreasing trend with a small increase since 2001 (fig 8.2) (ASRTU 2002; CIRT various years). It increased for two years between 1994 and 1996 possibly reflecting the public's mistrust of the private buses which were involved in reckless driving causing numerous accidents (Deb 2002;

Agarwal 2006; Badami and Haider 2007). The decline in passenger-km since the mid-1990s could also be due to the increase in the use of personal vehicles which was made possible by the improved economy[26] (Chaitanya 2004; Reddy 2008). Moreover, motorcycles cost only between $600 and $1500 and are affordable to many Indians (Panagariya 2004).

*Figure 8.3 Load- Factor for Delhi Transport Corporation Buses (Percentage)*




*Source*: ASRTU 2002; CIRT 2005; CIRT 2006; CIRT 2007; CIRT 2008
(The load factor is calculated as the ratio of passenger-km to place-km, where place includes both seating and standing capacity)

Load factor is calculated as the ratio of passenger-km to place-km, where place includes both seating and standing capacity. Though it is a liberal definition of capacity when compared to occupancy ratio which is the ratio of pass-km to seat-km, load factor

[26] The Indian economy has been growing at a rate of 4-7% since the 1990s and has allowed more disposable income to more people

provides a more accurate reflection of the Indian context as city buses are designed with more standing room and intended to carry more passengers (Badami and Haider 2007). Until 1992, DTC buses used to be very crowded, with load factors above 110%, which means that there would be no space even to stand in the buses (ASRTU 2002). Between 1992 and 1994, load factor decreased from 110% to about 80% (see fig 8.3). At an 80% load factor there would still be no empty seats on the bus. The load factor remained fairly stable between 1994 and 2000 at rates between 80 and 90% (ASRTU 2002). By 2004, DTC buses were not crowded at all, because at 45% load factor, even the seats are not filled. However, these are average load factors, and the buses are more crowded during the peak hours and less filled during the off-peak hours.

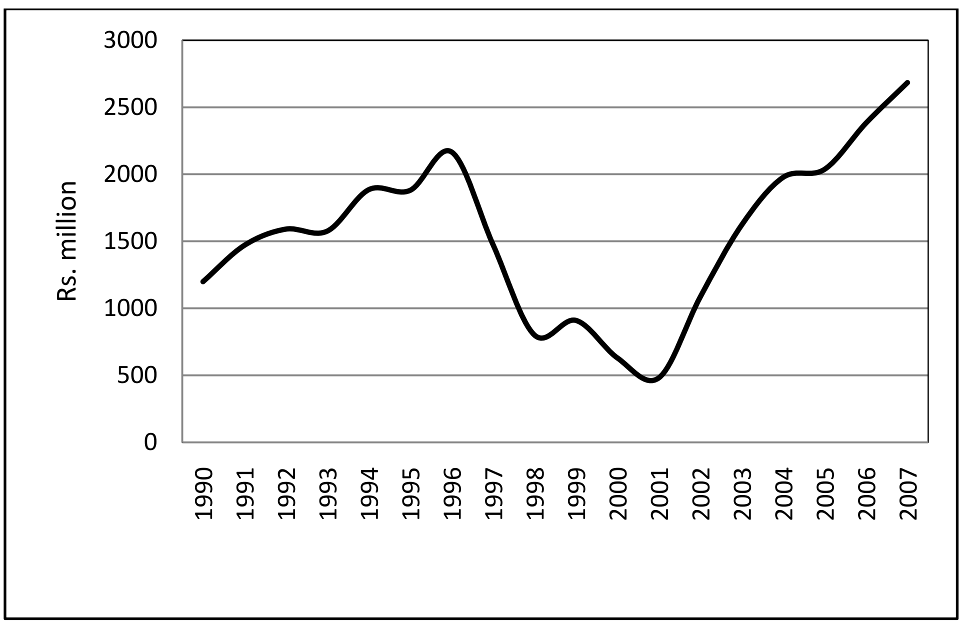
The average number of employees per bus for urban public bus companies in India was 8.31 in 2007 (CIRT 2008). Delhi Transport Corporation has always had at least 10 employees per bus since 1989 (ASRTU 2002; CIRT 2005; CIRT 2007). During some years, DTC has had as many as 18.3 employees per bus. The average number of employees per bus for DTC between 1989 and 2007 has been 13.1 (ASRTU 2002; CIRT 2005; CIRT 2007).

Cost of personnel is a major source of expense for DTC, accounting on average, for about 62% of total expenses (CIRT 2008; Agarwal 2006). During most years, revenue only covered about one-third of the total cost of operation. In 2005, Delhi Transport Corporation had a total revenue of Rs. 3155.42 million (CIRT 2006). Expenditure on personnel was Rs. 3423.53 million (CIRT 2006). Their revenue did not cover even the payroll expenses. Total cost of operation including fuel and tires, etc. for that year was Rs. 9070.72 million which is almost three times the farebox revenue (CIRT

2006). In 2004, among all public sector bus operators in India, cost per bus per day was highest for Delhi Transport Corporation (CIRT 2005).

Delhi Transport Corporation has been incurring losses for almost 20 years (see figure 8.4). The losses decreased during the years when the DTC operated fewer buses and decreased its bus supply. When more vehicles were operated, the resultant increase in cost of operations was higher than the increase in revenue leading to more losses (Agarwal 2006).

*Figure 8.4 Loss at Constant 1990 Prices for Delhi Transport Corporation (1990-2007)*




*Source*: ASRTU 2002; CIRT 2005; CIRT 2006; CIRT 2007; CIRT 2008

In 1993, Delhi started using private buses to augment their supply of public bus transport. Increasing losses made it difficult for DTC to expand its services to meet the increasing travel demand. There was also a change in the political attitude and the State began to be seen as a facilitator of services only and not as a provider of services.

### 8.1.2 Private Buses in Delhi

Following the Motor Vehicles (Amendment) Act 1988, STA granted permits to private buses to operate stage carriage services in Delhi under a net cost scheme called the Red Line Scheme (Marwah et.al 2001; Mathur 1999). The private buses were required to be painted in red and white and were called the Red Line buses. These buses became notorious for their disregard for rules and regulations. Later the State Transport Authority renamed the system as the Blue Line Scheme[27] (Agarwal 2006; Deb 2002; Marwah et.al 2001; Mathur 1999).

Privatization in Delhi resulted in an almost immediate increase in the supply of buses (Agarwal 2006; Mathur 1999). The load factor on public buses were as high as 110% before 1992, and were reduced to about 82% following the introduction of private buses (ASRTU 2002).

The fleet utilization of private buses in Delhi is better than that of DTC. The private bus owners' profits depend entirely on farebox revenue and they are highly motivated to have as much of their fleet in service as possible (Agarwal 2006; Mathur 1999). Every peak-hour trip that is missed adversely affects the traffic revenue.

Private buses in Delhi operate more kilometers per bus per day than DTC buses. However, they have been accused of not serving on their assigned routes, and taking the most profitable route between an origin-destination pair, instead (Agarwal 2006; Deb 2002; Marwah et. al. 2001). Private buses also generate more income per bus per day than DTC buses (see table 8.1). But, most private buses operate on profitable routes only

[27] The Red Line Buses were involved in numerous accidents in 1993 and 1994. Many accidents involved fatalities. Some superstitious managers decided that the name Red Line was unlucky because red is the color of blood and thought that a change of name from Red Line to Blue Line would make the private buses safer.

(Agarwal 2006; Deb 2002; Marwah et. al. 2001). So a comparison between incomes generated by the public and private buses is probably unfair.

Private operators are able to keep their costs of operation lower than that of DTC. In the 1990s the average cost per kilometer incurred by the public DTC was Rs17.15, where as it cost the private operators only Rs 7.73 per kilometer (Marwah et.al. 2001). Increasing costs of fuel, licensing and personnel increased the operating costs to Rs 30.22 per kilometer for DTC buses and to Rs 23.19 per kilometer for private buses by the year 2000-01(Tata Energy Research Institute 2002). However, the private buses were still able to make profits because they were able to earn about Rs 26.0 per km (Tata Energy Research Institute 2002).

Fuel efficiency achieved by private operators is slightly worse than that of DTC buses, probably owing to poor maintenance, and practices such as idling of buses at the stops waiting for passengers (Agarwal 2006). Most of the savings in cost of private operators is personnel costs. In 1993, DTC employed 9.56 persons per bus when compared to the private operators' 4.6 persons per bus in 1997 (Marwah et.al 2001). In 2000-01, DTC had 15.32 employees per bus while the private operators had only 3.84 employees per bus (Tata Energy Research Institute 2002). About 65% of private operators in Delhi own only one bus and many of them have only two employees, a driver and a conductor (Deb 2002; Marwah et.al 2001; Kapur and Ramamurthy 2002).

*Table 8.1 Comparison of Public and Private Buses in Delhi*

| | Public (1993-94) | Private (1997) | Public (2000-01) | Private (2000-01) | Public (2006-07) | Private (2006-07) |
|---|---|---|---|---|---|---|
| Fleet Utilization % | 82.6 | 93 | 43.3 | 93 | 88.1 | 94.1 |
| Vehicle Utilization (km/bus/day) | 216 | 246 | 196.2 | 225 | 198.4 | 229.4 |
| Staff/bus | 9.56 | 4.6 | 15.32 | 3.84 | 12.54 | 3.91 |
| Fuel Efficiency (km/liter) | 3.8 | 3 | 3.72 | 3.23 | 3.84 | 3.2 |
| Income/bus/day | 1321 | 2700 | 3608 | 5721 | 4201 | 6107 |
| Income/km | 6.12 | 10.97 | 18.39 | 25.43 | 24.16 | 32.79 |
| Total cost/km | 17.15 | 7.73 | 30.22 | 23.19 | 38.36 | 30.1 |
| Net earnings/km | -11.03 | 3.24 | -11.83 | 2.24 | -14.2 | 2.69 |

*Sources*: Marwah et. al. 2001; TERI 2002; ASRTU 2002; CIRT 2008; Government of Delhi 2008.

Customer satisfaction was higher for DTC buses when compared to private buses in 1997 (Dhingra and Sawant 1998). Passengers were dissatisfied about the driving practices of private operators, especially that they often stopped at bus stops for a long time, waiting till the bus was filled to capacity, while at other times they did not stop at all. Passengers were also dissatisfied about the unsafe driving of private buses, because of numerous accidents involving pedestrians at bus stops and crossings (Mathur 1999).

Enforcement efforts made by the police have been in the form of installing speed governors on buses and imposing fines on buses that do not adhere to their assigned schedule. These efforts have not been very effective as speed governors are often tampered with (Government of Delhi 2008). A lawyer for the city government reported to the Supreme Court in 2007 that 827 private buses were caught with tampered speed governors and that 25 bus drivers were prosecuted for drunk driving during that year (Government of Delhi 2008).

### 8.1.3 Planned Restructuring of Delhi Bus Services

In 2007, the Supreme Court ordered that the Blue Line Buses have become dangerous and ineffective and should be phased out (Sahai and Bishop 2008). In response to that, DTC procured funds to increase their fleet size. In 2008, the government of the National Capital Territory of Delhi and the Infrastructure Development Finance Company started a new Joint Venture Company called the Delhi Integrated Multimodal Transit System Ltd (DIMTS). DIMTS is a public sector company set up as a ‘special purpose vehicle’ to resolve the problem of public transport delivery in Delhi (DIMTS 2009). They have undertaken several projects such as multi-modal transit centers and automated fare collection systems. For improving bus services in Delhi, DIMTS has undertaken a project called ‘Corporatization of Private Stage Carriage Buses’ (Sahai and Bishop 2008).

The goal of the corporatization project is to phase out all Blue Line buses in response to the Supreme Court directive and replace them with ‘corporatized’ private companies which own at least 100 buses (DIMTS 2009). DIMTS identified that one of the major problems with the blue line scheme was the ownership pattern of buses, where most bus owners only owned one vehicle. To avoid that problem, DIMTS grouped the 657 bus routes in Delhi into 17 clusters and invited tenders from bus companies that owned at least 100 buses (Sahai and Bishop 2008). The new plan proposes that every cluster will be served by both DTC and private buses, with DTC providing about 60% of services in each cluster.

The tenders received from private bus companies were being reviewed in December 2009 (DIMTS 2009). DTC has acquired about 900 additional buses in 2009 and some Blue Line buses have been phased out (DIMTS 2009). All blue line buses are expected to be phased out by mid-2010, when Delhi will be served by the new bus companies and DTC buses.

DIMTS will also coordinate the routes and schedules of public and private buses to ensure an environment of cooperation and not one of competition (Sahai and Bishop 2008).

## 8.2 Bus Transportation in Bangalore

Bangalore is the capital city of the State of Karnataka and the fastest growing metropolitan area in India. The city had a population of 5.7 million in 2001 and is growing at a rate of 4.9 percent (Office of the Registrar General, India 2001a). Known as the “Silicon Valley of India”, Bangalore is the capital of India’s Information Technology industry, has a large skilled and unskilled migrant population and an estimated floating population of one million at all times (Ramanayya, Nagavendra and Roy 2007; RITES 2007) . Travel demand in Bangalore has been growing at a rate about 4% per year and is expected to reach 54 billion passenger km by 2010 (RITES 2007). The growth in the ownership and use of personal vehicles in Bangalore has been very high. The number of registered motor vehicles in Bangalore was only 400,000 in 1987, and increased to 1,450,000 vehicles in 2001, growing more than 200% in 14 years (RITES 2007).

Public transport in Bangalore began in the 1940s with 98 buses (BMTC 2006). By the 1960s the Karnataka State Road Transport Corporation (KSRTC) was operating city, suburban, express, luxury and inter-state services. However, city services suffered and various committees constituted to study bus services in Bangalore recommended that city operations for Bangalore be separated from the parent company. Thus the Bangalore

Metropolitan Transport Corporation (BMTC) was constituted in 1997 as an independent corporation (BMTC 2006).

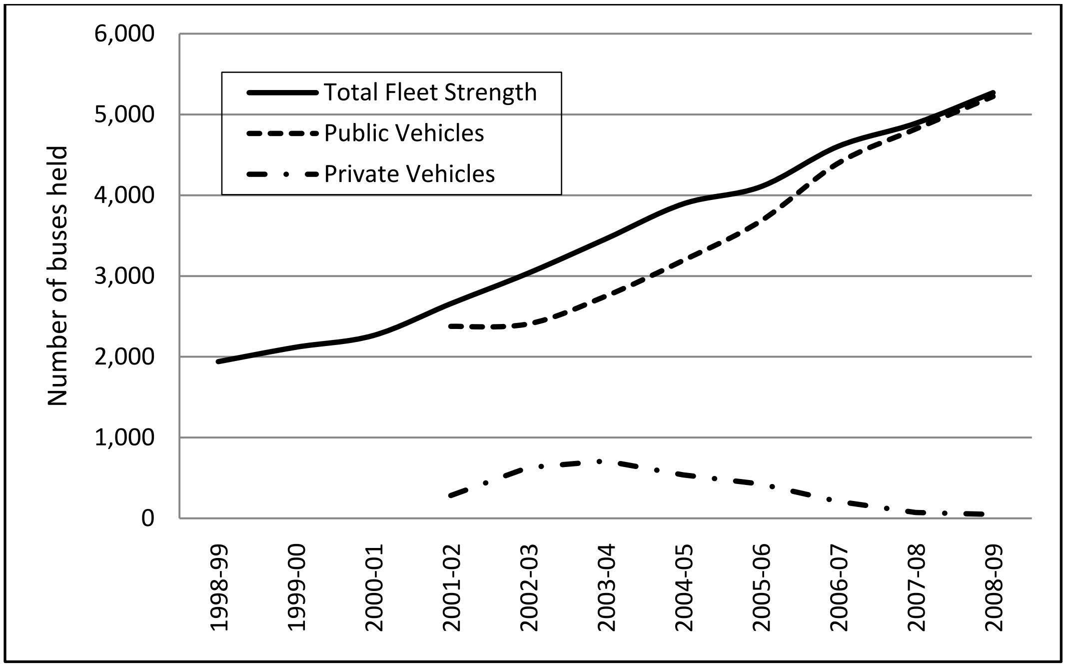
When BMTC was set up in 1997, it took over all city operations including depots, bus repair shops and bus stations from KSRTC (Bangalore Metropolitan Transport Corporation 2006). Currently Bangalore is served by BMTC buses, which are owned and operated by Bangalore Metropolitan Transport Corporation and private buses under the kilometer scheme, which is a gross cost, negative model (BMTC 2009). There have been improvements in efficiency and services and even a reduction in accidents since the inception of BMTC (ASRTU 2002; BMTC 2009). Between the years 2000 and 2008, Bangalore Metropolitan Transport Corporation was the only public sector urban transport company in India that made profits (BMTC 2006).

### 8.2.1 Performance Trends of BMTC

BMTC was set up only in 1997. So data for Bangalore is available only from 1997-98. Karnataka State Road Transport Corporation, which provided bus services in Bangalore before 1997 maintained separate data for its urban services. But that data is not useful because it includes all urban areas in Karnataka.

Since its inception in 1997, BMTC has been increasing its bus supply and expanding its services (BMTC 2009). The total number of buses serving Bangalore including private buses increased from about 2000 in 1998-99 to about 5200 in 2008-09 (see figure 8.5). But the number of private buses used by BMTC started to decrease after an initial increase for three years. As BMTC began to make profits, they started to purchase their own vehicles and reduce the number of private buses that they used to augment their bus supply.

*Figure 8.5 Trend in the Number of Public and Private Buses in Bangalore*

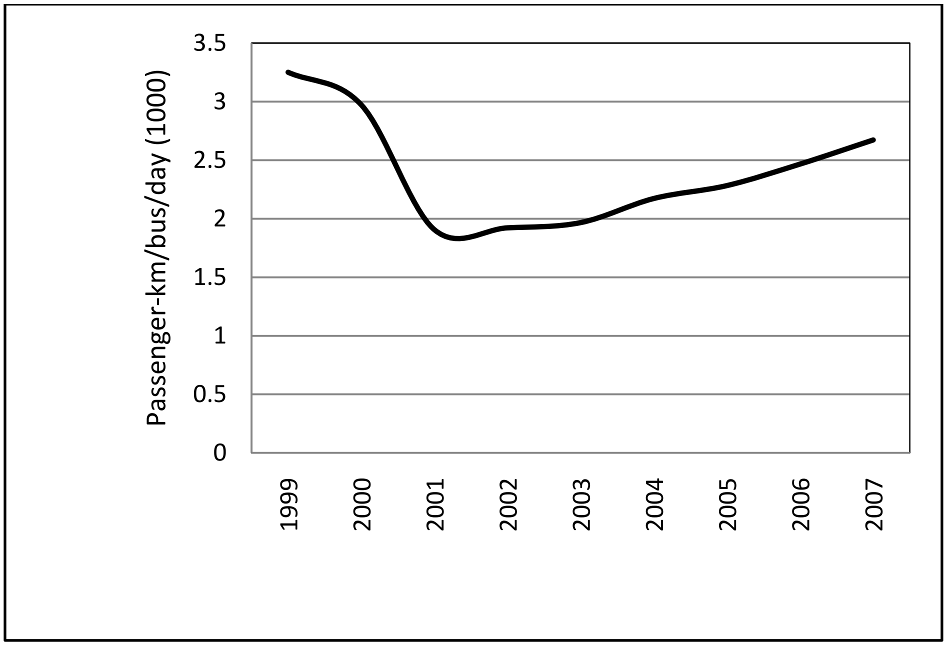



*Source*: ASRTU 2002; BMTC 2009

BMTC also consistently increased their bus capacity since 1998. This indicates an expansion of bus service in terms of routes or frequency or both (Badami and Haider 2007). Their fleet utilization has been consistent around 95% and they have been able to increase the number of buses held, increasing the quantity of service provided to the people of Bangalore (ASRTU 2002; BMTC 2009).

Decline in passenger-km at a time when BMTC increased its fleet strength led to a decrease in productivity in terms of passenger-km per bus (Ramanayya, Nagavendra and Roy 2007) (see figure 8.6). The modest increase in passenger-km since 2002, has led to a small increase in bus productivity as well.

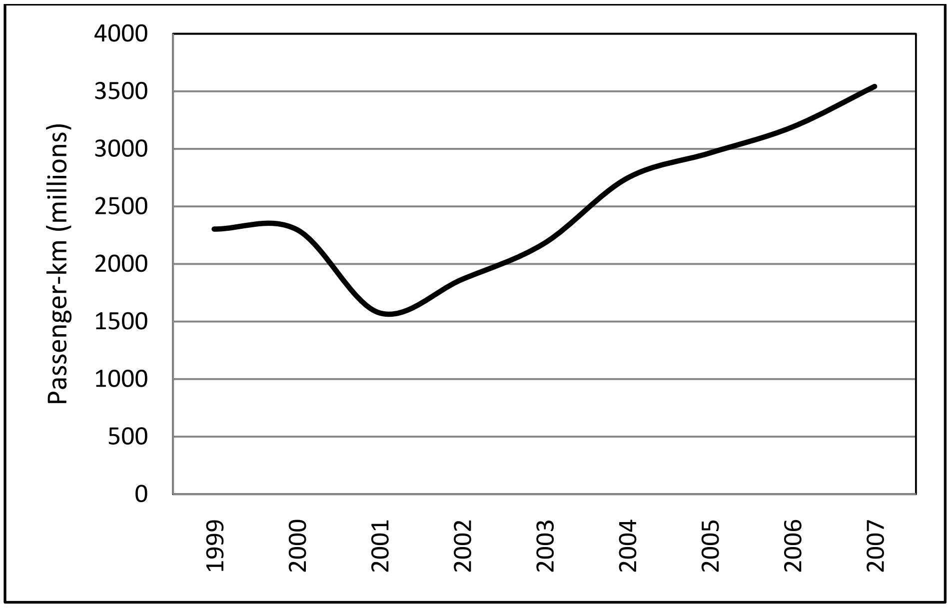
*Figure 8.6* *Bus Productivity for BMTC buses in Bangalore*




*Source*: ASRTU 2002; BMTC 2009

People of Bangalore enjoy higher disposable income allowing them to afford luxuries like personal modes of transportation. Passenger-km on buses in Bangalore fell from about 2300 million kilometers in 1999-00 to about 1800 million kilometers in 2002 (figure 8.7) (ASRTU 2002; BMTC 2009), while the rate of ownership and use of private vehicles increased. Since 2002, passenger-km has been increasing slowly and can be explained by the increase in population in the city, and the improvements in the quality of service offered by BMTC. BMTC has introduced luxury buses during peak hours for local commute. These buses are filled to capacity even though the fares on luxury buses are about 2.5 times that on ordinary buses (BMTC 2006).

*Figure 8.7 Trend in Use of buses in Bangalore*



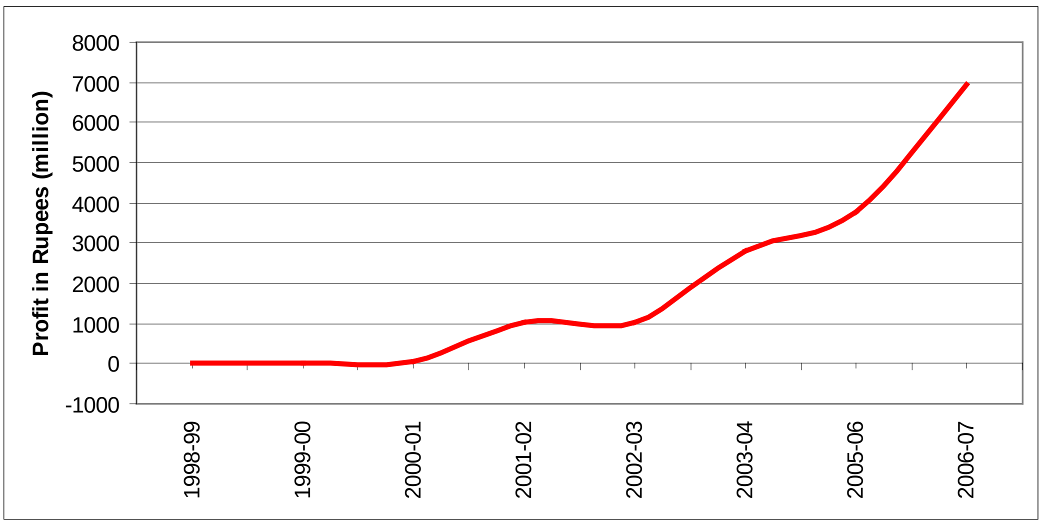

*Source*: ASRTU 2002; BMTC 2009

Load factor for BMTC buses declined from 67% in 1998-99 to 48% in 2002 and has improved to 54% in 2004. However, these are average load factors and during the peak hours, buses still operate at high occupancy rates. The decrease in average load factor despite increase in total travel demand in Bangalore indicates an increased use of alternative modes. Since transportation in Bangalore is entirely road-based, a loss of bus passengers is evidence of increasing use of private automobiles, and cannot be explained as possible loss of passengers to other public transport modes such as rail or light rail.

With an average employment rate of 5.5 employees per bus between 1997 and 2008, BMTC has one of the lowest employment rates among urban bus transport companies in India (ASRTU 2002; BMTC 2009). Number of employees per bus has been consistently decreasing for BMTC and the number of employees per bus decreased from 6.83 in 1998 to 4.81 in 2008 (ASRTU 2002; BMTC 2009).

Bangalore Metropolitan Transport Corporation has been making profits almost every year since the year of its inception (BMTC 2009). Even at constant 1990 prices, profits for BMTC have been on an overall increasing trend (see figure 8.8). For the year 1998-99 to 2000-01, profits were slightly less than Rs. 100 million per year at constant 1990 prices, then increased to about Rs. 1000 million per year for the years 2001-02 and 2002-03, about Rs 3000 million for 2003-04, about 4000 million for 2004-05 and about Rs 7000 million for 2006-07 (BMTC 2008; ASRTU 2002; Labor Bureau 2009[28]).

*Figure 8.8* *Profits at Constant 1990 prices for BMTC, Bangalore*




*Source*: ASRTU 2002; BMTC 2009

BMTC has been able to meet its operating expenses using traffic revenue (BMTC 2009). They also earn revenue from advertisements on buses and from renting out BMTC buses using a scheme called "Hire a Bus", for private functions such as weddings, pilgrimages and school trips (BMTC 2006a). Even with marginally decreasing occupancy

[28] Data from the Labor Bureau was used to convert all monetary information to constant 1990 prices.

rates, BMTC has been able to make profits, and earn sufficient traffic revenue to meet operating expenses.

### 8.2.2 Private Buses in Bangalore

When BMTC was constituted in 1997, they did not have sufficient funds to increase their fleet size and expand their services in response to increasing growth in population and the subsequent increase in demand. So they decided to privatize part of their services (RITES 2007; BMTC 2006).

Bangalore adopted a gross-cost negative model for privatization (RITES 2007). A gross-cost negative scheme is one in which the public company awards route-based or area-based contracts to private operators. The private operators are usually compensated on the basis of kilometers operated or by using a profit-sharing formula that has been agreed upon and made part of the contract. Bangalore adopted a route-based system. They hire private buses which are operated on specified routes (BMTC 2006a).

*Table 8.2 Comparison of Public and Private Buses in Bangalore for 2006*

| | **BMTC (Public Buses)** | **Bangalore (Private Buses)** | **BMTC (Total)** |
|---|---|---|---|
| **Traffic Revenue (Rs million)** | 5460.72 | 831.92 | 6292.64 |
| **Other revenue (Rs million)** | 580.01 | 0 | 580.01 |
| **Total Revenue (Rs million)** | 6040.73 | 831.92 | 6872.65 |
| **Revenue (Rs/km)** | 21.92 | 20.39 | 21.72 |
| **Personnel costs (Rs million)** | 1782.29 | 94.53 | 1877.82 |
| **Total Costs (Rs million)** | 5020.02 | 722.73 | 5742.75 |
| **Costs (Rs per km)** | 18.21 | 17.71 | 18.15 |
| **Operating cost (Rs million)** | 4718.99 | 681.13 | 5400.13 |
| **Operating Ratio (traffic revenue/operating cost)** | 1.16 | 1.22 | 1.17 |
| **Surplus before tax (Rs million)** | 1293.74 | 150.79 | 1444.53 |
| **Net profit (Rs million)** | 1020.71 | 109.19 | 1129.90 |

*Source*: ASRTU 2002; BMTC 2009

The operating ratio for private buses in Bangalore is better than that of public buses but only by a very small margin (see table 8.2). BMTC is able to generate more revenue per kilometer from its own buses than from the hired private buses, despite having the same fares. It is however, only a difference of Rs. 1.50 per km, and costs per km is only Rs. 0.50 more per km for public buses.

The performance of BMTC, Bangalore improved following privatization. They were able to reduce their losses and increase supply and provide better services. The next section compares the privatization experiences of Delhi and Bangalore.

## 8.3 Comparison of the Privatization Experiences of Delhi and Bangalore

### 8.3.1. Institutional Differences

The major difference between the roles of various agencies in the governance of Delhi and Bangalore perhaps stems from the fact that Delhi is a city as well as a State (Government of Delhi 2008). Delhi is also part of the National Capital Territory which includes parts of neighboring States. Bangalore is a city in the State of Karnataka.

In India, all States have a State Road Transport Authority. In Delhi, the State Transport Authority (STA) has all the planning and licensing authority and Delhi Transport Corporation, which is an independent corporation under the Govt. of Delhi and not under STA, operates city bus services and some interstate services (Government of India and Government of National Capital Territory of Delhi 2001). The STA operates some interstate services as well. The STA does not operate any city services in Delhi, but grants permits to private buses to operate in the city. So DTC has not privatized any aspect of its operations and has no control or purview over the number or schedule of private buses that operate in Delhi. Such multi agency involvement results in a lack of coordination between services and creates an atmosphere of competition between DTC and private operators (Government of India and Government of National Capital Territory of Delhi 2001; Agarwal 2006).

In Karnataka, The Karnataka State Road Transport Corporation (KSRTC) plans and coordinates bus transportation for the entire state, including intercity services in and out of Bangalore. But BMTC maintains complete control of the planning and operations of all city bus services (BMTC 2006). They award contracts to private operators, and control and coordinate routes and schedules of both public and private buses. So there is better coordination of schedules and routes among buses that operate in Bangalore than among those that operate in Delhi (RITES 2007).

### 8.3.2. Method of Privatization

In Delhi, it was decided that privatization would follow a net-cost model (Government of India and Government of National Capital Territory of Delhi 2001). That would involve almost no expense to the government, and provide the private operator the opportunity to maximize their profit. The Government of Delhi was also of the opinion that the monopolistic privileges that DTC enjoyed for almost 4 decades was one of the major reasons for most of its problems such as high rate of employment, lack of motivation to make profits and increasing losses. So the government of Delhi wanted to break the monopoly and introduce competition (Government of India and Government of National Capital Territory of Delhi 2001). A net-cost model where the private operator carried revenue and cost risks was considered as the best choice to meet the travel demand in Delhi and satisfy the objectives of the government (Agarwal 2006). The Delhi government evaluated and rejected the gross-cost model because a gross-cost model does not motivate the private operator to take measures to increase ridership. In a gross-cost negative scheme, the private operators are assured of minimum returns based on kilometers operated and not on ridership.

In Bangalore, private buses are hired by BMTC under a gross-cost negative model (BMTC 2006). BMTC awards contracts to private owners to operate buses under the BMTC banner, on an assigned route following an assigned schedule. The private owner is responsible for the purchase of the bus, the maintenance of the bus, and all operational expenses such as the cost of fuel, tires, lubricants, etc. The driver is an employee of the bus owner as well. The conductors on all buses are employees of BMTC, and the fares that are collected belong to BMTC (BMTC 2006; RITES 2007). The private owner is assured of a minimum number of kilometers per day for which they are compensated even if services are cancelled due to reasons that are not a fault of the operator. They are paid at a fixed rate per kilometer for every extra kilometer operated (BMTC 2006).

Since the BMTC has been making profits, they have been gradually purchasing more buses and using fewer hired buses (Ramanayya, Nagavendra and Roy 2007; RITES 2007). Also, when the passenger-km per bus decreased during 2000-2002, BMTC responded by using fewer private buses (BMTC 2009).

### 8.3.3. Regulatory Differences

*Licensing:* In Delhi, the owner/operator is licensed to operate on permitted routes set by the State Transport Authority and collect appropriate fares, also set by the State Transport Authority. To obtain a permit, the owner of the bus has to participate in competitive bidding and pay a fee to the STA (Deb 2002; Agarwal 2006). The owner is responsible for the purchase, maintenance and operation of the vehicle. They are entitled to collect the fares and keep the fare box revenue (Marwah et.al. 2001).

The role of the State Transport Authority is limited to that of a licensing and supervising authority. The STA invites tenders on a route by route basis. The permits are then awarded to the highest bidder (Marwah et.al. 2001; Deb 2002; Agarwal 2006).

In Bangalore, there is an open bidding process and contracts are awarded to the lowest bidder (RITES 2007; Ramanayya, Nagavendra and Roy 2007). BMTC controls the number of permits that are awarded based on the city's travel demand the ability of

BMTC to purchase new vehicles to meet the demand. The private owner is responsible for the capital investment and all operational expenses (Ramanayya, Nagavendra and Roy 2007; Agarwal 2006; BMTC 2006).

*Routes, Schedules and Fares:* The routes, schedules, fares and bus-stops are set by the STA in Delhi and by the BMTC in Bangalore. In Delhi, private buses are required to operate along the routes that they have permits for, follow the schedule set by the STA, collect appropriate fares as scheduled by the STA and stop at designated bus-stops to pick up and drop off passengers (Marwah et.al. 2001; Deb 2002). In Bangalore, the regulations require the private operator to operate on routes planned by the BMTC and on a schedule set by the BMTC (RITES 2007; BMTC 2006).

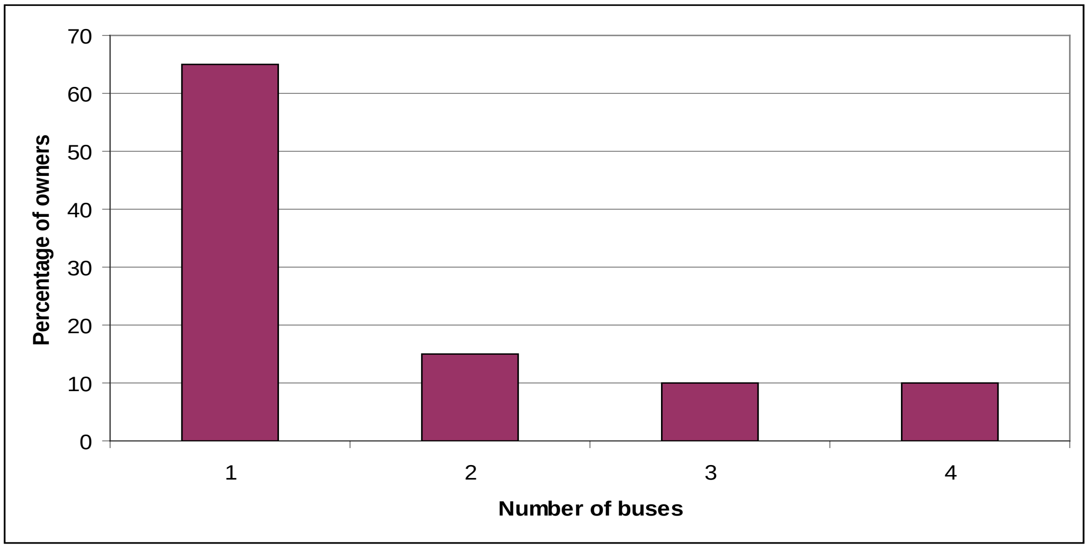
*Costs and Revenue Risks:* Cost risks are borne by the private owner/operator in both Delhi and Bangalore. However, in Bangalore, conductors on all buses including private buses are employed by BMTC (BMTC 2006; Agarwal 2006).

Revenue risks are borne by the BMTC in Bangalore and the private operators are paid at a contracted rate (Ramanayya, Nagavendra and Roy 2007; RITES 2007). Delhi, on the other hand, has a system where the revenue earned by the private operator depends primarily on farebox revenue.

One of the advantages of a net-cost system where the operator carries all the revenue risk is that the owner is motivated to maximize passenger-kilometers and may choose to provide superior service to attract more passengers (Agarwal 2006; Mathur 1999). That was also the benefit that Delhi hoped to gain from choosing a net-cost system over a gross-cost system. One of the possible disadvantages is that the private operator may increase fares. However, fares are regulated by STA and so the problem of the private operator charging high fares did not arise in Delhi. But, private bus operators in Delhi resorted to illegal and often unsafe driving practices such as road races to get to the next bus stop before other buses and making unscheduled stops to pick up extra passengers to maximize their patronage and revenue (Agarwal 2006; Deb 2001; Marwah et.al. 2001). In Bangalore, since the conductor is a BMTC employee, there is no problem of buses making unscheduled stops or idling at bus stops waiting for passengers.

*Ownership Pattern*: One of the qualifications required of private bus owners in Delhi was that the private owner shall not operate more than five buses (Marwah et.al 2001; Deb 2002; Agarwal 2006). This rule was motivated by the desire to eliminate a monopolistic operation and to increase competition (Government of India and Government of National Capital Territory of Delhi 2001). So in 2007, Delhi had about 5000 private buses in operation, operated by about 3500 owners (Government of Delhi 2008). About 65% of private bus owners in Delhi own only one bus, and another 15% own only 2 buses (see figure 8.9) (TERI 2002; Government of Delhi 2008). Such an ownership pattern has had serious negative implications on driver behavior and road safety.

*Figure 8.9 Number of Buses owned by Private Bus-Owners in Delhi*




*Source:* TERI, 2002; Government of Delhi 2008

In Bangalore, the issue of competition on the road did not arise at all, partly due to the method of privatization (Ramanayya, Nagavendra and Roy 2007). BMTC did not require that the private bus owners own only a certain number of buses. In 2007, the average number of buses owned by the private operator in Bangalore was 24 and the largest operator had 40 buses (BMTC 2009). Moreover, private bus owners' earnings did not depend on farebox revenue and therefore they were not tempted to engage in dangerous driving practices to increase ridership (RITES 2007).

*Quality Regulations:* The STA imposes regulations on the quality of buses in Delhi, though the Supreme Court of India has intervened and imposed quality regulations as well. In the 1990s all buses in Delhi used diesel as fuel and when the Supreme Court intervened to by ordering conversion of all public vehicles to CNG, that applied to private buses as well (Government of India and Government of National Capital Territory of Delhi 2001).

In Bangalore, standards for vehicle size, quality and emission are set by BMTC and are required to be met by the private operator. The drivers of the private buses are required to be trained by the BMTC along with the drivers of public buses. This ensures quality of drivers (BMTC 2006; RITES 2007).

*Oversight of Private Operations:* The traffic division of the police department is responsible for monitoring the behavior of buses on roads, and their compliance with traffic, speed and stoppage regulations. The police are also responsible for monitoring schedule compliance.

## 8.4 Lessons that can be learned from the experiences of Delhi and Bangalore

Both Delhi and Bangalore decided to use private buses to augment their supply of buses when they could not afford to increase their supply of public buses. Bus supply increased immediately in both cities, easing the overcrowding on buses and offering more comfortable rides (ASRTU 2002).

The experience with privatization of buses in Delhi has not been encouraging and the private buses have been subject to criticisms from the public and the judiciary. Even though they increased the supply of bus services in Delhi during a time when the DTC could not afford to increase its supply, the cost to the city in terms of the accidents and fatalities has forced the Supreme Court to intervene several times to ensure the safety of citizens in Delhi (Sahai and Bishop 2008). Privatization in Delhi did not help the public bus company to change its role to that of facilitator. It also did not help improve its efficiency of operation through coordination of schedules and other such practices. The Delhi government is reluctant to eliminate private buses, and is trying to rectify the problems through corporatization of private stage carriage buses. The reluctance could be partly due to the political lobbying from interest groups working for the private bus owners.

Privatization in Bangalore, on the other hand enabled BMTC to increase its bus supply without having to afford any capital investment. The system of privatization adopted and the regulations drafted by BMTC were conducive to the goals of the government (BMTC 2006; RITES 2007). BMTC intended to maintain control of the planning of networks and schedules and did not want an outright privatization where the private operator could decide the routes and schedules. So they did not allow the private operator any decision-making power in planning a bus service network (Mathur 1999; RITES 2007). They shouldered the revenue risks, and benefited from the increasing demand. When the passenger-km per bus declined, probably due to increase in private vehicle ownership, they reduced the number of private buses and managed to reverse the decreasing trend in bus-productivity (Ramanayya, Nagavendra and Roy 2007).

BMTC has been making profits since its inception and their profits have increased every year (ASRTU 2002; BMTC 2009). The increase in profits also allowed the BMTC to increase their own fleet and decrease the number of private buses used (BMTC 2009). They used privatization primarily as a source of immediate financing during a period when they could not afford to buy new buses to increase their supply.

The success of the BMTC and the profits that they have been making are not just due to the privatization process that they adopted. Bangalore has also been using a more efficient staffing ratio and has one of the lowest employment rates among all urban STUs in the country (ASRTU 2002; BMTC 2009). They have well-planned routes and networks and an increasing population that ensures an increasing demand. They also have an automatic fare revision policy, with a formula that increases fares periodically in response to inflation of the Rupee and the increases in the cost of operations (BMTC 2006a).

Bangalore has been able to operate an urban bus service and make profits and the gross cost franchising system that they adopted has allowed them to maintain control of the planning of the city bus service network and ensure coordination of services among the private and public operators. In their experience, it was wise to take the responsibility and the risks of revenue generation.

The following general lessons can be derived from the experiences of the two cities.

1. It is important that there is efficient *coordination between the routes and schedules* of public and private buses, if private buses will not replace all public buses. The institutional arrangement is crucial in this respect.
    - In Delhi, the involvement of multiple agencies created an environment of competition between public and private operators. Even though one of the expected benefits from privatization is that it will encourage competition between various providers, which will then motivate operators to provide better services at lower costs, Delhi did not benefit from the competition between providers (Gomez-Ibanez and Meyer 1993; Gwilliam and Scurfield 1996; Sheshinski and Lopez-Calva 2000). In Delhi, the private operators are not allowed to schedule their own routes or set their own fares. Thus competition did not lead to a reduction in fares or better

services. In Bangalore, the public and private buses were all scheduled and coordinated by BMTC, which led to more efficient service.

2. Regulations must be able to ensure a safe bus service and avoid the problem of dangerous driving practices. Some of the factors that need to be considered are the following.

    - Licensing: In Delhi, several operators were given permits to operate on the same routes. So instead of competition for the routes, the operators ended up competing on the roads leading to unsafe and illegal driving practices and numerous accidents often involving injuries and fatalities (Deb 2002; Agarwal 2006).
    - Revenue Risks: In Bangalore, the private operator carries very little revenue risk. They are assured of minimum revenue per day and earn extra revenue for every extra kilometer that they operate. So they were able to avoid competition on the road leading to a safer service. In Delhi, the private operator carried all revenue risks and their revenue depended almost entirely on farebox revenue. It then led private operators to engage in dangerous practices such as road-races with other buses to carry more passengers.
    - Ownership Patterns: The regulations that were adopted by Delhi allowed private operators to own only a maximum of 5 buses (Marwah et.al. 2001; Deb 2002). Most of them owned only one or two buses. So their profits depended on the farebox revenue from only one or two vehicles. The

ownership pattern combined with the revenue risks exacerbated the problem of dangerous driving practices by private operators in Delhi.

3. Broader problems such as *corruption in the government* can pose problems as well. During privatizations licenses were often granted based on political clout and not to the best applicant (Marwah et.al. 2002). Many bus owners bribe the officials of the government to ensure that their traffic violations are not reported and fined or prosecuted (Agarwal 2006).
4. Private operations have to be *constantly monitored*. The numerous accidents involving private buses and accusations of speeding and drunk driving forced the Supreme Court to order that speed monitors be installed in all private buses in Delhi (Agarwal 2006). Private buses have been accused of tampering with the speed monitors. Recently in 2007, the Supreme Court ordered that the Blue Line buses have to be phased out because they had become very dangerous and were involved in too many fatal accidents.

Overall, the experience of Delhi and Bangalore shows that privatization of bus services can improve bus services in Indian cities. But they have to be appropriately regulated to meet the needs of the government and to ensure a safe service for the people. Absent provisions to ensure quality of service, private buses can pose more problems than solutions.

# 9 Conclusions

Buses are the most popular mode of public transport in India. This dissertation aimed to study the efficiency of urban bus services in India, the factors that affect their efficiency and the role of privatization in improving their services. This chapter summarizes the findings from the research, discusses the limitations of the research and outlines directions for future research.

## 9.1 Nature of Urban Bus Transport in India and the need to privatize

One of the biggest changes that occurred in India since 1990 is the increase in the use of personal vehicles. It increased congestion and deteriorated air quality. While it is true that the increase in wealth has enabled many more Indians to afford a private vehicle, the inability of the public bus services to keep up with the demands for transport is partly to blame for the growth in private-vehicle use.

Following the Road Transport Corporation Act of 1950, most states in India incorporated State Road Transport Corporations to plan and operate bus services in their states and cities. Some states also organized separate State Transport Undertakings (STUs) for the large cities in their states. After decades of reputable service, the STUs became loss-making monopolies by the late 1980s.

India witnessed many economic and policy changes since the late 1980s. In 1988, the Motor Vehicles Amendment Act which allowed STUs to privatize all or part of their operations was passed into law. The government of India has recommended privatization of urban bus operations in every union budget proposal and Five-Year-Plan since early 1990[29] and the central government stopped funding the expansion of the fleets of STUs. To buy new vehicles and expand services, the STUs were encouraged to resort to privatization or to find other sources of funding. This was part of an overall policy shift from being a protectionist State to a more liberal State that allowed foreign direct investments and encouraged growth of industries in the private sector. Loans from agencies such as the World Bank also often came with a requirement to change the role of the government from that of a provider of services to that of a facilitator.

Increased investments in industries, especially those in the service industries led to a sustained growth in GDP starting in the early 1990s. Cities were the center of this growth leading to increasing demands for public transport. However, most STUs were unable to keep up with the demand due to lack of funds. The deterioration of service combined with the improving economy caused bus services to suffer a loss of ridership and revenue.

Delhi and Bangalore privatized a part of their bus services to increase their bus supply and several other cities such as Chennai, Hyderabad and Indore are considering privatizing part of their operations. However, there are also some cities such as Mumbai, where the STUs are prohibited by law from privatizing any aspect of their operations.

## 9.2 Improving the Performance of Urban Bus Services

This dissertation investigated the performance of 10 urban STUs in India over 15 years. The trend analysis showed that despite increasing losses, most STUs have

[29] 9th five year plan onwards

increased the size of their fleet. However, the capacity offered by most cities increased only marginally, due to a decline in fleet utilization and service. All cities have experienced a decline in the quantity of bus services available per capita. Ridership decreased in most cities between 1991 and 2004, despite increases in population and the resultant increase in total travel demand. This shows a decline in the modal share of bus transport in all cities[30].

The cities that were able to increase ridership such as Bangalore and Chennai did so by catering to the middle class. There are four groups of passengers in India, the high-income group, who will not use public transport regardless of the quality of service, the very low-income group who often cannot afford even the bus fares, the low-income group who will use public transport regardless of the quality of service and the middle-income group who can afford a private mode, but will use the bus if the services are reliable and attractive. The middle income group is thus the group that is usually willing to pay a higher fare for a limited stop bus, an air-conditioned bus or a no-standee bus. Attracting passengers to these premium services might also help to keep the fares lower on the ordinary buses.

Bangalore and Chandigarh are the only cities that have been able to stabilize their costs of operations. In all other cities the increase in revenue has failed to keep up with the increase in costs, leading to increasing losses and mounting debts. Overstaffing is an important factor that affects the operating costs of public bus companies in India. Many cities such as Delhi and Ahmedabad that have incurred increasing losses have employment rates that are about 3 times that in Bangalore and Chandigarh.

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[30] Data collected by the Ministry of Urban Development (2008) also confirms that modal share of buses has declined in all classes of cities.

Theoretically, privatization can be used to break up the employee unions, to reduce rates of employment and to decrease the cost of operations. However, one of the major arguments made against privatizations in India is that it will lead to more unemployment. Employee unions protested in Hyderabad when the Andhra Pradesh state government proposed to use private buses to augment the supply of buses in Hyderabad (Andhra News 2007; Andhra News 2007a). Their argument was that many employees would lose jobs following privatization. The government had to announce that there were no plans to privatize the Andhra Pradesh State Road Transport Corporation and that no positions would be terminated.

Multivariate analysis showed that several factors other than privatization influence efficiency. Higher population density can improve the efficiency of bus services. While this is not a factor that can be directly controlled by the STU, building codes mandating higher Floor Space Index (FSI) can increase population density in cities. In fact in several Indian cities, FSI is restricted. Many employment centers such as technology parks, housing numerous multinational companies in the information technology sector, are often developed outside city centers. Better coordination and land use planning and transport planning can help to improve the efficiency of bus services.

Higher traffic speeds can also improve efficiency of bus systems. The large number of private vehicles is the major cause of low traffic speed in large cities. In smaller cities, the higher proportion of slow moving traffic such as bicycles and rickshaws slow down all traffic. No city in India has separate lanes for fast and slow moving vehicles. So a policy that can improve the travel speed of buses will have to enforce lane separation during peak hours and provide priority for buses at intersections.

Increasing the cost of ownership of private vehicles, and the cost of obtaining driving licenses could deter many people from owning and using private vehicles. Though the average price of gasoline in India is higher than in the USA[31], cars and motorcycles cost much less, with prices starting at $ 250.00 for a new motorcycle and $2000.00 for a new car.

Since the 1990s, public bus companies in India have been unable to improve the quality of their buses by replacing older vehicles with new ones due to lack of funds. Using old vehicles does not seem to affect ridership, because many captive riders do not have another choice and thus does not have a significant effect on service efficiency. But, old vehicles have a small but significant negative effect on production efficiency. They breakdown more often and consume more fuel. Production efficiency can decline by about 0.05% to 0.08% for every year that a bus has been in service. New vehicles can also have features such as low floors for easy boarding which can improve efficiency and be less polluting. While capital investments can be expensive and involve high-interest rates, it can improve production efficiency. New vehicles can also make the service more attractive to the crucial middle-class group.

Higher fares do seem to improve efficiency. Cities such as Bangalore charge about 3 times more for a 10 km trip compared to Mumbai and Kolkata. In most cities, low fares are maintained as a matter of policy and not revised regularly to reflect the increases in cost of operations. Bangalore has a policy of automatic fare revisions based on a formula using cost of operations and revises the bus fares regularly. In almost all other cities, the revision of bus fares is a political decision and is avoided by politicians

[31] In May 2010, gasoline cost $3.00 per gallon in New York and approximately $4.00 per gallon in New Delhi.

even when bus operators face increasing losses and debts. Regression analysis showed that an increase in fare by 1 rupee/km can increase the efficiency of public buses by 11.9% to 12.3%. But the average distance travelled by commuters in most cities is about 10km, and the fare for a 10 km trip ranges from about Rs. 3.50 to about Rs. 12.00. So an increase in fares by 1 rupee per km will result in at least a doubling of fares. In some cities the fare will become 4 times higher than current fares. So such increases will have to be implemented over time. However, smaller increases can lead to significant benefits as well. As discussed above, there is a large group of middle-class passengers who are willing to pay for better services, and having several tiers of service can be beneficial.

Improving and increasing the supply of buses is one of the benefits that can be derived by using private buses to augment the supply of public buses. Bangalore and Delhi, which used private buses in addition to public buses benefited from an immediate increase in supply of buses, reduction in crowding on buses, and reduction in waiting times. These are all factors that can attract passengers toward bus transport. However, in contradiction to theoretical expectations, competition from private buses need not ensure operators of an improvement in their production efficiency. The nature of regulations governing private buses is more important than the introduction of competition itself in improving the overall quality of service.

## 9.3 The impact of competition on efficiency of bus services

Privatization theory proposes that competition between operators is beneficial. When a service is offered by numerous providers, the providers have to compete for customers and attract them by offering better services at lower prices. Such competition is expected to encourage innovations that will lower the costs of operation and allow the operators to charge a lower fare for their services.

The cases of Bangalore and Delhi offer a useful comparison of the effectiveness of competition as a factor that improves efficiency. Delhi and Bangalore are two cities that privatized part of their bus operations and experienced different outcomes. Bangalore Metropolitan Transport Corporation (BMTC) chose a gross-cost system because they wanted to maintain control of the planning and monitoring of public bus services, and only wanted to augment their supply of bus services with hired private buses. The State Transport Authority (STA) of Delhi considered the monopolistic privileges enjoyed by Delhi Transport Corporation (DTC) as one of the important reasons for its poor performance. Delhi chose a net-cost system of franchising which is closer to free entry but with route-based contracts. Permits to operate stage carriage buses were granted to numerous small private owners. DTC had no control or oversight over the schedules or operations of private buses in Delhi which were under the purview of the STA. The private operators were in fact competing with the public operators (DTC) as well as with other private operators.

The experience of Delhi and Bangalore does not support the theory that competition between operators improves efficiency. There is more competition between operators in Delhi than in Bangalore. Yet, the government of Delhi has received numerous complaints about the poor quality of service and unsafe driving practices of private operators, while the overall quality of bus services in Bangalore has improved since BMTC started hiring private buses. Since fares are scheduled by the STA, competition did not have any effect on the cost for passengers in Delhi. Besides, eighty percent of bus owners in Delhi owned only 1 or 2 buses. So they had to ensure that their buses were filled to capacity for every trip and it led to dangerous competition on the road.

The competition in Delhi was not true free market competition where supply and prices depend on demand. Such free competition is perhaps not suitable for the bus transport industry. Bus transport is important because it caters to those who cannot afford other means of transportation. If it can be made attractive to the middle-class who will only choose the bus if it is reliable and comfortable, bus transport can help reduce congestion and pollution.

## 9.4 Implications of the research

One of the most important implications of the study is that privatization by itself is unlikely to be as beneficial as expected. The cities that used private buses in addition to public buses experienced some of the benefits from privatization. The regression analysis indicated that factors other than privatization are important for improving efficiency. The benefits that can be derived from the use of private capital depend on how the privatization is planned and implemented. Other factors that affect efficiency, such as low traffic speeds, very low fares, etc also need to be addressed.

Data envelopment analysis (DEA) followed by regression has never been used to analyze the efficiency of public bus companies in India to the best of the author's knowledge. Data envelopment analysis is a versatile non-parametric method that allows the comparison of decision making units, especially those for whom financial performance may not be the only criterion for efficiency[32]. One of the advantages of using DEA is that it allows the decision making unit to define its own outputs. For example, in this research, the level of comfort was used as an output, because buses used to be overcrowded in many cities. To the best of the author's knowledge, crowding has not been used as a negative output, in any DEA analysis of public transport systems. The implications of including level of comfort as an indicator of crowding were significant[33].

The research offers a set of practical implications for cities that wish to improve the efficiency of their bus services without resorting to privatization. The multivariate analysis indicated that several factors can be sources of inefficiency. While some of these such as population density cannot be directly controlled by the transport company, land-use planning and zoning regulations can ensure higher population density in cities. Regular revision of fares, better cost management, and investments made to improve the quality of vehicles or to purchase new vehicles can all improve efficiency.

The research also offers several practical implications for cities that are planning to privatize their bus services. The comparison of the privatization experience of Delhi and Bangalore provides useful lessons that can inform privatization of public buses in other cities. One of the most important factors that affect success is the coordination of routes and services. This requires particular attention if the private buses will not replace all the public buses and the city will be served by both public and private buses at the same time. The agency responsible for coordination may be the public company that also operates buses or an independent government agency that is not directly involved with

[32] Other applications of DEA have been in the assessment of the efficiency of hospitals, schools and other public enterprises.
[33] Cities such as Delhi had a load factor above 100% which indicates that buses were filled beyond standing capacity. Without the crowding factor, such cases would be assigned a relative efficiency of 100%. With crowding factor, however, the author was able to control for such problems.

provision of public transport. In either case, the coordination of routes and schedules and efficient monitoring of performance and compliance is important. Appropriate regulations regarding qualifications for drivers, bus stops, capacities, and ownership patterns must be established to guard against dangerous driving practices and to ensure safety of passengers.

## 9.5 Limitations of research

The biggest challenge that the author faced during the research was the nature of the data that was available and the lack of data for several cities. Many cities that had a public service did not have an exclusive urban STU (State Transport Undertaking). They were served by their State Road Transport Corporation which did not have separate data for each city. So several cities had to be excluded from the study. Many cities, especially in southern India, were served by public as well as private buses. These cities could also not be included in the study due to lack of data on both public and private buses. All five of the medium sized cities chosen for the study are from western and northern parts of the country. Three of these five cities are from the same state. This skewed selection is because unlike other states, the state of Maharashtra established separate STUs for many of its urban areas and maintained separate data for each of the urban areas.

There were two major cities that followed a planned privatization, Delhi and Bangalore. Conventional analyses of the effectiveness of privatization are done by comparing the performance of a bus service before privatization to its performance after privatization. In most of these studies, privatization implies that the services offered by public buses are replaced by those offered by private buses. But public buses were not replaced by private buses in either Delhi or Bangalore. So the research compared the efficiency of the cities that privatized with other cities that did not privatize to assess whether privatization helped improve the efficiency of public transport.

Lack of detailed land use and geographic information on the cities was another limitation. Urban transport is influenced by the geography of the city and the distribution of residential, commercial, industrial and other land uses in the city. Since cities in India were not geo-coded, such a geographical analysis was not possible.

Another important factor that affects the comparison of cities is the difference in cost of living among the cities. The dissertation used the national consumer price index published by the labor bureau of India to convert all Rupee figures to constant 1990 prices. The center-wise index shows that the inflation rates in various cities are different affecting the cost of living and the cost of operation in these cities. It shows that Bangalore is the most expensive city to live in and Delhi is the cheapest among the cities chosen for the study. However, since city-wise data is not available for every year of the study period, it was not used[34].

## 9.6 Directions for future research

One of the factors that made the comparison between Delhi and Bangalore interesting and useful was that the two cities chose two different methods of privatization, adopted dissimilar regulations and experienced different outcomes. Delhi is changing its privatization scheme in 2010. As the new scheme is developed with larger private companies, better monitoring and more systematic collection of performance data from

[34] City-wise data is available for 2009, and the author considered using the same trend as the national index to extrapolate those indices for every year, but decided against it as the trends would not be the same for every city.

private operators can be expected. A few years later, it might allow a comparison of public and private operators in Delhi.

Demographic factors such as the size of families, number of workers per family, number of women who work outside the home etc., are important determinants of travel demands. It is hypothesized that higher rates of education and employment of women is one of the reasons for the high demand and use of public transport in small and medium cities in southern India, such as Kochi, Coimbatore and Mangalore (Ministry of Urban Development 2008). It will be interesting to include variables that reflect household characteristics in the study of efficiency of bus services.

With the changing economic conditions in India, the number of homes with internet and broadband connections has been increasing. The number of internet subscribers has increased from 6 million in 2005 to 40 million in 2010, and the number of broadband subscribers has increased from 3 million to 20 million during the same period. Such connectivity has the potential to increase opportunities for telecommuting and may have an impact on the volume of peak-hour traffic in Indian cities. The effects of such changes in commuting patterns will be interesting and need to be addressed in future studies on urban transport in India.

The Central Institute of Road Transport in Pune which is currently the organization that collects data from STUs, has undertaken a project to compile a similar data repository for private bus companies in the country. It has proven to be challenging because of the large number of small operators and the nature of data that they are willing to and legally required to divulge. However, even a non-financial data set regarding private operators in India will be useful and very interesting to study.

# Appendix Chapter 7

## Appendix 1 Calculating Efficiency Using Data Envelopment Analysis

Example: Production Efficiency for Delhi 1990.

*Appendix Table 1 Calculating Production Efficiency for Delhi (example)*

| City | Year | number of buses | Fuel used per year | Number of employees | Vehicle-km per year | Weighted inputs | weighted outputs | Difference | Efficiency (before iterations) | Efficiency (after iterations) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Delhi** | 1990 | 3860 | 87.97 | 41572 | 329 | 45519.97 | 329 | -45190.97 | 0.0072276 | 0.8938 |
| **Delhi** | 1991 | 3722 | 78.37 | 41277 | 297.8 | 45077.37 | 297.8 | -44779.57 | 0.0066064 | |
| **All cases** | | | | | | | | | | |
| **Weights (before iterations)** | | 1 | 1 | 1 | 1 | | | | | |
| **Weights (after iterations)** | | 0.00004988 | 0.00007285 | 0.00001613 | 0.00006398 | | | | | |

1. Input data into an MS excel file of the format shown in appendix table 1.

Initially, all inputs and outputs are assigned a weight of 1.00.

Weighted outputs for Delhi 1990 = 3860*1.00 + 87.97*1 + 41572*1

Weighted inputs for Delhi 1990 = 329*1.00

Similar calculations are made for all cases.

One of the constraints to be imposed while calculating the relative efficiency is that efficiency is always less than or equal to 1.00. To do this, a column 'difference' is added and its value is the difference between weighted output and weighted input.

Efficiency = weighted outputs/weighted inputs

2. DEA can be performed using the solver add-on in MS excel. The solver can maximize or minimize cell values subject to constraints imposed. The calculated efficiency for Delhi 1990 has to be the maximum relative efficiency for that case. To do this excel is programmed to maximize the cell 'weighted outputs' for Delhi 1990, by changing the weights, such that:
    a. the sum of weighted inputs for Delhi 1990 = 1 (This ensures that the efficiency estimated is the maximum possible efficiency for Delhi 1990)
    b. All weights have at least a small positive value (This is to prevent the program from ignoring any unfavorable variable. If another study requires the weights of a certain variable to be 50%, that can be added as a constraint too.)
    c. Difference <= 1.00 (This ensures that efficiency is always less than 1.00).

3. Calculation of weights is then done through iterations, which are stopped when any one case attains the efficiency of 1.00 or after a user-specified number of iterations. The weights thus obtained for Delhi 1990, is its relative efficiency.
4. The steps have to be then repeated for Delhi 1991, Delhi 1992 and so on for each case.

*Appendix Table 2: Efficiencies for Bangalore Metropolitan Transport Corporation for various years when compared against other large cities (with pass-km adjusted to reflect a maximum load factor of 100%, and level of comfort not included)*

| | Year | Production Efficiency | Rank | Service Efficiency | Rank | Combined Efficiency | Rank |
|---|---|---|---|---|---|---|---|
| Pre-privatization | 1999 | 95.83 | 10 | 69.28 | 8 | 97.12 | 10 |
| Post-privatization | 2000 | 96.56 | 9 | 76.28 | 6 | 98.01 | 6 |
| | 2001 | 97.48 | 8 | 61.02 | 10 | 97.22 | 9 |
| | 2002 | 98.13 | 6 | 65.28 | 9 | 97.29 | 8 |
| | 2003 | 97.84 | 7 | 72.63 | 7 | 98.31 | 5 |
| | 2004 | 98.69 | 5 | 78.47 | 5 | 97.65 | 7 |
| | 2005 | 98.95 | 4 | 86.49 | 2 | 98.38 | 4 |
| | 2006 | 99.26 | 3 | 88.62 | 1 | 100 | 1 |
| | 2007 | 100 | 1 | 81.25 | 4 | 99.95 | 2 |
| | 2008 | 99.72 | 2 | 83.78 | 3 | 99.21 | 3 |

*Appendix Table 3: Efficiencies for Bangalore Metropolitan Transport Corporation for various years when compared against all other cities included in the study (with pass-km adjusted to reflect a maximum load factor of 100%, and level of comfort not included)*

| | Year | Production Efficiency | Rank | Service Efficiency | Rank | Combined Efficiency | Rank |
|---|---|---|---|---|---|---|---|
| Pre-privatization | 1999 | 96.23 | 10 | 70.28 | 8 | 96.93 | 6 |
| Post-privatization | 2000 | 96.96 | 9 | 77.74 | 6 | 97.03 | 5 |
| | 2001 | 97.48 | 8 | 61.82 | 10 | 96.17 | 10 |
| | 2002 | 98.73 | 6 | 66.23 | 9 | 96.73 | 8 |
| | 2003 | 98.14 | 7 | 73.81 | 7 | 97.59 | 4 |
| | 2004 | 98.99 | 5 | 79.94 | 5 | 96.53 | 9 |
| | 2005 | 99.15 | 4 | 88.25 | 2 | 96.9 | 7 |
| | 2006 | 99.56 | 3 | 90.17 | 1 | 100 | 1 |
| | 2007 | 100 | 1 | 83.96 | 4 | 99.04 | 2 |
| | 2008 | 99.82 | 2 | 86.39 | 3 | 98.62 | 3 |

*Appendix Table 4: Efficiencies for Bangalore Metropolitan Transport Corporation for various years when compared against other large cities (with comfort variable included as output)*

| | Year | Production Efficiency | Rank | Service Efficiency | Rank | Combined Efficiency | Rank |
|---|---|---|---|---|---|---|---|
| Pre-privatization | 1999 | 95.83 | 10 | 89.46 | 10 | 97.92 | 10 |
| Post-privatization | 2000 | 96.56 | 9 | 92.78 | 9 | 98.71 | 8 |
| | 2001 | 97.48 | 8 | 95.42 | 8 | 98.52 | 9 |
| | 2002 | 98.13 | 6 | 97.38 | 7 | 98.79 | 7 |
| | 2003 | 97.84 | 7 | 98.43 | 6 | 99.29 | 5 |
| | 2004 | 98.69 | 5 | 99.82 | 4 | 98.85 | 6 |
| | 2005 | 98.95 | 4 | 99.92 | 3 | 99.38 | 4 |
| | 2006 | 99.26 | 3 | 100 | 1 | 100 | 1 |
| | 2007 | 100 | 1 | 99.37 | 5 | 99.95 | 3 |
| | 2008 | 99.72 | 2 | 100 | 1 | 100 | 1 |

*Appendix Table 5: Efficiencies for Delhi Transport Corporation for various years when compared against other large cities (with pass-km adjusted to reflect a maximum load factor of 100%)*

| | Year | Production Efficiency | Rank | Service Efficiency | Rank | Combined Efficiency | Rank |
|---|---|---|---|---|---|---|---|
| Pre-privatization | 1990 | 89.38 | 3 | 98.89 | 1 | 97.34 | 2 |
| | 1991 | 85.36 | 5 | 97.95 | 3 | 96.38 | 3 |
| | 1992 | 91.52 | 2 | 98.12 | 2 | 98.45 | 1 |
| | 1993 | 83.29 | 6 | 97.28 | 4 | 95.49 | 5 |
| Post-privatization | 1994 | 79.2 | 9 | 96.73 | 5 | 94.545 | 6 |
| | 1995 | 71.85 | 15 | 95.16 | 6 | 85.415 | 12 |
| | 1996 | 64.06 | 19 | 94.28 | 7 | 85.485 | 11 |
| | 1997 | 67.09 | 18 | 93.57 | 8 | 84.935 | 13 |
| | 1998 | 73.89 | 12 | 83.17 | 15 | 86.55 | 10 |
| | 1999 | 80.65 | 8 | 85.36 | 14 | 87.235 | 9 |
| | 2000 | 81.73 | 7 | 82.34 | 16 | 89.045 | 8 |
| | 2001 | 68.13 | 17 | 77.69 | 19 | 79.735 | 18 |
| | 2002 | 72.45 | 13 | 78.24 | 18 | 80.21 | 17 |
| | 2003 | 78.63 | 10 | 79.58 | 17 | 81.265 | 16 |
| | 2004 | 76.52 | 11 | 87.29 | 13 | 83.465 | 14 |
| | 2005 | 69.48 | 16 | 89.52 | 12 | 78.595 | 19 |
| | 2006 | 72.13 | 14 | 90.08 | 11 | 82.97 | 15 |
| | 2007 | 88.71 | 4 | 92.25 | 10 | 91.025 | 7 |
| | 2008 | 93.4 | 1 | 93.06 | 9 | 95.605 | 4 |
| | | | | | | | |

*Appendix Table 6: Efficiencies for Delhi Transport Corporation for various years when compared against other large cities (with comfort variables included)*

| | Year | Production Efficiency | Rank | Service Efficiency | Rank | Combined Efficiency | Rank |
|---|---|---|---|---|---|---|---|
| Pre-privatization | 1990 | 89.38 | 3 | 75.94 | 18 | 76.42 | 16 |
| | 1991 | 85.36 | 5 | 76.95 | 16 | 76.31 | 17 |
| | 1992 | 91.52 | 2 | 75.23 | 19 | 74.19 | 19 |
| | 1993 | 83.29 | 6 | 76.69 | 17 | 75.78 | 18 |
| Post-privatization | 1994 | 79.2 | 9 | 80.28 | 14 | 77.39 | 15 |
| | 1995 | 71.85 | 15 | 82.67 | 10 | 82.95 | 7 |
| | 1996 | 64.06 | 19 | 81.83 | 11 | 80.28 | 13 |
| | 1997 | 67.09 | 18 | 83.74 | 5 | 79.21 | 14 |
| | 1998 | 73.89 | 12 | 80.17 | 15 | 83.47 | 5 |
| | 1999 | 80.65 | 8 | 81.36 | 13 | 80.31 | 12 |
| | 2000 | 81.73 | 7 | 83.34 | 7 | 84.87 | 1 |
| | 2001 | 68.13 | 17 | 83.69 | 6 | 81.25 | 10 |
| | 2002 | 72.45 | 13 | 84.27 | 4 | 82.12 | 8 |
| | 2003 | 78.63 | 10 | 85.92 | 1 | 83.84 | 3 |
| | 2004 | 76.52 | 11 | 81.74 | 12 | 81.65 | 9 |
| | 2005 | 69.48 | 16 | 84.67 | 3 | 80.95 | 11 |
| | 2006 | 72.13 | 14 | 84.83 | 2 | 84.72 | 2 |
| | 2007 | 88.71 | 4 | 83.27 | 8 | 83.25 | 6 |
| | 2008 | 93.4 | 1 | 82.71 | 9 | 83.55 | 4 |
| | | | | | | | |

*Appendix Table 7: Efficiencies for Delhi Transport Corporation for various years when compared against all other cities included in the study (with pass-km adjusted to reflect a maximum load factor of 100%)*

| | Year | Production Efficiency | Rank | Service Efficiency | Rank | Combined Efficiency | Rank |
|---|---|---|---|---|---|---|---|
| Pre-privatization | 1990 | 92.42 | 3 | 99.14 | 1 | 98.15 | 2 |
| | 1991 | 87.92 | 5 | 98.49 | 3 | 97.48 | 3 |
| | 1992 | 95.19 | 2 | 98.95 | 2 | 99.71 | 1 |
| | 1993 | 85.93 | 6 | 98.34 | 4 | 97.04 | 5 |
| Post-privatization | 1994 | 81.26 | 9 | 97.57 | 5 | 96.13 | 6 |
| | 1995 | 71.91 | 15 | 95.82 | 6 | 86.04 | 12 |
| | 1996 | 64.21 | 19 | 95.68 | 7 | 86.86 | 11 |
| | 1997 | 65.27 | 18 | 95.66 | 8 | 85.84 | 13 |
| | 1998 | 74.83 | 12 | 85.92 | 15 | 88.92 | 10 |
| | 1999 | 83.11 | 8 | 87.81 | 14 | 89.35 | 9 |
| | 2000 | 83.84 | 7 | 82.89 | 16 | 92.75 | 8 |
| | 2001 | 67.68 | 17 | 80.02 | 19 | 82.32 | 18 |
| | 2002 | 74.82 | 13 | 80.77 | 18 | 82.43 | 17 |
| | 2003 | 78.92 | 10 | 81.52 | 17 | 83.17 | 16 |
| | 2004 | 78.56 | 11 | 90.15 | 13 | 85.84 | 13 |
| | 2005 | 71.9 | 16 | 92.85 | 12 | 79.93 | 19 |
| | 2006 | 74.28 | 14 | 92.99 | 11 | 85.48 | 15 |
| | 2007 | 92.12 | 4 | 94.73 | 10 | 93.01 | 7 |
| | 2008 | 96.67 | 1 | 94.75 | 9 | 97.38 | 4 |

*Appendix Table 8 Regression results for production efficiency (including dummy variables for years)*

| Variables | Tobit regression | | Truncated regression | |
|---|---|---|---|---|
| | **Coefficient** | **t** | **Coefficient** | **z** |
| Competition from private buses | 5.232322 | 1.82 | 6.73322 | 1.88 |
| Population density | -.0032158 | -2.07 | -.0001981 | -2.13 |
| Income per capita | .0004325 | 0.28 | .0004409 | 1.08 |
| Average traffic speed | .1366814 | 2.31 | .11528366 | 3.40 |
| Average age of buses | -.0394155 | -3.25 | -.0783814 | -2.68 |
| Fare per km | 11.45066 | 3.33 | 12.38122 | 3.27 |
| Time trend | .1538927 | 3.04 | .1539417 | 4.38 |
| Bangalore | 20.43507 | 6.78 | 20.3906 | 6.03 |
| Chandigarh | 19.47725 | 5.67 | 20.39532 | 5.25 |
| Chennai | 3.83944 | 3.18 | 3.391728 | 3.09 |
| Delhi | -16.39565 | -7.41 | -15.39195 | -7.24 |
| Kolhapur | -.8230678 | -0.24 | -.5394113 | -0.14 |
| Mumbai | -14.32506 | -5.44 | -15.39729 | -5.29 |
| Pimpri-Chinchwad | -7.732538 | -2.46 | -7.396248 | -2.15 |
| Pune | 8.038621 | 1.89 | 8.391615 | 1.73 |
| Year1990 | .3814209 | 0.07 | .4763809 | 0.04 |
| Year1991 | -.0196845 | -0.00 | -.0452945 | -0.03 |
| Year1992 | 1.426591 | 0.30 | 1.434821 | 0.32 |
| Year1993 | .2291635 | 0.05 | .2194725 | 0.07 |
| Year1994 | .0964232 | 0.02 | .0294632 | 0.03 |
| Year1995 | -1.648102 | -0.44 | -1.293462 | -0.41 |
| Year1996 | -1.16606 | -0.32 | -1.128405 | -0.35 |
| Year1997 | -.5501089 | -0.17 | -.6203812 | -0.27 |
| Year1998 | .5876141 | 0.20 | .5192743 | 0.40 |
| Year1999 | 1.083202 | 0.43 | 1.1028434 | 0.47 |
| Year2000 | 1.6914 | 0.72 | 1.726304 | 0.84 |
| Year2001 | -.0379584 | -0.02 | -.0482134 | -0.48 |
| Year2002 | .5092426 | 0.28 | .519274 | 0.58 |
| Year2003 | 1.8486788 | 1.13 | 1.8890388 | 1.12 |
| Constant | 84.47546 | 7.66 | 86.45128 | 6.91 |
| | | | | |
| Log likelihood | -326.65016 | | -317.68805 | |
| Wald chi$^2$ | | | 658.03 | |
| LR chi$^2$ | 275.67 | | | |
| Prob > chi$^2$ | 0.0000 | | 0.0000 | |

*Appendix Table 9 Regression results for service efficiency (including dummy variables for years)*

| Variables | Tobit regression | | Truncated regression | |
|---|---|---|---|---|
| | **Coefficient** | **t** | **Coefficient** | **z** |
| Competition from private buses | 4.323947 | 2.73 | 3.757766 | 2.19 |
| Population density | .0002659 | 3.07 | .0002887 | 3.09 |
| Income per capita | -.000178 | -3.54 | -.000192 | -3.18 |
| Average traffic speed | .0948774 | 2.50 | .0463948 | 2.23 |
| Average age of buses | -.1070572 | -0.86 | -.0976506 | -0.50 |
| Fare per km | 10.89022 | 5.32 | 12.57584 | 5.38 |
| Time trend | .6669024 | 3.62 | .731144 | 3.70 |
| Bangalore | 13.01687 | 12.33 | 13.77223 | 11.70 |
| Chandigarh | 10.25466 | 5.85 | 10.03096 | 5.43 |
| Chennai | 3.792542 | 2.26 | 4.390075 | 2.44 |
| Delhi | -12.91916 | -11.40 | -13.65928 | -10.49 |
| Kolhapur | 1.34489 | 0.75 | 1.00847 | 0.53 |
| Mumbai | 15.83759 | 1.39 | 16.37506 | 1.03 |
| Pimpri-Chinchwad | -5.219577 | -3.24 | -5.546077 | -3.22 |
| Pune | 9.042232 | 1.34 | 8.938897 | 1.39 |
| Year1990 | -6.74735 | -1.72 | -6.35735 | -1.12 |
| Year1991 | -7.191514 | -1.00 | -7.439514 | -1.10 |
| Year1992 | -7.862369 | -1.47 | -7.293369 | -1.27 |
| Year1993 | -7.332427 | -1.56 | -7.393427 | -1.36 |
| Year1994 | -5.50895 | -1.25 | -5.83995 | -1.45 |
| Year1995 | -6.101685 | -1.22 | -6.293585 | -1.12 |
| Year1996 | -4.214526 | -0.47 | -4.292326 | -0.47 |
| Year1997 | -4.7767 | -0.58 | -4.3917 | -0.28 |
| Year1998 | -2.807459 | -0.35 | -2.829239 | -0.35 |
| Year1999 | -.3216403 | -0.36 | -.3230333 | -0.56 |
| Year2000 | -.7547716 | -0.46 | -.2934946 | -0.66 |
| Year2001 | -.6938093 | -0.47 | -.3930343 | -0.17 |
| Year2002 | -.356728 | -0.81 | -.3529303 | -0.61 |
| Year2003 | -.482095 | -0.79 | -.4294394 | -0.89 |
| Constant | 82.76786 | 14.64 | 80.72097 | 13.30 |
| | | | | |
| Log likelihood | -283.44083 | | -284.90648 | |
| Wald $chi^2$ | | | 2475.44 | |
| LR $chi^2$ | 409.90 | | | |
| Prob > $chi^2$ | 0.0000 | | 0.0000 | |

*Appendix Table 10 Regression results for combined efficiency (including dummy variables for years)*

| Variables | Tobit regression | | Truncated regression | |
|---|---|---|---|---|
| | **Coefficient** | **t** | **Coefficient** | **z** |
| Competition from private buses | .94856 | 2.05 | 1.156741 | 2.10 |
| Population density | .0001257 | 2.11 | .0001349 | 2.27 |
| Income per capita | -.0001075 | -3.18 | -.0001155 | -3.06 |
| Average traffic speed | .1282438 | 2.58 | .1984993 | 2.85 |
| Average age of buses | -.198981 | -2.52 | -.2087139 | -2.95 |
| Fare per km | .4034169 | 4.19 | .6709075 | 3.44 |
| Time trend | .9696475 | 4.44 | 1.034815 | 4.48 |
| Bangalore | 14.64752 | 10.61 | 16.33485 | 9.68 |
| Chandigarh | 16.57455 | 7.78 | 16.52124 | 7.41 |
| Chennai | 6.095411 | 2.99 | 6.972583 | 3.20 |
| Delhi | -14.46362 | -10.51 | -14.12749 | -10.03 |
| Kolhapur | -.6019688 | -0.28 | -.9067162 | -0.40 |
| Mumbai | 9.761821 | 1.78 | 10.31528 | 1.78 |
| Pimpri-Chinchwad | -6.580098 | -3.35 | -6.68967 | -3.18 |
| Pune | 8.507004 | 1.19 | 8.513292 | 1.27 |
| Year1990 | 13.93922 | 1.30 | 13.36222 | 1.40 |
| Year1991 | 14.18636 | 1.53 | 14.48236 | 1.53 |
| Year1992 | 13.80372 | 1.65 | 13.389272 | 1.65 |
| Year1993 | 12.8772 | 1.78 | 12.3922 | 1.28 |
| Year1994 | 11.30002 | 1.37 | 11.323832 | 1.67 |
| Year1995 | 11.08298 | 1.75 | 11.838214 | 1.35 |
| Year1996 | 9.688011 | 1.27 | 9.3812011 | 1.77 |
| Year1997 | 8.126066 | 1.14 | 8.38366 | 1.24 |
| Year1998 | 6.3863 | 0.54 | 6.83483 | 0.54 |
| Year1999 | 5.99158 | 0.85 | 5.38398 | 0.75 |
| Year2000 | 4.719832 | 0.27 | 4.789392 | 0.87 |
| Year2001 | 3.739958 | 0.12 | 3.93488 | 0.62 |
| Year2002 | 3.163144 | 0.84 | 3.838234 | 0.74 |
| Year2003 | 2.8677 | 0.89 | 2.39823 | 0.49 |
| Constant | 76.4844 | 15.15 | 73.56917 | 13.24 |
| | | | | |
| Log likelihood | 264.20332 | | -257.01802 | |
| Wald $chi^2$ | | | 1179.43 | |
| LR $chi^2$ | 329.69 | | | |
| Prob > $chi^2$ | 0.0000 | | 0.0000 | |

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## Education

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## Publications

- Pucher, John, Zhong-Ren Peng, Neha Mittal, Yi Zhu and Nisha Korattyswaroopam, 2007. "Urban Transport Trends and Policies in China and India: Impacts of Rapid Economic Growth". *Transport Reviews*, Vol. 27, No. 4, 379–410, July 2007.

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