NATIONAL TRANSPORT RESEARCH CENTRE

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ECONOMICS OF TAXI OPERATION

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Preface

This study has been carried out by the National Transport Research Centre, Islamabad on behalf of the Government of Pakistan.

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The views expressed in this report are not necessarily those of the respective Governments.

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1. INTRODUCTION

The National Transport Research Centre is currently engaged in a study of the taxi industry in the major cities in Pakistan. The scope of the study is predominantly that of a fact-finding survey designed with the objective of obtaining, for the first time, some insights into the structure of the industry and its problems; covering such aspects as ownership patterns, cost profiles, earnings and resource productivity.

The purpose of this paper is to serve as a preface to the above study; the objective here being to identify the salient issues and economic principles which shape the structure and mode of operation of the taxi system in general. The intention is to provide a framework which, hopefully, could be used to guide subsequent analysis of survey findings and discussion of policy options. In this respect we should add the caveat that the paper does not attempt to provide a comprehensive review of the literature on the subject. The work draws primarily on a select number of published studies that were available to the author whilst working in Pakistan.

It should be recorded at the outset that since the context of paper also covers taxi operations in the Less Developed Countries (LDC"s) its scope also embraces the wide range of vehicle types and technologies employed in taxi services in these countries.

The first section of the paper presents a general model of the structural inter-relationships governing the manner in which the taxi component of the public passenger transport system operates. This is followed by an examination of the characteristics of the demand for taxi services; continuing with an analysis of the supply side of the market and its cost structures. The final section discusses the inter-relation between demand and supply conditions, focusing in particular on the role of government regulation.

2 STRUCTURE OF THE TAXI INDUSTRY

2.1 Definitions

Many attempts have been made to categorize the different public transport technologies and modes of operation and group them into meaningful classes. One such classification is shown in Table 2.1 where the taxi mode is placed in a position intermediate between the private transport group and the common carriers. Without going into the merits of the different possible classification schemes, the taxi can be considered as one of the Paratransit or Intermediate public transport modes for which the following definition is offered by Vuchic (1981).

"Paratransit is urban passenger transportation service usually in highway vehicles operated on public- streets and highways in mixed traffic; it is provided by private or public operators and it is available to certain groups of users or to the general public, but adaptable in its routing and scheduling to the individual user's desires in varying degrees."

Table 2.1

Classification of Urban Passenger Transport by type of usage.

Usage type / Characteristic	Private		For-hire		Public o Common Carrier
Carrier type	Individual			Group	
Modes	Automobile	carpools	taxi	Dial-a-ride	Street transit (bus, trolleybus, streetcar),
	Motorcycle	Vanpools	Rented car	(Jitney)	Semirapid transit (semirapid bus, light rail transit)
	Bicycle			Charter bus	Rapid transit (rail, rubber-tired, regional rail)
	Walking				Special and proposed modes
Optimum (but not exclusive) domain of operation:					
Area density	Low-medium	Origin: low. Destination: high	Low		High-medium
Routing Time	Dispersed off-peak	Radial Peak only	Dispersed All time		Concentrated (radial) Peak
Trip purposes	Recreation shopping, business	Work only	Business		Work, school, business

Source: Vuchic (1981)

Operated by small capacity vehicles using the public highway, the classic taxi mode has no fixed routes or schedules and in theory can link any origin with any desired destination at any time. Other variations of taxi operations include 'dial-a-ride' services and the shared taxi operation characterised by the Turkish Dolmus where the vehicle tends to follow a fixed route over most of the length of the journey.

2,2 Mode of Operation

There is a remarkable consistency, throughout the world, in the mode of operation of taxi services. Except for some of the Communist countries, taxis are primarily owned and operated by private sector undertakings. Ownership patterns vary between companies owning several hundred vehicles through to the single vehicle owner; Drivers may be regular employees of the company or even of the individual owner, or may be 'journey men' (drivers who contract to hire the vehicle from the owner for an agreed daily fee) or may be owner-drivers operating on their own account. The mix of operating practices varies widely from country to country and it is not uncommon to see all of the above practices functioning side-by-side within the same city.

The vehicles which ply for hire may operate from specially designated taxi ranks (stands) and/or may 'cruise' looking for potential customers. Cruising usually occurs in locations where there is a high density of urban activities, and hence a high concentration of potential passengers. Rank operation reduces operating costs and is more appropriate to locations where demand is highly localized and time depandent such as at transport interchanges and other major activity generators. Contract hire is another type of operation, employed for regular journies (to schools, hospitals etc) and for the carriage of documents and certain types of goods traffic.

Two-way radio control or 'despatched' operations are becoming an increasingly common feature of taxi operation. The central control may be operated by a large fleet owner exclusively for his own vehicles, or may be run on a more extensive basis where individual owner/drivers and contractors can subscribe to a common service.

The taxi is the most labour intensive of all public transport modes and because of the small size of the vehicle has the highest profile of operating costs per passenger kilometer. Hence, fares are amongst the highest of all public transport modes.

The most common practice is for fares to be regulated by some public agency, and to be charged on a pro-rata distance/time basis through the mechanism of the taxi meter. Practices and fare levels vary widely; depending on local custom, the structure of operating costs and the nature of the market. Washington DC. for example operates a zonal fare system. London has a more complex tariff structure with a fixed initial charge on the taxi meter which is then incremented on the basis of time and distance travelled and to which may be added various supplements for luggage, extra passengers, and night-time hirings. Rio de Janeiro's taxis have a metered, two-tier differential pricing structure with the higher charging rate authorized for fares in outer suburban areas, hilly parts of the city, trips made between midnight and 6 am. and at all times on Sundays and Public Holidays. The city of Sao Paulo has three classes of taxis; common, aire-conditioned and luxury; each has a different metered fare rate.

Apart from determining fare levels, public authorities may exercise varying degrees of control over other aspects of the industry's operation. They may exercise regulatory powers over the types and standards of vehicles that may be used-known as quality control; they may also determine the maximum number of vehicles which should be allowed to operate and over what geographical areas-known as quantity control. These issues are discussed at greater length later in this paper.

2.3 The Economic Mechanisms

One useful way in which to analyse the mechanisms of the taxi mode is to follow the framework offered by Transport Systems Analysis which suggests that any modal system can be analysed by identifying its components and grouping them in structured sets. At the broadest level we can adopt a framework composed of three major sets: (Fig. 2.1)

1. Demand characteristics
2. Supply characteristics
    - Vehicles
    - Right-of-way/Network/Terminals

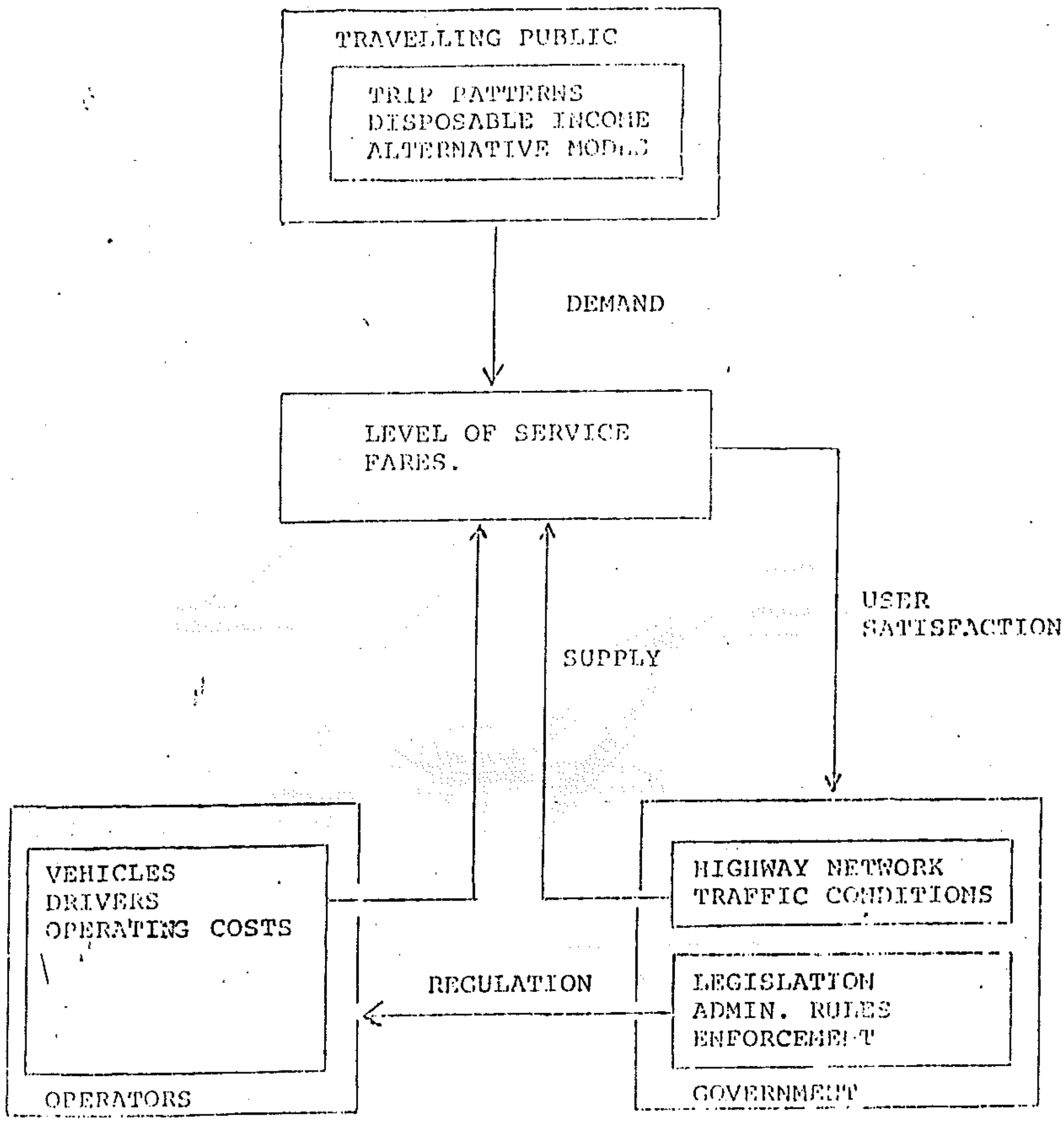

Figure 2.1

The principal mechanisums and components of the taxi system.

3. Regulation

- Operating and control systems

In interpreting Fig.2.1 it should be stated that one of the fundamental concepts in any analysis of the system is that of level-of-service.

This is a variable which expresses the resultant product of the interaction between demand and supply and describes both the quantitative and qualitative aspects of the system output. Level-of-service is a composite variable; a function of such attributes as fare, waiting time, journey time, access distance or time, comfort/convenience and safety.

The final level-of-service which the operator provides to the system user is the result of highly complex interactions between the three major components. Some interactions are weak, others extremely powerful. For example, there is an extremely strong interaction between the operator, and the user in which any substantive change in supply characteristics will strongly influence the nature of the demand and vice-versa. On the other, the regulatory component of the triangle acts principally on the supply side, with perhaps only a weak feed-back from the demand side, influencing the nature of the regulatory forces through the mechanisms of public opinion and political pressures.

In Fig. 2.2 some of the structural interactions involved are highlighted, showing the factors that determine the economic performance of the industry in terms of the return to the operator and how these industry profits feed back into the system through their influence on vehicle standards.

In the remaining sections of this paper we analyse the nature of each of the three major components or factors in the system; demand supply and regulation, and subsequently attempt to decipher how the interactions between them operate in reality.

3. DEMAND

3.1 Introduction

To understand the nature of demand for taxi services we need to appreciate that the very concept of demand is used to embrace a highly complex set of requirements, behavioural phenomena and constraints. In general, the nature of demand for travel can be disaggregated by:

- Spatial variation
- Temporal variation
- Journey purpose

Whilst demand itself is determined by two principal factors:

- Market segmentation
- Mode specific deterrence functions (price, distance, journey time)

Given the necessity of having to make a journey, the traveller in deciding how and when that journey will be make, generally attempts to reconcile a set of requirements which can include comfort, convenience, safety, time and cost against what is offered by the transport system. For each individual there are different trade-offs to be made and different constraints operating on his options according to different states or conditions of each of the above factors. This behaviour is termed by economists as the endeavour to maximise personal utility.

private car due to the difficulty and/or high cost of parking the car at the destination and of the trip. It is generally found, that for this group there is a large element of non home-based trip making in the use of taxis.

Given that he can afford the fare the captive public transport user will use the taxi for those journeys where the use of bus is precluded by:

- Bulky or heavy objects having to be Transported.
- Bus service is unavailable at the time at which travel is desired.
- Buses are full.
- No bus service is running sufficiently close to the origin or intended destination of the journey.
- III-health or physical disability.

Within each of these segments, the propensity to use taxis is conditioned by disposable income, and not unnaturally the higher income groups wanting a higher level of comfort and convenience are more likely to choose to ride by taxi than by conventional public transport services when compared with the lower income groups.

3.4 Journey purpose

Journey purpose' also plays a major role in accounting for the frequency of use of taxi services. In certain localities for example, tourists and other non-residents account for a significant part of the demand for taxis. This can occur because the visitor has an imperfect knowledge of the geography of the city and its public transport routes. In such a case the knowledge is provided instead by the driver. Visitors arriving (for whatever journey purpose) at inter-city public transport terminals (rail, bus, air) are also prime users.

3.5 Detterence functions: demand as a function of supply

As has been intimated earlier, demand for taxi-services is in part influenced by supply. Where the number of vehicles in operation is severely limited, this can result in the passenger having to wait a long time. These lengthy wait times will reduce the perceived level-of-service to such an extent that, in the longrun alternative arrangements will be made, On the other hand, in situations where high taxi availability prevails, a proportionally larger number of trips will be made by taxi, and stage-carriage services can begin to lose their market to the taxi. Thomas (1983) in his work in West Malaysia has suggested that for an inter-city taxi service, 51% of the people who normally travel by bus and who, on the day of the survey instead used taxi, did so because no bus was available at the time.

One of the attributes of level-of-service which can have an important effect on conditioning demand for taxi services within the non-captive segment of the market is that of fare level.

It would appear that only a very limited amount of work has been carried out on fare elasticities.

There is some evidence that for urban public transport services as a whole; passengers travelling in the peak hour for journeys to work exhibit a modal choice behaviour which is less price elastic than those travelling in off-peak periods where presumably 'other' journey purposes are predominant.

Specifically as far as taxis are concerned, Allen (1953) has suggested that price elasticity for London taxis was "around or rather below unity", and shreiber (1975) reports that for large cities in the USA, demand elasticity is below unity. Beesley (1979) in his study of the London taxi industry confirms these findings, but adds that there is a high price elasticity for long journeys but a low elasticity for short journeys. Hence we would expect that as fares increase, <u>ceteris paribus</u>, demand will decrease only in the case of the longer journies.

It is important to remember that there are also cross-elasticities at work. Price changes in near-competitors to the taxi will also affect the demand for taxis. Furthermore, as price differentials between taxi and near competitors are eroded, the relative service levels begin to assume a greater importance in determining market share. As the number of persons sharing a taxi increases, so the cost per passenger km. diminishes, and it is relevant to note that in London in 1976 the fare for a 2.5 mile (4.0 kms) taxi journey was about 3.6 times that of the fare by bus. At these price differentials a party of four passengers was able to travel by taxi at the same cost per passenger as by bus.

3.6 Trip rates

There is an apparent dearth of information about actual trip rates by taxi, and the proportion of total passenger trips within the urban area carried by taxi modes.

Beesely claims that about 20% of the total passenger miles carried by the public transport system in London are by taxi and private hire car, although it must be pointed out that in this case foreign tourists account for perhaps as much as 50% of the total passenger kilometres travelled in taxis.

At the other extreme, the capital of the state of Piaui in north-east Brasil with a high proportion of low income residents shows a model split for passenger transport of approximately 30% each for car, bus and cycle modes and only 2% of daily urban trips being made by taxi.

4 SUPPLY CHARACTERISTICS

4.1 Vehicle types

In the western world, the vehicles used in taxi services have evolved from the horse-drawn hackney carriages and Cabriolets (Cabs), Via a brief and disastrous experimentation with electric cars, to the widespread adoption of the internal combustion engined saloon cars as the standard type of vehicle. In the Less Developed Countries there is a much wider range of vehicle types being employed for taxi services. The list includes:

- Manual rickshaws
- Cycle rickshaws
- Auto rickshaws
- Saloon cars
- Pick-ups
- Horse drawn vehicles
- Water taxis

The rickshaw in its various forms is largely confined to the countries of South and Southeast Asia. Horse drawn vehicles also tend to be concentrated in this region, although even central New York has it's share of horse-drawn taxis (albeit confined to Central Park and provided primarily as a tourist facility). In the third world countries of Africa, Latin America and the Carribean, taxi services are almost exclusively provided by four-wheeled motor vehicles and usually in the form of the conventional saloon car.

4.2 Taxi Provision

The passenger transport service or output of the taxi industry can be expressed in terms of the total vehicle or passenger kms of service provided over a given period of time. In practice this output is dependent on a number of factors:

- The number of vehicles available
- Average journey speeds
- Vehicle occupancy
- The proportion of remunerated or engaged time in the total time that the vehicle is available for hire
- The number of hours per day that the vehicle is available for hire

The number of vehicles in service is itself a function of a number of determining factors which revolve around the issue of the availablility and degree of substitutability of alternative transport modes.

Table 4.1

Number of registered vehicles: Brazilian Metropolitan Areas.
1975-1979

	1975	1976	1977	1978	1979
RIO DE JANEIRO					
Population (000's)	8,329	8,601	8,883	9,174	9,473
Cars	453,402	535,862	546,189	593,852	611,428
Taxis	20,060	21,318	19,290	20,240	18,296
Buses	12,216	15,942	15,048	16,576	15,834
PORTO ALEGRE					
Population (000's)	1,836	1,903	1,971	2,042	2,116
Cars	136,718	161,688	170,683	186,144	191,987
Taxis	5,501	5,652	5,192	5,187	4,373
Buses	2,587	2,881	3,218	3,509	3,646
FORTALEZA					
Population (000's)	1,318	1,318	1,370	1,424	1,480
Cars	31,919	39,254	43,614	49,541	53,349
Taxis	3,462	3,863	3,639	3,957	3,643
Buses	1,175	1,411	1,655	1,872	2,005

Source:

Anuario Estatistica Dos Transportes: 1980
GEIPOT, Brasilia.

Table 4.2

Vehicle ownership rates: Brazilian metropolitan areas.

(Vehicles per 1000 population)

	1975	1976	1977	1978	1979	Rates of Change 1975-1979
RIO DE JANEIRO						
Cars	54.43	62,3	61.49	64.73	64.5	+ 18.5
Taxis	2.41	2.48	2.17	2.21	1.93	- 19.9
Buses	1.46	1.85	1.69	1.81	1.67	+ 14.38
PORTO ALEGRE						
Cars	74.46	84.96	86.59	91,51	90.73	+ 21.88
Taxis	2.99	2.97	2.63	2.54	2.06	- 31.1
Buses	1.41	1.51	1.63	1.72	1.72	+ 21.98
FORTALEZA						
Cars	24.2	29.78	31.83	34.79	36.72	+ 51.74
Taxis	2.63	2.93	2.66	2.78	2.46	- 6.46
Buses	0.89	1.07	1.21	1.31	1.35	+ 51.68

The data for the three Brazilian cities, shown in Tables 4.1 and 4.2 exemplify some of the factors involved. Porto Alegre, regional capital of southern Brazil lies in the most highly developed part of the country, Fortaleza is in the poorest northeast, whilst Rio de Janeiro lies geographically and economically somewhat between the other two. Over the period 1975-1979 there were significant increases in population and the number of vehicles registered alongwith an increase in the rate of car ownership and bus provision per 1000 capita in all three areas. Table 4.2 shows that as the levels of car ownership and bus provision increased between 1975 and 1979 so the level of taxi provision decreased,presumably due to the increasing proportion of the market share for travel being accomodated by the other modes. However, in the case of Fortaleza, where rates of car-ownership and bus provision were significantly lower than in either of the other two cities, the per-capita rate of taxi provision decreased at a much slower rate and indeed there was actually a small increase in the total number of taxis in service over the period in question.

For a country where the conventional taxicab is the only mode of taxi service available, the data show a total range of variation in the level of taxi provision from 1.93 to 2.99 vehicles per 1000 population.

Elsewhere in the world we see much wider variations. Table 4.3 shows data for India (FOURACRE P.R et al 1981). Delhi for example with a car ownership rate of 20.7 vehicles per 1000 population in 1977 and bus provision of 0.47, had a taxi rate of 1.06. However, in the Indian subcontinent in the Indian subcontinent in general, and to a somewhat smaller extent elsewhere in South-east Asia, the alternative vehicle technologies being used to provide taxi services should be taken into account if meaningful cross comparisons are to be made. In practice, the mix of vehicles being used for taxi services in any one location is largely a function of a cultural/historic tradition, tempered by a modicum of legislation and administrative regulation. The addition of rickshaws and cycle rickshaws to the motor taxis gives a total taxi provision of 5.65 vehicles per 1000 population for Delhi. To add tongas (horse-drawn vehicles) would further increase the rate by 0.4 to 6.05. In Hyderabad, where bus provision is only one half of that in Delhi and the car ownership level only some 25% of that in the capital, combined taxi and rickshaw provision is as high as 9.01 vehicles per 1000 population.

In 7 Indian cities for which complete data have been reported, all-vehicle taxi rates vary from a minimum of 3.13 in Madras to 9.01 in Hyderabad with an average of 5.14. The average bus provision is a low 0.3 compared with the average of [illegible] for the same year in the 3 Brazilian cities cited previously.

In considering private passenger vehicle ownership levels in the subcontinent, consideration should be given to the large number of motor cycles and scooters in use. Even so, the private vehicle ownership rate in Ahmedabad was substantially lower than Fortaleza (about 50%) whilst the taxi rate was double.

Table 4.4 shows data for Pakistan. These data should be interpreted with extreme caution, since the smallest level of aggregation for which statistics on vehicle registrations are published is the Administrative District; an area which can include a large rural population. At the 1981 census the urban population of Rawalpindi was 800,000. A survey carried out in 1981/2 by the Pakistan Federal Bureau of Statistics (1983) reported a total of 3085 taxis, 230 rickshaws 965 buses and 980 minibuses for Rawalpindi. These figures would give provision rates of 3.85 for taxis 0.29 for rickshaws, and 2.43 for all buses. Even here, bus provision levels must be treated with circumspection since it is probable that no distinction was made between urban and inter-urban services and no indicatinn is given of which vehicle types have been included in the category of mini-bus. In practice stage carriage services are operated by four types of vehicle; the conventional bus, a short wheel-base bus, smaller van-type vehicles typified by the Ford Transit Van, and an even smaller converted pick-up typified by the Suzuki. It can be seen that the combined taxi/ rickshaw provision rate of 4.14 calculated on the basis of the figures given in the text above are much closer to the data for India in Table 4.3 than the figure for Rawalpindi given in Table 4.4 Table 4.5 shows Taxi rates reported for other developing countries, whilst Table 4.6 shows the level of provision in the United Kingdom.

Table 4.3

Public and private transport provision rates - India 1977.

(Vehicles per 1000 population)

	DELHI	MADRAS	HYDERABAD	BANGALORE	AHMEDABAD	PUNE
POPULATION (MILLIONS)	4.83	3.10	2.27	2.08	1.95	1.08
BUSES	0.47	0.47	0.26	0.31	0.30	0.32
MOTOR CAR TAXIS	1.06	0.92	0.24	0.50	0.24	0.63
MOTOR RICKSHAWS	3.52	0.43	2.60	4.46	3.36	4.269
CYCLE RICKSHAWS	1.07	1.78	6.17	0.18	1.07	-
TOTAL TAXI MODE	5.65	3.13	9.01	5.14	4.67	4.92
PRIVATE CARS	20.7	7.10	5.80	12.00	5.70	14.60
M/CYCLES AND SCOOTERS	53.80	6.70	16.0	31.40	21.90	43.00
CARS & MOTOR CYCLES	74.50	13.80	21.80	43.40	27.60	57.60

Source:P.R Fouracre ET AL.(1981)

Table 4.4

Public and private transport prcvision rates - Pakistan 1981

(Vehicles per 1000 population)

District	Peshawar	Lahore	Faisalabad	Rawalpindi	Multan	Hyder abad	Karachi	Quetta
Population (000's)	2,246	3,512	4,656	2,123	4,068	2,080	5,353	380
Motor Cycle	2.90	17.00	5.05	11.60	4.80	9.20	17.00	4.50
Motor Car, Jeep, Station Wagon	4.50	6.60	1.13	9.10	1.50	2.30	15.80	5.90
Bus	1.13	0.60	0.38	1.08	0.23	0.97	1.09	0.90
Motor car taxi	0.72	0.20	0.01	0.84	0.10	0.41	1.49	0.07
Motor Rickshaw	1.70	2.80	0.54	0.12	3.29	1.47	1.80	3.20
Combined Cars & Motor cycles	7.40	23.30	6.18	20.70	6.30	11.50	32.80	10.40
Combined Taxi Modes	2.42	3.00	0.55	0.96	0.39	1.88	3.29	3.90

Source : NTRC

Table 4.5

Taxi provision in selected third world cities.

		NUMBER OF VEHICLES	RATE PER 1000 POPULATION
INDONESIA	Jakarta	4600	0.8
MALAYSIA	Kualalumpur	1000	1.0
	George Town	145	0.5
PHILIPPINES	Manila	8500	1.6
THAILAND	Bangkok	13500	3.0
JAMICA	Kingston	1600	2.3

Source: P.R. Fouracre,D.A.C. Maunder. (1979)

Table 4.6

Level of taxi provision in selected U.K towns. 1982.

	Population	Number of registered taxis	Taxis per 1000 population	Ratio of private hire cars to taxi	Hire cars and taxis per 1000 population
Wellingborough *	64,000	25	0.39	1.4	0.94
Bath *	83,000	51	0,61	1.3	1.41
Burnley *	91,000	12	0.13	6.7	1.02
Test Valley *	93,000	31	0.33	3.4	1.46
Darlington	95,000	63	0.66	0.1	0.73
Newark	101,000	44	0.43	0.5	0.65
Canterbury	120,000	89	0.74	0.4	1.04
Oldham *	123,000	76	0.34	4.3	1.81
Peterborough	132,000	74	0.56	0.2	0.67
South Oxon	135,000	77	0.57	na	na
Thamesdown *	144,000	38	0.26	na	na
South Tyneside	161,000	110	0.68	0.7	1.16
Swansea *	168,000	44	0.24	2.3	0.78
Leicester *	276,000	60	0.22	4.0	1.09
Nottingham	277,000	200	0.72	0.8	1.3
Cardiff	282,000	368	1.3	0.6	2.09
Manchester *	474,000	450	0.95	1.3	2.18
Liverpool *	514,000	1090	2.12	0.2	2,54
London (1969)	8,000,000	8181	1.0	2.45	3.35 "

Source: G A Coe, R.L Jackson (1983)
M. Sharp (1970)

* Areas which operate strict quantity licensing.

In the case of the United Kingdom, direct comparisons are rendered difficult due to differing practices adopted by different licensing authorities. Some authorities adopt strict quantity controls (as well as quality controls), the result of which is to foster the growth of 'parallel' taxi industry in the form of private car hire or 'mini-cab' operations. In such circumstances the parallel services which by law cannot be subjected to quantity controls, compete freely alongside the licensed taxi operations; the only proviso being that they may not use taxi ranks or cruise for passengers. However, with the widespread use of 2-way radio and widespread access to telephones these contraints are not too severe. Taking both licensed and non-licensed operators together, the average provision in UK for the sample of towns and cities included in the study by Coe and Jackson (1983) is 1.3 vehicles per 1000 population.

Although there are many anomalies there is a discernible trend in these data suggesting that the larger urban areas have higher levels of taxi provision. The all-vehicle average for cities with a population in excess of 200,000 (excluding London which can be considered as a special case) is 1.84. This may be attributable to a higher incidence of non home-based trip making in higher order cities, rather than to differences in car ownership or public transport level-of-service.

New York city is another case where parallel operators figure very large in the total provision of taxi services (Shreiber, 1975).

New York has 11,787 licensed taxis for a population of more than 7 million. This number has not changed since 1941 and it was reckoned that in 1972 there were some 15.000 unlicensed private hire cars or 'gypsies' operating in the city. The taxi provision rate in this case is 1.68 vehicles per 1000 population for licensed taxis and 3.86 for all taxi operations combined.

We should also add that inter-city comparability particularly in the developed world in made more difficult by the incidence of rapid transit systems which is many situations are near competitions to taxi services - especially in the congested inner city areas. There is very little evidence to suggest under what circumstances, metripolitan railways and taxis compete for the same markets.

4.3 Vehicle productivity

The number of vehicles in the taxi fleet is in itself an insufficient indicator of the supply side of the industry. To obtain a fuller picture of the performance of the industry we need to consider how those vehicles are actually employed. In other works, we need to look at the transport output or productivity of the industry. Under this heading we need to consider such factors as the number of hours worked, the average speed of the journeys made, the number of passengers carried and the ratio of remunerated or engaged time to empty or 'dead' time.

As an example, consider the hypothetical, but not untypical case where a taxi is worked for 16 hours daily by 2 drivers; running for 8 hours at an average speed of 20 kms per hour. (peak conditions) and 8 hours at an average speed of 40 kms per hour (off-peak conditions). Assuming that during peak conditions engaged time is 50% of the total time whilst in off-peak times the proportion decreases to 30%, then under these conditions the taxi would perform 176 kms of remunerated service per day. Furthermore, if average occupancy were 1.75 passengers per trip then the transport output of the vehicles would be 308 passenger kms per day. Assuming 320 working days per annum, the annual vehicle output would be in the order of 56,320 vehicle kms or 98,560 passenger kms.

Turning now to analyse what is know about the actual performance of taxi systems tables 4.7, 4.8 and 4.9 show data reported for all taxi modes in India, whilst Table 4.10 shows fare rates, average trip length and occupancy for the different taxi modes.

Although the figures in these tables show wide variations between cities, it can reasonably be concluded that the cycle rickshaws have a lower output than autorickshaws, and are being used for shorter journies. The motor taxi, in Delhi at least, has a slightly higher passenger output with an average 182 passenger kms per day compared to 178 passenger kms per day performed by the autorickshaw, despite the fact that the autorickshaw will perform a higher total kilometrage per day than the taxi. The equivalent value for the cycle rickshaw is just 18 passenger kms per day.

These differences in output are to some extent contributory to the fare levels given in Table 4.10 where it will be seen that the cycle rickshaw is the more expensive mode of travel.

In the United Kingdom it has been suggested (Beesley 1979) that in London more multiple shift working and improved servicing has resulted in an increase in the proportion of engaged output. In 1953 engaged distance covered was estimated to be about 53% of the total; by 1968 the figure had increased to around 60-65%. Since then traffic speeds in central London have improved and there have been organizational changes within the industry which have probably led to further increases.

In New York, Shreiber (1975) gives an estimate of the proportion of engaged time in 1961 at around 75%, falling to around 50% by 1975. With traffic speeds in Central London and New York at about 20 kms per hour, 12 hours of operation per day would give some 120 to 150 vehicle kms of remunerated service per day;; about the same as that reported for Calcutta.

Table 4.7

Cycle and hand rickshaw performance in selected Indian cities.

	Calcutta Hand	Calcutta Cycle	Dehli	Hyder-abad	Kanpur	Jaipur	Agra	Meerut	Faridabad
Daily vehicle kms	43	69	13*	33	19	25	33*	24*	22*
Passengers carried daily(per vehicle)	17	23	18	33	17	27	23	25	18
Average passenger trip length (kms)	2.0	3.0	1.0	2.3	1.7	1.5	2.8	1.5	1.8
Load factor	0.4	0.5	0.7	1.2	0.8	0.8	1.0	0.8	0.7
Vehicle trips per day	na	na	12	14	11	14	12	16	13
Average occupancy	na	na	1.5	2.4	1.6	1.9	1.9	1.6	1.4

* Revenue kms only.

Source: P.K Fouracre ET AL. (1981)

Table 4.8

Autorickshaw performance in selected Indian cities.

	Dehli	Hyderabad	Bangalore	Jaipur	Baroda
Daily vehicle kms	120*	80	214	92	75
Seats per vehicle	2	3	2	2	3
Passengers carried daily (per vehicle)	27	46	77	29	52
Average passenger trip length (kms)	6.5	3.6	4.2	3.9	2.5
Load factor	0.7	0.7	0.8	0.6	0.6
Vehicle trips per day	18	18	51	18	25
Average occupancy	1.5	2.6	1.5	1.6	2.1

*Revenue kms only.

Source: P.R Fouracre ET AL. (1981)

Table 4.9

Taxi performance in selected Indian Cities.

	Delhi	Calcutta
Daily vehicle kms	90	150
Seats per vehicle	4-5	4-5
Passengers carried daily (per vehicle)	18	na
Average passenger trip length	10.4	na
Load factor	0.5	0.3
Vehicle trips per day	7	na
Average occupancy	2.5	1.8

Source: FOURACRE PR and D.A.C MAUNDER (1979)

Table 4.10

Taxi vehicles, fare rates and performance in selected Indian Cities.

C i t y	Fare rates per passenger km (paise)			Average passenger trip length (km)			Occupancy per trip		
	C.R	A.R	Taxi	C.R	A.R	Taxi	C.R	A.R	Taxi
Faridabad.	63	-	-	1.8	-	-	1.4	-	-
Meerut	51	-	-	1.5	-	-	1.6	-	-
Agra	45	-	-	2.8	-	-	1.9	-	-
Jaipur	32	52	-	1.5	3.9	-	1.9	1.8	-
Kanpur	52	-	-	1.7	-	-	1.6	-	-
Hyderabad	16	33	-	2.3	3.6	-	2.4	2.6	-
Baroda	-	35	-	-	2.5	-	-	2.1	-
Bangalore	-	53	-		4.2	-	-	1.5	-
Delhi	67	53	50	1.0	6.6	10.4	1.5	1.5	2.5

CPR Cycle Rickshaw

A.R Auto Rickshaw

Source: P.R Fouracre ET AL. (1981)

4.4 COSTS

The resources employed in the taxi industry represent an economic cost. Those costs accrue largely to the operators (owners and drivers) and may be termed the supply side or industry costs and are principally attributable to capital and labour. There are however, other costs which, depending on the viewpoint of the analyst assume varying degrees of significance. The time that the user spends waiting for and travelling in the taxi is a real economic cost; as is the fare paid. This category of costs is termed as the user costs. The extra vehicle operating costs and time costs infl-icted on other road users by the presence of taxis on congested roads imposes social or external costs, whilst the air and noise pollution generated by the taxis also poses a real external (but largely intangible) cost on society as a whole. The public sector suffers costs in regulating the industry, in having to enforce the regulations and in providing and maintaining the highway infras-ture over which the taxi operates.

It is beyond the scope of this paper to examine these issues in and depth. Suffice it to say that, most economists would agree that it is important to understand the cost structure of the taxi industry (as for any other service industry), and to be able to identify the marginal costs of providing the service. This is because economic theory dictates that the correct price to charge in order to obtain optimal use of economic resources is that price which equals the marginal cost of providing the service. Unfortu-natly, economists very often fail to agree as to how the margin should be defined, whether it should be based on short-run or long-run costs, and even if short-run, how short is short!

For the purposes of this paper it would be more useful to adopt a rather more pragmatic approach and confine our discussion of costs to those of the supply side (without in any way denying the imprtance of the other cost categories).

Like many other service industries, such as electricity and telephone services, transport service supplied by the taxi industry cannot be stockpiled. If the service is not used at the time that it is offered, then the opportunity is lost. In other words, we are dealing with a time dependent product. A taxi which was not used between 8.00 am. and midday yesterday cannot now be used to provide eight hours of service between 8.00 am and midday today. There is also another feature in common with electricity generation and telephone supply. There is a category of costs associated with the scale and inherent capacity of the system, and which in the short-run cannot be altered to match short-run fluctuations in demand. In other words, these costs are fixed and inescapable in the short-run, so tht we can regard the stock of vehicles, premises and equipment as corresponding to the long-run, inescapable or fixed costs.

There is another category of costs which may or may not be escapable in the medium run; the labour costs associated with the industry. Whether in reality these are escapable or not depends on the nature of the contract between the owner of the vehicle and the operator. In the case of owner operators they may be able to put a vehicle in 'mothballs' in the case of a downturn in trade, but would still have to meet payments for their own subsistence and that of their dependents. So, at least until alternative employment outside the industry can be arranged we can assume that labour costs are escapable only in the medium term. Hence they can be thought of as semi-fixed costs. In this category we can also include certain routine vehicle maintenance and repairs that are more a function of time and the age of the vehicle than distance covered.

A third category is that of variable costs; those costs directly related to the actual kilometres performed by the vehicle and often referred to as the direct operating costs. In most accounting systems, fuel, lubricants and tyres would be included as variable costs.

Therefore, we can analyse the actual disbursements made by taxi operators over a period of (say) one year, and allocate the costs to the three groups. The correct identification and allocation of cost items is important since the higher the output of the vehicle over the year (in terms of kilometres travelled) the higher will be the sum of variable costs incurred, but the share of the fixed and semi-fixed costs per km travelled will be proportionally lower. Costs vary as a function of output, but are not necessarily linearly proportional.

Thus in analysing the economic performance of the taxi industry it is important to know in what way the costs vary for different quantities of output so that prices may be set to provide revenues which are related to the real costs. If revenues are less than costs, then the industry will contract. If revenues are greatly in excess of costs then the travelling public is being exploited and excessive profits are being made by the owners.

We now turn to examine the itemization of costs within each category.

1. Fixed costs.

a) Vehicle

- Depreciation
- Interest payments (or interest foregone on the capital value of the vehicle)
- Tax
- Insurance
- Vehicle tests

b) Premises associated with the operation of taxis.

- Garage (Annual rent and maintenance)
- Workshops and stores (Annual rent and maintenance)
- Offices (Annual rent and maintenance)
- Office and workshop equipment and tools (depreciation)

c) Overheads and Administration Expenses

- Property taxes and charges
- Electricity
- Stationery
- Telephone

- Insurance
- Association fees
- Professional fees

2. Semi-fixed costs.

a) Staff Costs.

- - Wages
  - Insurance
  - Welfare benefits
  - Allowances

b) Vehicle Costs.

- Major overhauls
- Renovations
- Accident repairs/compensation (in the event of not being covered by insurance)

2. Variable Costs.

- Oil
- Fuel
- Tyres and innertubes
- Minor repairs and servicing
- Part replacement

In urban public transport operations it is now becoming standard practice for the cost accounts to be expressed in terms of the cost per vehicle km per vehicle hour and even as the per vehicle peak hour. However, in the taxi industry where there is necessarily a considerable portion of the time spent either in waiting or in unremunerated running, it is more customary to express vehicle operating costs as a simple average unit cost per distance.

This does presuppose, however, that reliable estimates can be made of the total annual kilometres covered by the vehicles. The annual kilomters is a function of the number of hours worked daily, the engagement rate, whether unengaged periods are spent at a rank or in cruising, the average speed at which trips are made and the number of days per year the vehicle is off-the road due to holidays, sickness, repairs and servicing. In most studies carried out to-date, calculation of operating costs has been based on estimates of averages for the above parameters which must obscure some very wide ranges of variation.

By way of illustration Table 4.11 shows the percentage breakdown of costs for different types operation of ordinary taxis in Rio de Janeiro. In obtaining these proportions it was assumed in the study that owner-drivers covered 160,000 kms per annum, whilst taxis belonging to companies covered some 200,000 kms annually.

Table 4.11

Cost Structure of taxis in Rio De Janeiro-1979

(column percent)

		Company owned	Owner driver
Fixed costs	Overheads	2.52	1.84
	Vehicle	8.06	8.82
Semi-fixed costs	Labour	36.63	32.05
Variable costs	Tyres Servicing Repairs	16.10	19.31
	Fuel	36.76	38.02

Source: R.J. LUSTOSA (1982)

5. REGULATION

5.1 Introduction

Regulation of taxi operations by Government has been common practice for a long time. In the first place, in common with all highway users, the taxi industry is subject to regulation imposed by road traffic legislation and rules governing the use of the highways, the licensing of drivers and vehicles, vehicle taxation, insurance, and vehicle fitness. In addition, it is generally the case that public transport operators in general are subject to a further set of regulations specifically governing where and in what manner particular types of service and vehicle may operate. Typically these restrictions are imposed by means of administrative rule making by virtue of powers delegated to local authorities. Consequently, the types of regulation and practices may vary greatly from one locality to another.

Beesley *(1973) has suggested that there are three types of regulation which can be applied to passenger public transport undertakings; the right of monopoly, the conditions of entry and price control.

5.2 Right of monopoly

In theory monopolistic regulation provides the operator with the requisite conditions to provide a defined standard of service in the most economic way, permiting the use of discriminatory pricing and cross-subsidization in the interests of equity within a heterogeneous market. In practice however, monopolistic rights tend to be granted only to varying degrees. The most common of the variations are those which circumscribe geographical areas under which different operators will have monopolistic powers and those which pertain to type of operation. The resultant oligopolies, however, function much in the same way as for monopolistic conditions.

Monopolistic operations of urban public transport supply are quite common world-wide but in the taxi market complete monopoly is rarely encountered. This is probably more due to the highly fragmented ownership structure within the industry than for reasons of economic or social policy (this is in marked contrast to the situation which prevails in urban stage-carriage bus operations where public authorities have tended to create monopolistic operating conditions as the rule rather than the exception).

An example of how partial monopolies can be applied in practice within the taxi industry is seen in the city of Rio de Janeiro, where an exclusive franchise to operate taxi services from the International Airport has been given to just two taxi cooperatives. Both organizations, which operate air conditioned, radio-controlled vehicles of the same make and average age are required to charge identical fares. Fares are some 100% higher than those charged by common taxis. Taxis operated by the cooperatives are not, however, allowed to ply for hire in the normal way, being restricted to journeys which either originate or terminate at the airport.

5.3 Conditions of Entry

By far the most common type of regulation encountered in the taxi industry is that which governs the conditions of entry. Here there are two policy options open to government; quality control and quantity control.

5.3.1 Quality Control

Quality control is imposed in the interests of passenger safety and comfort. Regulations are made to ensure that certain minimum standards of vehicle fitness and road worthiness are adhered to. In practice the standards set and the degree of enforcement can vary widely from country to country and even between towns in the same country. Some of the most rigorous standards are set by the London Metropolitan Police who require that vehicles used as taxis should conform to very high specifications for passenger comfort and mechanical design; thus in effect limiting the type of vehicle that may be used as a taxi to just one make (the famous London type FX4 Cab). Regulations may also govern the age of the vehicle, mechanical fitness, vehicle colours, decorations, signs, etc. It should not be forgotten that quality controls can also be applied to the taxi driver, Again, London has a highly rigorous set of requirements for the licensing of taxi drivers. Applicants have to undergo a series of examinations to test their knowledge of the geography of the city (the so-called 'knowledge'). Other entry requirements can relate to such factors as minimum age, driving experience and criminal antecedents. The effect of quality control is to raise the costs of the industry-particularly those which are termed 'entry costs' (see below).= The higher the standards set, the higher are the costs incurred.

5.3.2 Quantity Control

Whilst most authorities appear to be unanimous about the desirability of imposing some type of quality control on the industry, opinions seem to be divided as to the efficacy of imposing quantity controls.

Very simply, quantity control is effected by the licensing agency determining that there should be a maximum number of taxis allowed to operate within its area of jurisdiction. There appears to be little uniformity in the practice of determining what this maximum number should be. Some authorities set very low limits, whilst at the other extreme the number is set so high that it becomes virtually self-negating as a control. The issues involved in the question of quantity control are quite complex, involving not only questions of economic efficiency but also those of transport level-of-service, cross-modality competition within the public transport sector and a set of externalities including socio/political considerations relating to working conditions, minimum wages, questions of public safety, traffic congestion, air pollution etc.

The reasons which have been advanced for introducing quantity controls can vary and sometimes are in fact never made explicit. Perhaps the first recorded case of quantity control being applied to the taxi industry was in London when in 1662 the number of Hackney carriages which had been providing a taxi services since 1625 was limited in the interests of trying to reduce traffic congestion in the city streets (Dyos H.J. and D.H Aldcroft, 1974). It is interesting to note that one of the effects of this action was that the excess cabs quickly spread to begin operating in the surrounding towns, and as far as can be deduced, the effect of the measures on London's traffic was not significant.

On the question of economic efficiency, it is argued that permitting free entry to the market inevitably results in over-provision of taxi numbers, and that this is undesirable in that some of the resources of capital and labour thus employed could be more productively used elsewhere in the economy. Over-provision tends to occur as a result of the imperfect information as to the nature of the market, the lack of price competition in the normal course of events, and a tendency for fare levels to creep upwards when the effects of over-provision begin to be felt by the operators.

The counter-argument holds that the number of taxis in operation is, in the long-run at least, self regulating since once conditions of acute over-provision set in, the result is such a low level of vehicle engagement that neither taxi owner nor driver receive adequate remuneration for the capital and labour resources emplyed so that they begin to more to other areas or to leave the industry altogether. It is further argued that since the ownership patterns are so fragmented and the value of investment is low in relation to other modes of transport, the taxi industry is the one mode which can adjust relatively rapidly to changes in demand.

However, in third world countries, and in other areas where entry costs are low, we do tend to find over-provision of supply, often associated with a high proportion of part-time operators, and which is not self-adjusting in relation to demand. There are a number of reasons for this. The first is connected with the opportunity cost of labour employed as drivers. When these opportunity costs are very low, drivers will be prepared to work long hours, often as a second-job, in order to supplement their incomes. This is particularly so in areas of high unemployment and where wage rates are very low. In fact the opportunity cost of labour in part-time taxi driving can be extremely low indeed, i.e. just above the zero which would otherwise be earned by sitting at home doing nothing.

A second reason is connected with the low cost of entry. Amongst low income families, the desire to own a private car may be realisable if that car can also be operated part-time as a taxi. In such cases, as long as earnings from taxi operations cover the hire purchase installments, the owner is quite happy. A further factor which contributes to over-provision of supply is the fact that many owners and owner/operators do not properly perceive the full extent of their true costs, and are satisfied with earnings which can be actually below the margin of profitability. In this respect it is not uncommon for owner operators not to make provision for vehicle depreciation or replacement in calulating their costs with the result that they are forced out of the market when their vehicle eventually becomes unserviceable and requires replacing.

Even when it is evident that conditions of over-supply are prevalent the operator may be reluctant to leave the industry for various reasons. He may not have finished paying for the vehicle, and the wages from alternative employment, even if available, may not be sufficient to cover the hire purchase instalments. At a time of over-provision it is likely that the value of the vehicle on the second-hand market would be depressed. Thus, by selling the vehicle at a loss he simply creates the opportunity for another person to enter the industry at a lower cost of entry than that at which he entered. Another consideration contributing to the reluctance to leave the trade is the prospect of future fare increases and in the longer run, particularly in third world countries, the prospect of an upturn in demand as more passengers come into the market due to an increasing urban population. There is thus an inherent conservativeness on the part of the small scale operator/owner to try to stay in business as long as possible and even when he is eventually forced out, we find that there are other people willing to take his place.

In the absence of effective controls, over-provision leads to a high turnover of entrants into the market and, it is claimed, leads to conditions of 'ruinous competition' for the full-time owners and drivers. In the longer term, pressures build up to force the full-time operators out of the market and the overall standards of vehicles and service decline.

In practice then, there is a tendency for conditions of over-provision to set in when the costs of entry are very low and an argument can be made for adopting quantity controls which would protect standards of service and conditions of labour within the industry.

In areas where costs of entry are high due to more rigorous quality controls being enforced, then the case for quantity control is less clearcut. Where quantity controls are imposed, it is often the case that they become inflexible, and are not reviewed in the light of changing market conditions. In situations where quantity controls become so fossilized that there is too small a supply of vehicles in relation to the potential demand, a number of adverse consequences can arise:

a) Taxi operators enjoy a high level of vehicle engagement and this enhanced revenue earning potential is usually manifested by high market values being placed on operator's licenses. This premium for entry into the industry reflects the economic rent of the protected operation.

   When high prices have been paid for a license, the operators not un-naturally have a vested interest in ensuring that the price of the license is maintained or even further enhanced, and powerful political pressures are applied to ensure that the value of the investment is not diluted by allowing an expansion in the number of licenses issued.

b) Level-of-service for passengers declines as a result of increased waiting times.

c) Where passenger demand is left unsatisfied, conditions are ripe for the entry into the market of parallel, un-licensed operators. As we have seen previously in the United Kingdom, those areas where local authorities enforce severe quantity controls have a burgeoning 'private hire' operation run in parallel and in competition with the licensed taxis.

5.4 Price Control

A third area where public authorities can, and generally do, exercise control on the taxi industry is through stipulating tariffs.

The fixing of maximum charges serves to protect both customer and operator but does require effective enforcement if these objectives are to be realised. The level at which prices are fixed should allow that revenues should be sufficient to cover operating costs and provide a reasonable rate of return on capital employed. One of the critical problems in defining this level is in knowing what are the industry-wide average costs and the average revenue earning potential. This latter is determined largely by the proportion of remunerated time or distance covered by the vehicle in an average day's operation, which as we have already indicated, is a function of the number of vehicles operating.

One not insignificant consideration in determining a fare level is vehicle productivity. A vehicle which operates in the Bazar areas of a large town on the Indian sub-continent may not be able to exceed an average speed of 5 kms per hour, and thus may be capable of performing only one tenth of the passenger kms performed by a vehicle operating on a network of high quality expressways and suburban arterial streets. Added to which, the direct or variable costs would be much higher for the operator in the Bazar areas due to the fact that at very low speeds there is a considerably higher fuel consumption per km. Problems obviously begin to occur when the industry-wide average for vehicle engaged output falls below the average levels adopted in calculating tariffs.

In theory when this happens some taxis will leave the industry - so allowing the remainder to improve their output (the same number of passenger distributed between a smaller number of vehicles) untill equilibrium is reached. In third world countries, however, as we have seen above, rather than leave the industry the taxi operators will instead seek to reduce their costs and standards in order to continue operating.

Where taxis operate largely by cruising, then there is no opportunity for price competition to arise except in exceptional conditions of over-supply. An individual cruising taxi operator cannot hope to get more passengers by independently lowering his rates; likewise the intending passenger is not prepared to wait for an indeterminate length of time in the hope of encountering a taxi offering a lower fare. Hence, there is no advantage to be gained in price competition. With rank working, however, when strict rules of 'first in first out' do not apply, one finds classic conditions for price competition. Where supply exceeds demand, operators can afford to reduce prices down to the marginal cost of the journey in the hope of making an additional journey. In extreme cases, where the probability of getting a good fare at the present location is very small, then he may even accept a fare at below the marginal cost, if the destination of the trip will take him to a location where there is the prospect of getting a good fare.

In reality the whole issue of pricing control is complicated by the fact that tariff structure can affect revenues just as much as the actual fare level. In London for example, due to the fixed sum supplement for night time journies, night time working is clearly more profitable than day time, especially if there is a high proportion of short journies. In Washington DC. where a zonal structure is in force, a journey which crosses a fare zone boundary is much more attractive to the taxi driver than a journey over a similar length where both origin and destination lie in the same zone.

6. LEVEL-OF-SERVICE AND SUPPLY CONDITIONS

6.1 Conditions of entry and level-of-service

The level-of-service afforded to the taxi passenger is measured by how long he has to wait, how long the journey takes, the price he has to pay for the distance travelled, and the general condition of the vehicle in which he travels (comfort, safety, cleanliness,etc).

The passenger's waiting time depends on the availability of taxis. This, in turn, depends on the number of vehicles operating in the area and the engaged output of those vehicles. The greater the number of vehicles, the lower the engaged output and the higher the availability. Hence, for a given level of demand, as vehicle numbers increase level-of-service will improve.

However, as the proportion of engaged output decreases so does the average revenue per taxi. As revenue decreases as a result of increasing vehicle numbers there will be a tendency for pressures to arise from the operators to seek an increase in fares in order to re-establish a reasonable level of earnings.

In the situation where demand is not particularly price sensitive (elasticity of demand is below unity), any increase in fares will increase the total revenue to all operators. As prices increase, and assuming costs remain constant, then profits increase. The possibility of earning enhanced profits will attract new entrants; whereupon the market share of each will fall, revenue and hence prfits will fall, and there will be pressure to further increase fares to restore a reasonable profit margin.

Thus under conditions of free entry, price inelastic demand and in the absence of effective price regulation, the prevailing tendency is for an upward spiral of increasing numbers of vehicles and increasing fares until a stage is reached where fare levels have escalated to the point where price elasticity begins to take effect and any further price increases will result in a fall-off in demand, so that further price rises will not increase revenue and operators will be forced to either leave the industry, or reduce costs and standards.

In short, in the absence of any controls, there is a natural tendency, for conditions of over-provision to occur. In the extreme situation, one can arrive at the state which is said to prevail in North Yemen where over-provision is so acute that taxis can wait for up to 3 days before engaging a fare, and yet (or because of this) fare levels are very high. (Boyes 1986).

When conditions of over-provision have set in, operating costs can be reduced by resorting to rank working rather than cruising. However, rank working, does have a significant disadvantage for the operator in that it provides conditions for price bargaining to occur and industry revenues will be reduced even further.

In the situation where entry and price controls do not exist or are ineffectual we can expect to find over-provision and prices which are relatively high, despite the opportunities afforded for fare bargaining. The level-of-service, in terms of availability and waiting time, is very high, although this tends to be offset by increased shortcomings with respect to other level-of-service attributes such as vehicle standards, safety etc.

6.2 Problems attendant on the imposition of quantity controls

We have argued that free entry, or poorly enforced entry controls even with strict price controls tend to result in over-provision. Whilst, in certain respects this gives some advantages to the passenger, it is economically ineffecient in that both capital resources and labour are being under-utilized. In conditions of over-provision it should be possible to reduce the number of vehicles permitted to operate without significantly altering the passenger's waiting time. The most logical policy to obtain the desired effect would seem to be the imposition of some form of quantity control.

In practice however, the use of quantity controls, rarely achieves the desired effect and the results are, very often, equally undesirable. We have seen in the previous section that quantitative limits can be set in an arbitrary and unscientific manner; they tend to become fossilized and subject to political manipulation. Where limits are too high they are obviously ineffectual; where they are too low they result in under-supply and the encouragement of parallel operators and high market values for taxi operator's licences.

One of the most extreme cases manifesting the later type of problem is that of New York City, where the cost of entry into the licensed taxi sector is extremely high; at a currently quoted price of $ 100,000 (Economist 1986). Even so the medallions (licences) change hands frequently; about 5% of the total are sold to new owners each year. Buying into the industry, some families run their taxi 20 hours a day, seven days a week and can pay off the cost of the medallion relatively quickly. This suggests that the business is highly profitable. An indication of the extent to which large profits can be earned is given by the fact that the price of medallions has increased at a phenomenal rate over the past 40 years.

Table 6.1

New York City Medallion Prices.

Year	Price (US $)
1947	2,000
1950	6,000
1960	20,650
1970	28,000
1980	50,000
1986	100,000

Sources: C. Shreiber (1975)
The Economist (1986)

Clearly in the case of New York the quantity controls are incorrectly set. Taxi availability is low, high profits are being made and there is a burgeoning and uncontrolled parallel industry already considerably larger in size than that of the regulated industry.

6.3 Price control and level-of-service

In those localities where price controls are effectively enforced and fare levels are not allowed to rise in response to decreasing revenues but otherwise there is free entry; then attempts have to be made by the operators to reduce costs. This can be achieved by lowering vehicle standards, (employing old vehicles rather then new, smaller vehicles rather then larger) by spending less on maintenance, and by reducing labour costs (exploiting the labour force). There is also a temptation to increase revenues by exploiting the passenger; adopting such practices as tampering with the meter, charging higher fares to tourists and visitors, using roundabout routes etc.

Free entry with price control will generally again lead to over provision resulting in high availability for the passenger but with low quality vehicles and labour, and operators working very close to the margin.

6.4 Quality control and level-of-service

The effectiveness of quality controls depends on the standards which are set and how well they are enforced. High standards and rigorous enforcement result in high entry costs and resultant higher operating costs. Since larger revenues have to be earned to cover the higher costs there is a tendency for less risk-taking to occur and pospective entrants into the industry are more cautious before committing themselves. Once operating however, there is an incentive to improve revenue by more intensive use of the resources employed. The more intensively a vehicle is used, the higher the total direct operating costs, but revenue is also higher and overall unit costs (per km or per hour) are lower and hence returns are higher.

From the operator's point of view this situation is advantageous; good returns are obtained and it is unlikely that over-provision will be encountered. From the passenger's point of view however, the result of high quality standards is likely to be a low level-of-service in terms of availability, especially at peak times. The tendency for taxi numbers to fall below that which is sufficient to satisfy demand with a reasonable level of vehicle availability when quality controls are very rigorous is exemplified by the case of London's flourishing parallel taxi industry.

Where low standards of quality control are permitted, or enforcement is lax then the effect is to dilute or nullify the need to achieve higher productivity to offset higher operating costs. The industry will effectively revert to operate under conditions of free entry, and particularly in the LDC's the attendent problems of over-supply will begin to emerge.

6.5 The problem of over-supply

In the previous sections the problem of over-supply has been touched upon several times. Whilst over-supply is a phenomenon readily identifiable once it has set in and its consequences can be described in qualitative terms, it is much more difficult to treat the concept in quantitative terms, This may seem somewhat paradoxical since the very concept itself implicitly deals with numbers.

The problem can be stated using simple logic; if over-supply signifies a number (x) which is too large, then there must be a number (z) smaller than (x) which is too small and which corresponds to some degree of under-supply. The natural extension of this proposition is that there then must be a number (y) somewhere intermediate between (x) and (z) which is neither too small nor too large, and hence is just right. We could suggest that (y) represents the optimal number of taxis for a given market profile. However, in attempting to define optimality we must be aware that there are two conflicting objective functions; the operator's desire to maximise revenue and the user's desire for a high level-of-service. They are mutually opposed and have to be measured in different ways.

It would be more appropriate to state the problem in terms of defining the number of taxis that maximises level-of-service, subject to the constraint of providing a defined average revenue (or profit) to the operator. The following model suggests how, conceptually, this redefined optimum number of vehicles could be

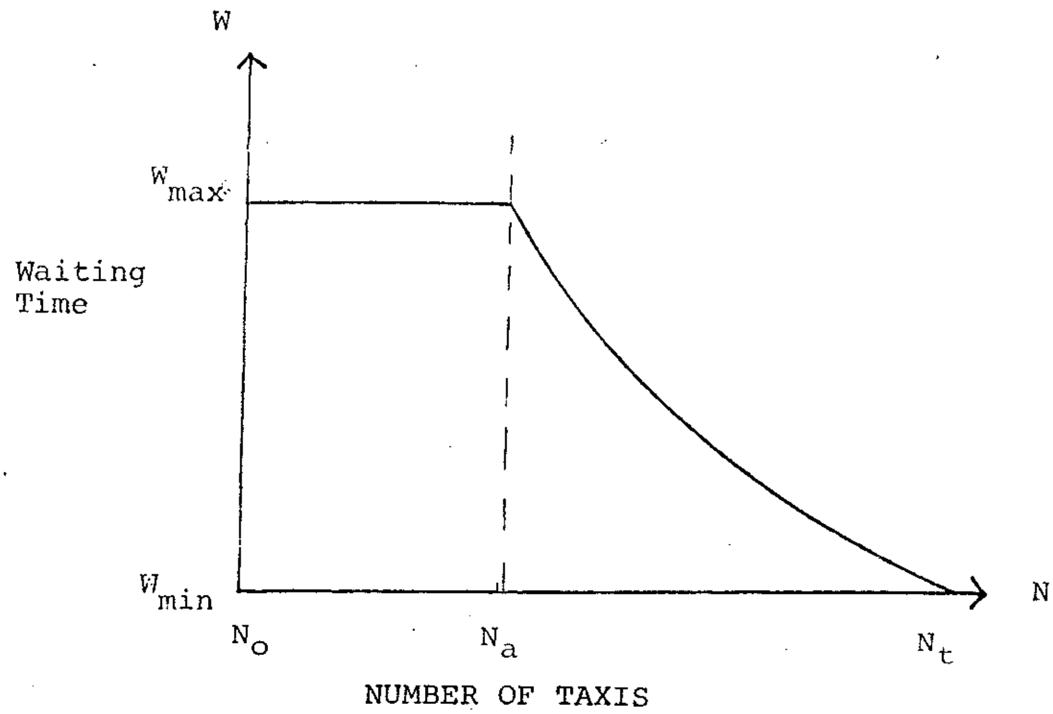

Figure 6.1

Relation between passenger's waiting time and the number of taxis in operation.

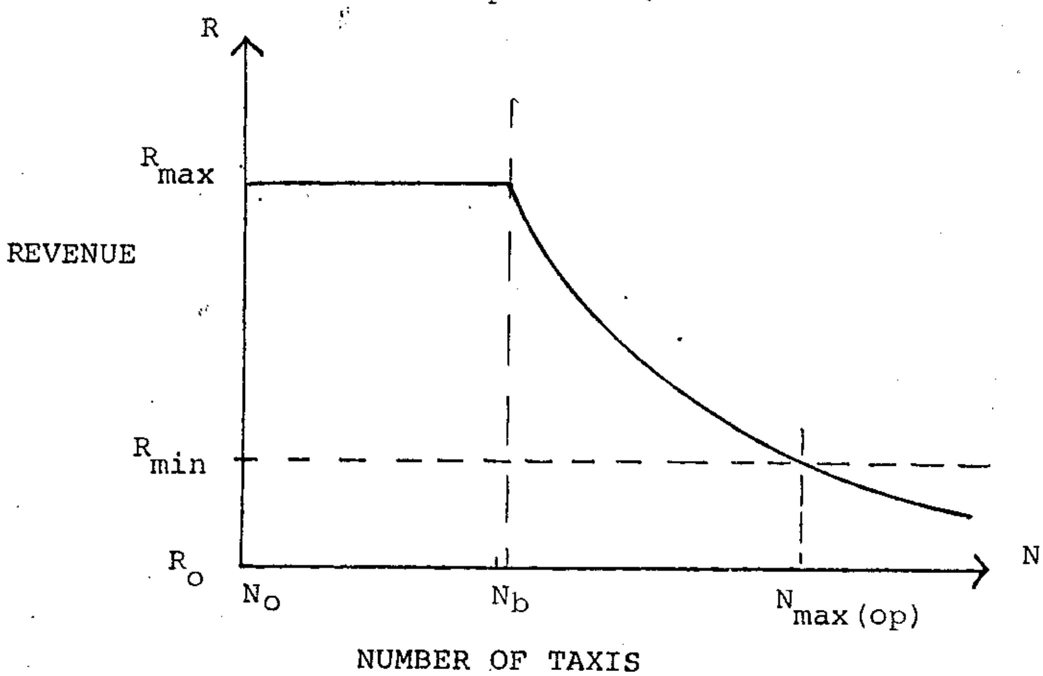

Figure 6.2

Relation between operator's average revenue and the number of taxis in operation.

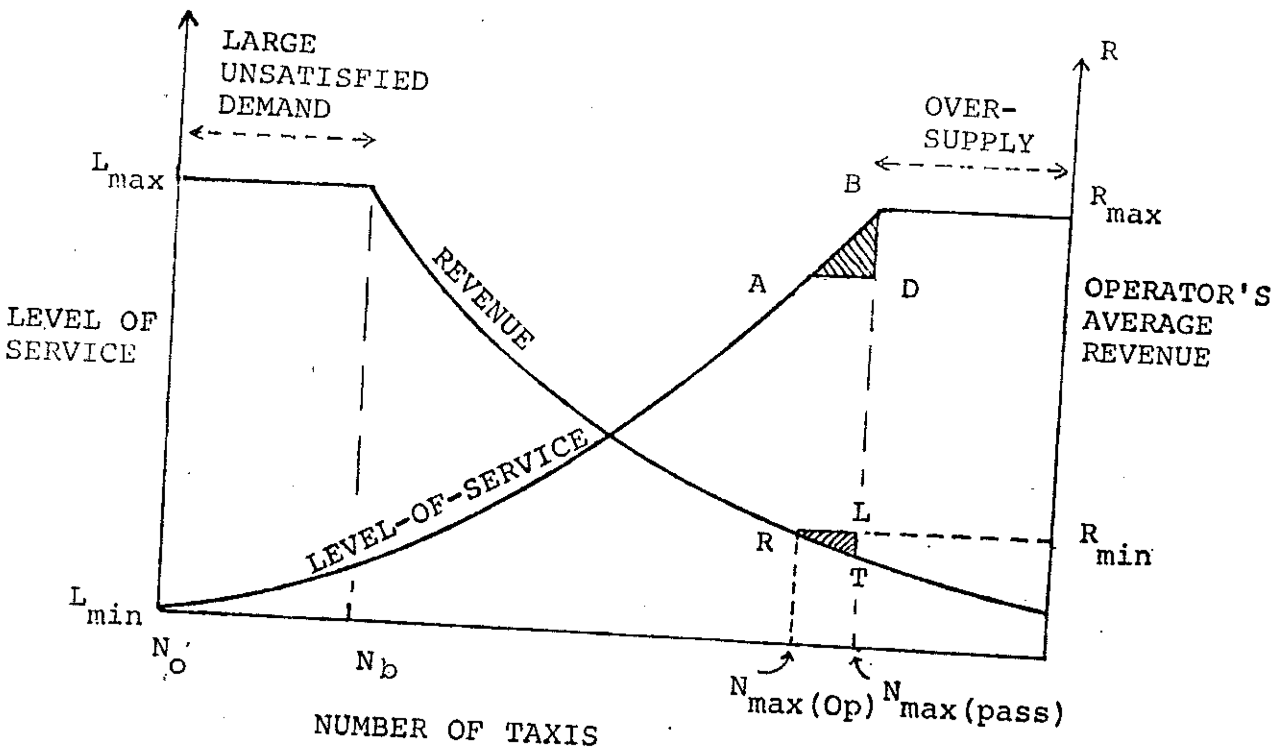

Figure 6.3

Relation between level-of-service, operator's revenues and the number of taxis.

level-of-service as being inversely proportional to waiting time. At this stage, we can only hypothesise about the shape of the curve shown. However, it is plausible that there must be an upper limit W_{max} beyond which people are not prepared to wait and which corresponds to only a small number of taxis operating. Thereafter the form of the curve should be exponentially negative, and that beyond N_t (the point at which over-supply has been reached) then the waiting time is W_{min} or close to zero.

If we now postulate another relationship; that of the operator's average revenue as a function of the total number of taxis operating (fig. 6.2) we fill find a similar relationship to that described for level-of-service. As long as all vehicles are operating at or near 100% capacity (a very high engagement ratio) and there is unsatisfied demand, the entry of another vehicle will not reduce average earnings since that vehicle will also be operating at or near 100% capacity. Only when a certain critical number of vehicles (N_b) has been reached will the incremental effect of increasing numbers begin to reduce the average earnings of each. Assuming that the market is inelastic, then the reduction in average earnings will be of a negative exponential order.

As more vehicles are added to the total fleet, average earnings will be reduced and at some point the average earnings will fall to a value which represents the operator's break even point (R_{min}) at which point we would theoretically expect no more vehicles to enter the market. However, in the LDC's, for reasons argued above and specially if the break even point lies on the 'flatter' part of the curve we can still expect additional vehicles to enter.

From the operator's point of view, the optimum number of taxis would be that which just satisfied the demand with maximum engaged output for all vehicles (N_b) *. At the same time the maximum number of taxis tolerable (N_{max}) would be that at which, for the industry as a whole, average earnings just equal the minimum acceptable rate of return on the total investment involved in operations (R_{min}). The actual value of this minimum acceptable rate of return will depend on return to be obtained from alternative investment opportunities and of course will be a function of the profile of operating costs prevailing for the industry in the one particular location. If fares were to increase, then a larger number of vehicles would be allowed to enter the market before that threshold would be reached. Conversley, if operating costs were to increase, the effect would be to move the break-even point higher on the y axis and the maximum number of taxis would be reduced.

If we superimpose the two curves,** we see that the optimum number of the vehicles from the point of view of maximising the operator's revenue (N_b) is far removed from the minimum number required to

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* In reality 100% engaged output is not feasible. Where most taxi working is from ranks we should rather define maximum engaged output to include time for the taxi to return to the nearest stand after dropping the last fare at his destination.

** For the sake of clarity in exposition and avoid the superimposition of two similar shaped curves the level of service curve is now inverted, and can be thought of as being equated to waiting time(-1).

maximise passenger level-of-service N_{max} (pass).

If N_{max} (op) is smaller then N_{max} (pass), then from a welfare view-point, if the additional user benefits obtained by allowing the number of taxis to increase (represented by the area of the triangle DAB) are greater than the sum of the additional operating costs incurred by the extra vehicles (represented by the area of the triangle TRL) then the optimum number of taxis lies to the right of the curve at N_{max}(pass), In any event the maximum number of vehicles should not exceed N_{max}(pass), since there are no additional user benefits to be obtained from an increase in vehicle numbers.

The above concept and relationships provide a model which can be used to define, for a given set of conditions, what should be the maximum Number of taxis permitted. It requires knowledge of the demand profile, interms of the number of journies made and the average journey length. It also requires knowledge as to the industry operating costs. The model should also prove useful in that it would allowing the testing of policy options, such as changes in quality control standards and fares to assess their effect on the maximum number of vehicles that could be permitted and the consequent effect of this number on passenger level-of-service

It is acknowledge that the above model is in some respects, simplistic. In reality passengers are not prepared to wait around for an indeterminate length of time to ride in a taxi; neither is the demand uniformly spread over the day, nor geographically distributed so that a taxi will find a passenger to pick up exactly at the point where the last fare was set down.

On the other hand, any government agency which has the responsibility of regulating a taxi industry ideally needs carry to out such an exercise periodically if it is to exercise its function responsibly. It would appear that, unfortunately, the majority of agencies exercise their quantity controls on a "hit or miss" basis - the result is usually a miss.

7 CONCLUSIONS

In this paper we have attempted to identify and discuss the principle factors which combine to determine how the taxi industry is structured and operates.

Attention has been drawn to the factors which contribute to the demand for taxi services, and those which can determine supply. In the context of Third World Countries in particular, it has been shown that overall levels of taxi provision can vary widely, as a function of level of private vehicle ownership and of the level-of-service offered by stage carriage services.

The regulatory function of government has received particular emphasis given the importance of this role in influencing levels of profitability for operators and levels-of-service for users.

Accepting the hypothesis that some measure of government control over urban passenger transport operations is both necessary and benificial, then the task of the agency regulating the taxi industry is quite clear, it should be to determine the optimum number of vehicle for the specific market conditions prevailing in its area, and by a judicious choice of entry regulations ensure that the number of vehicles actually operating is close to that figure.

As far as price control is concerned, the objective should be to fix the lowest price possible (in order to maximise public welfare) consistent with the requirement of providing a reasonable return or profit for the operator (assuming that the question of subsidies does not enter into the argument). In each case the definition of what is deemed to be reasonable is open to enterpretation and probabaly is best left to the judgement of the society's elected representatives. In all circumstances however, the price must be set at a level so that revenues exceed costs.

In order to do this, it is obviously essential to know what the full industry costs are, and what revenues should be earned for a given fare level. This itself will require a constant monitoring of both supply and demand by the regulatory agency.

Industry costs need to be periodically checked and carefully evaluated. In a well regulated system, any significant change in component costs should automatically trigger a compensatory change in prices or entry policy. In calculating the composition of costs, provision should be made for inclusion of all relevant cost items fixed, semi-fixed and variable. For fixed costs, items like interest charges, depreciation on vehicles and equipment must be allowed for.

In computing semi-fixed costs, legislation governing labour welfare may require both employers and self-employed persons to contribute welfare benefits (sickness/disability insurance, paid holidays, pension provision etc). Where this is so, these items must be incorporated into the cost accounts.

As far as entry control is concerned, the necessity for this has hopefully been revealed in the foregoing arguments. Having stated that the price set should be sufficient to provide a reasonable profit for the operator, it must also be recognized that revenues are dependent on the number of vehicles that are competing for a share of a given market. In this respect it would seem desirable to employ a policy of using both quality controls and quantity controls in conjunction. Quantity control is necessary to prevent the supply entering the critical 'over-supply' stage, should be generous rather than restrictive and subject to constant review in those areas where urban populations and disposable income are increasing. The maximum number of vehicles allowed to operate by quantity controls should never be set, or left to become, so low that licenses start to acquire market values thus encouraging the entry of parallel operators.

Fine tuning of the number of vehicles permitted to operate could be best by achieved by adjusting standards of quality control. As vehicle numbers increase to approach the critical saturation point, stricter quality controls could be instituted, thereby raising entry costs for new entrants.

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