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SUSTAINABLE TRANSPORT PRICING IN INDIA

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Sustainable Transport Pricing in India
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Foreword

The exigencies and imperatives of industrialisation of the developing economies of the world have brought their governments face to face with several new problems of economic and social governance. Among the most critical of these is the issue of pricing of services. In the area of transport related services, this issue has several dimensions. These include the balancing of the interests of suppliers and users and need for providing an eco-friendly environment.

Although some of the costs of transport services are covered in the charges borne by the suppliers and users of these services, other costs – particularly environmental ones – lie outside the domain of conventional markets and are usually neglected in most debates on transport provision and use. In this background, sustainable development has as one of its essential conditions the structuring of pricing in such a way as to reflect, among other things, social concerns of environmental degradation and equity in accessibility to transport facilities.

In this monograph, Dr. Ramprasad Sengupta, who is one of India's foremost applied economists, has in the context of transport pricing dealt with the crucial issue of equity and its relationship with social sustainability both from a theoretical and an empirical perspective. He brings to bear his usual refreshing and comprehensive approach to the analytical complexities of pricing transport services in a socially equitable yet sustainable growth.

I am confident that this monograph will make a substantial contribution to the understanding of the several issues involved in the process of arriving at 'socially sustainable prices' for the transport sector.

K. L. Thapar
Director

Introduction

The concept of sustainability, when defined in the context of pricing of any product or service like transport, refers to the conditions which can ensure sustainable development of the concerned sector. The sustainability of the development of a sector again has three aspects : (a) financial sustainability; (b) social sustainability; and (c) environmental sustainability. Financial sustainability requires the price-cost situation for a product to be such that the total value realised through price is adequate to (a) compensate all the factors of production other than capital at the competitive normal rates, (b) provide for replacement of depreciated capital stock, and (c) generate a net surplus giving at least a normal rate of profit or interest on capital employed, while the price of the product has to be competitive to ensure a reasonable share of the market for the producer. Unless these conditions are fulfilled, the production of the concerned good or service cannot continue indefinitely nor can it grow even if the demand side condition warrants growth. Sustainability of a process of production or of its growth would thus require efficient allocation of resources. It is widely recognised that competitive market conditions would ensure such efficiency of production.

The issue of social sustainability of production and pricing arrangement of a society, however, arises from the failure of the market to take account of its distributive regime and labour market conditions often delimit the ability of a section of the population to have access to certain markets. If poverty deprives them of the required purchasing power for having access to the markets of necessities like food, energy, transport, etc. for the given prices, it is very likely that social tensions would be generated making the prices and supplies politically infeasible. The social sustainability of economic processes would, therefore, warrant both initiatives of social security as well as regulation of prices of such necessities in order to take account of equity considerations. In overpopulated developing countries like India, the mobilisation of finances for social security by the government has been very limited and difficult. As a result, social sustainability arising from distributive considerations has required the pricing for necessities like transport, energy, water resources, etc. to be politically determined based on equity considerations. While the consideration of allocative efficiency has warranted prices to follow long-run marginal cost pricing principle, equity consideration has often conflicted with the application of such marginalist principle. In practice, however, political determination of prices has often led to arbitrary and often socially suboptimal prices. Therefore, an important issue in pricing of essential goods and services is how to scientifically combine efficiency with equity and evolve such pricing and regulation which can resolve the conflict and ensure social efficiency of production in the political-economic sense.

The third aspect of environmental sustainability of sectoral development focuses on intergenerational equity. It may, however, be pointed out that social sustainability aspect is also concerned with intergenerational equity. The World Commission on Environment and Development defined sustainable development to be such development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs. Sustainability of development would thus require both conservation of scarce resource use as well as halting of any degradation of natural capital of air-sheds, water-bodies and land and soil by abating waste arising from the processes of production and consumption of goods and services. Transportation uses exhaustible fossil fuels and degrades the environment through emissions of various pollutants arising from fuel combustion. The prices of fuels do not often include the true scarcity premium that should be charged so as to ensure optimal depletion pattern of the resource. Again, as there is free access to nature as sink for the non-market service of waste consumption, and as pollution is a public bad, the costs of such externalities and of the use of sink are not monetized and are not reflected in prices. This obviously leads to the overuse of fuel resources and sink service of natural capital for transportation violating the principle of intergenerational equity.

In order to ensure environmental sustainability of the development of transport sector, it would be necessary to base its prices on true social costs of supply of such services, which would internalize the costs of externalities of pollution, congestion, etc. It is, therefore, important to define the approach vis-à-vis pricing consistent with environmental sustainability which would essentially involve public good pricing and extension of marginalist principle to integrated social cost of production internalizing all externalities in the context of transport.

Since transport sector provides a basic infrastructural service, its pricing in the Indian context raises the issues of both equity and environmental sustainability. This monograph deals with these two aspects of sustainability of transport pricing in India in two sections. Section I deals with the aspect of equity in the pricing of transport services, while Section II focuses on the aspect of environmental sustainability in transport pricing. These two sections are revised versions of the two papers originally written for the UN-ESCAP Conference on Transport Pricing and Charges for Promoting Sustainable Development, held at New Delhi on 6-8 December, 2000. Here, the two papers have been brought together to provide a holistic view on sustainable transport pricing in the Indian context.

I remain beholden to Shri K. L. Thapar, Director, Asian Institute of Transport Development and Prof Sarmila Banerjee of Calcutta University for helping me with suggestions, support, data, references and interpretation. I have also greatly benefited from the research and technical assistance provided by Prosenjit Dey Chaudhury, Firoz Huda and Manish Gupta. I thank them all. I alone am, however, responsible for all the assertions made in this monograph.

Ramprasad Sengupta

SECTION I

Equity and Transport Pricing

Sources of Inequality and Transport Pricing

Transport pricing has been a part of economic policy in almost every country, rich or poor. Transport prices have been among the regulatory instruments chosen by the state to influence particularly the use of the transport sector as a support to the development process of an economy. Fixing of these prices involves issues of both financial resource mobilisation for the growth of the sector as well as of equity or distributive justice. The issue of equity arises in this context as transport provides an essential support system for the living of the people in all parts of a country and of all socio-economic groups whose members have widely varying incomes, assets and access to economic opportunities of various kinds.

The growth of the transport sector and the consideration of allocative efficiency would require the pricing of any mode of transport to follow the long run marginal cost pricing principle. However, there are problems due to both market failures and distributive considerations which create problems in applying such a marginalist principle in the real life context. The ground-fixed infrastructural items (like roads, railbeds, terminals, etc.) have got certain 'public good' character while transport operation often exhibits tendencies of vertical integration and large-scale economies leading to a natural monopoly situation. There are also problems of negative externalities arising from environmental stress due to both fuel consumption as well as congestion in use. Besides, there are positive dynamic developmental externalities generated by the expansion of the transport sector and particularly the higher connectivity within a country. Finally, the skewed distribution of income and assets among individuals of a society like ours also creates problem of access to the market of transport service for the poor because of their limited ability to pay, if transport charges are to cover the full cost at the margin even under competitive conditions. In each of these cases, market driven prices give rise to a serious problem of inequity. Let us elaborate the sources of such inequity which would justify state intervention through price regulation of this sector, among others.

First of all, the public good character of the ground-fixed infrastructure, including the dynamic developmental externalities generated by its development, ideally requires individuals to pay according to their marginal benefits derived from the last unit of its supply. Since exclusion principle is either non-applicable or is of limited applicability in the case of use of such public good type service and since there is only limited subtractability in its consumption, marginal utilities would very likely differ among individuals for any given level of supply of the public good. However, the users of such service would very likely take advantage of free riding and the market would fail to elicit the true offer prices of consumers according to their respective marginal utility.

The asymmetry of information in such a situation between the suppliers or regulators of prices and the consumers leads often to a situation where it becomes difficult to finance a project as per the social (pareto) optimality rule that sum of the offer prices by all the individual consumers should equal the marginal cost of supply of the public good. That is why either the transport infrastructure would be undersupplied if it is left to the market mechanism with private capital to take the investment initiative, or the cost would not be recovered even if the state plays a pro-active role in augmenting the capacities of such infrastructure so that the society can benefit from its forward and backward linkage effects. In any case, there would be a failure of equitable pricing arrangement so that the sharing of cost conforms to the share of utilities derived from the marginal unit in the aggregate of such utilities over all the individuals. As a result, a social practice has evolved that public goods like roads are considered free access infrastructure and are maintained and expanded out of funds mobilised from various taxes and levies by the government which are not fixed as per any pricing formulae of private good. The social distributive consideration often leads to underpricing of such services vis-à-vis normative costs. We shall see in one of the following sections how in the Indian situation such charges for roads have resulted in underpricing, poor maintenance and delayed augmentation of capacities.

Secondly, the natural monopoly tendencies develop in transport sector due to large-scale economies or requirements of technicalities of operation of a transport network. These often lead to the emergence of a monopolistic situation in railways or urban transport causing iniquitous exchange and inefficient resource allocation. The consumer in such a situation is exploited due to the fact that the price paid is more than the marginal cost of supply of the transport service as the profit maximising objective of the monopolist results in the marginal revenue and not the price being equated with the marginal cost, the marginal revenue being less than the price in the case of a normal good with downward sloping demand curve. The resulting allocation of resources and the extent of supply of the transport service would be sub-optimal, and would reflect a situation of undersupply of the service. This explains the state intervention in taking over the responsibility of supplying the transport services fully or partially in a region and regulating the prices. The pricing and the decisions of investment or physical supply have often been independently decided under such a regulatory regime.

The planning for augmentation of capacity or operation of the transport infrastructure in a developing country like India has been guided by the normative requirements of the economy or society in different regions subject to the political-economic constraint of the mobilisable financial resources from the internal sources of the sector and the general exchequer of the state. The prices have, on the other hand, been guided by the social distributive consideration that such service is a ‘necessity’ of ‘common man’, often resulting in a large effective subsidy to the consumers. Alternatively, the pricing principle has taken advantage of cross-subsidisation whenever product diversification has been possible to lessen the burden of effective subsidy. We define the effective subsidy to a consumer to be the shortfall of the price charged from the cost of supply, and cross-subsidisation of consumer B by consumer A to be the excess of price over cost paid by consumer A to cover the shortfall of the price paid by consumer B from the cost of the product. Such subsidies lead, on the one hand, to the problem of resource mobilisation for the planned programme of maintenance and expansion of the transport system of the concerned mode and, on the other, cause the prices to induce diversion of resources to those modes of transport which might involve higher use of scarce resources of the society.

Thirdly, the adverse externalities generated by rail, road or air transport through emission of gases, road congestion, noise, etc. lead to unsustainable transport use causing enormous health and time cost to the society. As pollution has been a public bad in character, and as environmental services are not marketed, the market prices fail to reflect the cost of externalities and are often substantially lower than the marginal social cost involved in the supply of transport services. This also involves the serious issue of horizontal equity in exchange. The user of transport gets away without paying anything for the damage he causes to the society and thereby induces misallocation of resources in favour of a relatively more polluting mode of transport.

Finally, in developing economies with capitalist or mixed economy character, the market fails to take account of distributive consideration of the society because of the property right regime. The concern for equity in distributive sense is expressed in the inelastic nature of substitution among the individual utilities of the social welfare function, the latter exhibiting sharp concavity depending on the egalitarian or altruistic values of the society.

Again, transport having more of the character of a necessity in the basket of a poor man's consumption, the utility function of the poor will involve inelasticity of substitution between a transport and a non-transport good. Since variation in prices facing the poor would have both an income effect and substitution effect, a higher price of transport would have an adverse effect on real income as also on social welfare level. This leads often to the argument that ideally society should resolve such distribution problem by income transfers through lump-sum taxes and subsidies independent of the regime of the relative prices, as this would not cause any distortion in the allocation of resources. However, if the political-economic transaction cost of implementing such policies of income transfer becomes too high, reliance would have to be placed on the use of prices as instrument of resolving the distributive problem through subsidy in consumption of the necessities.

As transport prices have often been regulated in the name of serving social purpose without due regard to the consideration of covering costs, the total effective subsidy has been too large adversely affecting the quality of transport service if not also the quantity – of both ground infrastructure and transport operation. Where the regulating authority has been successful in controlling the aggregated effective subsidy, such control has been accompanied by extensive cross-subsidisation through product differentiation targeting the consumers of different income classes. However, the measures for introducing equity in distribution at macro level may conflict with equity in exchange at the micro level of individual consumers. The market responses to highly cross-subsidised pricing may also lead to sub-optimal allocation of resources. It may be noted that any scheme of subsidising prices implies that the society imputes differential weights to the utility of consumers of different income classes. Given such weighting diagram, the optimum extent of effective subsidy or cross-subsidy needs to be calculated. Raising the elements of such subsidies and taxes implicit in pricing at too high a level would only lead to suboptimal allocation of resources and distribution of real income.

The discussion in the following sections will concentrate on the role of distributive considerations in pricing and its impact on the growth of quantity and quality of Indian rail and road transport, pointing to the cost of equity in terms of sacrifice of efficiency due to inadequacy of internal sectoral resource generation. The discussion on Indian experience at macro level will mainly focus on the various aspects of subsidy and cross-subsidy issues relating to rail and road transport and will highlight the directions of their required change in the interest of an optimum trade-off between equity and efficiency in pricing.

Growth of High Volume Poor Quality Transport Service

Under the state initiative of physical planning for transport infrastructure and emphasis on real supply system irrespective of the consideration of pricing, the Indian transport sector's output experienced an impressive growth over the period 1950-51 to 1996-97 (i.e., till the Eighth Five Year Plan). The total passenger traffic carried by rail and road together increased from 98 billion passenger kilometre (pkm) in 1950-51 to 752 billion pkm in 1980-81, 1155 billion pkm in 1990-91 and 1784 billion pkm in 1996-97. The freight traffic grew from 50 billion tonne kilometre (tkm) in 1950-51 to 257 billion tkm in 1980-81, 746 billion tkm in 1990-91 and 1087 billion tkm in 1996-97 (Table 1). The pressure of growing population, urbanisation and industrialisation combined with transport pricing with all its implicit subsidies or cross-subsidies induced such growth of transport services. It may be noted that growth of income and movement of prices of passenger traffic resulted in the rise of per capita annual passenger transport use from 272 km in 1950-51 to 1090 km in 1980-81, 1375 km in 1990-91 and 1898 km in 1996-97. The per capita freight transport service use in the Indian economy also went up from 139 tkm in 1950-51 to 372 km in 1980-81, 888 tkm in 1990-91 and 1156 tkm in 1996-97. The share of road in passenger traffic increased from 32% in 1950-51 to 72% in 1980-81, 74% in 1990-91 and 80% in 1996-97. The share of road in freight traffic, on the other hand, rose from 12% in

Table 1 : Trends of Rail and Road Traffic & Macro-Economic Variables

Year	RLFRT BTKM	RLPAS BPKM	RDFRT BTKM	RDPAS BPKM	TLFRT BTKM	TLPAS BPKM	GDP[1] (Rs. crore)	TFI[2] (TKM per GDP) (Rs.)	TPI[3] (PKM per GDP) (Rs.)	PN[4]
1950-51	44	67	6	31	50	98	42871	0.116628957	0.228592755	0.36
1951-52	47	63	6	31	53	94	43872	0.120805981	0.214259664	0.37
1952-53	47	60	7	37	54	97	45117	0.119688809	0.214996564	0.38
1953-54	48	60	7	40	55	100	47863	0.114911309	0.208929653	0.38
1954-55	52	62	8	43	60	105	49895	0.12025253	0.210441928	0.39
1955-56	60	62	9	51	69	113	51173	0.13483673	0.220819573	0.40
1956-57	66	67	10	45	76	112	54086	0.140516954	0.207077617	0.41
1957-58	75	69	12	41	87	110	53432	0.162823776	0.205869142	0.41
1958-59	76	68	13	64	89	132	57487	0.154817611	0.229617131	0.42
1959-60	82	74	15	71	97	145	58745	0.165120436	0.246829517	0.43
1960-61	88	78	17	81	105	159	62904	0.166921023	0.25276612	0.44
1961-62	91	82	21	87	112	169	64856	0.172690268	0.260577279	0.45
1962-63	101	84	25	96	126	180	66228	0.190251857	0.271788367	0.46
1963-64	107	89	27	106	134	195	69581	0.192581308	0.280248919	0.47
1964-65	107	93	31	117	138	210	74858	0.184349034	0.280531139	0.48
1965-66	117	96	35	124	152	220	72122	0.210754	0.305038684	0.49
1966-67	117	102	39	139	156	241	72856	0.214121006	0.330789503	0.50
1967-68	119	107	43	158	162	265	78785	0.205622898	0.336358444	0.51
1968-69	125	107	47	172	172	279	80841	0.212763326	0.345121906	0.52
1969-70	128	113	52	189	180	302	86109	0.209037383	0.350718276	0.54
1970-71	127	118	57	210	184	328	90426	0.2034813	0.362727534	0.55
1971-72	133	125	62	225	195	350	91339	0.213490404	0.383187904	0.56
1972-73	137	134	51	223	188	357	91048	0.206484492	0.39210087	0.57
1973-74	122	136	54	257	176	393	95192	0.184889487	0.412849819	0.59
1974-75	134	126	56	293	190	419	96297	0.19730625	0.435112205	0.60
1975-76	148	149	59	308	207	457	104968	0.197202957	0.43537078	0.61
1976-77	157	164	65	318	222	482	106280	0.208882198	0.453519006	0.63
1977-78	163	177	68	397	231	574	114219	0.202243059	0.50254336	0.64
1978-79	155	193	76	409	231	602	120504	0.191694881	0.499568479	0.66
1979-80	156	199	84	421	240	620	114236	0.21009139	0.54273609	0.67
1980-81	159	209	98	543	257	752	122427	0.209921014	0.61424359	0.69
1981-82	174	221	113	595	287	816	129889	0.220957895	0.628228718	0.70
1982-83	178	227	129	597	307	824	133915	0.229249897	0.615315685	0.72
1983-84	178	223	145	674	323	897	144865	0.22296621	0.619197184	0.73
1984-85	182	227	161	739	343	966	150433	0.228008482	0.642146338	0.75
1985-86	206	241	193	850	399	1091	156566	0.254844602	0.69683073	0.76
1986-87	223	257	210	893	433	1150	163271	0.265203251	0.704350436	0.77
1988-89	230	264	420	765	650	1029	188461	0.344898945	0.54600156	0.81
1989-90	237	281	453	835	690	1116	201453	0.342511653	0.553975369	0.82
1990-91	243	296	503	859	746	1155	212253	0.351467353	0.54416192	0.84
1991-92	257	315	567	956	824	1271	213983	0.385077319	0.593972418	0.86
1992-93	258	300	610	1003	868	1303	225240	0.38536672	0.578494051	0.87
1993-94	257	296	646	1086	903	1382	238864	0.378039386	0.578571907	0.89
1994-95	253	319	672	1192	925	1511	256095	0.361194088	0.590015424	0.90
1995-96	274	342	762	1322	1036	1664	275531	0.376001248	0.603924785	0.92
1996-97	280	357	807	1427	1087	1784	297113	0.365854069	0.600444949	0.94

Note : (1) At Factor Cost At Constant Prices. (2) Total Freight Intensity. (3) Total Passenger Intensity. (4) Population in Billion.

RL, RD and TL stand for Rail, Road and Total (Rail + Road). FRT and PAS stand for Freight and Passenger carried respectively. BTKM and BPKM are the Billion Ton Kilo Metre and Billion Passenger Kilo Metre respectively.

Figures for the Year 1987-88 were not available.

Source : 1. Perspective Planning for Transport Development; Report of the Steering Committee, Planning Commission, Government of India (August 1988); pp. 282-283 (for the Years 1950-51 to 1986-87).

2 (a)Indian Railways Year Books (for Rail Statistics for the Years 1988-89 to 1996-97).

(b)Study on Road Traffic Flows in the Country, Ministry of Surface Transport (MOST) (1998); (for Road Statistics for the Years 1988-89 to 1996-97).

1950-51 to 38% in 1980-81, 67% in 1990-91 and 74% in 1996-97. So far as the transport intensity of GDP is concerned, the index increased about three times both for passenger and freight traffic between 1950-51 and 1996-97. The freight transport intensity of GDP increased from 0.117 tkm per rupee of GDP at factor cost in 1950-51 at 1980-81 prices to 0.210 tkm per rupee in 1980-81 and further rose sharply to 0.351 tkm per rupee in 1990-91 and 0.366 tkm per rupee in 1996-97. A cross-country comparison of transport intensity of GDP in purchasing power parity dollar (PPP$) also shows that India had a transport intensity of 0.51 tkm per PPP$ in 1989 with 3.288 million sq km land area, while the intensity ratio was 0.64 for USA with a land area of 9.167 million sq km and 0.78 for China with land area of 9.597 million sq km in the same year (Table 2).

The personal mobility in India compares favourably with many countries keeping in view the comparative rank of India in respect of per capita income. In 1988, USA had a GDP per capita in PPP$ 19 times that of India with per capita mobility 8.5 times. In 1982, the personal mobility involving transport use was 1144 km per year for India while the same was 1400 km for Korea, 3700 km for Brazil and 252 km only of inter-city movement in China. Thus, Indians do not appear to have consumed less transport services relative to income in comparison with other countries.

Table 2 : International Comparison of Freight Transport Intensity

Country	Area	Freight transport intensity ('000 km^2) (TKM per $1989 GDP, purchasing power adjusted)
FSU	22272	3.59
Poland	305	0.86
CSFR	125	0.82
China	9597	0.78
Canada	2305	0.74
Bulgaria	111	0.72
USA	9167	0.64
Hungary	92	0.58
India	2973	0.51
Yugoslavia	255	0.48
Spain	499	0.37
Holland	34	0.34
Sweden	412	0.32
Belgium	30	0.32
West Germany	244	0.28
UK	242	0.26
Italy	294	0.23
France	546	0.22
Austria	83	0.21

Source : The Indian Transport Sector : Long Term Issues (March, 1995); Report No.13192-IN of the Infrastructure Operations Divisions, Country Department II – India, South Asia Regional Office of the World Bank, p.4.

This growth of consumption of transport output in the Indian economy has taken place under the initiatives of both the public and the private sector. Rail transport has been a state monopoly departmental enterprise subject to price regulation by the Indian Parliament. The developmental perspective of the Indian government regarding the transport sector, including its emphasis on gauge conversion and electrification in the railways, indicates the intended priority for the railways. However, the growth of rail capacity has been constrained by both competition from road and the limited availability of funds for investment. As Indian Railways represents a vertically integrated structure, the cost of a railway service includes the shares of ground-fixed infrastructure (line track and signalling), traction and terminal handling, etc. The railways' pricing of passenger and freight services is supposed to cover cost, including 7% rate of return on the government funds employed. While the overall performance of railways sometimes meets this norm of return, the 7% interest rate itself includes an element of interest subsidy, given the opportunity cost of investible funds in India.

In the case of road transport, the ownership of ground-fixed infrastructure is different from the authority handling transport operation. While the Indian state builds and maintains the roads, transport operation is shared between the public and the private sector. The trucking industry is entirely in private hands. The haulage distance of trucks as well as their freight changes are completely deregulated. The passenger transport service by road, on the other hand, is operated both by the private and the public sector under a regulated regime for prices and route permits. In urban areas, it is mostly the public sector undertakings which operate passenger transport. Some of the routes are, however, shared by private operators who have to operate under the same price regime. In some cases, the public sector undertakings take on lease buses from private owners who provide buses, conductors, fuel and all other operating inputs excepting the driver against a charge on kilometreage basis. This may involve loss or gain for the public transport authority depending on whether the cost of kilometreage payment, drivers' salary and other concerned payments exceed or fall short of collection of fares from the sale of tickets. For inter-city road transport, the participation of private entrepreneurs would depend on state policy. There is thus regulation of entry as well as fare structure for the private operators in passenger road transport, while free market forces determine the prices and quantities of freight traffic by road. There may be certain product differentiation in road passenger public transport like AC, Deluxe and Chartered bus services, with fares including differential charges for the extra amenity or convenience. Even for such product variations in the area of exclusive private operations, the fare structure needs the approval of the state regulating authorities.

Prices and Subsidies

In the history of political economy of India, transport prices have been used for serving several policy purposes, including (a) mobilisation of financial resources for supporting the expanding supply of transport services, and (b) redistribution of real income without much emphasis on allocative efficiency in resource use. The mobilisation of inadequate resources has resulted in supply of high volume but low quality transport service. Most of the traffic has grown along the four sides and diagonals of the so-called golden quadrilateral of transport in India connecting Delhi, Calcutta, Mumbai and Chennai. The traffic density has been growing along these routes and is presently quite high. The strategy of supply and pricing of transport services along these routes has involved substantive cross-subsidisation between freight and passenger traffic (if not across regions) and across different income classes. For some of the sub-sectors like inter-city public sector passenger traffic transport, the consumers of transport service have received even effective subsidies through pricing. A cross-country comparison of the percentage ratio of passenger fare per pkm to the freight tariff per ntkm, shows it to be one of the lowest in the case of India. In 1995, it was 32.4% for India and as high as 151.6% for China, 191.6% for Japan and 625.3% for USA (Table 3).

Table 3 : Passenger Fare as Percentage of Freight Rate for Various Countries
(Ratio $ per Passenger-km to $ per Ton-km)

Country	Percentage	Country	Percentage	Country	Percentage	Country	Percentage
Sri Lanka	19.5	Turkey	42.7	Korea	87.4	Germany	164.2
India	32.4	Indonesia	43	France	141.2	Japan	191.6
Pakistan	33.8	Thailand	63.8	China	151.6	Canada	347.6
Greece	34.3	Portugal	77	UK	160.2	USA	625.3

Source : The Indian Transport Sector : Long Term Issues (March, 1995); Report No. 13192-IN of the Infrastructure Operations Divisions, Country Department II – India, South Asia Regional Office of the World Bank, p.79.

However, as these policies have often been pushed beyond the levels warranted by the optimisation of social welfare, the benefit of redistribution has been more than offset by the loss of allocative efficiency. This has resulted in the poor quality of infrastructure and its maintenance and its quantitative inadequacy relative to the demand for the given structure of prices (e.g., poor congested roads with weak structural foundations and high roughness index used for operation of overloaded trucks carrying high traffic volume, technologically outmoded ground infrastructure of railways, i.e, of the track and signalling system). The same is true of transport operation as well (e.g. poor quality and inadequacy of second class ordinary rail passenger coaching service or the overused crowded ordinary bus service with uncomfortable seats). The railway freight service has also suffered due to the lack of containerisation and failure to provide door-to-door service, slow speed due to inadequate capacity of railway track, etc. The lack of adequate internal generation of surplus funds and the problem of resource mobilisation from the budgetary source have caused delay in replacement and renewal of tracks, wagons, coaches etc. in the case of railways. The system has already been so run-down that track renewal alone would require Rs. 15000 crore. The asset failure rate (i.e., breakdowns) of Indian rail is 7-10 times higher than that of many other railway systems in the world. This is having its adverse impact in terms of quality of railways' service as well as safety. The nominal small overall profit that is shown for the Indian

Railways is often achieved at the cost of neglect of maintenance expenditure particularly in the loss-making areas, further aggravating the problem of quality of service.

In the road sector, on the other hand, Indian trucking industry is still dominated by two-axle, low-payload capacity, fuel inefficient trucks driven by subsidised high speed diesel. The pricing structure of the Indian rail and road transport which supports such inefficient low quality but reasonably high volume of traffic has involved substantive amounts of effective subsidies and cross-subsidisation of various kinds. Here, we review the subsidy situation as it presently obtains to be able to assess how or in which area subsidisation has grown into unsustainable proportions resulting in misallocation of resources.

Freight Equalisation

In the early phase of development planning, the political economy of India used transport pricing as a tool for achieving balanced regional development of industries. The policy of freight equalisation of essential developmental inputs like coal, steel, cement, fertilizers, etc. was introduced in order to make them available at identical prices irrespective of the distance between the source of supply and the consumers' location. This introduced disparity between the freight tariff payable by the consumers of the transport service in close proximity to the main producer or supplier of these commodities and that paid by the consumers of these commodities at distant locations. While the consumers of a freight equalised commodity were entitled to buy it at the same delivered price all over India from the main producer agencies, the latter were required to pay the transport agency the freight tariff for the actual haulage distance. The scheme was operated through a freight equalisation fund to which a supplier of the concerned commodity used to contribute the average fixed freight tariff built into the price and could charge from the same the reimbursement of actual freight cost paid to the railways. Thus, the consumers located nearer the sources of supplies of these basic industrial commodities cross-subsidised the consumers located at a disadvantageous distance.

This policy, which was advocated on the ground of regional equity, seriously distorted the comparative cost advantage of locations for industries using these freight equalised commodities as inputs and induced inefficient locations of industries in terms of true domestic resource cost of production and supply. Some of the important consequences of this policy were higher cost of industrial production, and substantially higher haulage of such freight equalised commodities vis-à-vis the benchmark of transport flows of freight traffic as per the efficient least cost locational pattern of industries. Part of the growth of high volume of freight traffic service as measured in tonne-kilometre unit is imputable to inefficient haulage caused by the distorted pattern of location induced by the freight tariff equalisation policy. Inefficient use of transport in macro-aggregative sense has involved wasteful use of scarce energy resources of the country. The distortions proved to be so costly that the Indian state gradually phased out the policy of freight equalisation either totally or partially in most of the concerned industries.

The policy has, however, caused some irreversible damage to the economy. In order to take advantage of freight equalisation, the regional governments developed infrastructure and gave fiscal concessions to induce certain industries using such freight equalised items to get located there which would have been an inefficient decision in ex-ante sense in the absence of such policies. Even after the dismantling of freight equalisation, many industries would find new entry or expansion in these already established regions or locations which developed benefitting from the freight equalisation policy to be less costly. The transaction costs of shifting locations of new units to where social resource costs are minimised are too high to offset the advantage of lower transportation requirement of the concerned freight traffic and the lower use of energy for transport. It is, in fact, important that the pricing of energy and transport services internalise the costs of environmental and social externalities, so that the financial costs of relocation of industries reflect the differential in terms of true resource costs of the society for expanding the industries at alternative locations. In order to correct the distorting long-range or intertemporal effects of the past policy of freight equalisation on the future pattern of growth of industries, it is important that social and environmental costs are built into energy and transport prices to ensure the condition of other kinds of intergenerational and social equity and yield a sustainable transport pricing regime.

Subsidies in Rail Transport

It is difficult to estimate the effective subsidies in the prices of the railway service in India because of the non-availability of estimates of normative costs. The actual data on working expenses and net earnings have built-in elements of inefficiency in them. The Government of India demands a dividend of 7% on its grants for the railways which itself contains an element of interest subsidy in view of the much higher opportunity cost of use of capital at the macro-economic level in India. Even with such subsidised financial charges on government funds, the railways' operating ratio (percentage of working expenses to gross earnings) has gradually declined and is estimated at 98.8% for 2000-01. It is suspected that this estimate is also a dressed-up figure not truly reflecting the full measure of financial liability. The loss of market share to road transport, lack of operational flexibility particularly in pricing, excessive overmanning, huge pension liability and poor investment decisions driven by the political-economic forces are responsible for this situation. In 1997-98, the overall net earnings, i.e, the excess of earnings over the working expenses (i.e., all expenses including depreciation but excluding any interest or payments as return to capital) was Rs 2594.78 crore in 1997-98 and Rs 1986.76 crore in 1998-99. The ratio of working expenses to gross earnings increased from 90.92% in 1997-98 to 93.34% in 1998-99. The percentage of net earnings to capital-at-charge of the railways correspondingly declined from 10.22% in 1997-98 to 7.25% in 1998-99. The budgetary support from the Central Government has also declined from a peak of 75% in the Fifth Plan to 25% in the ongoing Ninth Plan projects.

The railways are now being forced to shift from loans in perpetuity from the government to high-interest loans from capital market which is going to have a serious damaging effect on the railway finance and the future viability of the railways. While the Indian Railways have not as yet had any overall effective subsidy for current operations from the government (assuming 7% interest charge on government loan in perpetuity to be the legitimate cost of fund), the structures of passenger fare and freight tariff have involved substantive cross-subsidies given the costs of passenger traffic and freight traffic. There is cross-subsidisation (a) between passenger and freight traffic, (b) within passenger traffic across classes of coaching services, (c) within freight traffic across categories of commodities shipped, (d) the gauges of sections of railways, and (e) across regional railways. We give more detailed observations on each of these types of cross-subsidies in the following sections.

Cross-subsidy between Goods and Passenger Traffic in Railways

The goods traffic of Indian Railways earns net surplus after meeting all expenses, including interest as per the norms of the Railway Convention Committee. The railways run into substantive deficit in carrying passenger traffic. The surplus earned from the freight traffic compensates more than the losses in passenger traffic. Tables A.1(a) to A.1(c)* show the comparative performance of the railways in delivering the two kinds of transport output, namely, coaching service and goods haulage service.

The goods traffic constitutes 70% of the railways' physical output in gross tonne-kilometres of service excluding the weight of the engine and of the share of own departmental movements. However, as regards train movement, the share of goods traffic in terms of train-kilometres excluding departmental movements is about 40% only. Goods traffic constituted about 70% of earnings

* *See Annexure for tables A.1(a) to A.8(b)*

from railways traffic, while its share in total working expenses or in total cost inclusive of interest has remained around 47%. As a result, the goods traffic has contributed to net profit after paying interest to grants/loans, while the coaching service has involved losses both before and after deduction of interest. It may be noted that about 78% of profit generated by the goods traffic of Indian Railways is used to compensate for the losses on account of coaching services.

This cross-subsidisation stands in the way of modernisation and capacity augmentation of goods traffic causing serious distortion in resource use. If it is considered that the structure of railway freight traffic does not contain much of tax element by absolute standards, the surplus generated from the traffic needs to be used towards investments for promoting expansion of capacity and improvement of quality (e.g. containerisation, door-to-door service, reducing users' time cost involved in transit and delivery by appropriate mechanisation and electronic controls, etc). This is important in order to reverse the trend of rising share of road transport in freight traffic in view particularly of the higher energy intensity, degrading environmental impact and social cost of this mode. It should be noted in this context that the rate of charges for trucking for the movement of goods as determined in free market has nothing to do with pricing or subsidies for passenger road transport. If the Indian government intends to subsidise passenger traffic by rail, its grant to the railways should clearly account for subsidy for passenger traffic under a separate head so that the estimate of investible resource availability for correcting the existing modal imbalance in Indian transport system can be effectively augmented.

Besides, it is difficult to justify the use of the pricing relation between the railway freight and the railway passenger transport for achieving objectives of redistributive kind. While passenger service is by and large a direct consumption item of the household, the transport freight service is an input in the production and delivery system of our economy, demand for which is predominantly a derived demand. It is difficult to understand the theoretical rationale of imputing lower weightage to any surplus generation by the producers of goods and services using transport input vis-à-vis consumers' surplus appropriated from railway passenger service on the ground of allocative efficiency which takes account of the social welfare function with built-in concern for distributional equity.

Cross-subsidisation across Different Classes of Railways' Passenger Traffic

Although the railway incurs heavy losses on account of passenger traffic due to low tariff as well as inefficiency in delivering the transport service, the passenger fare on the average contains an element of effective subsidy (ignoring for the time being the issue of estimation of subsidy as per the normative cost of railway passenger service). However, the fare structure for different passenger classes involves marginal cross-subsidies as well. Tables 4 and 5 show the total passengers carried, total passenger kilometres and profitability of coaching services for 1997-98. Tables A.2(a) and A.2(b) show the earning, cost and profit per passenger as well as per passenger kilometre, separately for broad gauge and metre gauge in 1997-98. In broad gauge, it is only the AC classes (AC 1st class, AC Sleeper, AC 3 Tier and AC Chair Car) that make profit while non-AC first class and all other classes make losses, the highest profit per passenger kilometre (45 paise) being realised from AC first class and the highest losses per passenger kilometre being incurred for the ordinary first class (33 paise) in 1997-98. In metre gauge, all passenger classes involve losses depressing further the financial viability of the Indian Railways. Taking both broad gauge and metre gauge together, only the various air-conditioned classes appear to be making some profits while all the non-AC passenger traffic is making losses. The total loss in all the loss-making classes of broad gauge and metre gauge taken together was to the tune of Rs 4271.12 crore in 1997-98, while the profit-making classes could earn a meagre net profit of Rs 164.55 crore only, covering only 3.85% of the total loss of the loss-making classes.

Table 4 : Total Passengers Carried and Total Passenger Kilometre Service by Railway with Classwise Share in 1997-98

(All Railways) *(Unit '000)*

Category	Broad Gauge		Metre Gauge		Narrow Gauge		All gauges	
Mail / Express	**Passengers**	**PKMS**	**Passengers**	**PKMS**	**Passengers**	**PKMS**	**Passengers**	**PKMS**
AC First Class	735 (0.02)	492243 (0.14)	24 (0.01)	1072200 (2.95)	—	—	759 (0.02)	1564443 (0.41)
First Class	3171 (0.10)	2356793 (0.68)	552 (0.13)	239668 (0.66)	—	—	3723 (0.11)	2596461 (0.68)
AC Sleeper	8159 (0.26)	5915891 (1.71)	561 (0.14)	222838 (0.61)	—	—	8720 (0.25)	6138729 (1.60)
AC 3-Tier	3779 (0.12)	3047312 (0.88)	—	—	—	—	3779 (0.11)	3047312 (0.79)
AC Chair Car	6892 (0.22)	3399447 (0.98)	83 (0.02)	3000700 (8.25)	6 (0.03)	1240 (0.12)	6981 (0.20)	6401387 (1.67)
Sleeper Class	101651 (3.29)	72832216 (21.02)	9679 (2.36)	4411937 (12.13)	—	—	111330 (3.16)	77244153 (20.12)
Second Class	324089 (10.48)	101377179 (29.25)	31049 (7.57)	8865881 (24.38)	653 (2.85)	110138 (11.10)	355791 (10.09)	110353198 (28.74)
Ordinary								
First Class	5385 (0.17)	6146897 (1.77)	102 (0.02)	53366 (0.15)	86 (0.38)	15548 (1.57)	5574 (0.16)	6215811 (1.62)
Sleeper Class	4638 (0.15)	1801217 (0.52)	530 (0.13)	171227 (0.47)	—	—	5168 (0.15)	1972444 (0.51)
Second Class	100859 (3.26)	78409536 (22.62)	224811 (54.85)	15845342 (43.56)	22132 (96.74)	865709 (87.21)	347801 (9.86)	95120587 (24.78)
EMU Suburban Services	2533490 (81.91)	70785264 (20.42)	142503 (34.77)	2489129 (6.84)	—	—	2675993 (75.90)	73274393 (19.09)
Grand Total	3092855	346564003	409894	36372290	22877	992635	3525627	383928928

Note : The figures in the parenthesis are the column percentages.

Source : Government of India, Ministry of Railways (Railway Board); Indian Railways Annual Statistical Statements 1998-99.

Table 5 : Profitability of Railway Coaching Services for 1997-98

All Railways *(in crores of rupees and inclusive of interest)*

Category	Broad gauge			Metre gauge			Narrow gauge			Overall*		
	Expenses	Earnings	Gain/Loss	Expenses	Earnings	Gain/Loss	Expenses	Earnings	Gain/Loss	Expenses	Earnings	Gain/Loss
Mail/Express												
AC First Class	78.17	100.09	21.92	3.31	2.32	-0.99	NA	—	—	81.48	102.41	20.93
First Class	199.77	173.00	-26.77	69.37	22.16	-47.21	NA	—	—	269.14	195.17	-73.97
AC Sleeper	540.61	640.16	99.55	30.55	26.55	-4.00	NA	—	—	571.16	666.72	95.55
AC 3-Tier	145.63	186.14	40.51	—	—	—	NA	—	—	145.63	186.14	40.51
AC Chair Car	166.29	168.65	2.36	1.92	2.13	0.21	NA	0.0857	—	168.21	170.78	2.57
Sleeper Class	2791.71	1820.391	-971.32	289.95	104.68	-185.27	NA	—	—	3081.66	1925.07	-1156.59
Second Class	2095.86	2032.78	-63.08	409.93	168.68	-241.25	NA	2.933	—	2505.79	2201.46	-304.33
Ordinary												
First Class	28.66	15.66	-13.00	24.10	1.79	-22.31	NA	1.4284	—	52.76	17.45	-35.31
Sleeper Class	90.34	30.69	-59.65	42.15	2.97	-39.18	NA	15.1185	—	132.49	33.66	-98.83
Second Class	1831.50	911.69	-919.81	784.52	211.92	-572.60	NA	—	—	2616.02	1123.61	-1492.41
EMU Suburban Services	1215.88	882.30	-333.58	51.31	29.72	-21.59	NA	—	—	1267.19	912.02	-355.17
Total (Mail, Ordinary & suburban)	9184.42	6961.55	-2222.87	1707.11	572.93	-1134.18	NA	19.57	—	10891.53	7534.48	-3357.05
Others	1404.32	778.59	-625.73	271.25	84.39	-186.86	NA	2.59	—	1675.57	862.98	-812.59
Grand Total	10588.74	7740.13	-2848.61	1978.36	657.32	-1321.04	181.74	22.16	-159.58	12748.84	8419.61	-4329.22

	Broad gauge	Metre gauge	Broad gauge + Metre gauge
Total gains	164.34	0.21	164.55
Total losses	2949.87	1321.25	4271.12
Total gains as a % of total losses	5.57%	0.02%	3.85%
Non-suburban gains	164.34	0.21	164.55
Suburban losses	333.58	21.59	355.17
Non-suburban gains as a % of suburban losses	49.27%	0.97%	46.33%

* Figures pertain to Broad Gauge + Metre Gauge for individual classes and all the gauges together for Grand Total

Sources : (1) Indian Railways Annual Statistical Statements, 1998-99. (2) Summary of the End Results for Coaching Services Profitability / Unit Costs, 1997-98.

It may also be noted that whatever gains arise from passenger traffic are realised from non-suburban passenger traffic, suburban traffic involving only losses which amounted to 355.17 crore in 1997-98. However, such suburban losses constitute only 8.3% of the total loss of the loss-making passenger traffic in broad gauge and metre gauge. While the share of suburban traffic was 76% of passengers carried and 20% of passenger kilometre service of the overall rail passenger traffic in 1997-98, the share of responsibility of suburban passengers in losses was less than that of inter-city long-distance second-class passenger service (Tables 4 and 5). As there is some ground for treating suburban passenger service as a necessity for commuting to the place of work and business by the local people, the distributive argument would justify some subsidisation of this section of passenger traffic. The average loss per passenger in 1997-98 was Rs 1.33 for suburban passenger traffic against Rs.36.05 for inter-city passenger traffic. The loss per passenger kilometre in the same year was estimated to be 5 paise for suburban passenger traffic against 10 paise for inter-city long-distance traffic (Tables A.2(a) and A.2(b)). The non-suburban passenger traffic does not, in fact, cross-subsidise the suburban passengers. The air-conditioned coach passengers cross-subsidise the non-AC inter-city passengers only marginally.

The huge deficit in the railway passenger traffic service has resulted in poor quality of maintenance of railway stock of coaching services to second class passengers. Unclean dilapidated ordinary second class coach with defective or dry taps in toilets and no light at night at least in a couple of coaches involving high insecurity for the passengers is a common sight in India in the case of ordinary passenger trains moving along low-density traffic routes. A part of apparent financial subsidy is offset by the lowering of the quality of service which is not entirely reflected in a lowering of the cost. The differential in the quality of AC and non-AC passenger service is widening over time and the railways has been induced for legitimate financial reasons to lower the proportion of passenger capacity of ordinary trains and raise that of express trains with AC coaches resulting in increasing scarcity of the ordinary second class coaches relative to demand for mail/express or ordinary trains which are used by the poorer sections of the Indian people. In the name of distributive argument, the prices have been irrationally structured involving financial non-viability which combined with inefficiency has resulted in the lack of funding support for providing any service of minimum civilised standard on a sustainable basis for the poor. The high volume low quality service (low quality by any global standard) for ordinary railway passengers has resulted in counterproductivity of the passenger transport pricing policy since the price per unit of transport service measured in efficiency units has become high after adjustment of the measure of the service by some discounting rule for variation in quality.

Given the state of development of the Indian economy, the offer price (willingness to pay) of common people is often deliberately underestimated in order to make the pricing of state-owned services, like that of second class coaching service by the railways, a political issue. It is quite possible to segment the market of passenger service by appropriate product differentiation so that prices can take advantage of ability and willingness to pay of different income groups for the various classes of passenger service. Such willingness to pay would not always fall short of costs in case service of a certain assured quality in terms of timeliness of delivery, security, amenities, etc. is provided efficiently. This would also help to delimit the size of the market and the amount of passenger transport service requiring effective subsidy and also permit upgradation of the quality of the lowest class of passenger services for the poor without much of cross-subsidy. The ordinary first class or sleeper class should be charged on full-cost basis with improved quality of service or should be abolished if traffic volume in any area is too small involving huge losses, for example, ordinary first class or sleeper class in certain metre gauge areas. The other modes of transport can possibly take better care of such segment of transport market.

In order to minimise the distortions in the efficiency of resource allocation, what is important is to clearly identify the target section of passengers and the segment of the market which really needs subsidy. While we would always favour any policy of income subsidy to price subsidy, some subsidisation for the target group through transport pricing of only the appropriate segment may be required in view of its characteristic as a necessity. The suburban ordinary second class (mostly EMU/DMU coaching service) and the ordinary second class intercity travel service are the only priority areas of subsidy from the distributive angle. The inter-city travel demand is likely to be income-elastic. The real poor (those below the poverty line) require more of local travel facility than inter-city long distance travel facilities. Hence, the rationale of reducing subsidy in long-distance travel. Besides, the concessional fares or passes for privileged or disadvantaged classes of people (like MPs, senior citizens, students, nurses, etc.) have also a distorting effect. There is a loss of 20% of revenue due to all such concessions. It would be a more efficient arrangement with reference to the overall resource allocation if these people were given reimbursement of the concession (like LTC by the employer) directly through employer or some institutional mechanism and the railways charged the full price for the service rendered. There is enormous leakage of benefit in India for such widely distributed benefits in terms of price concessions, which quite often accrue to completely undeserving people (e.g., some of the Members of Parliament/Legislative Assembly or retired servicemen with taxable income drawing the benefit as senior citizens). Most of these customers receiving concessions are not at all poor and will reveal their real willingness to pay a higher price once such options of concession are withdrawn.

Cross-subsidisation across Different Commodities of Railway Freight Traffic

The tariff of railway freight contains, on the average, an implicit element of tax after covering costs which is used to compensate the entire loss on account of railway passenger traffic.

Table A.3 and Tables A.4(a) to A.4(c) give details of railway freight traffic and its profitability. However, the incidence of this implicit tax is not uniformly distributed across different commodities. The earning per net tonne kilometre is highest for mineral oils which is Rs.1.28 per net tonne kilometre and lowest for fertilizers, being Rs 0.39 per net tonne kilometre (Table 6). The cost estimates of haulage of freight traffic are not available commodity-wise, although the actual cost would differ for different commodities depending on the type of wagon and rake operation involved. However, the average cost of freight shipment per net tonne kilometre for the entire rail freight traffic exceeds the earning per net tonne kilometre only for two bulk items – food grains and fertilizers. If the excess of earning per net tonne kilometre of a commodity traffic over the average cost of the entire goods traffic per net tonne kilometre be any index of profitability, then food grains and fertilizers are the only loss-making items of freight traffic (Table 6).

The items of shipment of goods by the Indian Railways are mostly low value bulk items involving haulage over long distances. Energy, raw materials and products of steel plants, cement, fertilizers and food grains are among such items. Coal itself constitutes about 49% of total tonnage originating and 45% of the total net tonne kilometre service of railway freight traffic. While the freight traffic earns overall profit and the cross-subsidisation among different freight items, if any, is likely to be of marginal significance, the major problem for the railways has been the continuing loss of all high-value traffic to the roadways. The railways need to equip themselves with modern facilities capable of handling high-value low volume traffic. This requires containerisation and door-to-door delivery service which will mean lower cost and lesser transit time for the users. As high-value commodities can bear relatively high tariff per tonne kilometre, it is important for the railways to diversify the commodity mix of shipment and modernise the railway system. It is thus not merely the pricing but the very policy of product-mix, technology and quality of delivery in terms of

Table 6 : Commodity-wise Freight Earnings and Costs of Railways in 1997-98

All Gauges

Commodity	Tonnes Originating (thousand)	NTKMS (thousand)	Earnings (Rs. thousand)	Earnings per tonne carried (Rs.)	Earnings per NTKM (paise)	Cost per NTKM (paise)		Profit per NTKM with respect to overall cost per NTKM (paise)	
						Excluding interest	Including interest	Excluding interest	Including interest
Coal	208753	127514953	92450269	442.87	72.50			24.40	21.64
Raw Materials for Steel Plants	37807	13392078	8638392	228.49	64.50	—	—	16.40	13.64
Pig Iron and Finished Steel Booked from Steel Plants	11790	11562422	12056056	1022.57	104.27	—	—	56.17	53.41
Iron-ore for export	12156	6810737	4373345	359.77	64.21	—	—	16.11	13.35
Cement	37363	20944505	16097335	430.84	76.86	—	—	28.76	26.00
Food Grains	26311	30962124	12055168	458.18	38.94	—	—	-9.16	-11.92
Fertilizers	26669	22015403	8515271	319.29	38.68	—	—	-9.42	-12.18
Mineral Oils	30727	19655595	25212161	820.52	128.27	—	—	80.17	77.41
Other Commodities	37805	31391330	16552145	437.83	52.73	—	—	4.63	1.87
Total	429381	284249147	195950142	456.35	68.94	48.10	50.86	20.84	18.08

Source : Indian Railways Annual Statistical Statements, 1998-99.

user's cost of time and convenience which are important for the rail freight traffic business. This again takes us back to the issue of cross-subsidisation between the railway's passenger and freight traffic which needs to be stopped and the resources generated by the surplus from rail freight traffic need to be used for the development and promotion of business of the overall railway traffic.

Cross-subsidisation across Different Gauges of Railway Sections

The Indian railway's pricing of its coaching and goods transport services relative to their costs has also involved extensive cross-subsidisation among regions which are covered by different gauges of railway sections – broad gauge, metre gauge and narrow gauge. The broad gauge rail sections are the high-density traffic routes, while the metre gauge sections have much lower traffic density. The choice of narrow gauge for railways is, on the other hand, determined by the terrain condition apart from the density of traffic. If we include interest payment as per the Railway Convention Committee norms, the metre gauge sections of all the railways incur losses on both passenger and freight traffic. The loss per passenger kilometre was found to be as shockingly high as Rs. 9.45 for Ordinary First Class and Rs. 2.28 for Ordinary Sleeper Class in the metre gauge sections of all railways taken together in the year 1997-98. The only passenger class for which the metre gauge railways could show some profit in the same year has been AC Chair Car. It is also surprising that in spite of remunerative freight traffic in general, the metre gauge sections of all railways incur losses at the current level of traffic density (Table A.4(a)). The metre gauge railways contributed about 3.8% of total earnings of Indian Railways of all gauges, while they account for about 11.2% of the total working expenses including interest charges, resulting in considerable losses (Tables 7 and 8).

The narrow gauge railway sections which operated mostly in far-flung areas with difficult terrain have also been incurring losses. Table 8 shows that, among other things, the metre gauge and narrow gauge railway sections incurred losses of the order of Rs. 1986 crore and Rs. 211 crore, respectively. A share as high as 58% of the net profit of the broad gauge was used to make up for the losses of the metre gauge in 1997-98. The losses of narrow gauge also claimed 6.1% share of profit from the broad gauge to compensate for the losses. The share of claim on broad gauge profit for cross-subsidisation rose to 79% and 9% for metre gauge and narrow gauge railways, respectively, in 1998-99.

Table 7: Final Results of Railway Sections of Different Gauges

Year	Broad gauge	Metre gauge	Narrow gauge	Total
Total Earnings				
1997-98	27449 (96.1)	1086 (3.8)	32 (0.1)	28567 (100)
1998-99	28765 (96.5)	1015 (3.4)	34 (0.1)	29814 (100)
Total Working Expenses (incl. Interest)				
1997-98	24014 (87.9)	3072 (11.2)	243 (0.9)	27329 (100)
1998-99	26553 (89.9)	2756 (9.3)	234 (0.8)	29543 (100)
Profit(+) /Loss(-)				
1997-98	3435	(-) 1986	(-) 211	1238
1998-99	2211	(-) 1741	(-) 200	269

Source : Indian Railways Annual Statistical Statements, 1998-99.

Thus, the relative financial performance of different sections shows the inter-regional cross-subsidisation. The losses of low traffic density areas under metre gauge are being paid for by the higher traffic density areas under broad gauge. The Government of India decided on a programme of upgradation of lower gauge railways into broad gauge since the Eighth Plan – irrespective of whether there had been any growth in the density of traffic warranting such conversion. The growth of traffic density is a necessary condition for gauge conversion in the interest of overall profitability and better delivery of service. The gauge conversion, however, is not a sufficient condition for ensuring profitability of the railways. The metre gauge railways had a share of about 9.5% of the total passenger kilometre service by the Indian Railways and a negligible share of 2% in freight traffic in terms of originating traffic. The costs of lower gauge railway operation are high because of the diseconomies of scale of operation.

Table 8 : Profitability of Indian Railways as a whole in 1997-98

(in Rs. crore)

Railway	Broad gauge			Metre gauge			Narrow gauge			All gauges		
	Expenses	Earnings	Gain/Loss	Expenses	Earnings	Gain/Loss	Expenses	Earnings	Gain/Loss	Expenses	Earnings	Gain/Loss
Central	4197.83	4554.27	356.43	—	—	—	45.31	6.27	-39.05	4243.15	4560.53	317.39
Eastern	3609.97	3281.37	-328.61	—	—	—	3.24	0.59	-2.65	3613.21	3281.96	-331.26
Northern	4423.99	4722.52	298.52	127.82	65.13	-62.70	42.15	3.43	-38.72	4593.97	4791.07	197.11
North Eastern	479.63	545.27	65.64	851.10	212.66	-638.45	—	—	—	1330.74	757.93	-572.81
North-East Frontier	812.68	372.34	-440.34	332.11	110.60	-221.51	3.20	0.24	-2.96	1147.99	483.18	-664.81
Southern	1919.89	1764.02	-155.86	484.99	257.71	-227.28	—	—	—	2404.87	2021.73	-383.14
South Central	2017.20	2767.21	750.01	497.70	88.67	-409.03	—	—	—	2514.89	2855.88	340.98
South Eastern	4052.09	5525.26	1473.17	—	—	—	120.29	19.47	-100.82	4172.37	5544.73	1372.35
Western	2500.93	3917.18	1416.26	778.42	351.32	-427.10	29.03	1.97	-27.06	3308.38	4270.47	962.09
Total	24014.21	27449.44	3435.22	3072.14	1086.08	-1986.06	243.22	31.97	-211.26	27329.58	28567.48	1237.91

	Broad gauge	Metre gauge	Narrow gauge	All gauges
Total gains	4003.60	0	0	2872.53
Total losses	924.81	1986.06	211.26	1952.01
Surplus of gains over losses on BG	3078.79	—	—	—
Difference between surplus of gains on BG and losses on both MG & NG	881.47	—	—	—
Losses on MG and BG as a proportion of surplus of gains on BG	71.37%	—	—	—

Sources : (1) Indian Railways Annual Statistical Statements, 1998-99.
(2) Summary of the End Results for Coaching Services Profitability / Unit Costs, 1997-98.

The prices of railway service do not necessarily vary across gauges. Expansion of the capacity of a railway does not necessarily ensure the growth of demand. It is the growth of total volume of traffic by all modes (particularly, road and rail) in the concerned transport section which would only warrant taking advantage of the economies of scale; otherwise gauge conversion as such cannot be expected to resolve the problems of physical or financial productivity through its forward linkage effect. Any unwarranted gauge conversion would only aggravate the problem of financial viability, involve more of cross-subsidisation and have higher distortive effect on pricing under an administered uniform pricing regime across the gauges inducing a greater departure from the marginalist rule of resource allocation and pricing of neoclassical economics.

Cross-subsidisation across Regional Railways

There is also a problem of cross-subsidisation in the railways across the different geographic regions. The profitability of operation varies across these railways both for passenger and freight traffic. While all regional railways make losses only in coaching service, North East Frontier Railway incurs losses in goods traffic as well. Apart from the strategic sections of different railways, the Eastern Railway, the North Eastern Railway, North East Frontier Railway, Southern Railway and Metro Railway of Calcutta make losses. The profits of Central, Western, Northern, South Eastern and South Central Railways make up for the losses of the loss-making regional railways. The total losses of loss-making railways including all strategic sections amounted to Rs. 2503.09 crore in 1998-99 which used up 86% of the total profit of the profit-making railways in that year. While the service conditions and costs of coaching service and goods haulage per unit have varied across the regional railways (Tables A.5 and A.6), the fare structure and freight tariffs have been uniform across all the railways. The traffic composition and traffic density have also been different for the different railways leading to variation in profitability. The unmindful opening up of a new uneconomic railway section where the traffic density taking all modes together and the ability to pay have been low, has contributed to the losses on some of these railways. It may be pointed out that regional cross-subsidisation to some extent would be inevitable on grounds of equity and avoidance of administrative cost of any differential pricing system for different railways. However, the state should be careful regarding the expansion of capacities in loss-making railways and should take due account of relative competitive power of road vis-à-vis railways and the overall traffic density in the regions. Wrong investment decisions may involve such wasteful use of surplus generated in other areas that the railways may not be able to take advantage of the benefit of efficient pricing.

Subsidy to Labour

Finally, the data on financial and productivity performance of the Indian Railways show that they provide a substantive subsidy to labour. The Indian railway system is excessively overmanned. It has the lowest railway productivity when compared with any other major railway system of the world, including China (Table A.7). In the early nineties, the share of labour in total revenue was 13% and 28%, respectively for China rail and US Conrail while it was 42% for the Indian rail. The expenditure on labour and pensions as a proportion of total revenue has further increased since then and has now reached an unsustainable level of 52%. The redundant labour in the railway system has been estimated to be half a million who are unproductively employed by the uneconomic metre gauge system and by a large number of workshops, yards, freight and passenger stations/terminals in the broad gauge, as most of these establishments have very little use for such workforce in the post-steam unit train bulk freight operation. The profitability of the Indian Railways would substantially improve if the employment of labour could be rationalised. The Indian Railways has been used to redistribute income through labour subsidy and pay wages to the employees even if they had little meaningful work to do. It is not only the structure of prices but also that of the costs which has been seriously affected by the distributive concerns.

Roads

Roads in India provide a typical example of public good which has allowed open access to a mode of transport without any entry fee. The road network grew from a total length of 0.4 million km in 1951 to 2.1 million in 1995 and the target for 2001 has been 2.723 million km. There are five categories of roads in India for the purposes of administration and management – national highways, state highways, major district roads, other district roads and village roads. Table 9 gives the distribution of road length among different road categories. While the road length in India has increased at an annual average rate of 3.75%, the average yearly growth of road traffic has been at the rate of 8 to 10% per annum during the period 1951-1994, and the registered stock of road vehicles has grown at an annual average rate of 10.8%. The relative growth rate figures immediately indicate the order of inadequacy of Indian road network at the end of the 20th century. Besides, the inadequacy of road capacity relative to demand is further substantiated by the fact that out of 165000 km of national and state highways, only 2% length has four lanes, 34% double lane and 64% single lane. This limited capacity has resulted in slow speed of vehicles and lower delivery or service per unit of road vehicle. For example, commercial vehicles in India can run only 200-250 km on an average per day, while the estimate of distance travelled by similar vehicles in developed countries is 500-600 km per day. The overcrowding of vehicles has resulted in congestion in urban areas as well as on the inter-city highways along densely populated areas or along routes of high traffic density.

Table 9 : Growth of Road Network in India

(Unit: km)

Category	1951	1995	% Change	Target for 2001
Expressways	Nil	Nil	–	2,000
National Highways	19,811	34,000	55%	66,000
State Highways	60,000	131,000	118%	145,000
Other Roads	318,000	1,935,000	508%	2,510,000
Total	400,000	2,100,000	425%	2,723,000

Source : The India Infrastructure Report, Vol. III (1996); p.142.

Besides inadequate capacity, the major problem with the Indian roads has been their poor quality and poor maintenance.

Limited financial investible resources have been thinly and widely distributed over the road network resulting in inadequate structural thickness of roads and their poor riding quality. Overloading of commercial vehicles has further caused damage to the roads adding to the problem of inadequacy of maintenance expenditure and poor road quality. Poor roads affect not only the speed of vehicles but also their fuel consumption because of the consequential rise in the roughness index. The total impact on environment through vehicular emissions of polluting gases and congestion imposes considerable cost on the society. Part of the environmental cost of road transport is imputable to inadequate carrying capacity and quality of roads.

The major reason behind the low quality of inadequate road infrastructure service has been insufficient allocation of resources and poor management. Has the user's charge of road been inadequate for providing adequate road capacity with good quality of maintenance? Is the poor quality road service provided to Indian road users commensurate with the charges they pay? The problem in road pricing arises basically from the public good character of road service and asymmetry of information between the supplier and the user of road and the free riding tendency of the latter. That is why road charges are levied as taxes and the expenses on roads are charged on the government budget. This instantly makes the issue of implementing the social optimality rule of charges somewhat of a non-issue and the two are supposed to be independently determined.

The equity and distributive considerations have made access to road free in India except for certain limited sections of the road network or bridges where tolls are imposed for access. However, the main charges which road users pay in India to the Central and State governments are of three kinds : (a) taxes on vehicles, (b) taxes on fuel and lubricants, and (c) taxes on passenger and goods traffic. The total taxes mobilised have grown at current prices from Rs. 47.5 crore in 1950-51 to Rs. 17168.9 crore in 1996-97 (Table 10). However, it is only a fraction of these charges which

Table 10 : Government Revenue from Road Transport : 1950-51 to 1996-97

Year (Ending 31st March)	Central				State			State			
	Motor vehicle & accessories		Tyres & tubes		Sales tax on motor spirit & lubricants	Total (of 2+3+4+5+6)	Total Central revenue	Motor vehicle taxes fees	Taxes on passenger & good traffic	Total state revenue (6+8+9)	Grand total (Central & state) (Col. 7+10)
	Import duty	Excise duty	Import duty	Excise dury							
1	2	3	4	5	6		7	8	9	10	11
1950-51	9.4	–	0.1	4.0	12.5	26	34.8	–	0.1	12.6	47.4
1955-56	10.2	–	0.1	5.6	8.9	24.8	45.6	13.9	3.0	25.8	71.4
1960-61	14.8	10.5	0.9	13.4	16.9	56.5	111.7	29.9	8.4	55.2	166.9
1965-66	26.9	20.8	0.2	28.8	31.5	108.2	272.3	61.8	33.4	126.7	399.0
1970-71	14.3	28.0	1.0	54.9	63.2	161.4	451.8	107.7	60.5	231.4	683.2
1975-76	54.8	82.3	1.4	134.5	92.0	365	546.5	209.7	160.5	462.2	1412.7
1980-81	52.7	250.4	1.6	288.3	154.5	747.5	930.9	356.3	239.6	750.4	2173.4
1985-86	198.4	482.3	–	492.9	322.0	1495.6	2460.7	835.5	395.7	1553.2	4013.9
1990-91	351.8	1510.9	–	803.4	631.5	3297.6	4596.0	1374.3	884.9	3035.2	7631.2
1991-92	293.7	1803.7	–	810.7	1223.4	4131.5	4896.2	1849.5	1128.8	4201.7	9097.9
1992-93	300.1	1591.5	–	836.6	1338.3	4066.5	4792.3	2162.9	1262.6	4763.8	9556.1
1993-94	459.5	1423.1	–	1280.1	1558.6	4721.3	5377.2	1526.7	908.0	3993.3	9370.5
1994-95	706.3	1846.9	–	1553.4	1474.5	5581.1	6918.2	1988.8	961.4	4424.7	11342.9
1995-96	1122.9	2446.1	–	1597.0	1743.3	6909.3	8032.7	2554.5	1536.2	5834.0	13866.7
1996-97	1463.1	3201.2	–	1754.8	1897.4	8316.5	10620.6	3226.8	1424.1	6548.3	17168.9

Note : The Import & Excise Duty figures of High Speed Diesel Oil include the figures for R. D. Oil and Diesel Oil.
Sales Tax on Motor Spirit & Lubricants excludes Union Territories.
(*) – Includes High Speed Diesel Oil.

Source : 1. Figures of Central Revenue are taken from Directorate of Statistics & Intelligence (Central Excise & Customs).
2. Figures of Sales Tax on Motor Spirit are taken from RBI Bulletin.

is actually spent on roads. While road users contributed 11.6% of government revenue, the government spent only 5.5% of this revenue on roads in 1980 (Table 11). The share of expenses on roads in road revenue has been about 43% in 1990-91. The road users as a group thus appear to be cross-subsidising the general beneficiaries of expenditure from the government budget.

Table 11 : Road User Tax, Expenditure and GNP of Selected Countries

Country	Year	Road user taxation as percentage of GNP	Road user taxation as percentage of Govt. revenue	Expenditure on roads as percentage of road user taxation	Expenditure on roads as percentage of Govt. revenue
Europe					
Austria	1981	2.1	7.5	122.2	9.2
Denmark	1980	4.6	23.0	45.9	10.6
Finland	1980	3.5	13.2	61.4	8.1
France	1979	2.9	13.9	49.8	6.9
Germany (FRG)	1981	1.8	6.0	82.2	4.9
Great Britain	1981	4.0	7.9	29.5	2.3
Greece	1978	3.9	15.2	21.1	3.2
Italy	1979	4.4	32.3	69.1	15.8
Netherlands	1981	2.4	7.8	22.2	1.7
Norway	1981	2.6	8.7	77.2	6.7
Spain	1981	1.8	11.6	18.5	2.1
Sweden	1981	2.0	7.1	41.9	3.0
Switzerland	1979	2.3	8.6	42.9	3.7
Africa					
Ethiopia	1981	2.0	6.4	149.2	9.5
America					
USA	1979	1.6	4.9	95.7	4.7
Asia & Middle East					
India	1980	2.1	11.6	47.7	5.5
Japan	1980	1.8	3.8	127.9	4.9
Sri Lanka	1978	0.7	2.1	56.9	1.2
Oceania					
New Zealand	1980	0.8	8.7	44.2	3.8

Source : The India Infrastructure Report, Vol. III (1996); p.172.

There are, however, difficulties in this assertion on two counts. First, the taxes on vehicles or fuel or passenger tax cannot be described to be representing a charge related to the extent of physical use of a road. A question arises, as to whether the existing taxes or new ones which may be designed, can really be described as road user's charge. There is definitely a component in the total tax revenue from road users as presented in Table 10, which would be a pure tax or transfer unrelated with road use. Secondly, road users cause some environmental externalities through vehicular emissions and road congestion. These externalities impose cost on the society against which, given the present state of environmental regulation, Indian road users do not pay anything. The social resource cost for providing road service after internalising the monetised cost of environmental damage may not fall short of what road users pay in the form of various direct or indirect taxes connected with road use as described above. Since the monetised estimate of environmental damage of road use is not available in any organised statistics, it is difficult to assess if road users in India do really cross-subsidise the general public in terms of net real resource transfer.

Within the road sector, the allocation of expenditure on plan account has been tilted in favour of rural roads in India on grounds of deliberate policy of equity. According to the Eighth Plan allocation, the badly congested national highways, which account for 40% of the total traffic, were to receive 57% of the plan resources. The other roads of rural areas which receive even less than 1% of traffic were to receive 23% of the Eighth Plan allocation. In India, the high priority of improving rural connectivity by all-weather roads justifies such plan allocation on the ground of distributional equity. It is, however, quite possible that the high density corridor road users in India cross-subsidise the low density rural roads in view of such allocation patterns and much higher rates of return of investment on road expansion or upgradation along high density corridors than that on low density rural roads.

The development of capacity as well as quality of main roads in India requires substantive resource mobilisation. The main roads – national highways, state highways and supernational highways – together would require Rs. 627 billion in 1995 prices during the five-year period 2001-02 to 2005-06 out of which Rs. 147.63 billion would be required for development and expansion in the terminal year 2005-06. The maintenance of roads of the same category would require Rs. 92.5 billion during the five years

1996-2001 and Rs. 113.5 billion during the period 2001-2006. In view of the budgetary resource constraint, it is important to commercialise the road sector and devise road user's charges in a manner as to ascribe some private character to its use by making exclusion principle applicable. The toll system needs to be introduced for access to a new road section in order to relate the charge for the road use with the extent of physical use of the identified section. This would make private investment and commercial use feasible in new areas. As charges would be related to use, the expenditure for better maintenance can be built into cost and reflected in the prices in a regime of commercial operation. This would, of course, involve some compromise with the consideration of distributive equity.

Again, keeping the option of alternative free access road for travel for the same origin-destination pair has been sometimes insisted upon on the ground of equity. However, such option often defeats the basic purpose of commercial viability of toll road built through private initiative. The imposition of tolls on the road option alternative to the privately constructed new toll road is now increasingly being accepted in various countries. Such arrangement would facilitate upgradation and better maintenance of the existing roads as well by making additional resources available. If toll roads are better maintained, the net cost of transport operation cum road use need not be higher. A rupee spent on better maintenance saves 2 to 3 rupees in vehicular operating cost. Such higher efficiency in the improvement of road service has an impact on higher overall productivity for the road users. The higher overall productivity effect would also have some income effect on different sections of the economic community through various dynamic externalities as well. The net redistributional effect of imposition of toll and of the higher income arising from higher efficiency of road service need not necessarily be adverse.

While private sector participation in road development may be possible along high density traffic routes, the expansion, upgradation and maintenance of low density traffic road network will remain the responsibility of the state. However, for improved quality of roads and their better maintenance, state needs to relate the charges of road use with the normative expenditure for roads at least at macro level. It is necessary to earmark some of the revenue from taxes/cesses/levies imposed on road use for development and maintenance of roads only. The neoclassical economists resist any kind of earmarking of funds on the ground that the government funds should be allowed to be freely allocated according to the ordering as per the social rate of return from investment. It is absolutely clear that the political economy of use of the resources of the exchequer in India does not go by the ordering of social rate of return. The estimates of shadow value of some of the environmental and social externalities have often been doubtful or unconvincing because of the difficulty of monetisation of intangibles and have not been internalised in the socially accepted estimates of costs.

The awful neglect of road maintenance in India implies unreliability of the existing institutional arrangement for the management of road development and road use. It is the management concern for higher efficiency which dictates the need for movement towards corporatisation of the road sector and introduction of the system of earmarking taxes from road use for expenditure on roads only. It is also the consideration of equity which demands that road users' charges should have a relation of balance with the costs incurred by the supplier of roads. In a situation of poor state of road quality and inadequacy of road capacity, it is unfair to ask the Indian road users to cross-subsidise other beneficiaries of governmental budgetary expenses as is currently manifest in the budgetary statistics.

Road Freight Transport

Road freight transport has been one of the fast growing activities in India. The commercial freight by road has been entirely privatised and the prices of trucking services have been determined by market forces. As the passenger traffic and freight traffic have been serviced by completely separate sets of transport agencies, no issue of subsidy or cross-subsidisation has been relevant in the context of pricing of trucking services. The only equity issue which has come up in the context of trucking industry is the cost of externalities of trucking operation in terms of environmental damage or road damage caused by overloading. It may be noted here that overloading has a very damaging impact on the road which involves external cost to other users by raising their vehicular maintenance cost, higher fuel use and higher emissions. If A be the road stress or damage estimate of a vehicle without overloading, α be the rated vehicle axle load, β be the actual load on the vehicle, and $\beta>\alpha$, then the damage effect on road due to overloading would be $A*(\beta/\alpha)^4$. In view of this serious adverse effect of overloading on the axle, it is important to regulate the vehicular weight in trucking for efficiency of the road service and efficiency of all kinds of road transport using the concerned road. Due to weak enforcement of laws and regulations in India, the irresponsible and rent-seeking behaviour of the truck operators as well as the agents of the regulatory bodies, there is an unfair or iniquitous use of road. A toll system on main roads, with truck-weighing bridge facilities and electronic controls can, however, facilitate the enforcement of laws and conservation of roads. It is thus road pricing along with quantitative regulatory controls and modern facilities which can help the abatement of road damage and iniquitous use of road by transport operators.

Public Bus Passenger Transport

The public passenger transport service is provided by both the public sector agencies and private operators for passenger movement within a city as well as inter-city. In almost every state in India, the state road transport corporation provides a major share of bus passenger transport service, while private operators provide the service with permits for certain routes at regulated fares. The passenger fares are regulated in all the states in India for any kind of service which is commonly provided by both the public and the private sector for reasons of the essential character of this transportation service and of distributive justice. Such fares are also regulated even for routes where only private operators are allowed to run their buses. Private operators are sometimes allowed to operate buses for different kinds of service for which fares are not everywhere regulated, e.g., chartered bus service for commuters or school children. There is also a scheme in some of the state transport corporations as in Delhi (DTC) in which the transport authority hires buses from private operators and asks them to operate under a payment scheme on kilometre basis. In this case, if fare collection falls short of payments as per the contractual agreement, the concerned state transport company will have to effectively subsidise the bus service. However, private operators provide bus service under the regulated regime only if they are able to make profit. The market forces along with government policies have determined the size and the share of the private operators in the concerned market.

However, it is important to note that the public sector city transport undertakings of the major cities in India have all incurred losses in 1997-98. Similarly, the inter-city bus service operated by the public sector state transport undertakings has made losses in most of the states excepting Karnataka (Tables A.8(a) and A.8(b)). These losses, of course, reflect the combined effect of operational inefficiency, subsidy to labour, and some subsidy to consumer as well. There is substantive overmanning in public sector road transport agencies. The average number of employees has been 7.5 per bus in the public sector, while the same has been 3.0 per bus for private operation. Labour cost constitutes about 37% of the total cost for state operation, while it varies between a wide range of 6 to 13% of total cost for private operation. About half of the labour force is redundant in the state undertakings. The redundant staff has been retained through subsidy in the form of income transfer to them in spite of zero if not negative productivity at the margin.

The rationale of state operation in passenger road transport involves distributional considerations. It was felt that the state must operate on low traffic density unprofitable rural routes where private operators would not like to offer any service, as they wish to operate only on high density traffic routes. However, public-private sharing of the market has so evolved for various policy reasons that the public sector is now operating in a money losing combination of the highest density and the lowest density routes. The earning structure of the different state road transport undertakings for 1996-97, as shown in Table 12, shows that these undertakings were earning profits in 19.3% of the routes on all India basis. Out of the balance 80.7% routes, variable costs were being recovered for 60.3% of the routes while the remaining 20.4% of the routes could not recover even the variable costs. The private sector, on the other hand, is being allowed to operate on medium density routes and is even taking over low density routes in case they can make profit without much upward restructuring of prices. In order to contain the losses of the state monopoly road transport agencies, private sector participation has steadily increased in India

Table 12 : Earning Structure of Routes Allocated to State Road Transport Undertakings (1996-97)

State road transport undertaking	Total number of routes	Routes earning profit		Routes covering variable cost only		Routes not covering even variable cost	
		Numbers	%	Numbers	%	Numbers	%
Andhra Pradesh	7670	4002	52.2	3668	47.8	0	0.0
Arunachal Pradesh	118	42	35.6	22	18.6	54	45.8
Bihar	220	17	7.7	140	63.6	63	28.6
Goa (Kadamba)	216	50	23.1	116	53.7	50	23.1
Gujrat	18120	1382	7.6	11756	64.9	4982	27.5
Haryana	1809	362	20.0	1266	70.0	181	10.0
Himachal Pradesh	1625	26	1.6	1194	73.5	405	24.9
Jammu & Kashmir	273	0	0.0	273	100.0	0	0.0
Karnataka	9744	2533	26.0	3508	36.0	3703	0.0
Kerala	3179	620	19.5	777	24.4	1782	56.1
Manipur	55	33	60.0	8	14.5	14	25.5
Meghalaya	56	2	3.6	20	35.7	34	60.7
Mizoram	23	5	21.7	6	26.1	12	52.2
Nagaland	60	26	43.3	20	33.3	14	23.3
Punjab Roadways	1376	256	18.6	1113	80.9	7	0.5
PEPSU RTC	607	60	9.9	545	89.8	2	0.3
Tamil Nadu	8057	1136	14.1	6916	85.8	5	0.1
Uttar Pradesh	2500	200	8.0	2215	88.6	85	3.4
South Bengal STC	177	23	13.0	120	67.8	34	19.2
All India	55885	10775	19.3	33683	60.3	11427	20.4

Note : Figures for Assam, Madhya Pradesh, Maharastra, Orissa, Rajasthan, Sikkim, Tripura, Calcutta and North Bengal SRTUs were not available.

Source : Motor Transport Statistics of India – 1997, Ministry of Surface Transport (MOST); p.48.

in passenger transport segment. The share of the public sector buses in the total fleet of buses at national level declined from 43% in 1981 to 32% in 1991, and to 23% in 1997. Thus, privatisation in road passenger transport has made it possible to provide service at reasonable price without any explicit effective subsidy. The financial viability of road transport requires institutional reorganisation without restructuring prices or without inducing any significant reverse redistributive effect.

There remains, however, the problem of low quality and inefficiency in the delivery of transport service that is associated with the problem of losses and consequent lack of funds/resources for upgradation of the quality of bus service and expansion of its capacity in public sector. In view of the general excess demand for passenger road transport service and poor quality of public transport, there is no compulsive force to induce the private operators to upgrade the quality of their services. In fact, subsidy to labour and operational inefficiency have to be removed for the purpose of upgrading the bus system of our country. For better quality of service, the passengers are often willing to pay higher prices. The low priced passenger bus service is really justified only for a target group of poor people. We may have a fleet of well-maintained buses with lifeline rates to serve the poor. They may be cross-subsidised by other types of road passenger service of a higher category (Deluxe or AC buses with modern vintage coach, etc.) which would be used and paid for by people with much higher capacity to pay. It is the political-economic forces in India that often shape our perception about the ability of the common man to pay which ends up with low value high volume of traffic.

Approach to Pricing with Equity : A Simple Model

For any transport mode, the problem of pricing poses a big challenge in a developing economy. It requires to combine the considerations of growth, efficiency and quality of the transport system with the consideration of equity and distributive justice in view of the high political-economic transaction cost of direct income and asset transfer. Given the real life problems being faced by the transport sector in the Indian context, as described above, it is important to define a model of pricing in a conceptual framework which can address the concerned issues and can be operationalised quantitatively. Since internal financial resource generation, efficiency and quality are interactive, the objective of developing such a model would mainly be to solve for the prices and quantities as per the optimal trade-off between the considerations of equity and internal resource generation. We pose below the construct of a model for the pricing of railway services in a static framework. However, it can be generalised for application in any sector where price is regulated for equity consideration and product diversification and/or market segmentation is possible.

Again, for a growing transport system, the range of products, market systems, demand and cost functions and the exogenous financial resource requirements for supporting growth would change over time. The model can be repeatedly solved for different periods with different sets of quantitative specifications for such changes to obtain the path of supporting prices for the concerned transport system or subsystem. We illustrate below our construct of the model for the railways.

How can we incorporate the concerns relating to equity and obtain the right prices for the various railway transport services? First of all, the railways would require to segment the market according to the different categories of service catering for the requirements of various sections of society and combine the objective of financial resource mobilisation as well as that of redistribution by taking the best advantage of such market segmentation. The social optimisation would need to be given a choice of prices and quantities for the various types of railway services provided so that the social surplus is maximised subject to the constraint of minimum financial resource mobilisation and that of ceiling of prices of certain services for which there is intense modal competition.

If the prices in any segmented market could reflect the social valuation of the product service at the margin, the objective function could be the sum of the surpluses over all the market segments. The social surplus would be represented by the monetised value of the total utility minus the total cost of the concerned passenger traffic or the total value contribution of freight traffic in the production system minus its total cost of supply. The redistributive objective implies imputation of differential weights to the utility of passengers or the value of goods transport service in the different market segments. Considering such different weights for the values of monetised benefits in the different market segments of passenger or goods traffic, one can formalise the model of pricing as follows.

We take Marshallian interpretation of the demand curve and obtain the estimate of optimal prices by solving for quantities in the different market segments. Let p_i be the offer price of the i-th segment of rail transport service market at the margin and q_i be the quantity of service that is offered by the railways in passenger kilometre or the net freight tonne kilometre in that segment. p_i is a function of q_i. The market segmentations differ according to the quality of product or income group of consumers or their combination. There are n such segments. Let us assume there are some costs which are variable and specifically related with the volume of output for the market segment and some common for the entire railways and are fixed. Let $C(q_1, q_2, \ldots.., q_n)$ be the total variable cost of providing the product mix of railway service q_1, $q_2, \ldots.., q_n$. Let F be the overall fixed cost of the railway other than capital servicing charges. C and F are normative estimates of the functions. Let K be the total capital assets and r be the normative rate of return for the railway taking due weightage of dependence on capital market. Finally, let T be the bound on the total transfer from exchequer to compensate for losses on uneconomic railway sections in order to delimit regional cross-subsidisation.

Let W_i be the weightage of the benefit of users of railway in the i-th market segment. Thus, for a higher social priority the objective of optimum resource allocation would be :

$$\text{Maximise } \sum_{i=1}^{n} \int_0^{q_i} W_i\, p_i(\tilde{q}_i)\, d\tilde{q}_i - C(q_1, q_2, \ldots\ldots, q_n) - F$$

$$\text{Subject to } \sum_i p_i(q_i)\, q_i - C(q_1, q_2, \ldots\ldots, q_n) - F = rK - T$$

$p_i \text{ £ } \bar{p}_i$ for i e S where S is the set of indices of the market segments which face stiff competition from road. This is a static model to be solved for a single period. However, the range of i-values, i.e., n, specifications of p_i and C functions and F, T, r, K, p, can change over time yielding different solutions for different periods. Besides, the essence of this abstract model has got generality of application to any other sector which has price regulation for distributive reasons.

In the absence of any resource mobilisation constraint, the optimising condition would have yielded for a given period the prices to be such that $W_i\, p_i = C_{q_i}$ where C_{q_i} is the marginal cost of production of q_i. In a situation where $C(q_1, q_2, \ldots, q_n) =$ $\sum_{i=1}^{n} \int_0^{q_i} W_i\, p_i(\tilde{q}_i)\, d\tilde{q}_i - C(q_1, q_2, \ldots, q_n) + \lambda$ $\sum \mu_i (\bar{p}_i - p_i(q_i))$ $\sum_i C_i(q_i)$ implying $C_{q_i} =$ where is the marginal cost of production of q_i. This would imply $W_i\, p_i =$ for all i. Thus, a relatively high W_i will permit only relatively low price to be charged for the i-th market segment.

In the presence of the constraints as given in the above maximisation problem, the saddle point of the Lagrangian function

L =

$$[\sum_i p_i(q_i)\, q_i - C(q_1, q_2, \ldots\ldots, q_n) - rK + T] + \qquad)$$

would yield as first order condition among others the following:

$$W_i\, p_i - C_{q_i} = \lambda[(p_i + q_i \qquad) - C_{q_i}] - \mu_i \frac{dp_i}{dq_i} = 0$$

or, $\dfrac{W_i p_i - C_{q_i} + \mu_i \dfrac{dp_i}{dq_i}}{mr_i(q_i) - C_{q_i}}$ = 1 for all i, where $mr_i(q_i)$ is the marginal revenue of q_i and equal to $p_i + q_i \dfrac{dp_i}{dq_i}$.

Thus, the resource allocation for the products of different market segments should be such that the marginal social net benefit of an additional unit of supply in any market segment as a ratio to marginal profit from the same should be equal everywhere and be equal to the marginal social value of transfer of a unit of financial resources from the government to the railways. The prices yielded by such optimum quantities as per the independent demand functions of the different markets should guide the railway fare and freight structure if resource mobilisation for the long-run efficient delivery of service is to be combined with distributive consideration. The choice of weights should be consistent with the individual and social preference structure as given by the individual utility functions of transport and non-transport goods/services and the social utility function. An alternative construct of a model in a full general equilibrium framework of analysis would have as well yielded the pricing results for railways using the basic functions. We have chosen a partial equilibrium framework in the interest of simplicity of the model and for obtaining more direct insight into the relevant aspects of the analytical problem.

In any case, if the society desires that certain minimum consumption should be attainable for certain sections of population at a certain rate of railway service charge, the choice of weights should be such that p_i, q_i of the concerned market segment satisfy these conditions. If $C(q_1, q_2, \ldots, q_n)$ be additively separable, i.e., $C = \sum_i C_i(q_i)$, the surplus for i-th segment S_i can be calculated as

$$S_i = p_i(q_i)\, q_i - C_i(q_i) - \frac{F * \phi_i(q_i)}{\sum_i \phi_i(q_i)}$$

where ϕ is the variable (e.g., time utilised) determining the allocation of cost of common fixed assets like track, signalling, engine etc. If n = 2, $S_1 > 0$ and $S_2 < 0$, then the required extent of cross-subsidy would be given by $\frac{S_2}{S_1} *$ 100 per cent of profit of the first market segment.

Conclusion

The characteristics of the results of a model as posed above would depend on its specification. The specification of the model would, in turn, depend on the issues of concern for growth, efficiency and equity which need to be incorporated. Again, mere knowledge of the solution for prices and quantities is not sufficient to resolve our problems related to the transport sector. Institutional arrangement for delivering transport service and non-price regulatory measures may be required, among others, to supplement pricing to take care of parametric assumptions of the model and resolve the real life problems of availability and quality of transport service in India on a sustained basis. We, therefore, summarise below the major conclusions that we have drawn from the observations on the price related issues of the Indian transport system as discussed above. These conclusions should guide us both in the specification of the model as also in the translation of its solution into real life policies.

First of all, in a fast developing economy like that of India, pricing has to give high priority to the covering of costs and generation of internal surplus to financially support at least partly the capital renewals, capacity expansion and technological upgradation and meet the growing transport demand with improved quality. In order to deliver higher quantity of transport service of improved quality, each transport mode needs to be cost competitive. For example, the Indian railways would be required to be more competitive vis-à-vis road transport for the long distance travel and shipment of goods.

Second, the normative costs of a transport mode should take account of the actual cost of funds. For example, if the railways are asked to increasingly rely on capital market for raising funds for such a purpose, it cannot be asked at the same time to subsidise the passenger traffic at the existing scale without non-viable cross-subsidisation. The normative cost should take the normative rate of return on capital to be higher than the existing 7% and be equal to the weighted average of the interest rate on government loan in perpetuity and the borrowing rate in the capital market, the weights depending on the shares of the sources of borrowing in financing capital assets. The prices of passenger coaching service and goods traffic service on the whole should meet this requirement of higher rate of return. Similar conclusion would be valid for public sector bus passenger transport service as well.

Third, the scope of subsidy to consumers for distributive reasons should be reduced to the minimum by identifying the target group of the poor and introducing product diversification. While the poor have to get the subsistence transport service at a lifeline rate, others are to be attracted by the quality of the other differentiated product services of higher quality which do not attract any price subsidy. The price subsidy for the consumer is to be replaced by the higher quality of transport service. This would elicit higher willingness to pay with less political resistance (Example : AC 3 tier railway coach or luxury bus coach).

Fourth, the scope of concessions in railway or bus fare should be reduced and it should be substituted by income benefit in the kind form of travel by rail which is financed by the employer or some social security system. We badly need to introduce a social security system to take care of the distributive justice along with better and transparent accounting for costs and its sharing in the society. The concessional fare and quantum of passenger service qualifying for concessions should again be fixed as per the concept of lifeline rates (prices) of essential services so that the poor or underprivileged class of people can afford some minimum railway service that is considered essential, like commuting to the place of work. There should not be any wasteful expansion of scope of such concessions in future.

Fifth, in case the distributive consideration makes some cross-subsidisation necessary, the pricing should take care of the constraint of the threat of competition from other modes for the taxed categories of service. For example, too high AC First Class charge may induce the passengers to opt for air travel, or the remunerative goods freight traffic may move increasingly by road not merely because of the capacity constraint of the rail, but because of the high cost for the customers due to high rail tariff. There should thus be a ceiling on the prices of taxed railway service items keeping in view the competitive market conditions.

Sixth, the concern for regional equity and political compulsions has resulted in substantive inter-regional cross-subsidisation between broad gauge and other gauges and among the different regional railways, the sections of some of the latter being highly uneconomical. The government should have separate accounting for some of these identified sections and grant direct 'subsidies' from the exchequer to the railways as per certain norms in order to avoid undue cross-subsidisation within the railways. The regions with low traffic density should be left to be better served by the other modes of transport.

Seventh, the road sector in India needs commercialisation and privatisation for better quality maintenance and expansion. The charges for road use should be linked with actual use of the infrastructure. Access to new roads and to their alternative options needs to be priced through toll system.

Eighth, trucking sector should be compulsorily subjected to truck-weighing and be charged for the use of main roads through toll system. The weighing bridge facilities need to be introduced and expanded in many areas of congestion and overuse of road. Road toll or tax for both the trucks and the passenger vehicles should include a component reflecting congestion cost.

Ninth, the subsidy to labour in the railways and the public sector bus transport is to be phased out by voluntary retirement scheme or transfer of labour to other useful activities in the economy through retraining. The growth in labour productivity is crucial for any kind of reform in this sector.

Tenth, costs and prices should internalise environmental externality through appropriate environmental control measures, including taxation, in order to make the rail-road competition fair from the social point of view. The ceiling of prices for transport services for a competitive market area should take such concerns into account. As per the results of the environmental studies, the price-tax structure internalising such external costs should induce a massive modal shift in favour of rail for freight traffic. The decision regarding transport prices should keep in view the requirement that such environmentally sustainable prices should be finally profitable as well as competitive. If these are found non-competitive in an area, then the concerned mode of transport should withdraw from that area of business rather than continue with losses, even if the concerned supplying agency is a part of the public sector.

Both rail and road services are high volume and low quality in nature. The logic of distributive justice has led to various compromises with the quality and financial viability of our transport system. This is evidenced by the persistent resistance of the polity in any nominal price revision of transport and restructuring of manpower. The accumulation of losses in the state public transport undertakings has the effect of negative dynamic externalities on their efficiency and productivity. It is high time that we emphasise quality and upgrade our transport system. We need, therefore, to delimit the scope of subsidy to the target consumer group which should be well identified. In both road and rail, we require to be innovative to introduce better product mix in terms of transport service so that we may take best advantage of resource mobilisation through differential pricing of transport services without any great compromise with considerations of horizontal or vertical equity.

References

1. Asian Institute of Transport Development, *Indian Railways: Reshaping of Production Units*, 2000, New Delhi.

2. Expert Group on the Commercialisation of Infrastructure Projects, *The India Infrastructure Report: Policy Imperatives for Growth and Welfare*, Volume III, Ch.10, 1996.

3. Government of India; Ministry of Railways (Railway Board), *Indian Railways Annual Statistical Statements,* 1998-99.

4. Government of India; Ministry of Railways, Directorate of Statistics and Economics, *Summary of the End Results: Coaching Services Profitability/Unit Costs,* 1997-98.

5. Government of India; Ministry of Surface Transport, *Motor Transport Statistics of India,* 1997.

6. Government of India; Planning Commission, *Perspective Planning for Transport Development, 1988*.

7. World Bank, *India Transport Sector Long Term Issues*, Infrastructure Operations Division Country Department II – India, South Asia Regional Office, 1995.

Annexure

Table A.1(a) : Railway Output and Earnings from Coaching and Goods Traffic Service

Year	Transport output in billion gross tonne km excluding weight of engine and of departmental movements of railways		Transport output in million train km excluding the share of departmental movements of railways		Earnings (Rs. crore)	
	Coaching	Goods	Coaching	Goods	Coaching	Goods
1997-98	234.390 (30.00)	550.151 (70.00)	362.788 (59.0)	250.465 (41.0)	8419.61 (29.48)	20147.87 (70.52)
1998-99	251.019 (31.0)	548.550 (69.0)	377.300 (61.0)	246.185 (39.0)	9516.600 (31.92)	20297.760 (68.08)

Table A.1(b) : Railways' Operating Surplus in Coaching and Goods Traffic Service

Year	Revenue		Expenses excl. interest		Operating surplus	
	Coaching	Goods	Coaching	Goods	Coaching	Goods
1997-98	8419.61	20147.87	12228.19 (53.0)	13794.77 (47.0)	(-)3808.58	6353.09
1998-99	9516.6	20297.76	13213.44 (53.0)	14893.97 (47.0)	(-)3696.85	5403.79

Table A.1(c) : Railways' Profit (after payment of interest) from Coaching and Goods Traffic Service

Year	Earnings		Costs including interest		Profit	
	Coaching	Goods	Coaching	Goods	Coaching	Goods
1997-98	8419.61	20147.87	12748.84 (53.0)	14580.74 (47.0)	(-)4329.23	5567.13
1998-99	9516.60	20297.76	13808.37 (53.0)	15736.53 (47.0)	(-)4291.77	4561.23

Source : Government of India, Ministry of Railways (Railway Board); Indian Railways Annual Statistical Statements 1998-99.

Table A.2(a) : Profitability of Railway Coaching Services for 1997-98 per Passenger Carried

All Railways

(in Rupees)

Category	Broad gauge			Metre gauge			Narrow gauge			All gauges*		
	Expenses per pass.	Earnings per pass.	Gain/Loss per pass.	Expenses per pass.	Earnings per pass.	Gain/Loss per pass.	Expenses per pass.	Earnings per pass.	Gain/Loss per pass.	Expenses per pass.	Earnings per pass.	Gain/Loss per pass.
Mail/Express												
AC First Class	1063.54	1361.82	298.28	1408.51	985.36	-423.15	–	–	–	1074.23	1350.16	275.93
First Class	630.01	545.60	-84.41	1257.61	401.81	-855.81	–	–	–	723.01	524.29	-198.72
AC Sleeper	662.60	784.62	122.02	544.76	473.48	-71.28	–	–	–	655.02	764.61	109.59
AC 3-Tier	385.40	492.59	107.20	–	–	–	–	–	–	385.40	492.59	107.20
AC Chair Car	241.27	244.69	3.42	230.49	255.52	25.03	NA	155.82	–	240.95	244.63	3.68
Sleeper Class	274.64	179.08	-95.55	299.58	108.15	-191.42	–	–	–	276.81	172.92	-103.89
Second Class	64.67	62.72	-1.95	132.03	54.33	-77.70	NA	44.90	–	70.43	61.88	-8.55
Ordinary								–				
First Class	53.22	29.08	-24.15	2362.75	175.92	-2186.82	NA	165.32	–	94.66	33.31	-63.35
Sleeper Class	194.80	66.17	-128.63	794.83	55.96	-738.88	–	–	–	256.37	65.12	-191.25
Second Class	181.59	90.39	-91.20	34.90	9.43	-25.47	–	–	–	75.22	32.31	-42.91
EMU Suburban Services	4.80	3.48	-1.32	3.60	2.09	-1.51	–	–	–	4.74	3.41	-1.33
Grand Total	34.24	25.03	-9.21	48.27	16.04	-32.23	79.44	9.69	-69.75	31.04	21.47	-9.57

* not including narrow gauge

Sources : (1) Indian Railways Annual Statistical Statements, 1998-99. (2) Summary of the End Results for Coaching Services Profitability / Unit Costs, 1997-98.

Table A.2(b) : Profitability of Railway Coaching Services for 1997-98 per PKM

All Railways

(in Rupees)

Category	Broad gauge			Metre gauge			Narrow gauge			All gauges*		
	Expenses per pass.	Earnings per pass.	Gain/Loss per pass.	Expenses per pass.	Earnings per pass.	Gain/Loss per pass.	Expenses per pass.	Earnings per pass.	Gain/Loss per pass.	Expenses per pass.	Earnings per pass.	Gain/Loss per pass.
Mail/Express												
AC First Class	1.59	2.03	0.45	3.09	2.16	-0.93	–	–	–	1.62	2.04	0.42
First Class	0.85	0.73	-0.11	2.89	0.92	-1.97	–	–	–	1.04	0.75	-0.28
AC Sleeper	0.91	1.08	0.17	1.37	1.19	-0.18	–	–	–	0.93	1.09	0.16
AC 3-Tier	0.48	0.61	0.13	–	–	–	–	–	–	0.48	0.61	0.13
AC Chair Car	0.49	0.50	0.01	0.64	0.71	0.07	–	0.69	–	0.49	0.50	0.01
Sleeper Class	0.38	0.25	-0.13	0.66	0.24	-0.42	–	–	–	0.40	0.25	-0.15
Second Class	0.21	0.20	-0.01	0.46	0.19	-0.27	–	0.27	–	0.23	0.20	-0.03
Ordinary												
First Class	0.46	0.25	-0.21	10.21	0.76	-9.45	–	0.92	–	0.79	0.26	-0.53
Sleeper Class	0.50	0.17	-0.33	2.46	0.17	-2.29	–	–	–	0.67	0.17	-0.50
Second Class	0.23	0.12	-0.12	0.50	0.13	-0.36	–	–	–			
EMU Suburban Services	0.16	0.12	-0.04	0.20	0.12	-0.09	–	–	–	0.16	0.12	-0.05
Grand Total	0.31	0.22	-0.08	0.61	0.20	-0.41	1.83	0.22	-1.61	0.35	0.23	-0.12

* not including narrow gauge

Sources : (1) Indian Railways Annual Statistical Statements, 1998-99. (2) Summary of the End Results for Coaching Services Profitability / Unit Costs, 1997-98.

Table A.3 : Total Tonnes Originating and Total Net Tonne Kilometres (NTKMS) Freight Traffic Service by Railways in 1997-98

(Unit: '000)

Railway	Broad gauge		Metre gauge		Narrow gauge		All gauges	
	Tonnes originating	NTKMS	Tonnes originating	NTKMS	Tonnes originating	NTKMS	Tonnes originating	NTKMS
Central	43569	42733850	—	—	75	17245	43644	42751095
	(99.83)	(99.96)	—	—	(0.17)	(0.04)		
Eastern	79661	31508040	—	—	—	—	79661	31508040
	(100.00)	(100.00)	—	—	—	—		
Northern	25949	45262832	153	147039	1	191	26103	45410062
	(99.41)	(99.68)	(0.59)	(0.32)	(0.00)	(0.00)		
North Eastern	1073	4568369	1521	679876	—	—	2594	5248245
	(41.36)	(87.05)	(58.64)	(12.95)	—	—		
North-East Frontier	3721	4378902	1389	843693	—	—	5110	5222595
	(72.82)	(83.85)	(27.18)	(16.15)	—	—		
Southern	25923	14425112	1609	826249	—	—	27532	15251361
	(94.16)	(94.58)	(5.84)	(5.42)	—	—		
South Central	43849	30673541	256	276676	—	—	44105	30950217
	(99.42)	(99.11)	(0.58)	(0.89)	—	—		
South Eastern	169408	69010201	—	—	754	87876	170162	69098077
	(99.56)	(99.87)	—	—	(0.44)	(0.13)		
Western	25117	36167897	5353	2641533	—	—	30470	38809430
	(82.43)	(93.19)	(17.57)	(6.81)	—	—		
Total	418270	278728744	10281	5415066	830	105312	429381	284249122

Note : The percentages are shares in total tonnage originating and NTKMS.
Source : Indian Railways Annual Statistical Statements, 1998-99.

Table A.4(a) : Total Profitability of Railway Freight Traffic in 1997-98

(in Rs. crore)

Railway	Broad gauge			Metre gauge			Narrow gauge			All gauges		
	Expenses	Earnings	Gain/Loss	Expenses	Earnings	Gain/Loss	Expenses	Earnings	Gain/Loss	Expenses	Earnings	Gain/Loss
Central	2410.93	2867.75	456.82	—	—	—	16.51	1.90	-14.61	2427.44	2869.65	442.21
	(99.32)	(99.93)		—	—		(0.68)	(0.07)				
Eastern	1856.73	2436.80	580.08	—	—	—	—	—	—	1856.73	2436.80	580.08
	(100.00)	(100.00)		—	—		—	—				
Northern	2113.97	3142.61	1028.64	42.61	13.48	-29.13	12.57	0.07	-12.50	2169.16	3156.16	987.00
	(97.46)	(99.57)		(1.96)	(0.43)		(0.58)	(0.00)				
North Eastern	177.69	261.03	83.34	270.86	34.64	-236.22	—	—	—	448.55	295.67	-152.88
	(39.61)	(88.28)		(60.39)	(11.72)		—	—				
North-East Frontier	439.40	250.29	-189.11	164.34	61.41	-102.93	0.20	0.0	—	603.94	311.69	-292.24
	(72.76)	(80.30)		(27.21)	(19.70%		(0.03)	(0.0)				
Southern	890.09	1053.94	163.85	82.86	60.63	-22.23	—	—	—	972.95	1114.58	141.63
	(91.48)	(94.56)		(8.52)	(5.44)		—	—				
South Central	1174.42	2088.31	913.89	120.75	26.41	-94.34	—	—	—	1295.16	2114.72	819.55
	(90.68)	(98.75)		(9.32)	(1.25)		—	—				
South Eastern	3000.56	4962.57	1962.01	—	—	—	24.98	7.83	-17.14	3025.53	4970.40	1944.87
	(99.17)	(99.84)		—	—		(0.83)	(0.16)				
Western	1361.68	2646.00	1284.32	412.35	232.18	-180.17	7.23	0.00	-7.23	1781.27	2878.19	1096.91
	(76.44)	(91.93)		(23.15)	(8.07)		(0.41)	(0.00)				
Total	13425.47	19709.30	6283.83	1093.78	428.76	-665.02	61.49	9.81	-51.49	14580.74	20147.87	5567.13

Total gains on BG freight	6472.95	
Total losses on BG freight	189.11	
Surplus of gains over losses on BG freight	6283.83	
Total gains on MG & NG freight	0.00	
Total losses on MG & NG freight	716.50	(11% of surplus of gains on BG)
Difference between surplus of gains on BG freight and losses on both MG and NG freight	5567.33	
Overall net losses in coaching services	4329.22	
Overall rail balance after covering coaching losses	1238.11	

Note : Figures in the Parenthesis indicate Row Percentages.
Source : Indian Railways Annual Statistical Statements, 1998-99.

Table A.4(b) : Profitability of Railway Freight Traffic per Tonne of Originating Traffic in 1997-98

(in Rs. per tonne originating)

Railway	Broad gauge			Metre gauge			Narrow gauge			All gauges		
	Expenses per tonne origin.	Earnings per tonne origin.	Gain/Loss per tonne origin.	Expenses per tonne origin.	Earnings per tonne origin.	Gain/Loss per tonne origin.	Expenses per tonne origin.	Earnings per tonne origin.	Gain/Loss per tonne origin.	Expenses per tonne origin.	Earnings per tonne origin.	Gain/Loss per tonne origin.
Central	553.36	658.21	104.85	—	—	—	2201.20	253.61	-1947.59	556.19	657.51	101.32
Eastern	233.08	305.90	72.82	—	—	—	—	—	—	233.08	305.90	72.82
Northern	814.66	1211.07	396.41	2785.13	881.29	-1903.84	125744.00	702.00	-125042.00	831.00	1209.12	378.12
North Eastern	1656.02	2432.73	776.71	1780.83	227.76	-1553.07	—	—	—	1729.20	1139.84	-589.36
North-East Frontier	1180.87	672.64	-508.23	1183.16	442.09	-741.07	—	—	—	1181.87	609.97	-571.90
Southern	343.36	406.57	63.21	514.98	376.84	-138.14	—	—	—	353.39	404.83	51.44
South Central	267.83	476.25	208.42	4716.62	1031.64	-3684.98	—	—	—	293.65	479.47	185.82
South Eastern	177.12	292.94	115.82	—	—	—	331.25	103.89	-227.36	177.80	292.10	114.30
Western	542.14	1053.47	511.33	770.32	433.74	-336.58	—	—	—	584.60	944.60	360.00
Total	320.98	471.21	150.23	1063.88	417.04	-646.84	740.82	118.15	-622.67	339.58	469.23	129.65

Table A.4(c) : Profitability of Railway Freight Traffic per Net Tonne Kilometre in 1997-98

(in Rs per NTKM)

Railway	Broad gauge			Metre gauge			Narrow gauge			All gauges		
	Expenses per NTKM	Earnings per NTKM	Gain/Loss per NTKM	Expenses per NTKM	Earnings per NTKM	Gain/Loss per NTKM	Expenses per NTKM	Earnings per NTKM	Gain/Loss per NTKM	Expenses per NTKM	Earnings per NTKM	Gain/Loss per NTKM
Central	0.56	0.67	0.11	—	—	—	9.57	1.10	-8.47	0.57	0.67	0.10
Eastern	0.59	0.77	0.18	—	—	—	—	—	—	0.59	0.77	0.18
Northern	0.47	0.69	0.23	2.90	0.92	-1.98	658.35	3.68	-654.67	0.48	0.70	0.22
North Eastern	0.39	0.57	0.18	3.98	0.51	-3.47	—	—	—	0.85	0.56	-0.29
North-East Frontier	1.00	0.57	-0.43	1.95	0.73	-1.22	—	—	—	1.16	0.60	-0.56
Southern	0.62	0.73	0.11	1.00	0.73	-0.27	—	—	—	0.64	0.73	0.09
South Central	0.38	0.68	0.30	4.36	0.95	-3.41	—	—	—	0.42	0.68	0.26
South Eastern	0.43	0.72	0.28	—	—	—	2.84	0.89	-1.95	0.44	0.72	0.28
Western	0.38	0.73	0.36	1.56	0.88	-0.68	—	—	—	0.46	0.74	0.28
Total	0.48	0.71	0.23	2.02	0.79	-1.23	5.84	0.93	-4.91	0.51	0.71	0.20

Source : Indian Railways Annual Statistical Statements, 1998-99.

Table A.5 : Statement of Financial Results of Government Railways as on 31st March, 1999

(in Rs. crore)

Railway	Gross earnings	Gross expenses	Net traffic receipts	Net misc. receipts	Net revenue receipts	Dividend payment	Net gain or loss	Percentage of gain/loss on capital-at-charge
Central	4883.67	4326.18	557.49	42.34	599.83	216.96	382.87	12.83
Eastern	3326.56	3713.31	-386.76	33.71	-353.05	183.25	-536.30	-19.46
Northern								
Commercial	5068.41	4646.87	421.54	73.98	495.52	262.36	233.16	6.53
Strategic	26.89	75.13	-48.24	26.49	-21.75	-21.02	-0.74	-0.19
North Eastern	972.23	1443.34	-471.10	13.23	-457.87	68.71	-526.58	-56.31
Northeast Frontier								
Commercial	520.63	977.31	-456.68	122.45	-334.23	125.31	-459.55	-23.92
Strategic	71.64	218.21	-146.57	5.77	-140.80	-150.26	9.46	11.11
Southern	2104.80	2423.34	-318.54	75.54	-243.00	185.71	-428.71	-16.78
South Central	2916.08	2439.56	476.51	4.27	480.78	142.34	338.44	17.10
South Eastern	5367.42	4107.63	1259.80	142.61	1402.41	288.13	1114.27	32.51
Western								
Commercial	4336.80	3392.62	944.18	3.74	947.93	123.95	823.97	44.09
Strategic	0.18	3.19	-3.02	0.02	-3.00	2.35	-5.36	-15.96
Metro Railway	24.16	67.92	-43.76	0.00	-43.76	0.00	-43.76	-2.69
Miscellaneous	0.00	0.00	0.00	-187.84	-187.84	314.26	-502.10	-15.83
Total	29619.46	27834.60	1784.86	356.30	2141.16	1742.08	399.08	9.16

Source: Indian Railways Annual Statistical Statements, 1998-99

Table A.6 : Regional Railway-wise Passenger and Freight Traffic and Profitability for 1997-98

Railway	Passengers originating (million)	PKMS (million)	Tonnage originating (million)	NTKMS (million)	Gain/ loss per NTKM (Rs.)	Gain/ loss per PKM (Rs.)	Total Gain/ Loss (Rs. crore)
Central	1146	96016.98	43.57	42733.85	0.10	-0.01	317.39
Eastern	567	38230.07	79.66	31508.04	0.18	-0.24	-331.26
Northern	411	56560.08	25.95	45262.83	0.22	-0.14	197.11
North Eastern	165	29991.35	1.07	4568.37	-0.29	-0.14	-572.81
North-East Frontier	23	7787.62	3.72	4378.90	-0.56	-0.48	-664.81
Southern	417	35328.02	25.92	14425.11	0.09	-0.15	-383.14
South Central	139	27806.49	43.85	30673.54	0.26	-0.17	340.98
South Eastern	189	21186.00	169.41	69010.20	0.28	-0.27	1372.35
Western	1291	66990.15	25.12	36167.90	0.28	-0.02	962.09
Total	4348	379896.76	418.27	278728.74	0.20	-0.11	1237.91

Sources : (1) Indian Railways Annual Statistical Statements, 1998-99
(2) Summary of the End Results for Coaching Services Profitability per unit Costs, 1997-98

Table A.7 : International Comparisons of Railway Productivity

Railway/ Country	TU ('000)/ Route-Km.	TU ('000)/ Locomotive	TU ('000)/ Employee	Wages/ Revenues (%)
Mexico	2343	27440	587	85(1980), 45 (1984)
France	3312	26863	538	90
Germany	3663	18051	398	126
Spain	2079	19144	125	125
Conrail	7112	54800	4174	40
India BG	12629	99017	329	51
China	24749	217421	729	23

Note : TU is Traffic Units (ton-km plus passenger-km).
Source : The Indian Transport Sector : Long Term Issues (March, 1995); Report No. 13192-IN of the Infrastructure Operations Divisions, Country Department II – India, South Asia Regional Office of the World Bank, p.76.

Table A.8(a) : Physical and Financial Performance Indicators of State Road Transport Undertakings in 1997-98

Name of the undertaking	Passenger kms. performed (lakhs)	Passenger carried (lakhs)	Total revenue (Rs. lakh)	Total costs (Rs. lakh)	Net profit/ loss (Rs. lakh)	Revenue /km. (paise)	Cost /km. (paise)	Revenue /bus /day (Rs.)	Cost/ bus /day (Rs.)
A. Corporations									
Calcutta STC	25223	2690	4682	12169	-7487	808	2101	1157	3006
Delhi TC	123459	10022	26878	44655	-17777	1070	1778	2127	3534
Karnataka SRTC	459683	22002	110387	106626	3761	1014	979	2820	2724
Kerala SRTC	143708	9359	39605	43507	-3902	1125	1236	2868	3151
Maharastra SRTC	636421	25946	179063	191819	-12756	1083	1161	3018	3233
Rajasthan SRTC	173085	2779	49439	49113	326	968	962	2708	2690
B. Companies									
State Exp. TC (TN Dvn-I) Ltd.	61066	304	13302	16635	-3333	733	917	4313	5393
TN STC (Coimbatore Dvn-I) Ltd.	79615	6162	15893	16042	-149	968	977	3662	3696
TN STC (Kumbakonam Dvn-II) Ltd.	67129	3417	11754	12253	-499	882	920	3570	3722
C. Government Departments									
Punjab Roadways	72350	3139	19532	24862	-5330	1023	1302	2259	2875
D. Municipal Undertakings									
B.E.S.T. Undertaking	98150	15314	52820	62578	-9758	2220	2630	4225	5006
Thane MT	1322	207	673	689	-16	2118	2169	850	870
Total / Average	4067927	204861	831140	941947	-110807	1021	1157	2730	3094

Source : Motor Transport Statistics of India – 1997, Ministry of Surface Transport (MOST); p.30-47.

Table A.8(b) : Physical and Financial Performance Indicators of State Road Transport Undertakings in 1997-98

Name of the undertaking	Interest (Rs. lakh)	Depreciation (Rs. lakh)	Taxes (Rs. lakh)	Profit before tax (Rs. lakh)	Profit before tax& interest payment (Rs. lakh)	Revenue/ passenger km. (paise)	Cost/ passenger km. (paise)	Profit before tax/ passenger km.(paise)
A. Corporations								
Calcutta STC	1550	765	30	-7457	-5907	18.56	48.25	-29.56
Delhi TC	NA	1308	2111	-15666	NA	21.77	36.16	12.69
Karnataka SRTC	5261	7566	7340	11101	16362	24.01	23.20	2.41
Kerala SRTC	2300	2200	2835	-1067	1233	27.56	30.27	-0.74
Maharastra SRTC	4482	12049	29470	16714	21196	28.14	30.14	2.63
Rajasthan SRTC	944	3917	7495	7821	8765	28.56	28.38	4.52
B. Companies								
State Exp. TC (TN Dvn-I) Ltd.	1298	1354	632	-2701	-1403	21.78	27.24	-4.42
TN STC (Coimbatore Dvn-I) Ltd.	759	1208	1199	1050	1809	19.96	20.15	1.32
TN STC (Kumbakonam Dvn-II) Ltd.	439	753	916	417	856	17.51	18.25	0.62
C. Government Departments								
Punjab Roadways	330	907	6174	844	1174	27.00	34.36	1.17
D. Municipal Undertakings								
B.E.S.T. Undertaking	3053	3858	3049	-6709	-3656	53.82	63.76	-6.84
Thane MT	29	78	81	65	94	50.91	52.12	4.92
Total / Average	42014	57907	93409	-17398	24616	20.43	23.16	-0.43

Source : Motor Transport Statistics of India – 1997, Ministry of Surface Transport (MOST); p.30-47.

SECTION II

Environmental Sustainability and Transport Pricing

Introduction

Transport activity causes stress on nature in two ways :

(i) by drawing scarce resources – fossil fuel, minerals, various non-metallic minerals and other materials like sand, stones, etc. and by using land; and

(ii) by giving rise to wastes like pollutant gases, solid wastes, noise, etc. which all flow back to nature that acts as a sink to absorb them, and by partitioning or destroying the ecosystem of the neighbourhoods of transport operation like farm land, wildlife, habitats, etc.

The delivery of transportation service directly or indirectly involves three kinds of activities :

(i) construction activity of ground-fixed infrastructure, including roads or railbed, signalling system, terminals, ports, etc., and their maintenance.

(ii) manufacture of rolling stock – automobiles, wagons, coaches, railway engines, aircraft, ships, etc.

(iii) operation of the rolling stock using ground-fixed infrastructural facilities to provide the final service.

Each of these components involves entropic use of increasing amounts of a large number of material resources drawn from nature. While fuel is burnt to generate the energy required to operate motor vehicles, steel goes into the body of the rolling stock, and materials like cement, sand, bitumen, gravel, etc. are used for the physical construction of roads. Since all the materials and energy are conserved by nature, they all flow back to the sink of the nature after providing service to the human economic system, in a different material form – described often chemically a different compound with different physical and chemical properties. These transformed materials – in solid, liquid or gaseous form – are called wastes because any such transformed material represents a much more disordered structure of the basic useful constituent elements so that they cannot perform the same function for the economic system with the same efficiency. While the ecosystem which receives the wastes can absorb them and further transform them, the time rate of such absorption and regeneration of resources has an upper limit (e.g., the rate of degradation of CO_2 or SO_x in atmosphere, or that of waste oil in landfill or water body).

If the growth of transport operation causes flow of wastes into the local ecosystem which exceeds its maximum absorptive power, the unabsorbed wastes would accumulate in the concerned air-shed, water body or landfill. The stock of such unabsorbed wastes – called pollutants – causes damage to human health or economic productivity of natural resources or regenerative activity of the ecosystem, depending on the nature of the pollutant. The diversion of land use from agriculture to road or rail also has some important opportunity cost and causes some physical loss for the neighbouring ecosystem. The arisings of noise, heat, dust, congestion and accidents are also expressions either of byproduct waste arisings from the transformation process of the material and energy throughput into transportation service, or of the degradation of land, air-shed, water body and immediate ambience which provide support to this service activity, but are themselves affected in quality in the process.

The quality of the ecosystem and of ambience is thus affected by the transport activities, the growth of which involves costs to society. A transport user generates externalities which may involve costs for others and possibly himself as well. The pollution or degraded ambient environment often has the character of 'public bad'. The monetised value of the damage cost to other persons or other economic activities would constitute external cost of supply and use of transport service. Since the environmental service is not a marketed product and one is not, therefore, required to pay for the use of nature for its service as a sink, the private cost of transportation activity does not include this cost. This discrepancy leads to unsustainable overuse of transport service. Transport pricing needs to address the issue of internalising such external social cost for a sustainable transport policy.

What is meant by a sustainable transport policy? It means such intervention into the market system which would ensure the fulfilment of the following two conditions :

(i) The direct or indirect use of natural resources should be such that they can at least be replaced by natural regeneration (e.g. hydroelectric energy used for electric traction), or by discovery of new deposits of the currently used exhaustible resource (e.g., oil or natural gas reserves exploited for driving of automobiles), or by the use of a new renewable resource like hydroelectric or solar power replacing fossil fuel used for generating motive power in transport, or by conserving the use of resources per unit of transportation, or by a combination of these.

(ii) The damage of the environment should be controlled in such a way that the productivity of other economic activities and the quality of human life in terms of health and security against accidents, etc. do not deteriorate over time.

The scarcity value of natural resources used and the external cost involved in transportation activity due to pollution arisings and degradation of environment need thus to be built into the social cost of transport service. The socially optimal resource allocation rule warrants price to be equalised with the long-run marginal social cost of supply and use of transport service. Only such allocation of resources would correctly describe the socially optimal modal choice of transport. In this paper, we will attempt the following in the context of environmentally sustainable transport pricing :

(a) Identify the specific environmental problem which needs to be considered on a priority basis in transport pricing in the interest of sustainable transport development in the Indian context.

(b) Work out a conceptual model for the modal choice of transport and pricing.

(c) Prepare empirical estimates of the comparative environmental impacts of road and rail along with their implications in respect of relative social modal costs of transportation and pricing.

(d) Recommend policies for environmental control and spell out their implications for transport prices.

Environmental Impacts of Transport Development

While urban transport almost entirely represents road mode of transportation by automobiles, the inter-city transportation represents a modal mix of rail, road, air and marine or inland water transport. While the rail and road modes of transport carry both passenger and freight traffic, airlines predominantly carry passengers and coastal shipping mainly moves bulk commodities over long distances. The inland water transport unfortunately carries little traffic in India because of the neglect of the riverways due to dam construction on several major rivers to raise the storage capacity, overall harvesting rate of the flow of fresh water and lack of maintenance activity for the requisite navigability of the rivers. Different modes of transport have different types of environmental effects. Table 1 describes the important effects for the above-mentioned four modes of transport. The water and air transport constitute a small share in the total passenger and freight

Table 1 : Selected Environmental Effects of Principal Transport Modes

	Marine and Inland WaterTransport	Rail Transport	Road Transport	Air Transport
Air		Air pollution in populated areas, global pollution from thermal generating stations for electric traction	Air pollution (CO, HC, NO_x, Particulars & fuel additives such as lead),global pollution (CO_2, CFCs)	Air pollution, greenhouse & ozone depletion effects at higher altitudes due to NO_x emissions
Water Resources	Discharge of ballast water, oil spills, etc. of modification water systems during port construction & canal cutting and dredging		Pollution of surface and ground water by surface run-off; modification of water system by road building	Modification of water tables, river courses and field drainage in airport construction
Land Resources	Land taken for infrastructures; dereliction of absolete port facilities & canals	Land taken for right-of-way and terminals; dereliction of absolete facilities	Land taken for infrastructure; extraction of road building materials	Land taken for infrastructures; dereliction of absolete facilities
Solid Waste	Vessels and craft withdrawn from service	Abandoned lines, equipment and rolling stock	Abandoned spoil tips and rubble from road works; road vehicles withdrawn from service; waste oil	Aircraft withdrawn from service
Noise		Noise & vibration around terminals and railway lines	Noise and vibration from cars, motorcycles & lorries in cities & along main roads	Noise around airports
Risk of Accidents	Bulk transport of fuels and hazardous substances	Derailment or collision of freight trains carrying hazardous substances	Deaths, injuries & property damage due to road accidents; risk in the transport of hazardous substances; risk of structural failure in old or worn road facilities	Death, injuries property damage, due to aircraft accidents
Other Impacts		Partition or destruction of neighbourhoods, farmland and wildlife habitats	Partition or destruction of neighbourhoods, farmland and wildlife habitat; congestion	

Source : State of the Environment in Asia and the Pacific (1995), UN-ESCAP/ADB; ST/ESCAP/1585; p.289.

movement and their impact causes damage of a lower order. It is, in fact, the rail and road modes of transport which are responsible both for the depletion of natural resource base like that of fossil fuel and other exhaustible materials and for environmental degradation due to pollution arisings.

The problem of sustainable resource supply is most acute in the case of fossil fuel which can have only entropic use in combustion. A large number of materials – like steel, cement, ballast, bitumen, etc. – flow as a throughput to the systems of different transport modes. However, a large portion of withdrawn or scrapped rolling stock like cars, buses, ships, railway wagons, trucks, or aircraft, which are manufacturing output, are disassemblable and recyclable. Similarly, some of the replaceable portions of the ground-fixed infrastructure have recyclable component. The economics of industrial ecology will indicate the economically cut-off grade of recyclable material and the economically viable extent of recycling. The net pressure on the resource system will be the flow of virgin resources which are required to sustain the level and growth of transport output. In view of this, it is the fossil fuel, which is entirely non-recyclable, that deserves serious policy attention for conservation through technological upgradation of transportation.

It is also to be noted that all modes of transport involve some use of land to a large or small extent. The diversion of land use is, however, substantive in the case of road and rail modes as land is required for the right-of-way and the construction of ground-fixed infrastructure of railbed or road in addition to terminals and stations. Since the availability of resource of land is fixed, its use for any one purpose needs to take account of its social opportunity cost correctly.

The sustainable use of fossil fuel, other material resources or land in transportation sector needs to be ensured through appropriate pricing of these resources which should be inclusive of the scarcity premium or optimal resource rent. The cost of transportation would thus be inclusive of scarcity premium of resources – fuel, land and other materials. The materials which are outputs of other industries and are used in transport should also ideally reflect the true value of raw materials entering as throughput in the making of those products as well as the costs of environmental externalities like those of steel making, automobile manufacture, cement making, etc. However, the externalities that are generated by the transportation activity itself have to be internalised in the costs and prices of transportation in an explicit way. In respect of rail and road modes of transport, the physical environmental effects that are significant are : air pollution, noise pollution, risk of accidents, congestion and ecosystem degradation (i.e., deforestation, destruction of wildlife habitat and of biodiversity, etc.). There are serious difficulties in environmental impact assessment and its valuation due to either the problem of measurability or that of monetisation in the absence of any suitable surrogate market.

While the progress of science and technology has led to increasingly precise and reliable assessment of environment, the valuation of environmental service is still far from perfect. The research in environmental economics is trying to grapple with the problem of such valuation in the vastly differing ecological, social and institutional context. The methods of hedonic pricing, travel cost and contingent valuation through stated preferences of individuals in response to interviews have been evolved and are being applied in various case studies. However, the reliability of estimates using such methods would depend on the perception of the people of an environmental damage and their preference structure for environmental service and non-environmental goods. The latter would determine how importantly environmental consideration would figure in their individual and collective choices.

Environmental service is supposed to be an income elastic item. In an economy with a large proportion of population being below the poverty line, it would not be surprising if there is relatively low social preference for environmental service and, accordingly, low value is imputed to it. The lack of stringency in environmental laws and regulations in poor economies is indicative of such low valuation. It is not surprising that a poor villager will consider noise pollution or biodiversity loss or global warming quite remote issues to affect his well-being. Besides, the waste absorptive capacity of nature or an ecosystem differs from region to region depending on the agro-ecological conditions implying differential impact in the form of change in physical environment at different places. The same level of waste or pollution arisings may, therefore, be quite differently valued in different regions and countries. The high preference for non-environmental goods of essential nature (such as, food, energy, etc.) in poorer countries has led to choice in favour of growth of income and employment whenever there has been conflict between conventional development and conservation of environmental quality.

In view of such perception about impact and damage value of various pollution arisings as is prevailing in developing economies like India, it is mainly the local air pollution from automobile emissions, congestion and accidents which have been considered of higher importance and greater damage value. As these three factors are having perceptible physical impact in the form of higher morbidity, death, permanent disability, time cost and disutility of congestion, we shall confine our analysis to the internalisation of cost externalities of air pollution, congestion and accidents in costs and prices of rail and road transport. We would first define a conceptual model framework for such internalisation in the following section. We would then pass on to the analysis of comparative environmental effects of road and rail transport in India and their implications in respect of economic costs and sustainable prices.

Sustainable Modal Choice and Transport Pricing

The modal choice of transport in India has changed over time in favour of road transport both in passenger and freight traffic

(Table 2). The structure of prices combined with the greater user's convenience like door-to-door service by road transport, has induced such continuous shift. There are two factors which distort the structure of relative prices. First, rail transport builds into its

Table 2 : Modal Share of Rail and Road Traffic

Year	RLFRT	RLPAS	RDFRT	RDPAS	TLFRT	TLPAS	Share of RLFRT in TLFRT	Share of RDFRT in TLFRT	Share of RLPAS in TLPAS	Share of RDPAS in TLPAS
1970-71	127	118	57	210	184	328	69.02	30.98	35.98	64.02
1971-72	133	125	62	225	195	350	68.21	31.79	35.71	64.29
1972-73	137	134	51	223	188	357	72.87	27.13	37.54	62.46
1973-74	122	136	54	257	176	393	69.32	30.68	34.61	65.39
1974-75	134	126	56	293	190	419	70.53	29.47	30.07	69.93
1975-76	148	149	59	308	207	457	71.50	28.50	32.60	67.40
1976-77	157	164	65	318	222	482	70.72	29.28	34.02	65.98
1977-78	163	177	68	397	231	574	70.56	29.44	30.84	69.16
1978-79	155	193	76	409	231	602	67.10	32.90	32.06	67.94
1979-80	156	199	84	421	240	620	65.00	35.00	32.10	67.90
1980-81	159	209	98	543	257	752	61.87	38.13	27.79	72.21
1981-82	174	221	113	595	287	816	60.63	39.37	27.08	72.92
1982-83	178	227	129	597	307	824	57.98	42.02	27.55	72.45
1983-84	178	223	145	674	323	897	55.11	44.89	24.86	75.14
1984-85	182	227	161	739	343	966	53.06	46.94	23.50	76.50
1985-86	206	241	193	850	399	1091	51.63	48.37	22.09	77.91
1986-87	223	257	210	893	433	1150	51.50	48.50	22.35	77.65
1988-89	230	264	420	765	650	1029	35.38	64.62	25.66	74.34
1989-90	237	281	453	835	690	1116	34.35	65.65	25.18	74.82
1990-91	243	296	503	859	746	1155	32.57	67.43	25.63	74.37
1991-92	257	315	567	956	824	1271	31.19	68.81	24.78	75.22
1992-93	258	300	610	1003	868	1303	29.72	70.28	23.02	76.98
1993-94	257	296	646	1086	903	1382	28.48	71.54	21.42	78.58
1994-95	253	319	672	1192	925	1511	27.35	72.65	21.11	78.89
1995-96	274	342	762	1322	1036	1664	26.45	73.55	20.55	79.45
1996-97	280	357	807	1427	1087	1784	25.76	74.24	20.01	79.99

Note : RL, RD and TL stand for Rail, Road and Total (Rail + Road). FRT and PAS stand for Freight and Passengers carried respectively. BTKM and BPKM are the Billion Ton Kilo Metre and Billion Passenger Kilo Metre respectively. Figures for the Year 1987-88 were no available.

Source : 1. Perspective Planning for Transport Development; Report of the Steering Committee, Planning Commission, Government of India (August 1988); pp.282-283 (for the Years 1950-51 to 1986-87).

2. (a)Indian Railways Year Books (for Rail Statistics for the years 1988-89 to 1996-97).

(b) Study on Road Traffic Flows in the Country, Ministry of Surface Transport (MOST) (1998) (for Road Statistics for the years 1988-89 to 1996-97).

charge for transport service all costs including ground infrastructure (railbed, signalling, etc.), whereas the road transport operator pays through road and fuel taxes far less than what is required to cover the full normative cost. It is, however, true that the total spending on the road sector in India, particularly for the maintenance of roads, falls short of the tax revenues from roads. It is also a fact that the road vehicle, fuel and passenger taxes are paid as related with such variables of control as fuel use, choice of vehicular model, etc. and that often it has hardly any relation with the true resource cost of capital and maintenance for the road length travelled. Thus, it is quite possible that the road user receives some implicit subsidy. Second, there is a substantive differential between the environmental externalities generated in the form of air pollution, congestion and accidents between the two modes. Rail is a superior mode on each of these three counts. Since transport cost and pricing do not internalise any of these environmental costs, the structure of transport pricing does not have any inducing effect in favour of environmentally sustainable modal choice in India.

We would now present a conceptual framework which can define the approach of environmentally sustainable transport pricing for rail and road and of allocation of resources for sustainable modal distribution of traffic in India. Of the two modes of transport, rail is a state monopoly subject to price regulation, while the road transport market is privatised and competitive for freight traffic. The prices of freight transport service by trucking are determined by free market forces. For passenger road transport, both public sector undertakings and private operators supply the service under a regime of price regulation. Although same transport service can be provided by either mode, the associated users' cost in freight traffic or passenger traffic may be quite different for the two modes. Again, for passenger transport service, the perception of the user in respect of the quality of service may be different for the two modes for the same passenger kilometre service. Besides, the users' cost in the objective sense like time cost involved in the use may also be different. For freight traffic, the differential in users' cost may also influence the choice of modal share for a given net tonne kilometre movement of freight traffic. There are environmental externalities both due to pollution arisings and congestion. The costs on account of these will have to be taken into account in price, tax or other regulatory measures for sustainable transport use. The conventional private costs of supply along with the social costs of externalities need to be considered together to decide on prices or taxes to ensure socially optimal allocation of resources.

The Model for Modal Choice

Assume an economy like that of India comprising 'n' consumers of passenger (or freight) traffic service. We describe below the model for passenger transport. The model for freight transport would be very similar in formal structure.

Let U^i be the utility of the i-th individual consumer of passenger transport service which is a concave function of x_1^i, x_2^i and x_3^i that represent consumption of passenger rail transport, road passenger transport and consumption of a composite good comprising all other items together, respectively. The utility is net of user's cost arising from factors which do not involve any externality for others (e.g., cost of reaching a rail station or a bus station). The marginal utility of income of the individual being assumed to be constant, we use income as numeraire and express utility in nominal value terms.

The social utility is just the sum of individual utilities. Thus, for any given income distribution given by the vector $\bar{y} = (y_1, y_2, ..., y_n)$ and prices p_1, p_2 and p_3 of the three consumption goods of the model, the process of utility maximisation by the individual consumer for given income and prices will yield the demand of the ith individual for the goods to be $x_1^i(p_1, p_2, p_3, y_i)$, $x_2^i(p_1, p_2, p_3, y_i)$, $x_3^i(p_1, p_2, p_3, y_i)$. These optimised individual demand patterns will yield the aggregate market demand and social utility to be

$$x_j (p_1, p_2, p_3, \quad) = \sum_i x^i_j (p_1, p_2, p_3, y_i) \; j = 1,2,3 \tag{1}$$

$$U = \sum u^i \left(x_1^i (p_1,p_2,p_3,y_i),\ x_2^i (p_1,p_2,p_3,y_i),\ x_3^i (p_1,p_2,p_3,y_i)\right) \tag{2}$$

We can express such optimised social utility for unchanged income distribution in competitive condition among consumers as function of aggregate market demand

$$U = U \left(x_1(p_1,p_2,p_3, \bar{y}),\ x_2 (p_1,p_2,p_3, \quad),\ x_3 (p_1,p_2,p_3, \quad)\right) \tag{3}$$

Let and $\delta_1(x_2)$ be the congestion cost in consumption suffered by any individual consumer for the aggregate passenger traffic x_1 by rail mode and x_2 by road mode.

There is no congestion cost involved in the consumption of the third good. It is important to note here two points.

(i) First, the externality generated by congestion is reciprocal in nature. Any user considers in his choice the additional cost of congestion suffered by himself caused by his own contribution to the addition of congestion, but would not consider the cost that his consumption inflicts on others. As a result, the social cost of congestion will be $n\delta_j(x_j)$ for j = 1, 2 while the private cost has been $\delta_j(x_j)$ for j = 1, 2; the cost of reciprocal externality of consumption by any single individual being $(n-1)\delta_j(x_j)$.

$\delta_1(x_1)$

(ii) Second, any given mode of rail or road transport will carry both passenger and freight traffic. The parameters of δ-function for the congestion of passenger traffic incorporates the congestion effect of freight traffic on the ground-fixed infrastructure by taking volume of the latter traffic here as given. Similarly, the congestion function of freight traffic will assume the volume of passenger traffic to be given for a given mode.

Let $s_j(x_j)$ be the industry supply curve or the industry level marginal cost curve of the jth good for the competitive or price taker assumption of suppliers of all the three items. Let $C_j(x_j)$ be the corresponding total cost function at the aggregate industry level which is convex in nature. Since rail or road would carry both passenger and freight traffic, the cost function of passenger transport would assume certain allocation of capacity and fixed cost of ground-fixed infrastructure for goods traffic of certain assumed volume by rail or road.

Let and $\psi_2(x_2)$ be the pollution arisings and a_1 and a_2 be the abatement of such pollution in rail and road transport respectively. $D_j(\psi_j(x_j) - a_j)\ j = 1,2$ represent the total damage cost of pollution and $G_j(a_j)$ j = 1, 2 be the abatement costs of pollution in rail and road passenger transport. D_j and G_j functions are convex functions. We assume for the sake of simplicity that the third good (other composite good) does not involve any pollution externality. Our results are, however, perfectly generalisable if we allow externalities in production and consumption for the third good of the model.

The social (pareto) optimum of allocation of resources and optimal choice of transport mode would be provided by x_j^* and a_j^* which maximise the net social surplus W where

$$W = U\,(x_1(p_1, p_2, p_3, \bar{y}), x_2\,(p_1, p_2, p_3, \quad), x_3\,(p_1, p_2, p_3, \quad))$$

$$- \sum_j C_j(x_j) - \sum_j D_j(\psi_j(x_j) - a_j) - \sum_j G_j(a_j) - \sum_j n\delta_j(x_j) \qquad (4)$$

How should prices and taxes be set for the products and services involved in order to induce the market to converge to the socially optimal allocation of resources?

The utility maximisation in an unregulated market situation induces each individual to choose x_j^i for j = 1, 2, 3 such that

$$p_j = U^i\,x_j - \delta'_j \quad \forall\, j \qquad (5)$$

where, $U^i\,x_j$ and are the paritial or simple derivative with regard to x_j respectively.

The profit maximisation by the suppliers under the regulated regime would again ensure pj = $C'_j\ \forall$ j, where C'_j is the derivative of $C_j\,(x_j)$. The equilibrium market allocation of resources would thus be given by the following equations :

$$U\,x^i{}_1\,(\bar{x}_1^i, \bar{x}_2^i, \bar{x}_3^i) - \delta'_j(\bar{x}_1)\ \forall\, i \qquad (6)$$

$$U\,x^i{}_2\,(\bar{x}_1^i, \bar{x}_2^i, \bar{x}_3^i) - \delta'_j(\bar{x}_2)\ \forall\, i \qquad (7)$$

$$U\,x^i{}_3\,(\bar{x}_1^i, \bar{x}_2^i, \bar{x}_3^i) - \delta'_j(\bar{x}_3)\ \forall\, i \qquad (8)$$

A comparison between the equation system (1) to (5) and that of (6) to (8) would imply the failure of market (unregulated) to optimally allocate the resources and arrive at the right price structure. The market equilibrium would, in fact, indicate no abatement of pollution, higher congestion and overuse of road passenger transport service if the road mode is more pollution intensive and involves higher congestion in use than rail. How should then the prices of the transport services i.e., p_1 and p_2 be regulated to ensure socially optimal levels of passenger transport service by rail and road? A pigovian scheme of tax and price or the direct quantitative regulation by restricting emission control (e.g., on emission standard) and certificates or physical volume of traffic (e.g., licensing in automobile industry, particularly of personal transport vehicles like cars or two-wheelers, or banning certain kinds of vehicles on certain roads, etc.) would be the illustrative alternative choices. If one opts for market based instruments, which are likely to involve less transaction cost in administration, one can choose a Pigovian tax-cum-pricing approach. Comparing the system of equations (1) to (5) with (6) to (8) one would immediately arrive at the following tax-pricing scheme. Let t_1 and t_2 be the Pigovian output tax for passenger rail transport and passenger road transport. t_j^p and t_j^c (j = 1, 2) are the two components of tax on account of pollution and congestion, respectively. The environmental regulator has to set, for i = 1, 2.

$$t_j^{p*} = D'_j(\psi_j(x_j^*) - a_j^*)*\psi'(x_j^*) = G'(a_j^*)*\psi'(x_j^*)$$

$$t_j^{c*} = (n-1)\delta'_j(x_j^*)$$

$$t_j^* = D'_j(\psi_j(x_j^*) - a_j^*)*\psi'_j(x_j^*) + (n-1)\delta'_j(x_j^*)$$

The optimal prices that would then emerge in the market with such taxes would be the following which would guide the market to the socially optimal resource allocation.

$$p_1^* = C'_1(x_1^*) + t_1^* = C'_1(x_1^*) + D'_1(\psi_1(x_1^*) - a_1^*)*\psi'_1(x_1^*) + (n-1)\delta'_1(x_1^*)$$
$$= U^i_{x_1}(x_1^{i*}, x_2^{i*}, x_3^{i*}) - \delta'_1(x_1^*) \ \forall \text{ i}$$

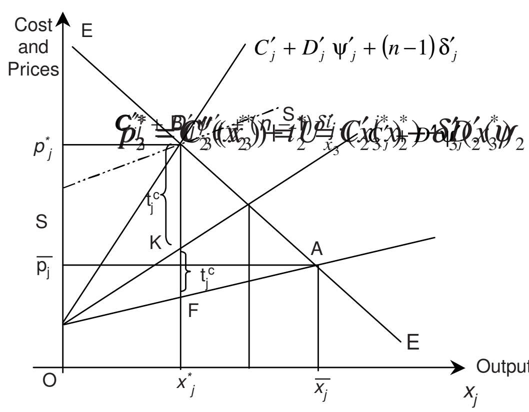
$$= U^i_{x_2}(x_1^{i*}, x_2^{i*}, x_3^{i*}) - \delta_2'(x_2^*) \ \forall \text{ i}$$

$$\forall \text{ i}$$

The results showing the optimal tax and price level for optimum transport use may be diagrammatically described as given in Figures 1 and 2 for any mode of transport.

In Figure 1, EE represents the aggregate demand curve of the ith service, while the long-run marginal social cost of supply is given by the curve The long run marginal private industrial cost of supply is given by the curve C_j'. The points A and B describe the market equilibrium and the social optimal scale of x_j at aggregate level. Optimum output taxes t^p_j and t^c_j are indicated as KF and BK, respectively, in Figure 1 at optimum transport output level by the concerned mode. In Figure 2, AC represents the level of optimum abatement and t_j^p / ψ'_j = BC gives the optimum pollution tax per unit of pollution at the optimum abatement level in the concerned mode of transport. In Figure 1, SS describes the post-tax market supply curve, tax rate being the marginal cost of externalities in rendering and using the service at the optimum allocation of resources. Point B describes the post-tax market equilibrium as well. Comparison of the economy in passenger transport use in the two modes as a result of taxation would indicate it to be higher for road than rail if t_1 is found to be higher than t_2 due to higher social adverse externalities of the mode of road than rail. Apart from resource

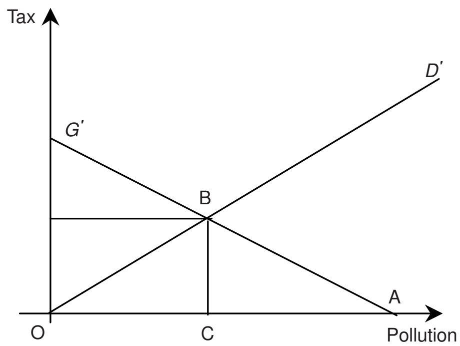
Figure 1 : Optimum Output, Tax and Price



$$p_2^* = C_2'(x_2^*) + t_2 = C_2'(x_2^*) + D_2'(\psi_2(x_2^*) - a_2^*) * \psi_2'(x_2^*) + (n-1)\delta_2'(x_2^*)$$

conserving effect on both the modes, there could be a net substitution effect between the two modes.

Figure 2 : Optimum Pollution and Tax



So far as the analysis of freight traffic is concerned, the model would be very similar since both road and rail operators would be price takers in spite of trucking industry being private due to its competitive nature. The only difference between the models would be in respect of the interpretation of users' optimisation problem in transport choice. Since freight traffic is mostly a service used by industry and business sectors, the consumers' utility maximisation model of choice will be placed by a model of derivation of derived demand from the marginal value productivity behaviour of freight transport input in the activity of the ultimate end commercial product. The construct of the analytical model and the methods of addressing the problem of environmental control would be exactly similar. We, therefore, avoid the repetition of detailed presentation of the model for the pricing of freight transport.

We may make here a further comment regarding the choice of instruments. While the railway itself owns, maintains and operates both ground infrastructure of railbed and the trains, the tax can be imposed on the final rail transport service by incorporating it in the tariff and including in it the components of cost of externalities due to both congestion and pollution. Unlike the railways, roads and road transport are owned by different agencies. While pollution tax has to be imposed on passenger transport or freight transport by road, the congestion tax should be imposed on road use and collected by the road authority. Since the congestion cost reflects the cost of scarcity of road capacity, its imposition should be linked directly with the use of the scarce road capacity. One can derive road tax in terms of vehicle km or different fixed charges for the different slabs of lengths of distance travelled from $t^c{}_2$ which is an output tax per pkm or ntkm. However, it also remains true that while toll tax for road system would be reasonable for inter-city traffic, the transaction cost of administering it may be quite high in the urban areas where quantitative regulation like one-way entry or banning use of personal vehicles on certain urban roads during certain hours may be a more cost-effective instrument.

This model can be used for finding out the time of day tariff for road traffic or suburban rail traffic in order to incorporate the effect of different congestion costs at different hours of the day. One can specify the functions and parameters of the model for different time intervals to solve such a problem. This would also involve assumptions regarding the volume of goods traffic on the concerned infrastructure at different hours of the day.

The above analysis can be further extended to the problem of choice among a large number of vehicular models within road transport or traction choice within rail transport. The different vehicular models differ in respect of passenger or goods traffic carrying capacity, pcu (passenger car unit) equivalent road space requirement and fuel efficiency of engine which would all make differences in consequential emissions of pollution and congestion. The tax-price structure of transport by the different modes of road transport would have to take care of differences in these costs of externalities. Choice between diesel and electric traction would also make difference in pollution cost and congestion cost due to variation in direct and indirect fuel efficiency (taking account of power stations' emission externality) and speed differential of trains between the two. The conceptual model approach, as described above, can be used to take care of the problem of such choices and to obtain sustainable modal prices of transport.

Accidents and Environmental Externality

It may be further pointed out that road or rail accident related cost may be treated as part of the environmental cost. Any accident can, in fact, cause two types of damage : (a) personal injuries, and (b) damage of vehicular and other assets (goods damaged or lost). The personal injuries may be fatal, serious or minor in nature caused to users (passengers) or agents of the supplier of the service (driver or conductor of bus or train) or third party (passer-by or personal transport user involved in accident). The cost of vehicular or asset damage can, on the other hand, accrue to the user or to the supplier of transport service depending on the ownership of the damaged asset. The cost of damage due to insecurity of a transport arising from the risk of accident thus would be partly user's cost, partly supplier's cost and the balance cost incurred by the external third party if no such costs are compensated. To the extent the affected parties are fully compensated by the transport operator for the cost of damage by way of insurance of goods, vehicle, life and health injuries, these costs are internalised and reflected in the books of account of the supplier of transport service for passenger or goods traffic in road and rail transport.

While the transport supplier's own losses are bound to be reflected in the costs and balance sheets of assets, the cost of damage suffered by the user or external third party would be reflected in the cost of transport supply only to the extent these parties are compensated for the damage. If the user or the third external party is not fully compensated, the uncompensated cost would be considered as either user's cost or cost of externality like that of pollution damage. The transport demand behaviour of the consumer will thus be influenced by such uncompensated user's cost. The cost of damage to third party on account of unilateral externality, on the other hand, is a 'public bad' and has conceptually the same status as damage from pollution due to emission in our analytical framework. The abatement of such insecurity by safety measures can also be introduced in the scheme of analysis like pollution abatement. Social optimum choice of mode of transport and pricing should take care of such unilateral cost of externality due to accident, and the transport prices should internalise the costs of all such externalities.

There is, however, one important difference between accident cost and pollution or congestion cost. Unlike the latter, the affected party suffering losses in an accident is identifiable and regulatory regime can insist on compensation for the loss by the transport operator by way of compulsory subscribing of insurance scheme for covering the cost of compensation for damages of all kinds. The cost of transport supply can then build into itself the entire cost of accidental damage. The marginal cost based supply prices of transport can thus internalise these costs. Such regulatory arrangement can lower the transaction cost of accident related environmental control and ensure socially optimal level of the use of the alternative models of transport service without requiring separate taxes and transfers to be introduced for the purpose and ensuring a more horizontally equitable distributive effect. In any case, the incidence of the cost of insecurity due to accidents is likely to be more on road than in rail. This is particularly true in the context of the cost of unilateral externalities on account of damage to third party (including pedestrians, personal transport users, unorganised sector transport operators like rickshaw operators for road, etc.). The costs of accident related externality need to be internalised by either regulatory requirement of insurance coverage or imposition of taxes to induce sustainable modal choice involving less of human suffering.

Environmental Impact of Transport in India

In India, transport sector is a major contributor to the air pollution in urban areas. Both urban transport and inter-city transport have impact on the ambient environment, but of a different character. A much larger portion of the city population is exposed to health risk due to pollution from transport than the population of non-urban areas. Nevertheless, the inter-city traffic also moves through urban sections of the route, the pollution of urban section being higher for road movement than rail movement. A study of 36 cities in India having population of 1 million or more showed the health damage cost of air pollution of these cities for 1991-92, which involved 40,351 premature deaths, to range between US $170 million and 1615 million on account of such deaths alone. The estimate of damage rises to anywhere in the range of US $517 million and 2102 million when we consider the effects in terms of higher mortality and morbidity together (Brandon and Homman, 1995). The share of 3 mega cities of Mumbai, Kolkata and Delhi accounted for 40% of the deaths.

The share of the transport sector in the urban air pollution in terms of emission flow of all kinds was 64% in the case of Delhi in 1991. Shares of the transport sector in the emissions of the individual air pollutants were found to be 97% for HC, 48% for NO_x, 76% for CO, 10% for SPM and 6% for SO_2. For the Mumbai city, the share of transport sector in emission flows in 1991 is given in Table 3.

Table 3 : Share of Individual Transport Modes in Pollution Flows in Mumbai in 1991

Pollutants	Type of vehicle		Re-suspended particulate matter	
	Petrol vehicle	Diesel vehicle	Unit	% of total
Total suspended particulate matter	5	9	40	54
PM_{10}	8	16	16	40
SO_2	12	4	–	16
NO_x	18	34	–	52

* The particulate matters which have been re-suspended in the air by the driving of vehicles.

Source : Agarwal, Anil : Slow Murder, State of Environment Series.

Different vehicles have different emission coefficient per vehicle kilometre depending on the energy use, type of fuel requirement, combustion efficiency, etc. Different pollutants have again different kinds of impact on humans and other effects like crop loss, forest damage, oil spills in water bodies, climate change, etc. Transport policy regarding vehicular modal composition can thus influence the physical impact of pollution as well as the corresponding monetised damage cost. If we impute to transport sector two-thirds of the total loss due to urban air pollution level exceeding WHO guidelines, the absolute health costs on account of transport sector for the 36 cities referred to above, would be in the range of US $340 million and 1385 million.

Among other kinds of damage caused by transport emissions, the global externality of rise in global temperature on account of greenhouse gas (GHG) emissions is an important one. While the transport sector contributed 2% of national level net GHG emission in 1990, it contributed in the same year 15% of total CO_2 emission, which is the most important GHG contributing 58% of net emission of all GHGs in CO_2 equivalent from all sources including land use in India. Transport has the largest share in CO_2 arisings from petroleum products which amounted to 65% in 1994-95. The CO_2 emissions from motor vehicles are estimated to have increased at a composite emission rate of 9.1% per year during 1989-90 to 1994-95 with an annual growth of 7.7% and 9.4%, respectively, for emissions from petroleum-powered and diesel-powered vehicles (UNDP et. al, ALGAS 1998). It may be pointed out that diesel has much higher emission rate per vehicle kilometre than petrol. Table 4 illustrates the situation for Calcutta (Government of West Bengal, 1996).

Table 4 : Vehicular Emission Flow in Calcutta
(gram/Vehicle Kilometre)

Vehicular model	Types of emission				
	SO_2	NO_x	SPM	HC	CO
Motor cycle (Two wheeler)	0.02	0.07	0.20	10.00	17.00
Petrol car	0.08	3.20	0.33	6.00	40.00
Diesel car	0.39	0.99	2.00	0.28	1.10
Heavy duty vehicle (bus, truck, etc.)	1.50	21.00	3.00	2.10	12.70

Source : Government of West Bengal, Sustaining Calcutta, 1996.

In inter-city transportation, the choice between rail and road also makes a major difference, rail being substantively more energy and pollution saving. However, the damage impact of a given emission of pollutant on local ambient environment is more acutely felt in intra-city urban movement than in inter-city movement. As regards global or broad regional impacts like global warming effect, acid rain or ozone depletion, the location of the source of the emission or its stationary or fugitive character makes no difference. The emission flow from inter-city transport is, therefore, as important as that from urban transport. The rail being a much cleaner mode of transport than road, we submit the results of some case analyses currently being done by the author in collaboration with the Asian Institute of Transport Development on comparative environmental emission effect of air pollution from rail and road modes of transport for certain chosen railway/roadway sections. The ratio of a given type of emission between the two modes for a given traffic movement would be equally valid between inter-city and intra-city transportation. If surface or underground metro rail is considered as a matter of serious choice in populous cities, rail would be conserving energy and saving pollution in urban areas as indicated by these ratios although the local environmental damage saving role of rail would be more for the urban use of rail than its use for inter-city traffic. Our case study would also show the differential effect in the form of pollution emission of petrol-driven personal transport and diesel-driven public transport within road mode and between electric traction and diesel traction within rail mode. The terrain condition – plain or rolling – is also found to have different impact on energy use and emission of polluting gases.

Case Study of Comparative Environmental Impact of Rail and Road Transport

In our ongoing study on comparative environmental effect on rail and road modal choice, we have considered for case analysis the following four transport sections which represent different transport characteristics:

(i) New Delhi – Mughal Sarai : plain terrain; rail with electric traction; national highway road.
(ii) Lucknow – Gorakhpur : plain terrain; rail with diesel traction; national highway road.
(iii) Ratlam – Godhra : rolling terrain; rail with electric traction; state highway road.
(iv) Secunderabad – Wadi : rolling terrain; rail with diesel traction; state highway road.

The road route has both urban and non-urban sections; the share of the former varies between 10 and 20 per cent along these routes. We have considered the emission impact of carrying additional passenger and freight traffic separately. In each transport situation, the relative effect of additional traffic on pollution in the baseline business-as-usual-scenario has been worked out, since the effect of traffic congestion on speed and fuel used would depend on this relative increase over the baseline. This is more true about road than rail, as in the latter case there is very often an easily augmentable capacity potential with higher efficiency of operation or with marginal investments over the capital base. The capacity constraint would be more seriously felt in the case of road for similar traffic increase at the margin in most of the above-mentioned populous routes. For the rail, we have not considered any relative upward effect of congestion by such traffic increase at the margin. The additional traffic has been considered to be 10,440 tonne of freight traffic carried per day over the entire distance of the concerned transport section. Our estimation method duly considers, among others, movement of additional empty rakes too as implied by such additional traffic by rail. In respect of road transport mode, it considers the vehicular composition of light commercial vehicles, heavy commercial vehicles and multiple-axle vehicles and the dynamics of their share over time. The differential in fuel efficiency and congestion effect of the different vehicular models would make this composition as one of the determinants of fuel use and vehicular emission per net tonne kilometre of traffic.

The additional passenger traffic has been considered to be 10,000 passengers per day carried over the entire stretch of the transport section. The composition of the additional trains over the section – Superfast, Mail or Express, Passenger, Local – has been worked out on the specific section for carrying such additional traffic. The distribution of passengers over the origin-destination choice has been calculated to work out such train compositions which have effect on speed, fuel efficiency and emissions. For the road, we have also considered the existing vehicular composition of petrol-driven personal cars and diesel-driven cars, buses, etc. in estimating emission effects. We have also considered the effects of varying choices of vehicular composition in order to trace the differential effects of various vehicular mixes on fuel use, emissions and congestion for delivering a given passenger kilometre service.

In order to find out the fuel use, we have used the models of transport engineering for road transport and some software simulation packages for diesel traction rail traffic. For electric traction, the fuel usage has been estimated on the basis of the actual railway data on electricity consumption for electric traction and traffic volume for the individual railway section. We have also internalised the fuel loss in conversion of fossil fuel in power station to arrive at the comparable coefficients between electric traction and diesel traction.

Tables 5(a) and 5(b) give the results of the effect of energy use and emission pollution per tonne kilometre of freight traffic service for the marginal change considered for rail as well as road for the 4 sections. The tables show the relative energy use and emissions of CO_2, CO, NO_x, NMVOCs, CH_4, N_2O, SO_x and TSP and the extent of saving of energy as well as emission as a result of substitution of road transport by rail transport for the concerned section.

Table 5(a) : Change in Daily Emission Levels for Increase in 10440 Tonnes of Freight

Grams per NTKM

	Section : New Delhi – Mughal Sarai (Plain terrain with electrical rail) Road length : 825 km				Section : Lucknow – Gorakhpur (Plain terrain with diesel rail) Road length : 265 km			
	Rail	Road	Ratio rail to road levels	Percentage savings due to substitution of road by rail	Rail	Road	Ratio rail to road levels	Percentage savings due to substitution of road by rail
Energy consumption (Mega Jule per NTKM)	0.116	1.083	10.69%	89.31%	0.179	1.108	16.16%	83.84%
Pollutants								
CO_2	15.60	80.19	19.46%	80.54%	6.57	82.11	8.00%	92.00%
CO	0.00	3.91	0.03%	99.97%	0.05	4.01	1.36%	98.64%
NO_x	0.08	5.13	1.51%	98.49%	0.16	5.26	3.07%	96.93%
NMVOCs	NA	1.08	—	—	0.01	1.11	1.05%	98.95%
CH_4	0.00	0.01	0.91%	99.09%	0.00	0.01	7.44%	92.52%
N_2O	0.00	0.00	2.15%	97.85%	0.00	0.00	4.89%	95.11%
SO_x	NA	0.17	—	—	NA	0.18	—	—
TSP	NA	0.07	—	—	NA	0.07	—	—

Source : Author's Own Estimates

Table 5(b) : Change in Daily Emission Levels for Increase in 5220 Tonnes of Freight

Grams per NTKM

	Section : Ratlam – Godhra (Rolling Terrain with Electrical Rail) Road Length : 285 km				Section : Secunderabad – Wadi (Rolling Terrain With Diesel Rail) Road Length : 200 km			
	Rail	**Road**	**Ratio of rail to road levels**	**Percentage savings due to substitution of road by rail**	**Rail**	**Road**	**Ratio rail to road levels**	**Percentage savings due to substitution of road by rail**
Energy consumption (Mega Jule per NTKM)	0.170	1.461	11.64%	88.36%	0.372	1.489	25.01%	74.99%
<u>Pollutants</u>								
CO_2	25.61	108.23	23.66%	76.34%	27.30	110.28	24.75%	75.25%
CO	0.00	5.10	0.04%	99.96%	0.23	5.22	4.35%	95.65%
NO_x	0.13	6.76	1.88%	98.13%	0.67	6.91	9.71%	90.29%
NMVOCs	NA	1.48	—	—	0.05	1.50	3.22%	96.78%
CH_4	0.00	0.01	1.15%	98.85%	0.00	0.01	24.04%	75.96%
N_2O	0.00	0.00	2.58%	97.42%	0.00	0.00	14.94%	85.06%
SO_x	NA	0.23	—	—	NA	0.23	—	—
TSP	NA	0.09	—	—	NA	0.09	—	—

Source : Author's Own Estimates

For all the four sections, our results show that savings of various pollutant emissions vary between 75% and 99%. In diesel rail traction, the saving of CO_2 is more because of internalisation of the emission of the pollutant of a thermal power station (coal-based) supplying power to rail in our calculation. In rolling terrain, the CO_2 intensities of diesel and electric traction per net tonne kilometre are similar both for diesel and electric traction. It may also be noted that the saving is higher in plain terrain than in rolling terrain for diesel traction. This differential in saving in rail-road substitution is, however, negligible for electric traction when comparison is made between plain and rolling terrain. The difference in terrain or traction condition has, in any case, significance only of a second order as compared to that of the basic modal choice for saving the environment from the stress of pollution.

Tables 6(a) to 6(d) provide the energy and pollutant emissions intensity per passenger kilometre of the rail and road transport and also individually for petrol-driven and diesel-driven

Table 6(a) : Change in Daily Emission Levels for Increase in Traffic of 10000 Passengers

Grams per PKM

Section : New Delhi – Mughal Sarai (Plain terrain with electrical rail)							Road length : 825 km	
	Rail	Road (car & bus)	Road (car only)	Road (bus only)	Ratio of rail to road levels (car & bus)	Ratio of rail to road levels (car only)	Ratio of rail to road levels (bus only)	Percentage savings due to substitution of road (car & bus) by rail
Energy consumption (Mega Jule per NTKM)	0.180	0.269	0.2923	0.186	66.89%	61.59%	96.70%	33.11%
Pollutants								
CO_2	24.26	19.32	20.86	13.79	125.60%	116.30%	175.97%	-25.60%
CO	0.00	1.05	1.14	0.72	0.19%	0.17%	0.27%	99.81%
NO_x	0.12	0.74	0.69	0.93	16.18%	17.39%	12.93%	83.82%
NMVOCs	NA	0.23	0.24	0.18	—	—	—	—
CH_4	0.00	0.00	0.00	0.00	2.36%	1.98%	7.54%	97.64%
N_2O	0.00	0.00	0.00	0.00	21.36%	21.73%	20.12%	78.64%
SO_x	NA	0.02	0.02	0.03	—	—	—	—
TSP	NA	0.01	0.01	0.01	—	—	—	—

Source : Author's Own Estimates

Table 6(b) : Change in Daily Emission Levels for Increase in Traffic of 10000 Passengers

Grams per PKM

Section : Lucknow – Gorakhpur (Plain terrain with diesel rail)							Road length : 265 km	
	Rail	Road (car & bus)	Road (car only)	Road (bus only)	Ratio of rail to road levels (car & bus)	Ratio of rail to road levels (car only)	Ratio of rail to road levels (bus only)	Percentage savings due to substitution of road (car & bus) by rail
Energy Consumption (Mega Jule per NTKM)	0.152	0.259	0.283	0.192	58.67%	53.64%	79.10%	41.33%
Pollutants								
CO_2	11.12	18.65	20.26	14.21	59.63%	54.88%	78.27%	40.37%
CO	0.09	1.01	1.11	0.75	9.16%	8.37%	12.41%	90.84%
NO_x	0.27	0.80	0.74	0.96	34.13%	36.28%	28.47%	65.87%
NMVOCs	0.02	0.23	0.24	0.19	8.71%	8.19%	10.57%	91.29%
CH_4	0.00	0.00	0.00	0.00	24.43%	19.85%	67.09%	75.57%
N_2O	0.00	0.00	0.00	0.00	57.18%	53.25%	49.44%	47.82%
SO_x	NA	0.03	0.02	0.03	—	—	—	—
TSP	NA	0.01	0.01	0.01	—	—	—	—

Source : Author's Own Estimates

Table 6(c) : Change in Daily Emission Levels for Increase in Traffic of 5000 Passengers

Grams per PKM

Section : Ratlam – Godhra (Rolling terrain with electric rail)							Road length : 285 km	
	Rail	**Road (car & bus)**	**Road (car only)**	**Road (bus only)**	**Ratio of rail to road levels (car & bus)**	**Ratio of rail to road levels (car only)**	**Ratio of rail to road levels (bus only)**	**Percentage savings due to substitution of road (car & bus) by rail**
Energy consumption (Mega Jule per NTKM)	0.179	0.3359	0.3682	0.206	53.30%	48.61%	86.72%	46.70%
Pollutants								
CO_2	26.91	23.99	26.17	15.29	112.14%	102.82%	175.89%	-12.14%
CO	0.00	1.31	1.44	0.80	0.17%	0.15%	0.27%	99.83%
NO_x	0.13	0.82	0.76	1.03	16.36%	17.53%	12.93%	83.64%
NMVOCs	NA	0.28	0.30	0.20	—	—	—	—
CH_4	0.00	0.00	0.01	0.00	1.93%	1.63%	7.54%	98.07%
N_2O	0.00	0.00	0.00	0.00	20.64%	20.78%	20.12%	79.36%
SO_x	NA	0.03	0.03	0.03	—	—	—	—
TSP	NA	0.01	0.01	0.01	—	—	—	—

Source : Author's Own Estimates

Table 6(d) : Change in Daily Emission Levels for Increase in Traffic of 5000 Passengers

Grams per PKM

Section : Secunderabad – Wadi (Rolling terrain with diesel rail)							Road length : 200 km	
	Rail	**Road (car & bus)**	**Road (car only)**	**Road (bus only)**	**Ratio of rail to road levels (car & bus)**	**Ratio of rail to road levels (car only)**	**Ratio of rail to road levels (bus only)**	**Percentage savings due to substitution of road (car & bus) by rail**
Energy consumption (Mega Jule per NTKM)	0.165	0.337	0.369	0.210	48.97%	44.74%	78.77%	51.03%
Pollutants								
CO_2	12.11	24.10	26.24	15.53	50.23%	46.13%	77.94%	49.77%
CO	0.10	1.32	1.45	0.82	7.63%	6.97%	12.35%	92.37%
NO_x	0.30	0.83	0.77	1.05	35.95%	38.52%	28.35%	64.05%
NMVOCs	0.02	0.28	0.30	0.20	7.56%	7.06%	10.53%	92.44%
CH_4	0.00	0.00	0.01	0.00	17.41%	14.69%	66.81%	82.59%
N_2O	0.00	0.00	0.00	0.00	50.79%	51.19%	49.23%	49.21%
SO_x	NA	0.03	0.03	0.03	—	—	—	—
TSP	NA	0.01	0.01	0.01	—	—	—	—

Source : Author's Own Estimates

modes of road transport. While rail is significantly pollution saving, the extent of saving for passenger traffic is of somewhat lower order as compared to the freight traffic. In respect of gross energy use and emission of $CO_{2,}$ road is a better mode than rail with electric traction because of the relative higher CO_2 emission in power station for rail per passenger kilometre than the gross energy use and CO_2 emitted from diesel burnt for driving locomotive per pkm. This is true irrespective of the terrain condition. The saving of other pollutants in the substitution of road passenger traffic by rail passenger traffic varies between 40 to 99%, depending on the pollutant and the terrain condition. The variation across modal choices has more significant effect on pollution saving than the variation in terrain condition. Within road transport, bus is a better choice in respect of CO_2, CO, NMVOCs, $CH_{4,}$ while petrol-driven car is a better choice in respect of N_2O and NO_x. The petrol-driven passenger car has advantage in respect of certain pollutants per vehicle kilometre when compared with bus, but not per passenger kilometre, since passenger carrying capacity per vehicle (load factor) is higher in the case of diesel-driven bus. The net effect is represented in the emission estimates per pkm for alternative combination of car and bus as shown in the tables. We have assumed in our estimation all cars to be petrol-driven. In general, bus, the public transport mode, is found to be more environment friendly.

As has already been mentioned, the additionality of both freight and passenger traffic taken together may have significant congestion effect on road, while it would be quite marginal or negligible for rail. We present in Table 7 total number of vehicles, number of vehicles in passenger car units (pcu) and volume to capacity ratio (capacity being defined in terms of daily traffic flow in pcu units) for New Delhi – Mughal Sarai as well as Lucknow – Gorakhpur road sections, both being national highway road sections. For either of these sections, the growth of congestion is significantly moderated for a shift of traffic from road to rail and greatly affected by shift of the same from rail to road. For

Table 7 : Projected Growth of Road Congestion for Different Scenarios
(Unit : Volume to Capacity Ratio of Traffic)

Section : New Delhi – Mughal Sarai (Plain terrain with electric rail) Road length : 825 km				Section : Lucknow – Gorakhpur (Plain terrain with diesel rail) Road length : 265 km		
V/C Ratio (1)						
Year	**BAU**	**Levels after increase in 10000 passengers & 10440 tonnes to rail**	**Levels after increase in 10000 passengers & 10440 tonnes to rail**	**BAU**	**Levels after increase in 10000 passengers & 10440 tonnes to rail**	**Levels after increase in 10000 passengers & 10440 tonnes to rail**
2000	1.465	1.161	1.769	1.184	0.818	1.549
2001	1.558	1.254	1.862	1.257	0.892	1.623
2002	1.660	1.356	1.964	1.339	0.973	1.705
2003	1.773	1.469	2.077	1.429	1.063	1.795
2004	1.898	1.594	2.202	1.529	1.163	1.895
2005	2.037	1.733	2.341	1.640	1.274	2.006
2006	2.160	1.856	2.464	1.738	1.372	2.104
2007	2.294	1.990	2.598	1.844	1.478	2.210
2008	2.439	2.135	2.743	1.960	1.594	2.326
2009	2.597	2.293	2.901	2.085	1.719	2.451
2010	2.769	2.465	3.073	2.222	1.856	2.588

Source : Author's Own Estimates
BAU : Business-as-usual

Lucknow – Gorakhpur section, the volume to capacity ratio grows from 1.184 in 2000 to 2.222 in 2010 as per the business-as-usual scenario, while for a shift of traffic from road to rail, the time profile of volume to capacity ratio shifts downwards and rises from 0.818 in 2000 to 1.856 in 2010. On the other hand, a switch of the traffic from rail to road worsens the scenario by causing an upward shift of the time path of volume to capacity ratio from 1.549 in 2000 to 2.588 in 2010. Since a bus is equivalent to 3 pcu, while the passenger loading rate of a bus is at least 10 times that of a car, the congestion effect of personal transport by car would be more than 3 times that of public transport bus. Again, all the commercial vehicles occupy similar road space, while the payload for a light commercial vehicle, heavy commercial vehicle and multi-axle vehicle is 5, 9 and 18 tonnes, respectively. Substitution of personal transport by public transport and of low payload commercial vehicle by multi-axle higher payload fuel-efficient truck would reduce both congestion and pollution effect.

Health Cost of Transport Air Pollution

The above results in respect of energy intensity, pollutant emission and congestion for alternative modes can give us broad guidance for bringing about policy change to induce shift of modal choice in favour of rail, particularly for freight traffic, and in favour of public road transport. The extent of potential benefits from modal substitution is so large that immediate introduction of appropriate policy to reverse the alarming trend of growing share of road in both freight and passenger traffic has become an imperative. However, any use of market based policy instrument or of physical control would need the monetisation of pollution or congestion cost. This would involve several additional steps. In the case of pollution, one has to translate the effect of variation in pollution or emission flow into change in the load of pollution, i.e., concentration of pollutant in ppm unit and estimate the physical damage impact of such change in air quality (or other kinds of quality) on the human population or on the segment of the production system exposed to the polluting environment through the use of appropriate dose-response function. Finally, one has to monetise the physical damage by working out prices of environmental services from prices of surrogate market or from stated preferences.

Since the tracing of physical impact is sometimes quite site or economy-region specific, the present environmental database available for the concerned regions of our case study is far from adequate for carrying out such estimates, particularly the physical damage estimates. Nevertheless, we have worked out some second-best cost estimates for health damage due to transport emissions for our sample rail and road sections using the US $ cost coefficient per kg of the relevant pollutants as worked out by Delucchi for US situation (Delucchi, 2000). One would think that the estimates of such coefficients for US would have an upward bias due to higher value of statistical life, wage rate and cost of treatment per illness, but would also have a lower bias due to lower size of population exposed to any adverse environmental change due to variation in pollution load. Given the lower standard of living conditions in our country, a higher percentage of population is in a state of marginal health due to lower nutritional and immunity levels. As a result, the net bias of such monetised estimates could be in either direction. However, we have taken the low cost scenario for all US urban areas as estimated by Delucchi for our use. We have adjusted the US $ cost in 1991 prices per kg of pollutant change for variation in purchasing power of currencies and Indian inflation and have expressed them in 1998-99 rupee unit before using them to estimate the health cost implication of emission flows. The monetised health cost has been assumed to be Rs 0.11 , Rs 17.47 , Rs 151.00 , and Rs 105.72 per kg of vehicular emission of CO, NO_x, PM_{10} and SO_x, respectively.

We have considered only four pollutants for finding out the cost implication of emission of pollutants for our case analyses – CO, NO_x, PM_{10} and SO_x. PM_{10} (which consists of particulate matter of aerodynamic diameter of 10 microns or less) flow has been taken to be 45% of the total suspended particulate (TSP) matter. Neither in PM_{10} nor in TSP have we included the share of road dust resuspended. These pollutants mostly cause respiratory tract illness, chronic bronchitis, hypertension, coronary heart disease, etc. The change in the incidence of illness results in higher rates of mortality and morbidity which can then be monetised for the value of life lost, loss of earning due to man-days lost, treatment cost and disutility of suffering from illness.

The estimates of rupee health cost per unit of pollutant emission for the above four pollutants are given in Tables 8(a) to 8(d) along with the total health cost per passenger kilometre for passenger traffic and per net tonne kilometre for freight traffic. The health cost of passenger traffic thus varies from 0.21 paise per pkm to 2.42 paise per pkm, the rail mode being the least cost one for any route section. It is surprising that the petrol car is next in merit ordering in respect of health cost per pkm. This is explained by

Table 8(a) : Health Costs for Passenger Traffic in 1998-99 Prices

(Paise/PKM)

Section : New Delhi – Mughal Sarai (Plain terrain with electric rail)						Road length : 825 km	
Pollutants	**Rail**	**Road (car & bus)**	**Road (car only)**	**Road (bus only)**	**Ratio of rail to road levels (car & bus)**	**Ratio o frail to road levels (car only)**	**Ratio of rail to road levels (bus only)**
CO	0.00	0.01	0.01	0.01	0.19%	0.17%	0.27%
NO_x	0.21	1.30	1.21	1.63	16.18%	17.39%	12.93%
SO_x	–	0.26	0.25	0.33	–	–	–
PM_{10}	–	0.06	0.06	0.08	–	–	–
Total	0.21	1.64	1.52	2.05	12.84%	13.80%	10.29%

Table 8(b) : Health Costs for Passenger Traffic in 1998-99 Prices

(Paise/PKM)

Section : Lucknow – Gorakhpur (Plain terrain with diesel rail)						Road length : 265 km	
Pollutants	**Rail**	**Road (car & bus)**	**Road (car only)**	**Road (bus only)**	**Ratio of rail to road levels (car & bus)**	**Ratio o frail to road levels (car only)**	**Ratio of rail to road levels (bus only)**
CO	0.00	0.01	0.01	0.01	10.64%	9.72%	14.41%
NO_x	0.48	1.40	1.30	1.68	39.64%	42.72%	33.07%
SO_x	—	0.28	0.26	0.34	—	—	—
PM_{10}	—	0.07	0.06	0.09	—	—	—
Total	0.48	1.76	1.63	2.11	27.17%	29.26%	22.69%

Table 8(c) : Health Costs for Passenger Traffic in 1998-99 Prices

(Paise/PKM)

Section : Ratlam – Godhra (Plain terrain with electric rail)						Road length : 285 km	
Pollutants	**Rail**	**Road (car & bus)**	**Road (car only)**	**Road (bus only)**	**Ratio of rail to road levels (car & bus)**	**Ratio o frail to road levels (car only)**	**Ratio of rail to road levels (bus only)**
CO	0.00	0.01	0.02	0.01	0.17%	0.15%	0.27%
NO_x	0.23	1.43	1.33	1.80	16.36%	17.53%	12.93%
SO_x	—	0.29	0.27	0.36	—	—	—
PM_{10}	—	0.07	0.06	0.09	—	—	—
Total	0.23	1.80	1.68	2.27	12.99%	13.90%	10.29%

Table 8(d) : Health Costs for Passenger Traffic in 1998-99 Prices

(Paise/PKM)

Section : Secunderabad – Wadi (Plain terrain with diesel rail)						Road length : 200 km	
Pollutants	**Rail**	**Road (car & bus)**	**Road (car only)**	**Road (bus only)**	**Ratio of rail to road levels (car & bus)**	**Ratio o frail to road levels (car only)**	**Ratio of rail to road levels (bus only)**
CO	0.00	0.01	0.02	0.01	7.63%	6.97%	12.35%
NO_x	0.52	1.45	1.35	1.83	35.95%	38.52%	28.35%
SO_x	—	0.29	0.28	0.37	—	—	—
PM_{10}	—	0.07	0.06	0.09	—	—	—
Total	0.52	1.82	1.70	2.30	28.59%	30.62%	22.60%

Source : Author's Own Estimates

higher emission rates of PM_{10}, NO_x and SO_x for bus in comparison with car not only per vehicle kilometre but also per passenger kilometre. The substitution of bus by rail and passenger car in Mughalsarai-Delhi section involves a saving of 90% and 26%, respectively (Table 8(a)). Tables 9(a) and 9(b) further show the health cost to be varying between 0.13 paise and 15.21 paise per net tonne kilometre for our selected transport sections and modal choices. It is important to notice the significant health cost incidence of inter-city freight traffic, if the traffic moves through urban sections. The health cost saving potential of rail-road substitution for freight traffic is about 98% which is, in fact, higher than what it would be for passenger traffic.

Table 9(a) : Health Costs for Freight Traffic in 1998-99 Prices

(Paise/NTKM)

	Section : New Delhi – Mughal Sarai (Plain terain with electric rail) Road length : 825 km			Section : Lucknow – Gorakhpur (Plain terrain with diesel rail) Road length : 265 km		
Pollutants	**Rail**	**Road**	**Ratio of rail to road Levels**	**Rail**	**Road**	**Ratio of rail to road Levels**
CO	0.00	0.04	0.03%	0.00	0.04	1.36%
NO_x	0.14	8.96	1.51%	0.28	9.19	3.07%
SO_x	—	1.83	—	—	1.88	—
PM_{10}	—	0.46	—	—	0.47	—
Total	0.14	11.30	1.20%	0.28	11.58	2.44%

Table 9(b) : Health Costs for Freight Traffic in 1998-99 Prices

(Paise/NTKM)

	Section : Secunderabad – Wadi (Rolling terain with diesel rail) Road length : 200 km			Section : Ratlam – Godhra (Rolling terrain with electric rail) Road length : 285 km		
Pollutants	**Rail**	**Road**	**Ratio of rail to road Levels**	**Rail**	**Road**	**Ratio of rail to road Levels**
CO	0.00	0.06	4.36%	0.00	0.06	0.04%
NO_x	1.17	12.07	9.71%	0.22	11.81	1.87%
SO_x	—	2.48	—	—	2.43	—
PM_{10}	—	0.62	—	—	0.60	—
Total	1.17	15.22	7.71%	0.22	14.90	1.48%

Source : Author's Own Estimates

The results of our case study point to the interesting problem of substitution between petrol-driven personal car transport and diesel-driven public bus transport due to the higher health cost of travel by the latter mode per passenger kilometre. While substitution of passenger cars by diesel buses would substantially reduce congestion, conserve energy and abate greenhouse gas emission, they will inflict higher health cost on the passengers.

On the other hand, in over-populated cities of India with income inequality, the policy of promoting personal car transport to substitute bus transport would be inequitable because of the limited capacity of majority of the population to pay for car travel. Such substitution would also be infeasible in congested cities, because it would result in too high user's cost due to congestion. The policy implication of the result of our analysis showing higher health cost of public bus transport is that the bus technology needs to be upgraded and cleaner fuel (like CNG) driven buses should replace the polluting diesel-driven buses. These observations on higher health cost of diesel-driven automobiles vis-à-vis petrol-driven cars also suggest that diesel-driven cars should be replaced entirely by efficient petrol or CNG driven cars.

User's Cost and Cost of Accidents

The evolution of user's cost due to congestion involves assessing the time cost of user in passenger and freight traffic. For passenger traffic, the value of additional time in travel can be monetised in terms of wages for overtime work at the margin in the concerned labour market as well as the cost of delay in reaching the destination. The latter component can be evaluated by contingent valuation or travel cost method (e.g., extra charge paid for express road, etc.). For freight traffic, user's marginal cost due to increased congestion would essentially be the cost of holding extra inventory in the form of freight in transit. The interest charge for the value of the higher volume of inventory for all the users together requires to be fully built into the prices.

While we have not estimated other types of environmental damage cost and cost of congestion for our case analysis, we indicate here the incidence of accidents and cost of accidents by road and rail. Tables 10 to 15 provide the estimates of incidence of accidents by rail and road and their implications in respect of cost of accident per passenger kilometre and per net tonne freight kilometre for road and rail separately. Tables 10 to 13 give an overview of rail and road accidents in India. Table 10 shows that both the absolute number and the incidence of rail accidents declined in the nineties. For the road transport, Table 12 shows the absolute number to be rising, although the incidence of accidents per '000 vehicle has been declining over time.

Table 10 : General Overview : Conseqential Rail Accidents

Year	No. of colli-sions	No. of derail-ments	Other train accidents	Total train accidents	Incidence per million km
1988-89	30	457	58	545	0.91
1989-90	34	457	50	541	0.88
1990-91	41	445	46	532	0.86
1991-92	30	655	57	742	1.18
1992-93	53	613	80	746	1.18
1993-94	54	547	74	675	1.07
1994-95	36	487	81	604	0.94
1995-96	29	336	75	440	0.67
1996-97	26	338	72	426	0.64
1997-98	35	315	70	420	0.62

Source : Government of India, Ministry of Railways (Railway Board) (1998), Report of the Ralway Safety Review Committee, Part-I.

The costs of rail accidents per '000 net tonne kilometre of freight traffic and that per '000 passenger kilometre of passenger traffic have been estimated as Rs.1.36 and Rs.1.46, respectively (Table 14). Similar estimates of accident cost for road traffic for the case analysis of Lucknow-Gorakhpur section are Rs.10.00 per '000 net tonne kilometre of freight traffic and Rs.5.49 per '000 passenger kilometre of passenger traffic (Table 15).

These costs would appear to be negligible as compared with the freight or passenger tariff or unit cost for rail or road. It is nevertheless important to note that the cost of road accident is more than 7 times that of rail accident for freight

Table 11 : Casualties in Train Accidents

(Unit : No. of Persons)

Year	Killed	Injured	Total
1988-89	231	736	967
1989-90	239	992	1231
1990-91	322	888	1210
1991-92	235	896	1131
1992-93	282	908	1190
1993-94	369	906	1275
1994-95	298	676	974
1995-96	589	934	1523
1996-97	353	610	963
1997-98	316	977	1293

Source : Government of India, Ministry of Railways (Railway Board) (1998), Report of the Ralway Safety Review Committee, Part-I.

traffic and more than 3.75 times that of rail accident for passenger traffic. More regulatory measures and better enforcement of regulations are called for in order to abate accidents and ensure safety. Since the cost of safety component in price would be negligible, the abatement of accidents would require more of physical regulatory control.

Overaged railway material, wagons and signalling system, old vehicles and bad road conditions are often responsible for accidents. The replacement of rolling stock and equipment on time, and their technological upgradation are important for greater safety. The banning of overaged vehicles, setting of both environmental and safety standards, safety inspection of rolling stock and other equipment as also of signalling system are more important than efforts to build in any market-based instrument for being internalised into price. It is, in fact, the higher cost required for such physical control for safety which when built into prices would induce a different allocation of resources. The policy of quantitative and physical regulation would induce reallocation of resources which will have its impact on prices.

Table 12 : Trend of Vehicle Population and Road Accidents in India

Year	Total vehicles ('000)	No. of vehicles ('000)	Incidence of accidents per ('000 vehicles)
1985-86	10577	215.5	20.4
1990-91	21374	293.4	13.7
1991-92	23507	260.3	11.1
1992-93	25505	280.1	11.0
1993-94	27660	320.4	11.6
1994-95	30295	348.9	11.5
1995-96	33783	368.8	10.9
1996-97	37231	368.7	9.9
1997-98(E)	41217	386.8	9.4
1998-99(E)	45491	413.9	9.1

Table 13 : Growth in Casualties in Road Accidents in India

Year	Persons Killed		Persons Injured	
	No. in ('000)	incidence (per '000 vehicles)	No. in ('000)	incidence (per ('000 vehicles)
1985-86	40.0	3.8	176.4	16.7
1990-91	56.3	2.6	255.0	11.9
1991-92	57.2	2.4	267.1	11.4
1992-93	60.7	2.4	287.9	11.3
1993-94	64.0	2.3	310.8	11.2
1994-95	70.7	2.3	322.9	10.7
1995-96	74.7	2.2	364.2	10.8
1996-97	75.3	2.0	370.9	10.0
1997-98(E)	79.9	1.9	386.2	9.4
1998-99(E)	81.9	1.8	418.5	9.2

Source : Road Safety Cell/Pocket Book on Transport Statistic in India, 1999, Ministry of Surface Transport, Asian Institute of Transport Development.

Note : E : Estimate

Table 14 : Cost Estimates of Railway Accident for 1998-99

1.	Annual incidence of train accident per million train km				0.580
2.	Annual incidence of goods train km per '000 net tonne km				0.875
3.	Annual incidence of passenger train km per '000 passenger km				0.934
4.	Cost of damage to engine and rolling stock per accident (Rs. in million)				1.214
5.	Cost of damage to permanent way per accident (Rs. in million)				0.552
6.	Cost of personal injury :				
	Type of injury	No. of casualties per accident	Cost of injury per casulaty (Rs.)	Cost of injury per accident (Rs. in million)	
	(a) Fatal	1.260	5,35,489	0.674716	
	(b) Serious	0.928	2,42,736	0.225259	
	(c) Minor	1.379	18,855	0.260010	
	(d) Total cost of injury per accident			0.925976	
7.	Total cost per accident (Rs. in million)				2.691976
8.	Cost of accident per train km (Rs.)				1.56
9.	Cost of accident per '000 net freight tonne km (Rs.)				1.36
10.	Cost of accident per '000 passenger km (Rs.)				1.46

Source : Based on Assumptions derived from Government of India, Indian Railway Annual Statistical Statements 1998-99 and Government of India, Ministry of Railways (Railway Board) [1998], Report of the Railway Safety Review Committee, Part-I.

Table 15 : Cost of Road Accident : A Normative Case Study Result for Lucknow-Gorakhpur Highway Section for a Hypothetical Rise in Traffic Movement

1.		*Change in traffic*	
	(a)	Freight movement (tonne per day)	10,440
	(b)	Passenger movement (passengers per day)	10,000
	(c)	Distance (km)	265
2.		*Rolling stock (No.)*	
	(a)	Car	2,085
	(b)	Bus	757
	(c)	Truck	4,466
3.	(a)	Incidence of accidents (per '000 vehicles per annum)	9.1
	(b)	Incidence of fatal injuries (per '000 vehicles per annum)	1.8
	(c)	Incidence of injuries (per '000 vehicles per annum)	9.2
4.		*Cost of vehicular damage per vehicle (in Rs.)*	
	(a)	Car	16,200
	(b)	Bus	47,100
	(c)	Truck	48,700
5.		*Cost of personal injury (Rs. per casulaty)*	
	(a)	Fatal	5,35,489
	(b)	(i) Serious	2,42,736
		(ii) Minor	18,855
		(iii) Average of (i) & (ii)	92,736
6.	(a)	*Total daily cost of accidents (Rs. '000)*	
		(i) Freight	27.670
		(ii) Passenger	13.380
		(iii) Total	41.050
	(b)	*Accident cost per '000 (in Rs.)*	
		(i) Tonnes of freight tonne kilometre	10.00
		(ii) Passenger kilometre	5.49

Source : Based on assumptions derived from Tata Consultancy Service (1999), Evaluation of Road Accident Costs, TCS, New Delhi and Author's own study.

Conclusion

The capitalist market fails to provide clean, uncongested and safe transport. The conservation of environmental resources for the sustainability of the development process requires upgradation of transport technology, enhancement of capacity and improvement in the quality of the ground-fixed infrastructure through better maintenance and safety regulation. Apart from the upgradation of any given mode of transport, restructuring of the modal share of transport is most crucial for abating pollution, congestion and accidents.

Rail is a much cleaner and safer transport mode involving much less problems of congestion in consumption. This is true both for inter-city and intra-city transport, although the cost of environmental loss in absolute sense by any mode is less for inter-city transport than for urban transport. Prices and taxes thus need to be used as instruments to induce not only upgradation of technology but also shift of modal choice in favour of the railways for an optimal reallocation of resources. While the control of production externality may be more effectively induced through taxes on either the transport service or on its input, i.e. fuel, the externality of congestion should be abated by imposing tax or toll directly on the use of ground-fixed infrastructure like roads, bridges, etc. Commercialisation of roads would facilitate the use of such a policy instrument. However, the congestion problem also requires some command and quantitative control measures to optimally regulate traffic flow. The provision of safety is, on the other hand, not really of any great importance in matters of pricing because of its relative small share in cost and prices. But it would demand introduction and enforcement of physical controls like traffic laws and insistence on wider insurance coverage of various types of accident-related risks. This is more true in the case of road transport where externality in the form of suffering of the third party is much higher.

For a modal substitution in favour of railways, massive investment is required to substantively enhance its capacity. The decline of the railways, modal share has been both due to the shifts of demand curve and supply curve of the railways. Modernisation of the railways with a view not only to improving the efficiency of supply but also to reducing the users' cost is extremely important for increasing its attractiveness. Railways should place special emphasis on attracting more goods traffic as the environmental resource conserving relative advantage of rail is more for goods traffic than for passenger traffic.

The experience of toll tax system on road as price for congestion has often resulted in underuse of the concerned right-of-way and greater congestion on other roads which offer an option of free access. This is often true about a new road or a new bridge. The system thus causes some externality for normal users of other roads due to diversion of traffic. It is, therefore, equitable to use part of the revenue from a toll road to upgrade the free access roads and also to widen the coverage of roads under toll pricing system. The latter can only induce wider acceptance of such levies by consumers. Besides, reduction of environmental degradation of road transport also requires expansion of road capacity, upgradation of roads and their better maintenance.

The metro railway as surface or underground transport is an absolute imperative from environmental point of view for all the megacities of India with adequate traffic density. The saving of health cost and users' cost due to the decongestion effect of metro rail is likely to be so huge in highly populated cities that the introduction of metro rail for environmental sustainability needs to be accorded a high priority. The financial resources for investment in metro rail projects will have to be mobilised from the public and from private sources. In view of the relatively high financial capital cost, this mode of urban transport may require to be subsidised for distributive reasons. The resources mobilised from road tolls and taxes may be used for the purpose of cross-subsidisation of this transport mode.

In urban road transport, public bus transport should substitute personal car transport in order to conserve energy, abate GHG emission and reduce congestion. However, bus technology needs to be upgraded through substitution of diesel by cleaner fuels like CNG in order to abate high health cost of diesel buses.

While road and rail would both demand investment of funds on a much higher scale, the modal shift would suggest a higher priority to rail in terms of allocation of resources at the margin. This should get reflected in plan allocation as well as prices. Besides, in view of the limited ability of the state to spare resources, mobilisation of private funds from domestic and global sources is important. This obviously leads to issues of institutional choice, like unbundling monolithic rail for privatisation or privatisation of investment in roads. The pricing of transport has to ensure the financial viability of such an institutional arrangement. Again, such increased dependence on private market for capital mobilisation would require careful regulation of prices and quantities to internalise the cost of use of sink of the nature.

The issues of environmental performances and regulation, and those of pricing and financial resource mobilisation and institutional choice are thus interactive. Sustainable transport policy needs a careful packaging of the policies on all these fronts taking a holistic view. Since the political economy of India often poses problems in the choice of the optimum package, the involvement of all the stakeholders in arriving at such decisions at as decentralised a level as possible will have to be initiated. Here, the problems of choice and of their solutions are often well articulated and well known. The real problem has been one of implementation and delivery through correct management. Sustainable transport policy would require attention to be focused on the right social choice for tax, price and modal share, as well as on the right choice of institutional mechanism for their effective implementation.

References

1. Agarwal, Anil, *Slow Murder*, State of the Environment Series, Centre for Science and Environment, New Delhi.
2. Brandon, Carter and Homman, K. (1995), "*The Cost of Action: Valuing the Economy-wide Cost of Environmental Degradation in India*", mimeo, October.
3. Delucchi, Mark A. (2000) "Environmental Externalities of Motor-Vehicle Use in the US", *Journal of Transport Economics and Policy*, Vol.34, Part II, pp.135-168.
4. Government of India, Indian Railway Annual Statistical Statements 1998-99.
5. Government of India, Ministry of Railways (Railway Board) (1998), *Report of the Railway Safety Review Committee*, Part I.
6. Government of West Bengal (1996), *Sustaining Calcutta*, Present Status Report of the Urban People's Environment.
7. Tata Consultancy Service, New Delhi (1999), *Evaluation of Road Accident Costs*.
8. UNDP, GEF / ADB (1998), *Asia Least Cost Greenhouse Gas Abatement Strategy (ALGAS) India*, Manila, October.
9. UN-ESCAP / ADB (1995), *State of the Environment in Asia and the Pacific*, Chapter 12.