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PRICING OF NATIONAL HIGHWAYS IN INDIA REVISITED

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1. ECONOMICS OF ROAD PRICING

Before revisiting the road use pricing in the Indian context let us have a look on most significant and representative characteristics of a Road Pricing (RP) Model[1] having significant implications for determination of optimum user fee rates. Any Road Pricing Model hinges on the following basic theoretical premises:

1.1 Pareto Optimality

The fundamental premises on which RP is based are either Pareto optimality of RP implementation strictu sensu or the less binding potential Pareto optimality. The potential Pareto improvement criterion, usually applied in the analysis of economic externalities, is solely concerned with efficiency aspects, bypassing equity ones since unresolved interpersonal utility comparisons can be avoided. The Kaldor-Hicks compensation criterion just asks for the potential capability of the gainers to compensate the losers without questioning the need for its actual occurrence. The important thing to them is that society as a whole is potentially in a better position to distribute its own resources. On the other hand, strict Pareto optimality is the discriminating factor in practical policy-making and equity issues, which should be considered at least as important as efficiency ones. This last issue is of the utmost importance from the policy-maker's point of view since whereas efficiency is constraint equity may well be an objective.

1.2 First-best versus Second-best

Although from a theoretical perspective RP has been considered for a long period a first-best solution for tackling congestion under an efficiency point of view, but there has been little public and political support for it. The standard argument given is that congestion arises since marginal social costs of road use diverge from private costs. So if the aim is to create the most favorable conditions to get the traffic flows at the levels most beneficial to society as a whole, we have to make road users to take account of the costs imposed by them on others. In other words, we have to internalize the external costs by levying a congestion charge equal to the difference between social and private costs referred to congestion. In a second-best scenario this is not necessarily so simple because relevant changes in the evaluation procedures occur, the efficiency-equity dilemma can no longer be avoided. The optimization process becomes more intricate and the value of the signals provided by the price system outside a first-best world becomes undoubtedly ambiguous.

1.3 Short-run versus Long run-Analysis

In some earlier works[2], the problem of tolling transport facilities is strictly linked to the problem of investment therefore implicitly adopting a long-run perspective. Some of the more recent literature is not always clear about the time span taken as a reference. More in detail, if one looks at the problem of congestion in a short-run perspective, existing road capacity is taken as given and the issue restricts to the calculation of the net benefit maximizing with respect to the quantity of road use; whereas, from a long run perspective, optimal road capacity and quantity of use are determined simultaneously[3]. Besides, in the long run one has to consider other elements influencing the level of congestion[4].

1.4 Fixed versus Variable Value of Time

In the early works on congestion, the internalization of the excess time spent on the network was based on the assumption that the value of the marginal unit of time was the same for every journey[5] whereas, in subsequent

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works[6], it has been progressively recognized the inevitable variability of the value of time among travellers and there has been a critical revision of the consequences for the analysis of dropping this assumption. Further research on this issue has showed that the values of time vary widely between users of different transport modes and that the strength of income relationships is mode-dependent. While for low incomes the values are fairly similar for all modes, at higher incomes values for rail and coach users tend to diverge from those of other modes, with urban bus-users showing the lowest variation with income[7]. Further insights into a more accurate evaluation of time can be achieved by expanding the neo-classical model of consumer theory to include the time dimension bridging this theoretical basis with that of discrete choice models, and providing an interesting basis for the empirical measurement of different values of time.

1.5 Full Information versus Imperfect Information

Most of the works on the effects of RP do not explicitly mention the quality of information available to the network users; however, the implicit assumption is that perfect information is available to all, since the time/cost minimizing driver hypothesis is usually put forward. One can argue that in absence of full information event though the single traveller is trying to minimize the time allotment dedicated to transport, due to imperfect information, he is not optimizing his position. Some work has recently been conducted on the relative efficiency and the interaction between different information and pricing systems for the regulation of stochastic road traffic congestion[8]. This research endeavors might have particular repercussions on the acceptability of RP since they might contribute to avoid what can be defined "congestion overkill" when a poorly informed user might find himself in the very frustrating situation where he, not being aware of a certain congestion situation in a determined area of the network, involuntarily drives into it and not only will suffer an extra time loss due to congestion but will also have to pay for it since he is involuntarily contributing to it.

1.6 Charge Earmarking

Since it is almost universally accepted that RP systems provoke undesirable distributional effects, in absence of a redistribution of the resources generated, it becomes of the utmost importance for equity and acceptability purposes to describe, analyze and optimize the resource earmarking process by adopting a critical position in evaluating the institutional environment in which the process takes place. In other words, conscious of the state of affairs one should wonder whether the political process can reasonably be expected to operate not only to impose charges, where they are appropriate, but also if the level of charges imposed will be correct. Once the assumptions on the motivations of public workers are considered to be the same as non-government workers, that is simply welfare maximizing, one realizes that there is a strong case for a government pricing behavior inconsistent with the normative expectations.

1.7 Other Features of RP Modelling

Aim of above discussion is not to discuss the features of RP Model holistically or exhaustively. Therefore, the above description should be simply taken as a reflection on the most meaningful parameters that are considered for pricing the roads. There are few other aspects also that deserve a brief description. One is related with the fixed or stochastic characterization of demand. This aspect involves the introduction of a probabilistic approach into the model but the essence of the results does not necessarily change.

Another aspect taken into account is the network modeling method since it might influence the kind of trade-off between congestion creation and diffusion. In various models congestion is conceived as taking place in a bottleneck situation whereas in others a full network is assumed.

When assuming a long-run perspective, one has necessarily to take into consideration the secondary effects of the toll charging, since the monies levied are either channeled back into the transportation sector at large or, more directly, are used to determine a zero increase in the out-of-pocket money travelers have to pay, the indirect effects are always present. In this case the distinction between short and long-term analysis blurs and the overlapping of the adjustment process with the indirect effects becomes inextricable and both phenomena should be considered simultaneously.

Lastly, one has to consider the varying effects of the tariff structure and methods of payment. It is widely recognized that different tariff structures -- variable or fixed-- and the methods of payment -pre or post-payment- might have a strong influence both on the perception of a RP scheme as well as on the response to equal charges.

2. NATIONAL HIGHWAY PRICING IN INDIA

On the basis of some specific studies, Ministry of Shipping, Road Transport and Highways has capped the road user fee rates for various categories of vehicles for using all four lane divided carriageway facilities on recently upgraded National Highways and linked them to the wholesale price index (WPI) for escalation on yearly basis. These rates (at1997 prices) were Re. 0.40/km for car/jeep/van, Re. 0.70/km for LGV, Re 1.40/km for truck or bus and Rs. 3.0/km for heavy construction machinery and earth moving equipment. Assuming a per annum increase of five percent in WPI, in the year 2002 user fee rates escalate to Rs. 0.51, 0.89, 1.79 and Rs. 3.83 respectively while for the year 2005, the rates comes to be at Rs. 0.59, 1.03, 2.07 and Rs. 4.43 respectively.

3. REVALIDATION OF USER FEE RATES - A CASE STUDY

For revalidation of user fee rates capped by the Ministry, the WTP/ATP studies under taken for the following projects are discussed here as case studies:

– Case 1 (C-1): Chingelpet-Tindivanam Section of NH 45 in Tamil Nadu.

– Case 2 (C-2): Configuration of NH-47A and NH-47 in Kerala.

– Case 3 (C-3): Nagpur-Durg Section of NH-6 in Maharashtra and Madhya Pradesh.

As the mathematical equation for determination of user fee is a function of various variables, the discussion on revalidation of user fee rates should cover various aspects like socio-economic profile of the hinterland, pre and post up gradation quality of the highway, savings in vehicle operating cost (VOC) and travel time, and willingness and ability to pay the user fee.

3.1 Socio-Economic Profiles of Hinterlands

Socio-economic profile provides an overview of the hinterland's socio-economic status that shapes the demand for road transport. Major aspects having significant bearing on the demand for transport are demographics, macro-economic indicators, sector wise production of agricultural and allied activities, manufacturing, mining, service sector including infrastructure. The profile depicts the spatial distribution of economic activities and provides basic inputs for estimation of future growth in transport demand on the basis of perspective economic growth rates and transport demand elasticity.

3.1.1 Tamil Nadu

Agriculture is major occupation in Tamil Nadu. Major crops are paddy, millets, jowar, bajra, ragi, maize and pulses. Commercial crops cultivated in the state include sugarcane, cotton, sunflower, coconut, cashew, chilies, gingerly and groundnut. Plantation crops like tea, coffee, cardamom, cashew and rubber are also grown in the State. Tamil Nadu is one of the leading industrialized States in the Indian Union. It has been attracting investment from leading multinational giants. The important mineral resources of the State are lignite, limestone, magnetite, mica, quartz, salt, bauxite and gypsum.
The State is well linked by road and rail network. International Airport at Chennai and domestic airports at Tiruchirapalli, Madurai, Coimbatore and Salem connects the State with rest of the country and the world. Chennai, Mamallapuram, Poompuhar, Kancheepuram, Kumbakonam, Dharasuram and Chidambaram are some of the important tourist destinations in the State.

In year 2002-03, per capita net state domestic products at current prices was Rs. 21433 while, as per 1999-2000 estimates 20.55 percent of rural and 22.11 percent of urban population of the State is living below poverty line.

3.1.2 Kerala

Agriculture is the main occupation of people in the State. The State is major producer of coconut, rubber, pepper, cardamom, ginger, cocoa, cashew, arecanut, coffee and tea. Being the highest literate State of the country, Kerala has a number of large, medium and small-scale industrial units where traditional industries co-exist with modern ones. The State has abundance of important minerals like limonite, monazite, zircon, clay and quarts sand.

The State is well linked with road, rail, air and sea transport network. Thiruvanathapuram, Kochi and Kozhikode are the important airports in the State.

Kerala has the most attractive wildlife sanctuaries at Thekkady on the banks of river Periyar. Kovalam beach, Padmanabaswami temple, Shabarimala temple are some of the important tourist centers of the State.

In year 2004-05, per capita net state domestic products at current prices was Rs. 21853 while, as per 1999-2000 estimates 9.38 percent of rural and 20.27 percent of urban population of the State is living below poverty line.

3.1.3 Madhya Pradesh

Madhya Pradesh is the centrally situated State of the country. Agriculture is the mainstay of State's economy with production of oilseeds, pulses, soyabean, gram and linseed. Wheat, rice, jowar, sugarcane, cotton, tuar, mustard are the other principle crops cultivated. The State has co-existence of traditional industries with high-tech industries like petrochemicals, electronics, telecommunications, automobiles and optical fibre for telecommunication etc. Madhya Pradesh is the leading State in the country in the mineral production. Coal, bauxite, iron-ore, manganese-ore, rock-phosphate, dolomite, copper-ore, limestone are being mined in the State.

The State is well linked with roads, rail and air network. Bhopal, Gwalior, Indore, Khajuraho and (now in Chhatisgarh) are the important airports in the region. Ancient temples, palaces, forts and archeological sites are major tourist attractions in the State.
In year 2004-05 per capita net state domestic products at current prices was Rs. 11438 while, as per 1999-2000 estimates 37.06 percent of rural and 38.44 percent of urban population of the State is living below poverty line.

3.2 Pre and Post Up gradation Quality of Highways

Comparison of pre and post up gradation quality of road indicates towards the extent of betterment in quality and resulting savings vehicle operating cost and travel time.

3.2.1 Pre Up gradation Conditions[9]

Table 1 - Pre Upgradation Road Conditions

Indicator	Case 1	Case 2	Case 3
Road Length (Km)	94.00	15.82	226.00
Road Width (Mts)	7.00	7.00	7.00
Shoulder Width (Mts)	1.50	1.50	1.50
Effective Number of Lanes	2.00	2.00	2.00
Super elevation (%)	4.00	7.00	5.00
Curvature (deg/km)	50.00	5.00	15.00
Rise & Fall	10.00	1.40	10.00
Roughness (IRI)	3.60	2.80	4.56
Area all cracks (%)	12.00	25.00	27.00

3.2.2 Post Up gradation Quality

All the cases are strengthening and up gradation of existing 2-lane carriageway to 4-lane as per IRC/ASTHO codes with standard design parameters as specified.

3.3 Willingness to Pay /Ability to Pay (WTP/ATP) Toll Fee

WTP/ATP of consumer depends upon savings in travel time, vehicle operating cost, income and expenditure profile of the consumer, availability of competing routes, physical conditions of the road, volume, type and nature of traffic and psychological aspects influencing the behavior of the consumer etc.

Market segmentation based on WTP, in turn, forms the basis for devising the product, price and promotion strategies. Market segmentation also provides the basis for price differentiation across users. There are many ways in which an operator can design its tariff structure. Variation by time of day is quite common. Further, the idea of allowing the price of one lane to change with the degree of congestion to serve user in a rush allows the operator to make the most of differences in the value of time of the various users. But the viability of such a differentiation is doubtful in the Indian context because of the low preference given to travel time saving by road users here.

On the basis of WTP/ATP study, case wise user fee rates for each category of vehicle on each road section were determined as follows[10]:

Table 2 - User Fee Rates based of WTP/ATP Study

Type of Vehicles	User Fee Rate for the Length of highway (Rs.)			Per Km User Fee Rates (Rs.)		
	C-1	C-2	C-3	C-1	C-2	C-3
Truck	116	50	215	1.25	3.16	2.59
LGV	32	20	80	0.34	1.26	0.96
Bus	104	40	200	1.12	2.53	2.41
Car	40	8	45	0.43	0.51	0.54

The comparison of per km user fee rates announced by the Ministry with the rates arrived in the table above has significant diversions. While in Case 1, user fee rates are lower than the rates specified by the Ministry, in Case 2 and 3, these rates are on the higher side.

3.4 Relative Importance of Major Determinants of User Fee

An analysis of relative importance of determinants, i.e. savings in time and voc, income of consumers and the likely diversion, that determine the user fee rates based on WTP/ATP equations drawn from the analysis is summarized in Table below. Savings in time is assigned more relative importance in Case 3 in comparison to Cases 1 and 2 for all categories of vehicles. Similarly, relative importance of other factors also varies from case to case.

Table 3 - Relative Importance of Major Determinants of User Fee

Type of Vehicle	Savings in Time	Monthly Income	Savings in VOC	Diversion
Truck	C3>C2=C1	C3>C2=C1	C3	C3C1
LGV	C3>C2=C1	C3>C2=C1	C3>C2=C1	C3
Bus	C3>C2=C1	C3>C2=C1	C3>C2=C1	C3>C2=C1
Car	C3>C2=C1	C3>C2=C1	C3	C3=C2>C1

4. THE NEED TO RECONSIDER

The essence of the above analytical results is that uniform toll fee rates fixed by the Ministry for all national highway network are questionable in the light of various aspects of RP model such as nature of demand, issues related with efficiency and equity, ambiguity, congestion pricing versus investment orientation, fixed versus variable toll fee rates, value judgments under imperfect information and other indirect impacts that are discussed earlier in the paper. Therefore, need is to re-study the issue of road pricing for complete national highway network and region specific toll fee rates should be prescribed after due consideration of varying nature and magnitude of factors influencing WTP/ATP of consumers.

END NOTES

[**1**] For detailed discussion on most significant and representative characteristics of a Road Pricing (RP) Model, see Edoardo Marcucci, 'Road Pricing: Old Beliefs, Present Awareness and Future Research Patterns', International Symposium on Technological, Energy and Environmental Topics in Transport October 27-29, 1998, Palazzo delle Stelline, Corso Magenta, 63, Milano, Italy.

[**2**] C. Ellet "A popular exposition of the incorrectness of the tariffs on tolls in use on the public improvements of the United States" J. Franklin Institute, vol. 29, 1840 and J. Dupuit "On tolls and transport charges" reprinted in International Economic Papers, (1962) vol. 11, 1849.

[**3**] Road user charges and optimal investment, though often treated separately by policy analysts, are facets of the same problem: both are aimed at minimizing the total costs of building, maintaining, and using a road system. Although investment pertains to the initial design and construction of a road and user charges pertain to ongoing user and maintenance activities, the two are interdependent.

[**4**] The congestion pricing also affects the rates of population growth, income growth and, of course, increases in road capacity over time in order to estimate, among other things, to what degree does lagged adjustment in the housing sector- a sector complementary with transportation in producing urban output- works as an implicit congestion toll potentially representing a second-best alternative to the toll.

[**5**] A.A. Walters "The theory of measurement of private and social costs of highway congestion" Econometrica, vol. 29, 1961.

[**6**] The path-breaking articles under this respect were: R. Layard "The distributional effects of congestion taxes" Econometrica, vol. 44, 1977 and A. Glazer "Congestion tolls and consumer welfare" Public Finance, vol. 36, 1981.

[**7**] MVA The Value of Travel Time savings, Policy Journals, Institute of Transport Studies-University of Leeds, Transport Studies Unit-University of Oxford, 1987.

[**8**] E. Verhoef, R.H.M. Emmerink, P. Nijkamp, P. Rietveld "Information provision, flat and fine congestion tolling and the efficiency of road usage" Regional Science and Urban Economics, vol. 26, 1996.

[**9**] Source: Detailed Project Reports for the up gradation of respective road sections prepared during the years 2000 and 2001.

[**10**] Here, it is pertinent to note that use of ITS results in savings in VOC, travel time and accident savings which in turn impacts WTP positively.