OPTIMAL PRICING OF URBAN ROAD TRANSPORT - A CASE OF DELHI

by

AKSHAYA KUMAR SEN

DEPARTMENT OF HUMANITIES AND SOCIAL SCIENCES

Submitted

In fulfillment of the requirement of the Degree of Doctor of Philosophy

to the

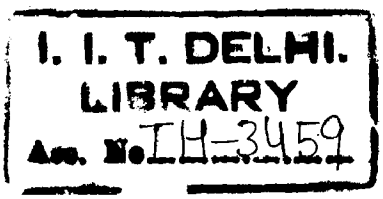
INDIAN INSTITUTE OF TECHNOLOGY DELHI

HAUZ KHAS, NEW DELHI – 110016

NOVEMBER 2006

Urban road transport – Delhi

TH
35.073.537(540.23)
SEN-O



CERTIFICATE

Certified that Shri Akshaya Kumar Sen was permitted to work for his Ph.D Degree in Economics at the IIT, Delhi, on the problem entitled "OPTIMAL PRICING OF URBAN ROAD TRANSPORT: A CASE OF DELHI". He has faithfully carried out his study under our guidance and supervision and the accompanying thesis is his genuine and original work.

The results contained in this thesis have not been submitted, in part or full, to any other University or Institute for the award of any degree or diploma.

Shri Akshaya Kumar Sen has completed necessary course work and put in the required attendance in this Department.

Dr. Geetam Tiwari
Associate Professor
TRIPP
I.I.T. Delhi, INDIA

Prof. V. Upadhyay
Professor of Economics
Department of Humanities
& Social Sciences
I.I.T. Delhi, INDIA

Dated. 30 November 2006

ACKNOWLEDGEMENT

I am extremely grateful to my supervisors, Prof. V. Upadhyay & Dr. Geetam Tiwari under whose able guidance, invaluable suggestions and constant encouragement at every stage of the work, this work has been completed.

I take this opportunity to thank Prof. Stef Proost, CES, Catholic University of Leuven, Belgium, who introduced me to urban transport pricing research. It is his guidance and teaching during my two years stay at KULeuven that inspired me to take up this important subject. I also express my sincere thanks to Prof. Bruno De Borger, Antwerp University, Dr. Inge Mayeres, Dr. Kurt van Dender and Dr. Edward Calthrop for their help and support during my research at KULeuven.

I am grateful to Dr. P.S. Rana, CMD, HUDCO, for his kind support to carry out the present research at IIT, Delhi. My sincere thanks are due to Dr. Kiran Wadhva, Ex-Executive Director (Research), HUDCO for her constant encouragement for undertaking Ph.D research on Urban Transport.

Co-operation extended by Mr. V. Suresh, Ex-CMD, HUDCO, Dr. D. Subrahmanyam, Executive Director, HSMI, Dr. K.K. Pandey, Chief (R & E), HUDCO and Mr. A.K. Sharma, Chief (HR & Law), HUDCO for various things at various stages of the study is gratefully acknowledged.

I take this opportunity to thank faculty members at TRIPP and Department of Humanities & Social Sciences, IIT Delhi for their help in this study. Particularly, I would like to thank Prof. Dinesh Mohan, Ms. Anvita Anand, Ms. Mukti Advani and Mr. Mahesh Gaur for their useful inputs at various states in the completion of this study.

I extend my hearty thanks to all my friends and colleagues for their constant encouragement and help. Though it is impossible to mention all of them, I would like to mention my colleagues from HUDCO/HSMI Messrs. Raghunath Mishra, Atul Srivastava, SGS Panicker, Deepa Krishnan, Shameek Bose and Siddhartha Mukhopadhyay for their help at various stages in the completion of this study. My special thanks to my dear friend Dr. Manoj Nath for his encouragement and advice at every stage of this work.

I thank Mr. R.L. Sehgal, Library-in-charge of HSMI for his help in providing me necessary library assistance. I am also thankful to the library staff of IIT Delhi for their help in my reference work.

I would like to express my deep sense of reverence to my parents, respected in-laws, brothers and sisters for their constant encouragement and assistance.

I would like to take this opportunity to express my sincere thanks to my dear wife Dr. Mousumi Sen for her sustained help, suggestions and looking after the family affairs without bothering me during my long journey through this work.

Last but not the least, I would like to dedicate this research work to my dear son 'Soham', who was born during the last stage of my research project.

(Akshaya Kumar Sen)

ABSTRACT

In India, as in other developing countries, urbanization is most evident in the country's metropolitan areas. Delhi has been experiencing a consistently high rate of growth of motor vehicles during the last few decades. Rising real incomes of the people, the dissatisfaction with public transport and the consequent increase in personalized mode of transport is leading to tremendous increase in traffic density resulting in longer travel time, reduction in average speed, greater fuel consumption, higher levels of pollution and discomfort to road users. All these are resulting in considerable environmental damage, health hazards and road accidents.

Though marginal social cost pricing has been identified in the economic literature as the pricing regime that maximizes efficiency in the transport system by tackling the above problems, examples of its implementation in transport are rare, particularly so in India. The current study has addressed the issues and questions related to the phased approach of introducing urban road pricing based on the principle of marginal social cost pricing. The key objectives of the research study were related to the two key research themes and their interaction: (i) to develop an integrated approach to analyse marginal social cost pricing; and (ii) to evaluate the impact of implementing integrated marginal social cost pricing on selected transport externalities.

By developing a theoretical model, which captures transport tax reforms in the presence of various negative transport externalities, the study shows that the reference traffic equilibrium of Delhi in 2005 is characterized by a severe peak congestion problem where 77.5% of passenger car units per day ply in peak hours. Policy instruments, which differentiate taxes between peak and off-peak hours, could therefore generate important welfare gains. In fact, the largest welfare gains are to be expected from the internalisation of external congestion costs, as these are the dominant inefficiencies in the present urban transport

equilibrium. Optimal pricing would generate financial surplus of both private and public transport modes. In the urban transport optimum pricing scenario, the peak car money price would increase in the range of 22% to 77% from the reference situation level for a volume reduction in peak traffic in the range of 13.50% to 35.50%. For off-peak cars, the optimal money price would increase in the range of 10% to 95% from the reference situation level for a volume reduction in traffic in the range of 20% to 30%. For public transport, there were mixed results depending upon the objective of the government. Accordingly, the volume change would be in the range of -44% to +4%, depending upon the pricing of public transport

The study shows that successive combination of pricing instruments yield higher welfare gains than introducing them in isolation. For example, when rationalised parking is introduced as the single pricing instrument, the welfare gain was only 0.03% over the reference situation. But when it is combined with optimal private and public transport pricing, the welfare gain increased by 4.69% over the reference period, with significant reduction in peak traffic volumes (37%) and increase in peak period speed.

In many instances the authority over the different instruments is spread over different government levels. By analysing the coordination problems and possible efficiency losses when different pricing instruments are controlled by different levels of governments to address external costs in transportation, the study found that since there were many interactions and many externalities between the two levels of government, a division of roles between them did not guarantee an efficient pricing outcome. Different tax externalities and the incomplete consideration of transport externalities might lead to over- or undercharging by local government levels. The precise result would depend on the institutional set-up and on the correspondence between the objective functions of the two government levels. By examining the case where parking charges were controlled by city government (Municipal Corporation of Delhi and New Delhi

Municipal Council) and road toll was controlled by the Government of National Capital Territory of Delhi, the study finds that the efficiency loss due to non-coordinated or non-cooperative situation is marginal compared to the cooperative centralised solution.

The study has also explored the role of endogenous labour supply in determining optimal transport pricing in a multiple trip purpose setting. It finds that relaxing strict complementarity assumption between commuting transport and labour supply can enable one to determine unique optimal tax rates for commuting transport, non-commuting transport and labour supply. For a given labour tax rate, the study shows that, commuting trips should be taxed less than non-commuting trips, the more complementary commuting is with labour. Introduction of differentiated transport tax system in Delhi for a given level of labour tax leads to a welfare gain of 9.42 percent of generalised income, an increase in labour supply by 47%, a traffic volume reduction of 22% and increased peak period speed of over 22% thereby reducing congestion conditions considerably in Delhi.

Despite the growing awareness of efficiency and welfare gain achieved from marginal social cost pricing in urban transport, its acceptability, both public and political, has been identified as the main obstacle in implementing marginal cost pricing in practice. Reasons behind opposition to efficient pricing are manifold: the equity and distributional impacts are considerable, the benefits are not obvious to transport users, important behavioural changes might be induced affecting people's daily habits and even location choices. On these issues, the study suggests some reform measures that could be initiated in Delhi. This research study could be seen as a first step towards introducing marginal social cost based urban transport pricing in India. The scope for further research in the area of urban transport pricing is fairly wide.

TABLE OF CONTENTS