CHAPTER – VII

SUMMARY AND CONCLUSIONS
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This chapter summarizes the main ideas and findings of the present thesis and dwells on the limitations and policy aspects related to the control of vehicular pollution.

The primary objective of the study 'Health Cost of Vehicular Pollution: A Case Study of Guwahati City' was to value health damage costs of vehicular pollution to the residents of Guwahati in the wake of tremendous increase of vehicles in the recent years. Household survey conducted in sample areas of Guwahati provides evidence of augmenting health costs of vehicular pollution and draws attention to the benefits that can be reaped by judicious management of vehicles in the city.

The sum and substance of each chapter of the present thesis is outlined below

7.1 Summary

Chapter I 'Introduction' introduces the problem of proliferation of vehicles and rise in vehicular air pollution in the broader context of urbanization and the pattern of development extant in many developing countries of Asia including India. The veritable increase in road transport is the outcome of rapid urbanization as it is one of the cogent factors behind it. The chapter deliberates in brief about the change that has taken place in the composition of vehicles on roads in India. Private modes of transport like cars and two-wheelers, have predominated the road transport scenario in the recent times while public modes of transport are declining. Vehicular pollution has increased in great measure owing to the exponential increase of vehicles which has in turn seriously affected human health. The city of Guwahati is seen to be replicating the same pattern of urbanization typical of the country and mirroring similar problems related to proliferation of vehicles which are reflected in the mounting costs of
pollution on environment and human health. The economic nature of the problem of vehicular pollution is highlighted and the subject of valuation of health cost is brought into focus. Related objectives of the thesis and glimpses of methodology, study design and scope are provided in this chapter. In all, the introductory chapter gives an idea of the overall organization of the thesis.

Chapter II ‘Literature Review’ carries a critical review of some of the existing literature related to various aspects of the stated problem. The chapter is organized in three sections.

Section I contemplates on the problem of rise in vehicular population and its ill impacts placing it within the wider gamut of the ongoing nature of urbanization typical of transition economies like India and other countries of Asia. Some of the important papers discussed in this connection are by Satterthwaite (2010), Dutta (2006), Padam and Singh, (2001), Pucher et al (2007).

Section II reviews studies dealing with the rising impact of air pollution on health in the context of Indian cities. A few important papers in this section are by Ingle, et al., (2005), Pal et al., (2010). Cropper et al., (1997) etc. These studies provide empirical evidences of health risks of air and vehicular pollution on human health.

Section III is further divided into two sub sections. The first sub section is a reflection on the literature related to the conceptual and theoretical foundations of environmental economics while the second sub section discusses other empirical studies related to the present one. This first sub section traces the origins of environmental economic thought and focuses on the conceptual foundations of externality, non-rivalry, non-excludability etc., as dealt with in neo-classical economic literature. The basic requisites of non market valuation in the modern day context of environmental

The second sub section particularly concentrates on studies related to valuation of health costs of air and vehicular pollution and estimation of benefits therefrom. The chapter reviews papers by Gerking and Stanley (1986), Ostro, et al., (1999) which used the household health production model for the economic analysis of air pollution and health. In the Asian context, important studies include Alberini and krupnick (2000), Murty, et al., (2003), Sengupta and Mandal (2004), Gupta (2006), Choudhury and Imran (2010). All the studies referred to, except Sengupta and Mandal (2004), used the household health production model to estimate the benefits from reduction in air and vehicular pollution. The results of the studies show that substantial monetary benefits in terms of health can be reaped by reduction of air and vehicular pollution.

Chapter III 'Concepts and Definitions' contains an outline of concepts and definitions of various terms used in the thesis. A discussion on major vehicular pollutants and their impacts on human health are ensued here. Further, there are various terms related to health, environment, pollution etc., which have been applied in the thesis, many of which are beyond the lexicon of economics in the strictest sense of the term. Considering the multidimensional nature of the present problem, the researcher deemed it appropriate to discuss the meaning and implications of these terms in Chapter III.

Chapter IV 'Theoretical Framework and Methodology' contains a thorough discussion of the theoretical framework and methodological issues related to the present research problem. Theoretical constructs of neo classical approach to
environment and theories of non market valuation are introduced here. Methodological underpinnings of the household health production model and econometric application of Poisson regression and Tobit regression models, applied to estimate the health damage cost of vehicular pollution in the present study, are dealt with in this chapter. The sampling design for conducting a household health survey is also explained in this chapter.

Chapter V 'Motor Vehicle Growth and Air Pollution in Guwahati' outlines the topographical and environmental profile of the city of Guwahati and focuses on increase in vehicular traffic and deteriorating air quality of the city. The chapter is organized in three sections. Section I carries a brief about the geographical, environmental and demographic profile of Guwahati. An overview of various pollution threats faced by the city is discussed with particular emphasis on air pollution. Section II discusses the trend of motor vehicle growth in the city, district and State levels. Section III gives an idea of the changing ambient air quality profile of the city.

A study of the components of motor vehicle growth shows that motor vehicle growth is extremely high for the State as well as the district of Kamrup. The growth of vehicles has been particularly steep in the recent decade (1998-2008). The percentage annual growth rate of vehicles on road in the recent years i.e., between (1998-2008), in Kamrup is found to surpass the corresponding overall growth rate in the State. A major part of this motor vehicle growth is contributed by the high growth of personalized modes of vehicles like cars and two wheelers. Commercial vehicles like taxis are also becoming popular, especially in Kamrup, while the growth rate of buses is declining. Since city figures pertaining to motor vehicle growth are not regularly available, one surmises from the statistics provided by the Comprehensive Master Plan of Guwahati.
as well as the available district figures that motor vehicle growth in the city is continuing at a tremendous pace with cars and two wheelers leading the growth. The increasing growth of vehicles explains the high risk of vehicular pollution in the city. The deteriorating air quality profile of the city supplements the contention.

The present SPM and RSPM levels are often found to be above the prescribed NAAQ standards and frequently borders between 'high' and 'critical' ranges of air pollution in Guwahati, especially in the winter months. Of particular concern is the rise in RSPM level and other finer particulates as these are many times more likely to penetrate the airway and cause permanent pulmonary damage and cardiovascular problems. SO$_2$ and NO$_2$, although found to be below safe limits in Guwahati, generally show a rising trend and would be a potential area of concern if the increase in vehicles continues unabated.

Chapter VI ‘Survey Findings’ highlights the main findings of the household survey conducted to study the health impact of vehicular pollution on the residents of Guwahati. The problem of estimation of health cost damages of vehicular air pollution are dealt with in this chapter. The households in the sample were selected from four pockets in Guwahati. Three of these are areas where vehicular pollution is known to be high and a fourth is a relatively low pollution area. The former three are the study areas of the sample while the fourth served as the control area of the sample. Size of the sample is 270 households and health information of 620 members was gathered from these households. A multistage mixed sampling method was employed to select the sample.

Household survey indicates that continuing trend of urbanization appears to have impacted the average Guwahatian’s life considerably. With rising incomes and presence of high income inequities, the consumption pattern of households is visibly
changing. Today expenses on education, house rent and vehicle fuel are definitely rising and occupy a substantial share in the consumption basket, especially for the higher expenditure groups. While a high percentage share of expenses on vehicle fuel indicates an upward tendency of vehicle ownership; on the flip side, this also means increasing vehicular pollution. The relatively weaker economic classes seems to bear the brunt of this inequitable pattern of development not only monetarily in terms of a major chunk of their budget being spent on acquiring essentials like food, cooking gas, medical expenses etc., but in addition, they are also the worst sufferers of the negative externality of pollution; in this case, vehicular pollution. The vulnerability of the economically weaker groups to the onslaught of vehicular pollution is highlighted by the fact that the share of MPCE on air pollution related illness is the highest among the economically weaker classes as compared to the relatively economically better-off classes. The adverse health impact of vehicular air pollution is further corroborated by the fact that percentage share of expenditure on air pollution related illness in the study areas is higher as compared to the control areas.

Illness symptoms associated with vehicular air pollution in Guwahati are usually cold, fever, skin, eye problems, dry and scratchy throat, etc. which are definitely a cause of constant irritation but are not always perceived to be severe enough to restrict patient’s movement to bed. This is one of the reasons why average days stayed indoors owing to air pollution related illness is 3.5 days annually although reported duration of illness throughout the year records an average of 32.2 days. Children and the elderly appear to be the most vulnerable in terms of being affected by air pollution related illness. The total annual health cost damages valued in terms of work day loss and mitigating expenses in Guwahati, is estimated to be Rs. 104.03 for a representative person. The
health cost of vehicular pollution for the entire population of Guwahati is estimated to be a huge Rs. 51.69 million per annum.

7.2 Limitations of the Study

This section takes into account some of the limitations and constraints which could not be avoided in the course of the study. Thereafter, a discussion is initiated on the extent to which proposed objectives of the study were realized in the wake of practical constraints faced by the researcher.

The main limitations of the study in the researcher’s view constituted the following:

**Paucity of data** - The prime hurdle faced by the researcher in the course of the study is the shortage of relevant secondary information. There is a dearth of secondary information with respect to number of vehicles in the city, emission load of automobiles and relevant published data on health. Generation of background information was also not possible for the present study owing to feasibility considerations.

**Conservative estimate of health costs** - As already discussed in chapter 6, the present valuation of health costs of vehicular pollution provides a monetary measure of workdays lost and mitigating expenditures owing to vehicular pollution. This gives a measure of the Cost of Illness (COI) which is a part of the MWTP for a reduction in vehicular air pollution. Monetary valuation of the discomfort associated with air pollution related illness is not attempted in the present study. Other studies like Murty, *et al.*, (2003), Sengupta and Mandal (2004), Gupta (2006), Choudhury and Imran (2010) etc., also do not attempt estimating the monetary cost of discomfort owing to air pollution related illness. This is largely due to the practical difficulty of measuring the disutility of illness associated with air pollution; the methodology for measuring which
still remains unresolved in economic literature. Moreover, monetary estimates of averting expenditures are also ruled out in the present study as averting activities were found to be negligible. Therefore the COI measured here provides a lower bound estimate of the total costs of vehicular air pollution. However the researcher hopes that the modest attempt for estimating health cost will open up new vistas for further research.

A discussion on the extent to which objectives of the study have been fulfilled is carried out as below.

**Objectives of the study**

The specific objectives of the study were outlined as:

i. To observe the changes in the ambient air quality of Guwahati.

ii. To observe the trend of vehicular traffic in Guwahati.

iii. To approximate how much of air pollution is generated by vehicles in Guwahati.

iv. To study the impact of vehicular pollution on the health of the residents of Guwahati.

v. To estimate the health cost of vehicular pollution of the residents of Guwahati.

The first questions that a researcher is likely to face when dealing with the problem of vehicular pollution in a city is regarding the number of vehicles plying on the city’s roads, the rate of increase in vehicles over time and how much of air pollution in a city is generated by vehicles. More technically, the first task would be having information on the emission load of automobiles in the city and secondly, to estimate how increment in doses of specific pollutants (emitted from automobiles) is responsible for augmenting certain diseases, i.e., the dose-response relationship of pollutants to...
diseases. Having these information at hand would enable precise estimation of the
damage cost of affected population. This is as much as the ideal situation warrants
which is conditional on the availability of relevant information.

A fundamental lacuna in this regard, is that there is no well-maintained database of
available transport figures for the city of Guwahati. Annual data for registered vehicles
and vehicles on road exist only at the State and the district levels. Hence one can form
an idea about the growth of vehicles over time from these figures and figures provided
by the Comprehensive Master Plan document, but precise assessment of the number of
vehicles and emission loads for the city is not possible. For estimating the total
emission load from automobiles, information on number of vehicles of a particular
type, kilometers travelled per year, type of vehicle fuel (diesel or gasoline), service life
of vehicles of different types, yearly distance covered by different modes of vehicles
etc., are required. In the absence of such information, total emission from vehicles
cannot be approximated. Hence the study could tackle objectives II and III only to a
limited extent owing to a lack of background information.

To prevail over the shortage of information on vehicular emissions, the researcher
made use of the ambient air quality data available with the Assam State Pollution
Control Board. A trend analysis of the changing ambient air quality profile for a
number of years, and an overview of the sources of air pollution in Guwahati discussed
in Chapter 5 enables one to form a fair idea about air pollution trend in Guwahati. Data
clearly shows that SPM and RSPM levels are frequently higher than the national
ambient air quality standards and secondary sources corroborate that pollution from
vehicles are of utmost concern in Guwahati. From the discussion it is evident that
objective I of the study has been achieved.
To understand the impact of vehicular pollution and estimate the related health costs, a household survey was conducted in some pockets of the city as mentioned earlier. From the households, information on air pollution induced diseases was collected for those members who reported to be more exposed to outdoor air pollution. Results show that vehicular air pollution is indeed a great health menace to the residents of Guwahati and they suffered substantial losses from vehicular air pollution induced diseases in terms of work day loss and mitigating expenses. The estimated annual health cost (Cost of illness) of vehicular air pollution in Guwahati stands at Rs. 51.69 million approx. which indicates that much is to be gained in terms of health by adopting measures to control vehicular air pollution. From this it may be concluded that objectives IV and V of the study mentioned above, are satisfied.

7.3 Policy implications and Suggested Measures

It is evident from an analysis of the present research problem that estimation of the health costs of (vehicular) pollution in particular and environmental costs in general can be the first step towards internalizing costs and determining the price of pollution. Calculating costs and benefits of pollution reduction to society can help identify regulatory standards that are cost effective and economically feasible. When benefits of pollution reduction exceed costs, a case for policies favouring reduction of pollution is built in a particular setting, thereby dictating future regulatory measures. The damage cost assessment done in this particular study points towards benefits that can be reaped by reducing vehicular pollution from current levels to safe levels and upholds the need for control of vehicular pollution.
Some direct and indirect measures that can taken to control vehicular pollution are discussed here:

**Updated database**: An updated and well maintained database is the primary requirement in the formulation of concrete policies for control of vehicular pollution. Dearth of adequate information in regard to volume of vehicles and emission loads and other relevant data on health and environment pose biggest hurdles in assessing the level of environmental damage. Physical emission accounts of the automobile sector in particular and other industrial sectors in general can give a clear allocation of environmental costs. Cost internalization with the application of economic instruments such as taxes, user fees, emission charges etc. are feasible when physical emission accounts are used in conjunction with sectoral environmental cost assessment. Economic instruments like taxes, user fees emission charges etc. are some of the tools that can be considered for internalization of costs.

Other direct measures that can be taken up for controlling vehicular pollution include

**Inspection and Maintenance**: Periodic inspection and regular maintenance of vehicles can be one of the immediate measures that can lead to effective control of vehicular emissions in Guwahati. It has been observed that motor vehicle pollution emission norms are slack in Guwahati and there is frequent violation of emission norms. Experts are of opinion that with a proper system of inspection and maintenance in place, the emissions from automobiles can be reduced by at least 10 to 15 per cent. In Guwahati, the issue of inspection and maintenance is particularly important as there is a large fleet of old vehicles and no system of phasing out old vehicles is still in place. In the
existing set-up, periodic inspection and maintenance becomes the only practical device for controlling emissions from in-use vehicles.

**Implementation of vehicular emission norms:** As per the Auto Fuel policy of 2003, it was recommended that from April 1, 2010, Euro III equivalent norms for new vehicles—would be implemented throughout the country, including Guwahati. But in the present scenario in view of the problems stated above, there is no way of ascertaining the scope of implementation of the policy. To reiterate, the need of the hour is a disaggregated database of old and new vehicles as well as taking stock of the situation for assessing as to what extent the new specifications have been met. Only then can problem areas be identified and necessary actions taken.

**Economic measures:** In India, the general focus for reduction of vehicular pollution till now seems to have been on supply side measures like improving fuel quality, upgradation of technology and stringent regulation norms etc. In a city like Guwahati, there is a great potential scope for initiating demand side economic measures for achieving a high reduction of vehicular pollution. Economic measures have been found to be more flexible than regulations as “users are more likely to modify their behavior when confronted with fiscal incentives than with regulatory controls” (OECD, 1991).

One of the most popular economic instruments is emission charges which is effective in controlling emission in various countries. Emission charges are charges based on discharge of pollutants into an environmental medium like air. Vehicular emission charges could be based on the nature and age of vehicle concerned where older vehicles may be considered for levying higher charges. In cases where emission charges are not suitable, product charges on inputs can play an important role in environmental policy: Fuels used in transport can be subjected to charges for reflecting
the environmental damage cost. Other economic instruments that can be considered are deposit-refund systems and marketable permits etc. These measures of course, cannot be implemented locally without due mandate at the national level. However, Some other measures like congestion charges and road pricing can perhaps be considered for application at the local level.

Auto fuels: For controlling vehicular pollution in Guwahati, use of alternative fuels may be a case for consideration. CNG has been successfully implemented in Delhi, while the use of electric fuel driven vehicles in Kathmandu city have yielded better results in terms of air quality. Taking cognizance of local topography and unique environmental concerns in Guwahati, alternative fuels like CNG can perhaps be considered for implementation after due feasibility studies. However, this need to be exercised with caution as there are apprehensions today of CNG also being in some ways counter productive to health and precipitating climate change.

Public Transport System and Alternative Transit Modes: In a city like Guwahati, there is a great need for improvement of road transport infrastructure for developing the quality of public transport services like buses. Other alternative modes of public transport may be given due consideration for easing the burden off roads. The measures discussed till now are often directed to curb vehicular pollution by discouraging users through charges and regulation. While such measures are necessary, a comprehensive transport system also demands that the comfort and convenience of consumers of all economic strata be given due importance. This can be done by improving and overhauling the public transport system which in turn will lure away users from private vehicle use: “Buses as a mode of public transport have a potential which is yet to be fully exploited. Given the priority that they deserve, buses can
ensure safety, act against pollution and promote mobility for the poor and the not so poor" (Padam & Singh, 2001). However, the use of buses is yet again dependent on improved road transport and traffic engineering management.

In India, rail transit systems exist in a very few cities like Mumbai, Delhi (Metro) and Chennai. The option of revamping an alternative public transport system like the railways can be seriously considered in Guwahati. In around 2005, according to newspaper reports there were plans to introduce sky-trains as a mode of public transport in Guwahati which were to be funded by the Asian Development Bank. Till date, nothing substantial has come of it and probably things have taken a back-seat. Perhaps the idea can be mooted and feasibility options be reconsidered.

Therefore a comprehensive and cogent transport policy is the need of the hour for addressing the problems of urban transport which in turn will have unavoidable repercussions on air quality and public health, good or bad. The development model within the ambit of which policies are framed today, itself needs to be revisited. But as in India where even the best policies fail to work at times, due to lack of implementation, political will may be critical. For making a difference at the local level, mass awareness campaigns regarding vehicular pollution and its ill impacts may be organized involving citizens from all social strata, students and NGO’s, doctors, voluntary organizations and others who have a stake in amelioration of environmental and air pollution for sustainable development, health being an intrinsic part of it.
References


OECD, (1991), *Environmental Policy: How to Apply Economic Instruments*, OECD.


