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The Demand for Personal Travel in Developing Countries

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Discussion Paper

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INFRASTRUCTURE AND URBAN DEVELOPMENT PAPERS, Report INU 1

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DISCUSSION PAPER

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INTRODUCTORY NOTE

This study was conceived as the first of two phases of an investigation of the determinants of demand for personal travel, urban and rural, in developing countries. Phase I was intended to

a. apply the methods of modern consumer theory to the study of personal travel on the basis of available data sets suitable for the purpose: combining travel-related information on households or persons with information on their socio-economic, demographic and locational status and representing the rural as well as the urban population of the country.
b. propose a form of travel survey for developing countries that would allow travel data (including quantities, prices and purposes) to be correlated with socio-economic, demographic and expenditure data on households and would cover travellers as well as non-travellers.

Travel surveys can only be designed with a specific environment in mind. We chose that of India because Indian travel, rural and urban, is so well documented. While the focus is thus on one country, care was taken to dwell on aspects of travel survey design that should be of general interest. The discussion of the requirements and the format of a travel survey, in Chapter 3 of the full report, are omitted from this Discussion Paper because the topic is of more specialist interest than the rest of the report. The purpose of the omitted Chapter 3 is to assist those who have to advise or comment on, the design of travel surveys. Copies of the omitted chapter are available from the Infrastructure Department, PPR.

ABSTRACT

The sources of data that were to be used in this study (First Phase) were chiefly household expenditure surveys. Such surveys do not normally record the prices and quantities of travel (fares, frequency, distance and mode of trips). That type of information is the standard content of travel surveys which, however, often lack full information on household characteristics and on people who do not travel. Only two travel surveys are covered in this study, each of high quality (all India and Jaipur). The range of questions on which the study could expect to throw light in this first phase was therefore circumscribed by the data that one could expect to find in the available sources.

What are the major observable determinants of personal travel in town and country?

This arises from the need to predict the future use of (demand for) new infrastructure and services. Particular uncertainty surrounds the determinants of non-urban ('rural') travel. In the Bank's own experience, personal traffic on rural (including inter-urban) roads has been particularly difficult to predict accurately -- the normal case has been one of marked underestimation (while freight traffic has tended to be predicted with fair accuracy).

What determines the choice of transport mode?

The question is relevant to the provision of infrastructure and transport services and, to the effects of price or tax changes. Once, again, it is rural mode=choice which is least well understood.

What are the effects of changes in transport prices and taxes on household welfare and what is their incidence on activities? What is the range of values of the elasticity of expenditure in transport with respect to income (or Per Capita Expenditure), given the purposes of travel?

This relates to the distributional effects of changes in the cost of travel and the incidence of such changes on different kinds of activity (e.g., work, education, social activity).

Specifically, what is the impact of transport price and subsidy policy on the poor?

This is relevant to the social welfare targets pursued through transport policy.

What determines ownership of transport means?

This is directly relevant to forecasting demand for infrastructure and service (because of opportunities for substituting public for own=account service), and to the incidence of price and tax variations and of import policy on regions, income classes and activities.

Answers and significance.

The sources.

The answers are based on household expenditure surveys for Hong Kong, Sri Lanka, Thailand and Tunisia, and two Indian travel surveys (All India and Jaipur). Except for Tunisia, therefore all the data are Asian. This regional concentration may restrict the validity of the answers for the generality of developing countries: only further studies can tell.

The surveys that we analysed differ in coverage and detail: the most notable difference being between household expenditure and travel surveys. Some of the reported conclusions were suggested most explicitly by only one or two of the data sets but none are presented as conclusions of some general relevance unless they appeared consistent with (or not contradicted by) the information in the remaining data sets.

Main Findings.

What may be strategically the most important finding is the similarity in structure between urban and rural travel. The explanation of either is dominated by income and household characteristics. This dependence on similar, observable factors seems to us of great importance for demand

prediction, for urban and especially for rural travel facilities. The similarity of determinants--at least of determinants of trip generation -- and the virtual absence of any residual rural-urban differentiae of travel is particularly interesting because urban travel studies are easier to conduct and, in any case, much more common. Their results should be more readily applicable, after suitable transformation, to travel in other sectors than hitherto believed.

A considerable amount of travel takes the form of walking; and another substantial proportion, of travel by non-motorized means, notably bicycles (owned, for example, by 28 percent of Thai households and 25 percent of Sri Lankan households). Surveys that omit counting those modes will seriously underestimate total travel. They will also underpredict future demand as income rises or costs are lowered because mode choice is largely determined by income and cost of using the mode.

The major factors in trip generation are: travel to work; sale from and purchases for, production, and travel to the place of education. Contrary to conventional belief, these purposes also dominate rural travel (accounting in India for 75 percent of trips by rural households and 58 percent of kms travelled by them). Subject only to the modal distribution of these trips, changes in transport cost therefore fall largely on production, working and education activities.

Indian data suggest that the number of trips per household can be explained almost entirely by the number of workers and of young people in education. Such trips are translated into expenditure via the mode choices (including walking) which tend to vary with income. The results of the analysis of budget shares are consistent with this finding (in terms of the explanatory power of household composition combined with household income).

Modal choice, from the range of modes available, appears to vary essentially with expenditure per head, and trip purpose (e.g., to or from work as distinct from school). The mediating variable, however, appears to be the demand for speed: the time required for transitting the distances that tend to lengthen as one moves up in the income scale. An increase in the price of all (motorized) modes should lead to slower modes being substituted for faster ones, and ultimately to a change in location to shorten the distance to regular destinations and the required travel time.

Elasticities of expenditure on travel with respect to Per Capita Expenditure (PCE) were estimated for public and private transport, and major modes (e.g., bus). Separate short-run and long-run elasticities were estimated, the former, by holding vehicle ownership constant and the latter, by allowing it to vary. Long-run total travel elasticities, invariably above the short-run, fall in the range 1.3 (Tunisia, Hong Kong) to 2.0 (Sri Lanka). The expenditure elasticity for private transport long-run, is typically twice or more that for public transport. Over wide ranges of PCE the share of travel expenditure appear to be constant. Taxes (or price changes) falling equally on all paid-for-travel tend therefore to be neutral as regards different income classes. This is most clearly the case for public transport (elasticity closest to 1). Those falling chiefly on private transport, however, are progressive.

The study discovered no significant proportion of households in the lowest income classes devoting inordinately large shares of their total expenditure (say, over 10%) to transport.

A substantial proportion of the poorer groups spend nothing on transport (e.g., in Sri Lanka, half the households in the lowest 5 percent by PCE, record no expenditure on travel, and even in the 20-30 percentile by PCE, 29 percent spend nothing.) Travel subsidies are either unlikely to reach these groups, or, if large, are unlikely to raise their welfare significantly: the welfare effect is measured by the share of travel in household expenditure and for these groups it would have to rise from zero to some positive value if they are to benefit at all.

While uniform changes in travel cost appear to be essentially neutral as regards the income distribution they are not neutral in their sectoral incidence. They will therefore not be neutral in terms of certain objectives of development policy. Since trips to work and to school dominate travel patterns in rural and urban areas, taxes or subsidies on fares are taxes on work or on education. If such taxes (or subsidies) provoke no change in mode -- we assume modal choice in work trips to be relatively insensitive to limited changes in cost -- they will act like an income tax.

The study finds that after incomes (or rather PCE) have been controlled for, rural households (or households in the less developed areas outside towns) are more likely to own vehicles for travel than urban households. This may be seen as a reflection of differential provision with transport services. Increases in costs or taxes falling on the operation or ownership of such means of transport will therefore raise the cost of travel relative to income more for rural households than for those in towns. Evidence was also found that rural owners of vehicles spend more on repairs and maintenance relative to fuel than urban owners. To the extent that this difference can be traced to poorer infrastructure in rural areas (rather than a systematic difference in vehicle ages), measures that raise the cost of materials or vehicles will similarly discriminate against rural households.

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Chapter 1

Introduction and Reader's Guide

This is the final report on a research project on the demand for personal travel in developing countries. The work was inspired by the ignorance that currently exists about patterns of personal travel in developing countries, and particularly in the rural areas of developing countries. Not only do we not have a detailed understanding of rural tripping patterns, but we know so little that it was not even clear how to ask the right questions to discover what we needed to know. This project is an attempt to collect together what data already exist on personal travel in developing countries, partly as a prior exercise to the gathering of better data, and partly for its own sake, in order to somewhat reduce the level of ignorance.

Our major source of data is the household survey. Large numbers of developing countries have collected such data at some point, and although the purpose of the survey is typically to collect consumer expenditure data for weights for a consumer price index, such surveys often contain a significant amount of data on travel. In particular, total travel expenditure is usually measured, as well as expenditures on a range of modes. Data on household characteristics are also collected, sometimes including the ownership of vehicles. While such data are far from yielding a complete picture of travel, they can tell us a great deal that was previously unknown.

During the course of the research, we were fortunate enough to be able to obtain two other sources of data, both <u>travel</u> surveys from India. One is a survey that was added to the 32nd round of the Indian National Sample Survey in 1977-78, and gathered data from more than three-quarters of a million people from all over India. The other survey was carried out in the city of

Jaipur in Rajasthan by the Overseas Unit of the Transport and Road Research Laboratory who very kindly made the data available to us. These travel surveys made our research effort much more valuable than it otherwise would have been. Not only do they give us a good deal of information about travel patterns in one of the most important developing countries, but they produce empirical regularities that help us interpret the expenditure surveys and to perceive relationships that may well hold beyond the Indian context.

In order to make this report easier to read, we have brought the main conclusions to the early chapters, leaving the detailed analyses of each of the surveys to the end. Part Two of the report, Chapters 4 and 5, are concerned with the two Indian surveys. The NSS data are analyzed in Chapter 4, and although the data are far from perfect in the form that they became available to us, the Chapter is a key one in suggesting patterns to be looked for in the other surveys. Chapter 5 analyzes the data from Jaipur, and is perhaps the most successful of our studies, at least as far as constructing models; of course we know much more about urban travel patterns and it is therefore much easier to interpret such data. Part Three of the report presents analyses of expenditure surveys from Tunisia, from Thailand, from Hong Kong, and from Sri Lanka. In each chapter, we follow a more or less similar pattern, tabulating travel expenditures and vehicle ownership in relation to household characteristics, and then fitting simple regressions. Each of the chapters contains a summary of the main stylized facts from each.

For readers not interested in the detailed results from each of the surveys, Part One provides an overview. Chapter 2 contains the methodological background for the study, and summarizes the main findings so far.

(Chapter 3 is omitted from this Discussion Paper. As explained in the Introductory Note, it discusses suitable methods and the format for a travel survey, taking India as its example.) Part Two presents results of travel surveys in India. The basis for Chapter 4 is the travel module of an Indian household survey, covering the rural as well as the urban sector. Chapter 5 presents the results of an anlysis of travel in one Indian city, Jaipur, based on the survey carried out by the Overseas Unit of the British Transport and Road Research Laboratory. These are the only travel surveys in our data, and the only sources of information on travel quantities (such as trips and distances), with a full coverage of modes, including walking. The results of these surveys suggest hypotheses on the determinants of modal choice in the longer run, (when household location cannot be treated as exogenously given but is itself a chosen by the household), and other aspects of travel behavior that are reflected in household expenditures on travel. Part Three reviews the analysis of travel-related expenditures from household surveys from Hong Kong, Thailand, Tunisia, and Sri Lanka. The format followed in these chapters is to start with a description of the relevant features of the countries, followed by an analysis of household expenditures on travel by per capita expenditure classes, which is viewed as a more appropriate indicator of household welfare than is income. The analysis distinguishes, as far as is possible, rural and urban regions, as well as expenditures on the different travel modes. That is followed by a discussion of vehicle ownership (motorized and other), and travel regressions which consider the influence of different household characteristics on travel behavior. Long-run and short-run elasticities of travel expenditure with respect to total expenditure are computed for each country.

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Chapter 2

Overview: Aims, methodology, and results

0. Introduction

Little is known about patterns of personal travel in poor countries, and even less is known about travel in the rural areas of poor countries. Such ignorance makes it difficult for the World Bank to reliably assess transport projects in developing countries, and there are many policy interventions the consequences of which can only be guessed at. This study is an attempt dispel some of the ignorance. It offers nothing like a complete understanding of the phenomena, but instead uses existing data to assemble stylized facts that can help to reduce the margin of uncertainty.

The ultimate aim of the type of research reported here is the construction of a model of rural and urban travel behavior that has been thoroughly tested in a range of countries and that can be readily adapted for application to new environments. Since such models typically evolve from decades of interaction between theory and evidence, and since our current ignorance is substantial, it seemed best to collect what data existed rather than to evolve a sophisticated but possibly irrelevant theory, and then perhaps to mount an expensive special survey that would serve only to demonstrate the theory's inappropriateness. It is difficult to devise an informative survey without a rather detailed understanding of the phenomena to be studied, and it is equally difficult to theorize without any sense of the facts.

At the outset, it seemed that household budget surveys, which exist for a large number of developing countries, could provide useful data on personal travel, even if they are rarely designed with that aim in mind. Such surveys collect data on <u>expenditures</u>, frequently in great detail, so that to the extent that tripping costs money, it shows up in an expenditure survey.

Household surveys also collect a great wealth of data on household social, demographic, and economic characteristics, frequently including ownership of vehicles, so that both vehicle ownership and travel expenditure patterns can be linked to the household characteristics. In Chapters 6 through 9, we examine household budget surveys from four countries, Tunisia, Thailand, Hong Kong, and Sri Lanka; in Section 2.1 we review the general theoretical background for these chapters and explain what can and cannot be learned from the exercise.

As we proceeded with the research, we discovered the existence of other sources of data, two of them relating to personal travel in India. The Overseas Unit of the British Transport and Road Research Laboratory (TRRL) has been recently engaged in a study of transport in three second-order Indian cities, and has over the last three years undertaken household travel surveys for each of the cities of Jaipur, Vadodara, and Patna. Although these data are concerned only with urban travel behavior, the fact that they are explicitly concerned with travel makes them an invaluable supplement to the household expenditure data. The TRRL work was done at the same time as the research for this report, so that the full results of their surveys have only recently become available. It would have tipped our own research too much toward India and to Indian urban behavior had we devoted resources to the analysis of all three surveys, but it seemed important to examine at least one in some detail. The Jaipur data were available first, and Chapter 5 is devoted to their analysis. We are grateful to the overseas unit of the TRRL for providing us with the original data, and to the extraordinarily generous amounts of time they have given to helping us with our work.

The second source of Indian travel data is a special questionnaire or "block" attached to the 32nd round of the Indian National Sample Survey (NSS) in 1977-78. Questions about travel were added at the request of the Indian Ministry of Shipping and Transport and were administered to the full NSS sample, that is to more than 150,000 households, or more than three-quarters of a million people. Not only is this undoubtedly the largest travel survey ever conducted, but it covers rural as well as urban households, and it is set in the context of a full household expenditure survey that collected the full range of socio-economic characteristics of the travelers. The existence of these data was not widely known in India, even among those much concerned with travel behavior, and was only revealed to the principal investigator by chance. The NSS has recently published preliminary tables from the subsequent household survey, but the 38th round from 1983, the 32nd round tabulations are not yet available. However, the NSS have kindly supplied us with preliminary tabulations of the travel block, and Chapter 4 presents some results based on these tables. The tables that were made available to us were those designated by the NSS and the Ministry of Shipping and Transport prior to the survey, so that we had no opportunity to request special tabulations for this report. The raw data were not made available to us.

Neither the Jaipur survey nor the National Sample Survey data are ideal for the purposes with which we began; Jaipur is a purely urban environment, and the NSS data, although valuable, are not available for a full analysis. Nevertheless, the existence of these travel data, together with the expenditure data enable us to see more clearly the outline structure of travel patterns in both city and countryside. Section 2.2 below discusses

our approach to the travel surveys, and serves as a methodological base for Chapters 4 and 5.

The detailed results of our analysis are given in Chapters 4 through 9, with different chapters concerned with different surveys. While each chapter contains a summary of its main results, Section 2.3 in this chapter, provides an overview of all the empirical results taken together; it is a summary of what we have learned so far, and provides the best description that we can of general stylized facts about personal travel in both urban and rural areas of developing countries. The final section of the chapter, Section 2.4, summarizes the policy implications of our findings.

From the outset of the research, it was recognized that a synthesis of existing data could not answer all the outstanding questions about personal travel in developing countries, and that ultimately, more data would be required. An important part of the research was to use the existing data to learn lessons about survey design and about the questions that ought to be asked. Chapter 3 is an attempt to fulfil that need. It presents the outline of a design for a rural travel survey, focusing specifically on India, for which we have the best background information, but easily adaptable to other contexts.

1. What can be learned about travel from budget surveys?

Household budget surveys collect data on household expenditures, not on household tripping patterns, and we begin with a review of what this limited information can tell us about personal travel and about the effects on people of travel related policies. At the most obvious level, certain types of trips, for example bus trips, cost money, so that expenditure on bus

fares by different households, while it cannot tell us about distances or number of trips, can tell us what types of household use buses, whether they are rich or poor, whether they are rural or urban, what their occupations are, how bus use relates to vehicle ownership, and how much each type of household will be affected by an increase in the price of bus trips. Household surveys can tell us which households spend nothing on travel, or spend nothing on certain types of travel, for example on private travel. Households that do not use a particular mode are not affected by a marginal change in the price of that mode, so that analysis of who spends and who does not spend tells us who will and who will not be affected by changes in prices such as would follow a change in the level of transport subsidies. Much of our analysis will therefore be concerned with the determinants of travel expenditures, with who travels, where they are in the income distribution, where they live, what they do, whether they are employees or students, and whether or not they own vehicles.

This approach to the expenditure surveys is one that bypasses many of the traditional concerns of travel demand analysis, but is nevertheless entirely consistent both with it and with standard models of consumer choice and welfare. To see this, consider a model of consumer behavior of the type popularized by Lancaster (1966) or Becker (1965) in which choice is exercised over "commodities," z_i say, which are themselves produced according to "household production functions" that require market goods and time as inputs. Formally, we would have preferences characterized by a utility function $\phi(\ )$, so that utility

$$u = \phi(z_1, z_2, \quad \ldots\ldots \quad, z_m) \tag{1}$$

is maximized subject to production constraints

$$z_i = f_i(q_{1i}, q_{2i}, \ldots\ldots, q_{ni}, t_i) \tag{2}$$

where t_i is the time devoted to producing z_i from the n market goods q. The budget and time constraints are written

$$\Sigma\, p.q_i = x \qquad\qquad \Sigma\, t_i = T \tag{3}$$

for total outlay x and time T. The price vector of market goods (possibly including leisure) is p, and q_i is the vector of market goods devoted to the production of the ith commodity.

Travel behavior can be fitted into this very general framework in a number of different ways. To the extent that travel generates no utility per se, for example travel to work, it can be included as an input to one of the production functions and a user of time. Other types of travel, for example social and leisure trips, may well be taken to be z-goods in their own right. Such standard concerns of travel demand analysis as modal choice can be thought of as choice of the most efficient technology for producing travel using commodities. Expenditure surveys, however, tell us nothing about the z's or the t's, so that they have to be "concentrated" out of the model. This can be done in two stages. First, remove the z's by substituting (2) into (1) to get utility in terms of market goods and time,

$$u = \phi\{f_1(q_1, t_1), \quad \ldots\ldots\ldots\ldots, \quad f_m(q_m, t_m)\} \tag{4}$$

to be maximized subject to (3) without reference to the z's. At the next stage, fix the allocation of market goods to activities at arbitrary levels q_1, q_2, ... q_m, and maximize (4) with respect to the t's subject to the

time constraint. The optimal t's are functions of the (arbitrary) settings of the market goods, so that substitution of these functions into (4) will lead to utility as a function of T and the m vectors q_1, q_2, ... q_m. But the price of a market good is independent of the commodity it is used to produce, so that, by the Hicks composite commodity theorem, the consumption of each market good can be taken as a composite in the utility function. Hence, dropping the time endowment T, we have a standard utility maximization problem of the form: maximize

$$u = v(q) \text{ s.t. } p.q = x \tag{5}$$

In such a model, we concern ourselves not with trips, distances, or time traveled, but with fares, tickets, gasoline, or whatever is actually bought.

What then can we still achieve with such a skeletal model? Note first that it is <u>applicable</u> to the household survey data, since we can estimate the relationship between expenditure patterns, income and socio-demographics without recourse to special travel surveys. But applicability is of limited interest unless useful results emerge. Our methodology below is based on the analysis of <u>expenditure shares</u>; in terms of the foregoing notation, the expenditure or budget share for good i is defined by

$$w_i = p_i q_i / x = \psi_i(x, p_1, p_2, \ldots\ldots, p_n) \tag{6}$$

Note that the budget shares are directly observable, even when neither quantities nor price are separately available. They are also extremely useful for the evaluation of welfare changes, as the following considerations show. Define the cost-of-living, or more simply cost function, $c(u,p)$, as the minimum amount of money that is necessary to achieve utility

level u when prices are p, i.e.

$$c(u,p) = \min_q \{p.q \text{ such that } v(q) = u\} \tag{7}$$

The cost function is the central link between behavior and welfare. Suppose that a policy change shifts the price vector from its original level p^0 to a new value p^1, say. Then we can evaluate the welfare cost of this price change with reference to one or both of the standard consumer surplus measures, the compensating variation

$$CV = c(u^0,p^1) - c(u^0,p^0) \tag{8}$$

or the equivalent variation

$$EV = c(u^1,p^1) - c(u^1, p^0) \tag{9}$$

where u^0 and u^1 are the welfare levels before and after the price change.

Much of the literature on applied welfare economics is concerned with methods of approximating (8) and (9) under alternative assumptions about what is or is not known. One of the simplest and most satisfactory approaches is based upon the budget shares. By Shephard's Lemma, see for example Deaton and Muellbauer (1980), we can write

$$w_i = \partial \ln c(u,p)/\partial \ln p_i \tag{10}$$

Hence, to a first approximation,

$$CV/x \simeq \Sigma\, w_k{}^0 (\ln p_k{}^1 - \ln p_k{}^0) \tag{11}$$

where $w_k{}^0$ is the budget share prior to the price change. We shall discuss the validity of this approximation below, but for the moment shall assume

that it is accurate, at least for small price changes. If so, equation (11) tells us that w_k^0 is the percentage of total outlay that an individual or household requires to compensate for a one percentage price increase, or equivalently, it is the price elasticity of the cost-of-living with respect to the ith price. Hence, the distribution of budget shares in the population tells us who gets hurt by price increases and who benefits from price reductions and by how much, at least when these price changes are small. We can tell what will be the regional effects of price changes, the effects as between cities, towns and countryside, the effects on the real distribution of income, the effects as between families of different sizes, and the effects on families with workers and with students. We can also tell whether the costs of a policy change are trivial or significant. It is our belief that such issues are at the heart of much policy making in developing countries. The price distortions and revenue costs associated with subsidies are recognized, but policy makers and politicians are apprehensive about the distributional consequences of price increases. It may be generally agreed that price control and subsidization of bus service may be responsible for poor service, inadequate maintenance, and less than optimal use of paratransit vehicles, but if price control is to be abolished, it is essential to know who will be hurt by the change, by how much, and whether there exist compensating policies that will cushion the economic and political consequences. The provision of this sort of information is one of the main objectives of Chapters 6 to 9 below.

What happens if the price changes are not small? In such circumstances, an accurate assessment of compensating or equivalent variation requires knowledge, not just of demands, but of price elasticities. One approach is

to take one further term in the expansion (11); for a single price change this yields

$$CV/x \approx w_i^0(\ln p_i^0 - \ln p_i^1) + (\theta_i/2)(\ln p_i^1 - \ln p_i^0)^2 \tag{12}$$

where θ_i is the utility compensated derivative of the ith budget share with respect to the logarithm of the ith price. It is not difficult to show that

$$\theta_i = w_i(1 + \eta_{ii} - w_i) \tag{13}$$

where η_{ii} is the compensated own-price elasticity of the ith good. Note that θ_i can be positive, negative, or zero, so that the original approximation is not necessarily an under- or overestimate as is always the case when the CV and EV are approximated by the cost of the price change at the original or new bundles. Note too that the approximation (11) is exact when the budget shares are unaffected by the price change, an occurrence that is much more likely than quantities being unaffected by price changes. Indeed, (11) is closely related to the Tornqvist (1936) price index, which as Diewert (1981) has shown, has very desirable approximation properties. There are therefore very good grounds for assessing welfare changes with reference to budget shares.

The use of the budget share criterion implies that individuals that do not spend on a good are not affected by changes in its price, so that, for example, cheaper buses, or better roads so that buses can run at all, will have no welfare benefits for those who travel by foot. This is sometimes objected to on the grounds that fare subsidization or road-building will create travelers who did not use the mode before and that these new travelers may benefit substantially from the change in policy or provision. Note

that this argument can only ever be correct if we are talking about non-marginal price changes. The rate of change of welfare with respect to price is zero for consumers that buy nothing of the good, and it makes no difference whether or not they are at the point where any further reduction in price would cause them to become consumers. When the price change is not infinitesimal, and when consumption becomes positive after the price change, there will be a positive welfare gain. However, this cannot be large unless the new consumption level is itself substantial; for example, in the approximation (12), the first term is zero, so that large welfare gains depend on the second term being large. Figure 2.1 illustrates the situation where none of the good is consumed at a price higher than p_i^*; this might be the critical bus fare that would induce an individual to ride the bus rather than walk to work. The logarithm of the cost of living is shown on the vertical axis, and it is flat for prices above p_i^* because above that price none is purchased, and the cost of living is independent of p_i. Suppose that a subsidization scheme is proposed that will reduce the price from p_i^0 to p_i^1, with a reduction in log costs (fractional change in the cost-of-living) of BA. As drawn, the cost function is piecewise linear, but not linear, so that the approximation (11), which is zero, understates the welfare gain. The alternative procedure of evaluating the welfare change using the <u>new</u> budget share, which is the slope of CD, gives a welfare change of AE which is too large. But this tells us what we need to know; if the new budget share remains small, the welfare gain cannot be significant. In summary then, unless the subsidization policy goes far enough to generate a sizeable budget share for the subsidized good, converting sub-marginal consumers to marginal consumers will have little impact on their welfare.

In Chapters 6 to 9 below, we examine household expenditure surveys from Tunisia, Thailand, Hong Kong and Sri Lanka, and although the details of the calculations vary from survey to survey depending on data availability and factors special to each country, we follow the same general scheme throughout. In each case, we examine travel expenditures and vehicle ownership in relation to living standards, household composition, the numbers of earners and students, the location of the household, the occupation and educational levels of its members, and vehicle ownership. The first step is to give a tabular overview of the main independent variables, particularly living standards, and household composition. Living standards are typically measured by per capita total household expenditure, PCE, and we describe the distribution of PCE over households and over regions and sectors. We then examine travel expenditures in relation to total household expenditure, first in total, and then by as many modes as the data permit. In all cases it is possible to distinguish between expenditures on public and private modes, though disaggregation beyond that is country and survey specific. We also present data for the fractions of households spending anything on travel and on the various modes of travel, and on how this fraction varies with levels of living. Our final set of cross-tabulations are concerned with vehicle ownership, the numbers of households owning bicycles, motorcycles and cars, and how ownership varies with household characteristics. All of our surveys except Hong Kong, which is entirely urban, permit us to distinguish between urban and rural households, and much of our effort is devoted to examining the differences in travel patterns between the two sectors.

Cross-tabulations are excellent tools for preliminary data analysis, and they are particularly valuable for giving information about something so little studied as personal travel in developing countries. Indeed, there are a very large number of tables in this report simply because, as far as we know, such data have never previously been examined. However, cross-tabulations are very difficult to use to examine high dimensional relationships, so that, for example, it becomes very difficult to tell whether travel expenditures or vehicle ownership is lower in rural than in urban areas just because rural incomes are lower or because there is something inherently different about rural travel. We therefore summarize the joint distributions of characteristics and travel patterns by means of regression functions fitted to budget shares with household characteristics as right hand side variables. Vehicle ownership is similarly modeled by fitting either a probit or a logit equation that models the probability of ownership in terms of household characteristics. The important relationship between travel expenditures and vehicle ownership is dealt with by estimating two sets of travel regressions, one that includes vehicle ownership dummies as explanatory variables, and one that does not. The econometric and technical aspects of these regressions are discussed in an appendix to this chapter. However, we interpret the two sets of regressions as representing long-run and short-run travel behavior. The short-run regressions include the ownership variables, and are supposed to represent the regression function linking expenditures to household characteristics with vehicle ownership held constant. The regressions that exclude the ownership dummies attempt to capture the relationship between characteristics and travel including not only the direct effects on travel patterns, but also the indirect longer run

effects that operate through changing ownership patterns. To give an example, the total expenditure elasticities of private and public transport expenditures may be rather similar in the short-run, while the former is typically much greater than the latter in the long-run. With vehicle ownership fixed, the effects of extra income are limited to more intensive use of existing vehicles, while when vehicle ownership is allowed to adjust, private transport will be substituted for public, and expenditure on private modes will expand along with ownership.

2. The role of the travel surveys

In this study, we have only two surveys that were explicitly organized to collect data on travel patterns, one from Jaipur, and one from all of India. The former is confined to urban households, and the latter is available to us only as a set of cross-tabulations. Our analyses of these data, reported in Chapters 4 and 5, are therefore constrained by what is feasible, and it is unnecessary to preface the results with a general methodological review of travel demand analysis. However, since the Jaipur and Indian data sets are different from one another and each are very different from the expenditure surveys, we give a brief description here of how we see the different types of data fitting together to tell something like a coherent story. Travel surveys, unlike expenditure surveys, collect data on the *physical* characteristics of trips, so that we know for each household how many trips were made, how frequently, by what mode, over what distance, taking how long, at what cost, by whom, and for what purpose. Such data allow us to fill in the "technology" of household production, and to trace the detailed behavior that lies beneath the expenditure patterns. We can also look at

trips that do not generate expenditures, particularly trips on foot and by bicycle, and these are very much more important in poor countries than they are in the United States or in Western Europe. An understanding of trip characteristics also enhances the value of the expenditure analyses; if patterns of expenditures can be given simple explanations in terms of trip generation and modal choice, then we can have greater confidence in the predictability and generality of the results from the expenditure surveys. It is also much easier to interpret travel expenditures once we have some evidence, even evidence from a different place, about the types of trips that generate cash outlays, and it is for this reason that we look at the travel surveys first.

For both our travel surveys, we analyze the data in the standard way, looking first at trip generation, and then at trip characteristics, particularly distances, times, and modes. In the Jaipur survey, with individual household data, we can match up employment trips with employees and student trips with students, while for the all India data, we examine the distribution of trips by purpose, with variation provided by data from different states and from urban and rural sectors within states. Although employment and educational trips account for a very large share of total trips, we pay considerable attention to the generation of other types of trips. Both data sets distinguish a large number of modes, so that it is possible to analyze the variation in mode by purpose and by levels of living. In the NSS data, we pay particular attention to differences in mode use between urban and rural, and to the respective roles of walk trips, bicycle trips, and trips involving motorized travel. For the Jaipur data, we develop a simple model of location and travel that characterizes the joint distributions of income,

and of distance and time spent travelling. The model appears to account quite well for many of the regularities in the data, and can be used to provide a very simple account of mode use and vehicle ownership. In Jaipur, it is also possible to trace out the implications for expenditure patterns of the tripping patterns observed in the data and predicted by the model. We can therefore estimate the same type of long-run and short-run travel expenditure regressions that are used for the non-travel surveys, with the added advantage of being able to interpret the results in terms of the known tripping patterns that lie beneath them. Information on expenditures is also available in the NSS data, and it is possible to examine the relationship between travel expenditures and income levels, and between expenditures and rural travel facilities. The travel surveys therefore provide us with a great deal of information that cannot be gleaned from the budget surveys, but they also tell us what to expect from expenditure surveys, and allow us to interpret them in the absence of physical data on tripping patterns.

It is perhaps worth noting at this point that this report makes little or no use of conventional modal split analysis. Partly, this is a matter of data; it is only in the case of Jaipur that it would have been *possible* to estimate the standard random utility models of the individual household level. However, even in the case of Jaipur, the modal split models did not seem to us to be very useful for what we wanted to describe. One immediate difficulty is that most individuals in Jaipur have little practical choice on a day to day basis. Once we know where a person lives, where he or she works, and what the transport system looks like, mode use is not likely to be a matter that is in much doubt. Once we know that someone lives a great distance from work, it is no great surprise to find that he or she does not

walk to work. But it is exactly this kind of conditional choice that modal split models seek to explain. In the longer run, there is much more choice, since individuals can choose where to live and where to work, and the city transport system, while playing a part in these choices, will also adapt to them as planners respond to needs and to profits, and private entrepreneurs to the latter. In this sense, transport facilities, and travelers origins and destinations are simultaneously determined within a system that determines the shape of the city and the travel patterns within it. While it is absurd to suppose that every household is always optimally located in relation to work, schooling, and transport facilities, we should surely expect household surveys to reveal a good deal of this long-run behavior. If so, modal split analysis is being used to explain one endogenous variable, the choice of mode, by means of other equally endogenous variables, the household's location and the transport facilities available to it. Because of the simultaneity, parameters from such a model will not reveal even the true conditional probabilities, but even if they did, they would not tell us what to expect when fare structures are changed or new modes made available, because they do not address the consequences in terms of changes in residential and work locations, nor reactions in the uncontrolled sector of transit supply.

Even so, it is clear that the specification of a fully satisfactory model of urban structure and transport patterns is well beyond the limits of current knowledge. The practical question is how it is possible to cut into the simultaneous structure and retrieve at least some relationships that help us understand what is going on and are useful for predicting the outcome of policy interventions. The model developed in Chapter 5 for Jaipur

represents some first steps in that direction, and while it is clearly in need of elaboration and further testing, it seems to be of some help. There is a clear need for further *theoretical* research on urban models that makes clear predictions about the relationships between household income, distance, and time spent travelling, and can do so without unwarranted assumptions about monocentrality or about where rich and poor people tend to live.

3. Summary of the empirical results

Each of the subsequent chapters contains a summary that brings together what seemed to us to be the most important findings. Here we try to bring those results together, and attempt to draw some general conclusions about personal travel in developing countries. In doing so, we are very conscious of the limited range of countries covered in this report. India, Sri Lanka, Hong Kong, Thailand, and Tunisia, are a rather odd collection of countries, we have no representation from Latin America, and only one country from North Africa. Even so, there is a large amount of data contained in the chapters below, and while there is very much still to be learned, we believe that our results add a great deal to the very little that was previously known. We hope that these data will be useful even to those who have little direct interest in the countries that we study. There are many common stylized facts, some of them seem likely to be true in other places at similar income levels, and our results can serve as a pattern to be modified in different contexts.

Most of our findings are phrased in qualitative rather than precise quantitative terms. In particular, we are extremely wary of using our results to make precise cross-country comparisons, for example of the share

of the budget devoted to travel, or of fractions of households owning vehicles of various kinds. Household survey instruments vary from country to country, and even the same instrument can be implemented differently in different countries or in different parts of the same country. There is no uniformity whatever in the surveys that are used in this report. All were carried out for other purposes, and each was developed independently by a different agency in a different country. Nevertheless, some data are relatively easy to collect and are likely to be quite uniform across countries; bicycle ownership is an example where the concept is clear and the evidence can readily be checked. But the quantities used in this report span the whole range of collection difficulty. Bus fares are well-defined, but rely on some sort of recall. Total or per capita household expenditure varies with the treatment of imputations, with the recall period, and with the degree of disaggregation adopted in the questionnaire. Expenditures on private travel may be one of the most difficult items to measure; not only is the depreciation element of user cost almost impossible to measure, but the outlays on repairs and running costs are sporadic and not always accurately recalled. To assemble a statistical abstract of international data on personal travel would require the use of a common instrument in different countries, together with very high quality international control and cooperation. In the mean time, it is still possible to say something useful about qualitative patterns.

Rural versus urban patterns of personal travel

At the beginning of the research, we had very little knowledge about rural travel patterns in developing countries. However, there seemed to be a general belief that rural travel is very different from urban travel, that

trips are very much less frequent, very much less dominated by trips to work and trips to school, very much longer, and likely to be characterized by multiple as opposed to single purpose. In the event, this characterization, although not without elements of truth, is quite misleading. Our findings suggest that personal travel in rural areas is very similar to urban travel, at least in general structure. The Indian NSS data are the most explicit on the issue, and they suggest that trip *generation*, if not trip *characteristics*, are very similar in urban and rural areas. The expenditure surveys, though silent on trip numbers, are entirely consistent with the Indian evidence.

In more detail, the Indian picture looks something as follows. The number of travelers per household is only slightly lower in rural than in urban areas, 0.8 as opposed to 0.9 travelers per household over a seven day period. In both sectors, the vast majority of trips are either trips to work or trips to school, and most are made on a daily basis. The major difference between the two sectors lies in mode use. Very few of the daily trips in the countryside use motorized transport, most are made on foot, or by bicycle. A great number of urban trips are also made on foot or on bicycle, but there is much greater use of buses, minibuses, and other transit vehicles in order to get to work, and to a somewhat lesser extent, to get to school. Motorized commutation is essentially absent from the Indian countryside. However, the existence of rural commutation *trips* suggests that the differences in mode use are more a matter of availability, or ultimately income levels, than of any deep structural difference between rural and urban travel. We would therefore expect differences in urban and rural travel *expenditures* to be largely explicable by urban and rural income differences,

something that is true in India and is largely borne out by the travel expenditure regressions from Tunisia, Sri Lanka, and Thailand. In all of these countries, the differences between sectors in the patterns of travel expenditure can be explained by income and household characteristics without resort to any unexplained urban/rural difference.

Because so many rural trips are made on foot, surveys that collect data from travelers on board motorized vehicles will give an incomplete and misleading picture of rural travel. Firstly, the purposes of motorized travel in the countryside are largely non-work and non-school, not because school and work trips do not predominate, just as they do in the cities, but because such trips are nearly all made on foot or by bicycle. By contrast, many bus passengers in cities will be on their way to work. Secondly, passenger surveys give a misleading picture of trip distance. For each mode, whether walk, bicycle, bus, or whatever, rural trips are longer than urban trips, but because a much higher fraction of rural trips are on foot, which is the shortest distance mode, rural trips are on average *shorter* than urban trips, something that would never be detected from passenger surveys.

Personal travel expenditures in the household budget

The share of the household budget devoted to travel varies from survey to survey and we cannot tell how much of this variation is real and how much reflects varying statistical practice and survey design. The NSS data suggest that 2.6% of rural budgets and 2.8% of urban budgets are devoted to personal travel. Rural and urban Tunisian households devote 3.0% and 4.2% of their budgets to travel with a countrywide average of 3.I% In Sri Lanka, the share is 3.2%, and the variation from urban to rural at 4.4% to 3.0% is almost identical to that in Tunisia. Thai households devote 4% of their

budgets to travel, and the urban rural split is 5.6% versus 3.6%. In Hong Kong, which is highly urbanized and relatively wealthy, the travel share in the budget is 5.7%. Finally, in Jaipur, the survey records a very high 8.5% of household income. We regard the Jaipur figure as being out of line with the others, though as discussed in Chapter 5, it is hard to see any obvious source of bias in the measurements. But Jaipur apart, there is a good deal of uniformity in these figures, especially given the variation in survey design. Moreover, the range is a plausible one and may well extend beyond the countries examined here; for example Musgrove (1978, Table 4-2) reports transport shares in the urban areas of Colombia and of Venezuela of 3.2% and 7.1% respectively.

Pervasiveness of travel expenditures

Although many trips in developing countries are made on foot and involve no cash outlays, the vast majority of households spend something on travel. In Tunisia, 65% of households report travel expenditures, in Thailand and Sri Lanka, it is 75%, and in Hong Kong, the ratio is 95%. Note also that surveys have limited recall periods, so that the true figures are at least as large as those given; some households that have spent money on travel at some point will record no travel expenditures over the survey period. Note that while these figures apply to <u>all</u> forms of transport, it is expenditures on <u>public</u> transport that are widely distributed. Although the rich may spend considerable sums on private vehicles, there are few of them, and most households do not spend anything on private transport. For example, although 75% of Thai households record travel expenditures of some sort, only 19% record expenditure on private modes.

Travel patterns and living standards

For most of the surveys examined here, the share of the budget spent on travel rises as we move from poorer to richer households, so that the estimated total expenditure elasticities are typically larger than unity. However, it is frequently the case that the share devoted to travel is roughly constant over a wide range of the income distribution. For example, in Hong Kong, nearly all income groups spend 5% of their budgets on travel and the mean share is only pulled up by the fact that households at the very top of the income distribution spend very large sums on private travel. Similarly, in Jaipur, nearly all income ranges spend the same fraction of their incomes on travel. However, in all the surveys, the expenditure split between public transport and private transport tips towards the latter as household incomes increase and expenditures on vehicle operation rise rapidly with income levels. Hence, even if, as happens in Tunisia, the share of public transport remains constant at all income levels, private transport rises rapidly with total outlay and total travel expenditure is income elastic. Translated into numbers, we find a total travel expenditure elasticity for Tunisia of 1.3, with 1.0 for public and 2.0 for private. For Thailand, the figures are 1.7 overall, and 1.3 and 2.8 for public and for private. In Hong Kong, the total elasticity is 1.3, with 0.9 for public and 3.1 for private. In Sri Lanka, the elasticity of private travel expenditures; of which there are very little, is 4.4, that for public transport is 1.4, and the total 2.0. In India, using rather different procedures, we estimate a total expenditure elasticity for personal travel of 1.4.

The physical tripping patterns underlying these elasticities can only be assessed from the Jaipur and Indian surveys. What appears to be the case is

that trip generation is *relatively* insensitive to living standards, and that the additional expenditure is largely generated by a switch from cheaper to more expensive modes. Work trips are sensitive to income only in the obvious way, that to earn an income it is necessary to go to work. There is some relationship between the probability of staying on at school and family income that induces a positive relationship between household income and the number of student trips. There is some evidence that other trips, particularly social and entertainment trips, are more income elastic. Even so, it is the upgrading of transport mode with income that maintains the rise in travel expenditures in proportion to, or more than in proportion to household incomes. As household incomes rise, pedestrians take to bicycles, then to buses or minibuses, to taxis and rickshaws, and finally to private vehicles, first motor-cycles and scooters, and ultimately motor cars.

Poverty and personal travel

Special attention always focusses on the travel needs of the poor, particularly in discussions of fare policies in urban transit. There has been some suggestion, particularly from the TRRL Indian studies, that very poor people spend very large shares of their budgets on travel, something that is of considerable concern in an environment such as New Delhi where many poor households have been relocated at some distance from the city center. In the surveys analyzed here, there is no evidence that the long-term poor either choose or are forced to spend large shares of their limited resources on travel. For example, if we define a great deal as more than 10% of the budget, we find that only a very small fraction of the poorest households, defined for example as being in the bottom decile or quintile, spend a great deal, four or five percent being typical figures. The difference between

our findings and those of the TRRL result from our use of total household expenditures to characterize living standards and their use of incomes. We believe that expenditures provide a more reliable guide to living standards than incomes, if only because the latter tend to be very variable. Households that report the lowest incomes over a limited period of time are likely to be relatively well off; zero or even negative income indicates the presence of wealth, and poor people have little or none. But wealthy individuals with temporarily low incomes go on consuming in the usual way, and will record very large shares of income on all sorts of things including transport. Indeed, there are two or three dozen households in the Jaipur survey that record no income over the survey period but do record travel expenditure; they have infinite budget shares! It is clear that to assess whether or not the poor find transport costs a great burden, it is necessary to find some way of "smoothing" income fluctuations. Switching to consumption is the obvious method, and once we do so, we find no evidence of excessive transport expenditures among the poor.

As far as other travel characteristics of the poor are concerned, they are very much as one would expect. Poor people tend to walk more than do rich people, they ride bicycles and buses, but rarely taxis or cars. As a consequence, substantial numbers of the poorest do not spend anything on transport. For Sri Lanka, Tunisia, and Thailand, about a half of households in the bottom decile of the consumption distribution spend nothing on travel. These people are not reached by subsidized fares and therefore cannot benefit from them.

Vehicle ownership and travel patterns

The ownership of motor cars is not a major factor in most poor countries, though of those countries examined here, Tunisia appears to be a notable exception. However, other vehicles, notably bicycles and motor-cycles, are widely owned, though the numbers vary widely from country to country and from region to region within countries, see in particular Thailand where topographical considerations appear to play a major role. Not surprisingly, household income is the major determinant of vehicle ownership, though we also generally find that when *per capita* household expenditure is held constant, larger households are more likely to own vehicles. The ownership of bicycles appears to first rise with income and then decline, as households move on to better, and more expensive modes, particularly motor-cycles and cars. Bicycles are a very important mode in several of the surveys examined here. We do not have data on bicycles for Tunisia, for Hong Kong, or for the All India data, but they are owned by most households in Jaipur (67%), and by substantial fractions in Sri Lanka (25%), and in Thailand (30%).

It is customary in the travel demand literature to examine the effects of vehicle ownership on travel patterns, though the results tend to be somewhat obvious. Owners of vehicles tend to use them, and spend money on maintaining them, while non-owners do not. Slightly more seriously, it is possible to analyze the effects of income growth on tripping patterns with and without vehicle ownership held fixed. Again not very surprisingly, we find that holding vehicle ownership fixed tends to reduce the income elasticity of private transport and to increase that of public transport. However, in all the countries we examined, ownership of vehicles of all

sorts is very responsive to household income, so that if ownership is not held constant, increases in income generate vehicle ownership and use, raising the income elasticity of private travel and reducing that of public travel.

Distance, speed, and mode

One of the most interesting findings from the Jaipur data is that there is a systematic positive relationship between household income and distance traveled to work. There are general theoretical reasons to expect this. In the simple model developed in Chapter 5, we assume that distance from work is itself desirable, but involves a cost, namely fares and time, so that richer households can afford more distance. But even without this, and with no residential segregation of rich and poor households, we should still expect rich individuals to travel further to work on average, essentially because traveling further costs the same for all, while the benefits of being able to seek a distant job are greater for those with higher wages. In Jaipur, as well as in the cities of Vadodara and Patna, also studied by the TRRL, the additional distance traveled by better-off households does not result in any additional time spent traveling. In other words, better-off individuals travel greater distances at a greater average speed by faster, and generally more comfortable modes. It is possible to think of the range of possible travel modes as facilitating this upgrading of travel that accompanies rising incomes, so that mode choice can be explained largely by the requirement that velocity increase with income. In Jaipur, the major modes, in order of increasing speed, are walk, bicycle, bus, and motor-cycle, and choice patterns, as well as ownership patterns, can largely be explained by people moving up this ordering as their incomes increase.

Interestingly, the other cities studied by the TRRL, Vadodara and Patna, were chosen because their transit systems are each very different both from each other and from that of Jaipur, so that patterns of mode choice are superficially rather different. However, the relationship between income and velocity is virtually identical in the three cities, so that what the modes seem to matter little, provided the range of speeds is available.

Sex bias in transport

During the course of this research it became clear to us that travel modes are not always neutral between sexes. The most obvious examples are physical: it is difficult for Indian women dressed in saris to ride bicycles, with or without a cross-bar. As we have seen, the bicycle plays a very important part in personal transport in India, and yet the presence of a bicycle in the household confers mobility much more to men than to women. There may well be substitute modes for women in some circumstances, so that women appear to be heavy users of cycle-rickshaws, but costs are far from being the same, and the substitution is likely to be highly imperfect. Other examples of sex bias have more to do with "custom," and it was argued, for example, that many Indian men would regard it as "unsafe" for their daughters to travel far to school, at least once they had reached a certain age, or for their wives to travel to work. It is difficult to find very direct evidence of these phenomena in the sort of data used here. Even so, there are several instances of apparent sex differences in our analyses of travel expenditures and of vehicle ownership, nearly always favoring men. For example, substituting men for women in the household would tend to increase both vehicle ownership and "discretionary" travel, e.g. non-local travel, bus travel in the countryside, and running costs of motor vehicles.

The whole topic of intra-household allocation and transport patterns is something that requires further investigation.

4. Some implications for policy

Given the pervasive ignorance about travel patterns in developing countries, this study has been more successful in collecting stylized facts than in producing and calibrating a detailed model of travel that would enable any policy exercise to be examined, or any project to be assessed. Nevertheless we can draw some implications for policy from the stylized facts and we can provide a background on which policy can be discussed. There are a number of apparently reasonable policies that would make little sense in the countries or cities we examine, and the burden would be on anyone claiming otherwise to show why the case would be very different in a different environment.

1. To the extent that a large fraction of trips are trips to work and trips to school, taxes or subsidies levied on fares are taxes on work or taxes on going to school. We should not expect the level of tripping to be very sensitive to prices, at least within a reasonable range, though marginal jobs may be discouraged by transport costs, and a few children may be deterred from another year's education by the cost of reaching a distant school. However, such taxes are far from lump sum since there will be associated changes in mode. Given our results here, we should expect higher fares to lead to a general "down-grading" of mode choice, with bus users reverting to bicycle use and to walking. In this way, travelers substitute their time for money, but the distortion is nevertheless real.

2. In the Jaipur survey, employment trips are much more heavily motorized than are trips to school. To the extent that this is a general phenomenon, we should expect mode choice for employment trips to be less sensitive than mode choice for school trips. If so, taxes and subsidies on employment modes will act very much like income taxes or subsidies.

3. Because the share of the budget spent on public transport appears to be roughly constant with income, taxes or subsidies that affect all public modes equally are neither regressive nor progressive. While such subsidies do not differentially help the poor, neither do they greatly favor the rich. Alternatively, if subsidy policy is to be targeted towards goods that are heavily used by the poor, and that are inferior over a broad range of incomes, then transport is unlikely to be a good commodity for special favors. Even bus fares, which are probably less income elastic than public transport as a whole, appear to have an income elasticity only slightly less than unity, so that subsidies to bus fares are only very slightly progressive. If the object is to improve the distribution of real income and alleviate poverty, there are almost certainly better goods to subsidize.

4. Focussing more directly on the poor leads to similar conclusions. Large fractions of poor people spend nothing on transport and are therefore quite unaffected by subsidies to (or taxes on) motorized transport. In any city where transit subsidies are being urged on the grounds of poverty relief, evidence should be first produced that the poor actually use such facilities, and do not either walk or cycling to work. In the countries examined here, transit subsidies would favor the middle classes, not the very poor.

5. The model of distance and time developed for Jaipur has a number of implications about the impact of fare policies on behavior. Changes in the price of the "paid-for" modes changes the cost of traveling greater distances in the same time since the walking and bicycling modes are largely unaffected. To the extent that it costs more to upgrade modes, for example because fuel costs more, we would expect average distances traveled to fall, use of the higher grade modes to fall, and vehicle ownership to switch towards cheaper modes. Note that the strongest effects will be on the highest ranked, highest speed modes. In the Jaipur context, this would be motor-scooters. Buses are hit too, and some bus passengers will become pedestrians or bicycle users. But people who could previously afford to use a motor-cycle will now downgrade to buses, so that the net effect on bus use may be positive or negative. The higher cost of distance will also exert a long-term force towards a smaller and more concentrated city than would otherwise have been the case.

6. Policies towards rural travel are fewer and harder to assess, though perhaps the most important intervention is the construction of rural roads and the increased mobility that they permit. The Indian survey analyzed here shows that, at least in India, there is a great deal of rural tripping for much the same purposes as urban tripping, mostly work and school. At present, much of this traveling is done on foot, but our analyses suggest that there is little to prevent these trips becoming bus or bicycle trips as soon as income and facilities permit. Put more dramatically, there may be a large reservoir of potential users who will adopt the upgraded modes as soon

as the price is sufficiently attractive. It is certainly clear that the use of passenger surveys to predict the generated traffic on new roads or bus routes is likely to produce underestimates, since most of the potential passengers are not currently using the mode at all. Given current knowledge, it is hard to go much beyond these generalities. Although there is a large number of rural pedestrian trips in India, we know little else about them. The data we have do not allow a good estimate of distance, and we cannot tell whether they are rather like commutation trips (the laborer goes to the village each day to get hired) or whether they are very different (the farmer visits his own fields or those of others in a pattern that has everything to do with seasons and nothing much to do with transport.) Nor do we even have anything like an accurate estimate of the numbers and distances of trips to school, again because of the peculiar construction of the Indian survey, (see Chapter 4 below.) We badly need better and fuller data on rural tripping patterns so that we can begin to build the sort of models that can make at least some sense of the urban data. The next chapter addresses the task of designing a suitable survey.

Appendix

Econometric issues for the analysis of the expenditure surveys

In this report we make fairly heavy use of standard ordinary least squares regressions, particularly to estimate relationships between travel expenditures and household characteristics. There are a number of econometric "problems" that have to be faced in interpreting these regressions, and this section provides a guide for the interested reader. Our procedures are much influenced by our desire to use the regressions as descriptive

devices. We are presenting a great deal of new data about phenomena that have not been much studied, and much of the quantitative information is presented in the form of cross-tabulations. We see the regression equations as natural extensions of the cross-tabulations, as a convenient way of describing higher dimensional aspects of the data than can be seen from tables. We shall be offering very little in the way of structural interpretation of the results, and the equations should be seen as estimates of the regression functions of the relevant conditional distributions. In such a context, not the least advantages of least squares are its ready comprehensibility and the full understanding that we have of its properties. It is therefore straightforward for readers to impose their own interpretation on the results that we present and they are invited to do so.

One of the immediate facts of Engel curve analysis on household survey data is the large number of "zero" observations, particularly when the analysis is to be carried out at a relatively detailed level of disaggregation. Most households spend money on transport, but substantial numbers do not, and when we move to the components of travel expenditure, such as running costs of motor cars, or airline tickets, it is quite possible for most observations to be zero. The standard model for the analysis of Engel curves with zeroes was proposed by Tobin (1958). In this, the basic regression equation with dependent variable y_i and regressors x_i is modified to read

$$y_i = \max\{x_i'\beta + u_i, 0\}, \tag{A1}$$

and such models can be routinely estimated by maximum likelihood techniques. Unfortunately, this is really not the right model for our data. There are

at least three reasons. First, it is possible to show that in a model with only two goods, the Tobit model is a correct representation of the "corner solution" that would occur when a consumer does not buy because the good is not worth to him or her what it costs. In models with more than two goods, maximization subject to inequality constraints does not yield the Tobit model, see for example, Wales and Woodland (1980), Deaton (1986), and Lee and Pitt (1986). The basic problem can be seen from noting that when a consumer becomes a non-purchaser of a good, perhaps because income falls below some threshold level, then to satisfy the budget constraint, the marginal propensity to spend on at least some of the other goods must change. The Tobit model takes no account of this. Second, there are lots of zeros in the data that do not correspond to corner solutions. A consumer that does not buy bicycle tires during the survey is not necessarily a non-consumer of tires, but simply does not buy tires during the period of the survey. It is possible to allow for this, but the presence of genuine zeros, i.e. corner solutions, much complicates the analysis, see Deaton and Irish (1984). The third problem is that the Tobit model assumes that the same process that makes for a larger value of the dependent variable is also possible for "switching" it on in the first place. By (A1), if it is true that low income consumers do not consume and high income consumers do, then increases in income must increase purchases throughout the range. When our dependent variables are budget shares, as here, it may well be that purchases, and hence shares, are zero at low levels of income, but that the good, once purchased at all, is a necessity with a budget share that is a declining function of income.

All three of these problems with Tobit can be handled one at a time, though it would be extremely difficult and costly to deal with all three at once. But it seems pointless to try. In the budget share regressions we have no prior knowledge about the shape of the Engel curves, and very general shapes (including Fourier expansions) are consistent with utility theory, see Gorman (1981). Without such knowledge, we cannot hope to identify separate functions for determining zeros on the one hand, and the Engel curve conditional on positive purchases on the other. In consequence, our regressions are run including all observations, whether zero or not, and while we recognize that the regression function contains a mixture of terms from the Engel curve and from whatever (unknown) process generates the zeros, we also recognize that there is no way of identifying one from the other.

The second main econometric issue arises from the sample design of the surveys used in the report. Nearly all large scale household surveys are stratified in more or less complex ways, and those used here are no exception. In practice, this means that each household in the population does not have an equal chance of being included in the survey. For example, it is typically more expensive to sample rural than urban households so that to achieve a given degree of precision, costs can be minimized by over-sampling in the urban areas. Of course, when the data have been collected, it is not possible to estimate population means from sample means, unless the different strata are homogeneous. This is routinely dealt with by weighting. Each household is assigned a weight that is the reciprocal of its sampling probability, so that when each observation is weighted and added up, an unbiased estimate of the population total is calculated. It is as if each

sample household had been replicated as many times there are population households for it to represent. For example, if there are 10,000,000 rural households, and 1,000,000 urban, and the survey has 5000 rural households and 1000 urban, each rural household in the sample would be replicated 2000 times and each urban household 1000 times, or if weighted means are calculated, the weights should be 2:1 in favor of rural.

All this is clear, but the clarity immediately vanishes when we come to estimate regressions instead of means. A survey of the issues can be found in DuMouchel and Duncan (1983). To summarize: if the regression function is the same in each stratum, pooling all the data is justified, the assumptions of the Gauss-Markov theorem are met, and weighting is worse than pointless; consistency is unaffected, but efficiency compromised. By contrast, if the regression relationship varies from stratum to stratum, pooling is illegitimate and it is easily shown that the neither ordinary least squares nor weighted least squares converge to the population weighted mean of the individual stratum regression coefficients. In neither case is there any justification for weighting. When there is stratum heterogeneity, the counsel of perfection would be to estimate separate regressions for each stratum and investigate patterns using covariance analysis, or perhaps to use "variable-parameter" techniques. However, in a survey as complicated as that for Hong Kong, nearly every household has a different weight, so that it is impossible to run separate regressions for each.

In spite of these arguments, we have chosen to weight the data in the regressions reported here. As is obvious from the replication argument, weighting is an attempt to make the sample look like the population, so that as the sample size becomes large, the weighted estimates will eventually

converge to those that would have been calculated with the data on the whole population. Unweighted regression would yield estimates that would converge to numbers that depend on the sample design, something that seems inherently undesirable. Of course, if the strata are not homogeneous, it is hard to interpret either set of estimates But in keeping with our descriptive goals, our regressions attempt to estimate the corresponding population regression functions, and weighting produces that result.

The third econometric issue concerns the appropriate calculation of standard errors. Given parameter variation across strata, and possibly across households, it would be surprising were the regression residuals to be homoskedastic, and standard tests show that they are not. Heteroskedasticity does not affect consistency of the estimates, and although efficiency is reduced, efficiency may not be the main concern in samples of the size used here. The main problem is that the standard ordinary least squares formula for the standard errors does not yield consistent estimates of the standard errors in the presence of heteroskedasticity. White (1980) has provided a technique that does provide consistent standard errors in the presence of an unknown form of heteroskedasticity, and the White technique has been refined in MacKinnon and White (1984) to yield a jack-knife estimator of the standard errors. The results reported below are all standard (incorrect) ordinary least squares standard errors, but for Sri Lanka we recalculated all the results using the White and jackknife procedures. While the corrections can make individual t-ratios either bigger or smaller, there is a tendency for the correct standard errors to be somewhat larger and the correct t-values somewhat smaller. However, none of the major inferences are seriously affected, though the inflation of t-values should

be borne in mind throughout. It is rarely sensible to make "knife-edge" inferences, and the heteroskedasticity issue should make us even more careful of doing so.

The final issue concerns our treatment of the effects of vehicle ownership on transport patterns, and the short-run and long-run regressions reported in Chapters 5 through 9. A simple model of vehicle ownership and transport expenditure might be written as follows:

$$w_i = \beta_i . x_1 + \delta_i z + \epsilon_{1i} \tag{A2}$$

$$v = \gamma . x_2 + \epsilon_{2i} \tag{A3}$$

$$z = 1 \text{ if } v \geq 0, \quad z = 0, \text{ otherwise.} \tag{A4}$$

Here equation (A2) is the expenditure relationship, with explanatory variables x_2 and a dummy variable z indicating whether or not the household owns a vehicle. The second equation generates a latent variable v, dependent on variables x_2, and the vehicle is owned if v is non-negative. In principle, the specification of a joint distribution for ϵ_1 and ϵ_2 allows a likelihood function to be derived and the parameters to be estimated by maximum likelihood. However, unless there is a good deal of non-overlap between the two vectors x_1 and x_2, the parameters will be identified only by the essentially arbitrary specification of the distribution of the errors. A few moments' thought will confirm that, in the current context, we have essentially no grounds for excluding any of the ownership variables from the expenditure equation or *vice versa*. The two vectors are therefore identical.

Our procedure is as follows. First we estimate (A3) and (A4) in the standard way using probit or logit techniques; these are alternative and

equally reasonable methods of describing the probability of ownership. We then estimate a "long-run" travel regression of the form

$$w_i = \beta_i . x_1 + \epsilon_{3i} \tag{A5}$$

Equation (A5) can be thought of as the result of substituting (A3) and (A4) into (A2), although the correspondence is not exact. Consider, for example, the case where ϵ_2 is normal. From (A3) and (A4), the expectation of z is the probability that it is unity, which is given by $\Phi(\gamma . x_2)$. Hence, we can write

$$z = \Phi(\gamma . x_2) + \epsilon_4 \tag{A6}$$

$$w_i = \beta_i . x_1 + \delta_i \Phi(\gamma . x_2) + \epsilon_{1i} + \delta_i \epsilon_4 \tag{A7}$$

Equation (A7) with its compound error is the "correct" form of (A5), but since x_1 and x_2 are identical vectors, and since we know nothing about the functional form of x in (A2) in the first place, it is futile to attempt to estimate (A7) rather the linear form (A5), particularly if we allow flexible functional forms and test for curvature.

The "short-run" travel regression is simply (A2) as is. Ordinary least squares is consistent for this regression provided that ϵ_1 and ϵ_2 are independent, and assumption that is essentially untestable given the fact that x_2 and x_1 are identical. The usual reasoning is that there will be bias because there are likely to be common variables omitted from both (A2) and (A3), so that the error terms will be correlated. But this is an odd argument. Omitted variables from either equation will make OLS inconsistent for each, so it is unclear why we should in addition worry about whether or not the same variables are omitted from both. It seems more reasonable to

assume, as with all regressions, that there are no omitted variables from either, and, in the same spirit, that the errors are independent. Once again, it is easy to reinterpret given regressions in the light of the failure of this assumption, provided there is good reason to think it false.

CHAPTER 3

The Design of a Rural Travel Survey

This chapter, being of more specialist interest than the remainder of the study, is omitted from this discussion paper.

Interested readers may obtain a copy from the World Bank Infrastructure & Urban Department (Transport Development Division).

PART TWO: PERSONAL TRAVEL IN INDIA

CHAPTER 4

TRAVEL PATTERNS IN INDIA 1977-78

0. Introduction

Detailed data on personal travel in developing countries were collected as part of the 32nd round of the Indian National Sample Survey in 1977 and 1978. The additional questions, "block 11", were included at the request of the Ministry of Shipping and Transport, and we are grateful to them and to the National Sample Survey Office for providing us with copies of the preliminary tabulations. At the time of writing, (May 1986), the full results of the 32nd round have not yet been published, and the tables from the travel block became available only very late in the project. While the data are clearly too important to exclude from the report, their late availability has meant that it has been possible to carry out only very limited analysis. We did not have access to the raw data, only to the tabulations requested from the NSSO by the Ministry of Shipping and Transport. Nevertheless, much can be learned from what is currently available to us.

Compared with the other household surveys discussed later in this report, the Indian survey has very great advantages. Firstly, the travel questionnaire was administered to the full 32nd round sample, i.e. to nearly 100,000 rural and to more than 58,000 urban households containing in all more than 800,000 persons. These sample sizes are large enough to provide estimates of travel patterns by state, by urban and rural, and by income level. At the aggregate, and for the larger states, it is also possible to distinguish a great deal of detail, even about some of the less frequent travel events. Secondly, questions were asked about the physical nature of travel, not just

about the money spent on it. Data were collected on distances, purposes, modes, frequencies, reasons for mode choice, and cost. In consequence, these are the only data reviewed in the report that tell us anything about the physical characteristics of rural travel. For this reason alone, these data are of great importance. The typology of urban travel in developing countries is relatively well understood and will be documented in this report in detail for the city of Jaipur, see Chapter 5 below. Rural travel patterns are widely thought to be very different, to be less dominated by school and work and more by the needs of small scale agriculture, to be less regular, and to be longer. The Indian data provide some information on these issues.

A brief discussion of the design of the NSSO survey is necessary for an understanding of the results that follow. The NSS collected information about journeys undertaken by the members of each sample household during the seven days preceding the date of the survey. Journeys had to begin and end in the seven days in order to be counted, and they had to be longer than one kilometer, so that, to quote the instructions to the field staff, "journeys like daily morning walk, going to the daily market or going to the river ghat for taking bath and the like will not be recorded." Each person in the household who had made at least one journey in the reference week was identified, and each journey listed. A journey was defined as a trip from A to B for some purpose, so that a round trip ABA is two journeys, while a circular trip AB, BC, CA is three journeys provided the traveller has some purpose in visiting both B and C. By contrast, if B is simply a place for changing modes and not a destination in itself, then AB, BC, CA, or AB, BC, CB, BA would count as two journeys rather than three or four. Part journeys

are recorded as such, so that each journey may have two or more parts. Each journey was identified as "regular" if it was undertaken at least once a week between two fixed places, otherwise it was listed as "irregular". For regular journeys, record was made of the number of days in the week on which it was made. Days of the week on which each journey took place were identified as weekdays, weekend days, or Sunday/holidays, or a combination for regular trips. Each trip was classified by a single main purpose under one of sixteen heads, namely, (1) attending place of work, (2) attending place of education, (3) attending doctor, health center, or hospital, (4) attending place of entertainment, (5) visiting bank, post-office, court, etc. for personal work, (6) sale of produce of own enterprise, (7) purchase for own enterprise, (8) household purchase, (9) official tour, (10) social visit, (11) pilgrimage, (12) for taking up employment, (13) in search of employment or for interview, (14) educational tour, (15) tour for health or excursion purposes, (16) others. There are nineteen recorded modes, (1) train, (2) tram, (3) bus, (4) minibus, (5) car, (6) three-wheeler, (7) scooter, motor-cycle or moped, (8) school/college/employers transport, (9) bicycle, (10) rickshaw, (11) bullock or buffalo cart, (12) horse cart, (13) other animal cart, (14) animal as carrier, (15) human drawn, including palki, duli rickshaw, (16) foot, (17) boat or country craft, (18) steamer or motor launch, (19) others. Each trip was classed as by owned or not owned mode, the former occurring when the transport equipment used for the journey was owned by the household or by a friend or relative and no fare has been paid for the journey. For each mode it was checked whether or not other modes were available (other than walking) and the respondent was asked why he or she chose the mode actually used. Five answers were permitted: less

expensive, quicker, more frequently available, more comfortable, others. For each journey or part journey distances and fares paid were recorded. Questions were also asked about concessional fares and about weekly expenditures when fares were charged on a monthly basis, for example when the employer provides a bus services.

This design is an excellent one, and it yielded a great mass of unique data. However, note that no information was gathered on the time spent travelling, perhaps the only really obvious omission. It is perhaps also unfortunate that all trips were defined to be for a single, main purpose. Such a definition rules out any investigation of the belief that rural trips are more multi-purpose than urban trips. There is also a severe problem introduced by the survey's inclusion only of journeys that were at least of one kilometer in length. In other surveys, for example those of Indian cities carried out by the TRRL one of which is discussed in the next Chapter, there is typically no exclusion by distance, a procedure that has its own problems, particularly whether or not to include trips for visiting a neighbor, taking a bath, and so on. However, when the purpose is clearly defined as is the case for trips to work and trips to school, the standard methodology seems preferable. A trip to school, even if only of a few hundred meters, is easily identified and counted, and since distance is measured separately, it is always possible to truncate on any given distance once the data have been collected. Truncation at the time of interview, however, raises difficulties of comparability. For example, there will be fewer apparent trips to school in small villages where the school is centrally located than in urban areas or larger villages. Households with small children of school age will record fewer trips than those with older

children for reasons that have nothing to do with school attendance. In general, we can expect the NSSO procedures to yield fewer work and educational trips than the purpose based definitions used in other surveys.

However, the major difficulty in writing this report has nothing to do with the survey itself, but is that we do not have access to the raw data, but only to the tabulations originally planned by the NSSO and the Ministry of Shipping and Transport. While these tables are extremely informative, much that is of potential interest is excluded, and the possibilities for multivariate analysis using two and three way cross-tabulations are severely limited. A full analysis of these data together with the rest of the expenditure survey from the 32nd round would provide answers to a large fraction of the questions with which this project began, at least for the Indian case.

1. Sample characteristics

The NSS 32nd round sample has an overall sampling fraction of one in a thousand for rural households and two and a quarter per thousand in urban areas. The numbers of households surveyed and the number of people in them are given in Table 4.1 and the corresponding population totals in Table 4.2, together with various other indicators. There are 26 urban "states" and 24 rural "states"; no households were sampled in rural Nagaland nor in rural Chandigarh. Overall, there were 77,476 rural respondents who had made at least one trip in the reference seven day period, i.e. 0.78 per household or one traveller per 6.76 persons. For the urban areas, there were 44,490 travellers, 0.76 per household, or one for every 6.38 persons. Note that

TABLE 4.1

Sample characteristics

Numbers of households, persons, and travelers

	Rural			Urban		
	hh	people	travs	hh	people	travs
Andhra Pradesh	8014	37402	7561	4575	21685	3551
Assam	4361	23805	1910	1728	7910	434
Bihar	9115	48342	2234	3690	17844	1327
Gujarat	3731	21384	3937	2868	15067	3231
Haryana	1714	10830	1080	850	4373	377
Himachal Pradesh	2220	11503	2002	574	2135	433
Jammu & Kashmir	4223	23424	2380	1727	9460	828
Karnataka	4217	24016	3687	2526	13222	1997
Kerala	4320	23318	5815	1728	9307	2148
Madhya Pradesh	8528	44778	6673	3375	17621	2642
Maharashtra	7451	38594	7369	7152	34962	8834
Manipur	1060	5307	816	427	2263	148
Meghalaya	867	4040	1877	432	1974	358
Nagaland	0	0	0	432	1541	71
Orissa	4286	21402	2082	1708	7427	624
Punjab	3724	20773	3163	1669	8071	926
Rajasthan	4184	23300	5110	2526	13666	1859
Tamil Nadu	6318	28375	5926	5461	25499	5402
Tripura	778	3899	796	428	2034	109
Uttar Pradesh	12538	65780	7601	6794	33885	3566
West Bengal	6587	35827	4215	5149	23420	3693
Arunachal Pradesh	858	4524	636	288	934	36
Chandigarh	0	0	0	95	394	168
Delhi	96	538	53	1384	6316	1237
Goa, Daman & Diu	288	1457	301	288	1322	355
Pondicherry	288	1488	252	288	1474	136
All India	99766	524106	77476	58162	283806	44490

Source: NSSO/Ministry of Shipping and Transport, Preliminary Tables from the 11th block of the 32nd round, 1977-78. Table (A/B).

TABLE 4.2

Population, household size, weekly expenditure per capita

	Rural			Urban			
(see key below)	pop	hhs	pce	pop	hhs	pce	urb
Andhra Pradesh	39.5	4.6	16.3	9.5	4.7	21.8	19.3
Assam	16.1	5.5	13.6	1.6	4.6	20.1	8.8
Bihar	56.8	5.3	13.5	6.3	4.9	20.0	10.0
Gujarat	22.4	5.7	17.2	8.8	5.2	24.1	28.1
Haryana	9.5	6.3	22.5	2.0	5.1	23.4	17.7
Himachal Pradesh	3.5	5.2	19.1	0.3	3.7	29.6	7.0
Jammu & Kashmir	6.4	5.6	17.4	1.3	5.6	19.2	17.2
Karnataka	25.2	5.7	15.2	8.1	5.2	20.4	24.3
Kerala	20.6	5.4	17.1	4.0	5.4	20.0	16.2
Madhya Pradesh	40.8	5.2	13.2	7.9	5.2	21.1	16.3
Maharashtra	39.9	5.2	14.3	18.1	4.9	27.3	31.2
Manipur	1.1	5.0	15.7	0.3	5.1	18.7	19.1
Meghalaya	1.0	4.7	13.9	0.2	4.6	29.8	14.5
Nagaland	*	*	*	0.1	3.6	31.1	*
Orissa	23.0	5.0	12.0	2.1	4.3	20.3	8.4
Punjab	11.7	5.6	27.8	3.6	4.8	26.5	23.8
Rajasthan	24.6	5.6	20.2	5.2	5.4	24.6	17.6
Tamil Nadu	32.3	4.5	14.5	14.0	4.7	19.9	30.3
Tripura	1.6	5.0	12.8	0.2	4.8	26.3	10.4
Uttar Pradesh	84.1	5.2	15.9	13.7	5.0	20.8	14.0
West Bengal	38.6	5.4	14.0	12.7	4.5	23.6	24.8
Arunachal Pradesh	0.5	5.3	18.3	0.0	3.2	40.9	3.7
Chandigarh	*	*	*	0.3	4.1	55.9	100
Delhi	0.6	5.6	25.1	4.8	4.6	32.5	89.7
Goa, Daman & Diu	0.7	5.1	21.0	0.3	4.6	31.0	26.4
Pondicherry	0.3	5.2	15.1	0.2	5.1	22.6	42.1
All India	500.7	5.2	15.5	125.5	4.9	23.0	20.0

Key: pop is population is in millions
hhs is average household size
pce is average weekly household expenditure per capita in rupees
urb is ratio of urban to total population

* indicates that no rural households were sampled.

because of the stratification, these are not estimates for the corresponding ratios for the population as a whole, only characteristics of the sample. For much of the subsequent discussion, these numbers of travellers constitute the effective sample size. While there are more trips than travellers, many are repeat trips and are thus not independent observations. It will therefore be necessary to repeatedly refer back to Table 4.1 to check the sample size on which various population estimates are based, particularly when trips are disaggregated, for example by purpose and by state.

Since the NSSO always disaggregates all tabulations by state, and since there is little other disaggregation in the tabulations that we have, some analysis can only be done by treating states as individual observations, and using variation across states to discover regularities. Comparing Tables 4.1 and 4.2, it can be seen that such analysis should be confined to the larger states where the population and sample sizes are adequate to support reasonably accurate estimates of means. For rural areas, the large population states are Andhra Pradesh, Assam, Bihar, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal. All of these have populations in excess of ten million, and all record more than two thousand travellers in the survey (except for Assam with 1910). The states containing the largest numbers of urban dwellers are Maharashtra, Tamil Nadu, Uttar Pradesh, and West Bengal; in the next group come Andhra Pradesh, Bihar, Gujarat, Karnataka, Kerala, Madhya Pradesh, Rajasthan, and Delhi, all of which have populations of four million or more, and all of these have samples of travellers of more than one thousand. These groups can therefore support substantial disaggregation of travel patterns from the survey.

2. Numbers of travellers and numbers of trips

Table 4.3 gives estimates for the larger areas of the number of travellers per household and of the numbers of trips reported per traveller. For every household in rural areas there were 0.8 persons reporting some kind of trip; half of these said they made regular trips and half irregular trips. The corresponding figure in urban areas is only very slightly higher, at 0.9, though here the split between regular and irregular is two to one in favor of the former. There is considerable variation in these figures across the states, with the level of development the most obvious covariate, something that will be investigated further below. Some of the figures are very low indeed; in Assam and Bihar, it took three households, each with more than five persons, to find one person who took a trip of more than one kilometer in the reference week. Even in the more developed regions, the number of travellers is rarely more than one per household, and only in urban Maharashtra is there an average as high as one regular traveller per week. The one kilometer cutoff is presumably important in removing most trips to school from these figures, since with them the numbers would have to be much larger.

The lower half of the table shows the corresponding ratios of trips to travellers, so that each rural traveller logged 5.6 (one-way) trips in the reference week, and each urban traveller 7.8. But these figures are not very meaningful because they lump together regular and irregular trips and divide by the total number of travellers, independently of the number of trips each took. More interesting are the figures for regular and irregular trips separately. Recall that a regular trip is defined as one that is made between two fixed destinations at least once per week. However most regular

TABLE 4.3

Travellers per household and trips per traveller

	Rural			Urban		
	reg.	irreg.	all	reg.	irreg.	all
Estimated travellers per household						
Andhra Pradesh	0.5	0.5	1.0	0.5	0.3	0.8
Assam	0.1	0.3	0.4	0.1	0.2	0.3
Bihar	0.1	0.2	0.3	0.2	0.1	0.3
Gujarat	0.6	0.5	1.1	0.8	0.4	1.2
Karnataka	0.4	0.4	0.9	0.5	0.3	0.8
Kerala	0.7	0.7	1.4	0.7	0.6	1.3
Madhya Pradesh	0.3	0.4	0.8	0.6	0.2	0.8
Maharashtra	0.6	0.5	1.0	1.0	0.3	1.3
Orissa	0.2	0.3	0.5	0.2	0.1	0.4
Punjab	0.4	0.5	0.9	0.4	0.2	0.6
Rajasthan	0.7	0.5	1.2	0.5	0.3	0.8
Tamil Nadu	0.5	0.5	1.0	0.6	0.4	1.0
Uttar Pradesh	0.2	0.4	0.6	0.4	0.2	0.5
West Bengal	0.3	0.4	0.7	0.5	0.2	0.7
Delhi	*	*	*	0.7	0.2	0.9
All India	0.4	0.4	0.8	0.6	0.3	0.9
Regular and irregular journeys per regular and irregular travelers						
Andhra Pradesh	10.2	2.2	6.3	10.9	2.2	7.6
Assam	8.1	1.7	3.7	10.4	1.8	5.1
Bihar	6.7	1.8	3.6	9.8	1.8	6.5
Gujarat	11.2	2.1	7.2	11.3	2.0	7.9
Karnataka	8.7	2.2	5.4	10.6	2.2	7.6
Kerala	8.8	2.3	5.6	9.6	2.4	6.4
Madhya Pradesh	10.9	2.1	6.0	11.2	2.1	8.6
Maharashtra	10.4	2.1	6.6	11.0	2.1	8.9
Orissa	5.6	1.7	2.9	6.7	1.8	5.0
Punjab	10.1	2.1	5.5	11.2	2.1	8.1
Rajasthan	7.9	1.7	5.4	10.7	2.0	7.6
Tamil Nadu	9.4	2.4	5.6	10.8	2.3	7.2
Uttar Pradesh	9.1	2.3	5.0	10.3	2.2	7.7
West Bengal	9.2	2.5	5.4	11.7	2.3	9.0
Delhi	*	*	*	6.2	1.2	5.1
All India	9.4	2.1	5.6	10.6	2.1	7.8

Source: NSSO/Ministry of Shipping and Transport, Preliminary Tables from the 11th block of the 32nd round, 1977-78. Table (2) and Table 3A.

trips are more frequent than this. A six day a week worker travelling twice a day would generate 12 trips in a week, and though none of the figures are this large, many are between 10 and 12, particularly in the urban and more developed rural areas. Once again, the one kilometer rule will exclude a number of work related trips, and can perhaps explain the very low figure of 6.2 recorded for the regular trips per regular tripper in urban Delhi. For comparison, In the TRRL studies of Delhi suburbs, Maunder (1981, 1982, 1983a), about ten per cent of employees walked to work with average trip lengths typically less than one kilometer; in Jaipur 19% walked to work over an average distance of 0.8 kilometers, Maunder (1983b) and Chapter 5 below.

Perhaps the most interesting aspect of these figures is not that in most of the urban areas, regular trippers take roughly one round trip per day, but that the same is true for several of the rural areas. In rural Andhra, Gujarat, Madhya Pradesh, Maharashtra, and Punjab, regular trippers average more than 10 trips a week. And although there are somewhat fewer regular travellers in rural areas, there is still a much greater amount of daily rural tripping than the previous conventional wisdom would suggest. Even counting in the less developed areas, the rural all India figure shows 9.4 trips per regular traveller per week compared with an urban figure of 10.6. This is a much smaller difference than would be expected if the typology of rural travel were quite different from that of urban travel.

3. Length and purpose of trips

Table 4.4 shows that for all of India, 57% of rural trips and 68% of urban trips are trips to the place of employment. For regular trips, the figures are higher, 68% and 74% respectively. Regular trips to work

dominate regular trips to school by about five to one. Since we know from the TRRL surveys of Delhi, Jaipur, Vadodara and Patna, (for the last three see Maunder (1985)), that regular employment and school trips are about equally frequent, the figures in the table tell us that trips to work are longer than trips to school, so that if we truncate at one kilometer, we lose many more school than work trips. For comparison, in the Jaipur study in Chapter 5 where all employment and school trips are included irrespective of distance, the average work trip is 2.9 kilometers and the average trip to school is 1.9 kilometers. Of the latter, 59% are made by foot with an average distance of

TABLE 4.4

Distribution of trips by purpose

	Rural			Urban		
	reg.	irreg.	all	reg.	irreg.	all
Employment trip	68.3	10.9	56.9	74.2	9.6	68.4
Educational trip	14.2	0.4	11.5	15.0	0.7	13.8
Doctor, health center	0.7	7.7	2.1	0.6	6.2	1.1
Entertainment	0.5	4.6	1.3	0.4	11.7	1.4
Bank, P.O., etc.	0.3	3.7	1.0	0.3	2.5	0.5
Sale of own produce	3.2	3.6	3.3	2.4	2.5	2.4
Purchase for own business	1.4	4.6	2.1	1.5	4.2	1.7
Household purchase	6.0	28.2	10.4	1.7	9.5	2.4
Official tour	0.2	0.7	0.3	0.3	2.4	0.5
Social visit	0.4	16.5	3.6	0.4	25.0	2.6
Pilgrimage	0.2	2.9	0.7	0.1	4.4	0.5
Taking up work	0.4	0.4	0.4	0.3	0.6	0.3
Looking for work	0.2	0.8	0.4	0.5	2.2	0.7
Educational tour	0.0	0.0	0.0	0.0	0.1	0.1
Health/excursion tour	0.0	0.1	0.0	0.0	0.5	0.1
Others	4.1	14.6	6.2	2.2	17.8	3.6
All purposes	100.0	100.0	100.0	100.0	100.0	100.0
No. of trips (millions)	338	84	421	156	15	171

Source: NSSO/Ministry of Shipping and Transport, Preliminary Tables from the 11th block of the 32nd round, 1977-78. Table 3A.

0.7 kilometers. While it is impossible to make the comparison for the rest of urban India, the ratio of work to school trips of 5:1 in Table 4.4 may therefore be entirely consistent with a true ratio of 1:1 in numbers of trips counted irrespective of distance.

Even under the one kilometer rule, trips to work and trips to school account for 82.5% and 89.2% of regular trips in rural and urban areas respectively. For the rest, the only purposes that generate significant numbers of regular trips are "household purchases", i.e. shopping, and trips for buying inputs and selling outputs of own enterprise business. By all accounts, rural trips to market frequently combine buying, selling and shopping activities, as well as occasional visits to banks, post offices and places of entertainment. The allocation between these categories almost certainly has a substantial arbitrary element. But however the accounting is done, such purposes generate a significant share of non-regular trips, particularly in the countryside. Shopping trips alone account for more than a quarter of rural irregular trips, and if the own-account sales and purchases are added in, the fraction rises to more than 36%. Put differently, a half of <u>all</u> rural trips that are not to work or to school are for purchasing or selling household goods or produce. It has been suggested that buying inputs for own account production is likely to generate more trips than the selling of the outputs. It is argued that the latter is too important to be held hostage to the difficulties of personal travel, so that some form of joint marketing arrangements typically exist. To the extent that the trips here are correctly categorized, this is not the case; there are about 50% more trips for sales than for purchases, and this is true in both urban and rural regions.

Social visits are also an important generator of irregular trips, and account for 11% (rural) and 15% (urban) of all non-work, non-school trips. Entertainment trips are next in importance, with about half as many trips as for social visits. The number of trips for medical purposes is about the same as the number of entertainment trips, i.e. 7% and 6% of trips not to work or school. None of the other purposes listed account for more than a very small fraction of trips.

Table 4.5 shows the average distance of trips by purpose, as well as total distance of all trips by purpose, again for the country as a whole. Once again, it must be remembered that these are truncated means; trips of less than one kilometer are excluded, and the bias is likely to be particularly severe for high frequency short-distance trips, particularly trips to work and to school. Even so, and as is to be expected, there is a strong inverse relationship between trip frequency and distance. Trips to work and school are short, as are shopping trips. Even so, the distances involved are substantial. Trips to work longer than one kilometer average 9.6 kilometers in urban and 6.4 kilometers in rural areas, while shopping trips average 6.3 and 7.9 kilometers. By and large, regular trips are shorter than irregular trips, and many of the latter are very long indeed. Individuals living in rural households travel on average 18.7 kilometers to visit a doctor or other health facility, and even in the urban areas the figure is 13.2 kilometers. Trips to sell produce or to buy inputs are of similar length. Perhaps most surprising given their importance as a share of total trips is the great average distance travelled for social visits. In rural areas, these average 27.8 kilometers, and in urban areas, an

TABLE 4.5

(i) Distances of trips by purpose (km.)

	Rural			Urban		
	reg.	irreg.	all	reg.	irreg.	all
Employment trip	6.3	9.0	6.4	9.4	24.9	9.6
Educational trip	7.0	19.8	7.1	6.6	21.4	6.7
Doctor, health center	16.9	19.3	18.7	7.8	18.7	13.2
Entertainment	16.3	11.3	12.7	7.5	9.7	9.1
Bank, P.O., etc.	16.1	24.1	22.2	11.4	28.9	19.4
Sale of own produce	12.2	15.2	12.9	10.9	28.9	12.6
Purchase for prodn.	11.2	23.3	16.6	13.3	36.2	18.3
Household purchase	5.7	9.9	7.9	4.1	10.3	6.3
Official tour	15.1	33.3	24.4	22.2	56.1	36.6
Social visit	22.3	28.3	27.8	32.3	42.7	41.3
Pilgrimage	7.0	42.0	35.7	8.2	48.8	39.6
Taking up work	10.6	27.7	14.1	9.9	56.6	17.5
Looking for work	9.6	42.1	24.9	9.5	30.6	15.9
Educational tour	6.3	49.5	18.1	3.8	118.0	25.5
Health/excursion tour	12.3	49.7	29.6	7.8	143.6	73.5
Others	9.4	24.9	16.7	13.0	42.3	26.1
All purposes	7.0	18.7	9.3	9.2	32.3	11.3

(ii) Distribution of total kilometers travelled by purpose

Employment trip	61.5	5.3	39.1	66.8	4.6	47.1
Educational trip	14.2	0.5	8.8	15.0	0.8	10.5
Doctor, health center	1.6	7.9	4.2	1.5	6.4	2.3
Entertainment	1.1	2.8	1.7	0.9	7.1	1.9
Bank, P.O., etc.	0.7	4.8	2.3	0.7	3.2	1.2
Sale of own produce	5.5	3.0	4.5	4.1	2.0	3.3
Purchase for prodn.	2.3	5.7	3.7	2.4	5.3	3.1
Household purchase	4.9	15.0	8.9	1.4	5.0	2.0
Official tour	0.4	1.3	0.7	0.7	4.3	1.3
Social visit	1.3	25.0	10.8	1.3	37.9	7.8
Pilgrimage	0.2	6.6	2.7	0.1	9.9	2.0
Taking up work	0.5	0.5	0.5	0.5	0.9	0.5
Looking for work	0.3	1.9	0.9	0.7	5.1	1.8
Educational tour	0.0	0.1	0.1	0.0	0.3	0.1
Health/excursion tour	0.1	0.3	0.1	0.1	1.2	0.3
Others	5.4	19.5	11.1	2.9	23.7	6.4
All purposes	100.0	100.0	100.0	100.0	100.0	100.0
Total kilometers (billions)	2.4	1.6	3.9	1.4	0.5	1.9

Source : As Table 4.4

extraordinary 41.3 kilometers. The lower half of the table shows that 10.8% of total distance travelled by individuals in rural households, or 420 million kilometers per week, is accounted for by social visits. For the urban areas, the ratio is 7.8% or nearly 150 million kilometers. Even a category like pilgrimages, which accounts for an insignificant share of total trips, involves average distances of nearly 40 kilometers, so that, in aggregate, pilgrimages account for about 2.5% of the total distance travelled. This represents about 12 km. per annum for each man, woman or child in India, or nearly 700 km. over an average lifespan.

Finally, Table 4.6 shows the average distance for all purposes disaggregated by state. These figures will be analyzed more formally below, but note that there is little relationship across states between trip distances and the level of development. The shortest trip distances occur

TABLE 4.6

Average distance traveled by state and urban rural

		rural	urban		
Andhra Pradesh	6.2	9.8	Nagaland	*	19.3
Assam	10.1	14.2	Orissa	10.7	20.0
Bihar	15.9	16.2	Punjab	12.2	13.3
Gujarat	6.4	8.1	Rajasthan	8.5	10.7
Haryana	13.9	19.3	Tamil Nadu	9.2	10.2
Himachal Pradesh	10.7	15.4	Tripura	6.5	7.6
Jammu & Kashmir	14.2	13.8	Uttar Pradesh	10.1	11.1
Karnataka	14.1	13.0	West Bengal	12.9	12.4
Kerala	9.4	8.1	Arunachal Pradesh	4.4	18.3
Madhya Pradesh	9.5	14.0	Chandigarh	*	6.6
Maharashtra	7.4	11.4	Delhi	15.4	11.2
Manipur	5.6	5.3	Goa, Daman & Diu	12.1	8.3
Meghalaya	10.7	42.4	Pondicherry	10.6	14.1
All India		9.3	11.3		

Source: NSSO/Ministry of Shipping and Transport, Preliminary Tables from the 11th block of the 32nd round, 1977-78, Table 3A. These figures for different states are likely to have very different sampling errors, see the sample sizes in Table 4.1

in backward areas such as Arunachal Pradesh, Tripura, and Manipur, as well as in such relatively developed areas as Andhra and Gujarat. Increasing living standards increases the ability to travel longer distances but also has the effect of bringing many essential services closer as infrastructure and markets develop. Note also that there is no evidence for the belief that urban trips tend to be shorter than rural trips. Indeed, for 17 of the cases listed, urban trips are on average longer than are rural trips, and only in six cases is the reverse true. However, we shall see in the next section that it is true that, conditional on mode choice, rural trips are longer than urban trips; rural walking or bicycle trips are on average longer than urban walking or bicycle trips, rural bus trips are longer than urban bus trips, and so on. But in the countryside, the vast majority of trips are walking trips so that these short trips dominate in the average.

4. Modes of transport, trip length and trip purpose

Table 4.7 shows how single-mode trips are allocated over various modes. In rural India, 72.3% of journeys of over one kilometer are made on foot, as compared with only 34.8% in urban areas. Bicycle trips are important in towns and countryside, accounting for 19% of trips in the former, and 10.8% in the latter. Buses account for 26.3% of urban trips and only 11.2% of rural trips. However, while trips on foot, bicycle or bus together account for nearly 95% of rural trips, other modes are more important in the towns, accounting for nearly 20% of all trips. Once again, the probable effect of the one kilometer rule must be noted. It is clear that there are large numbers of regular trips to work and school that are less than one kilometer, and to the extent that employment and educational facilities are

TABLE 4.7

Distribution of single mode trips by mode

1. Rural	walk	bike	bus	train	other
Andhra Pradesh	83.5	6.1	7.7	0.4	2.3
Assam	72.3	14.8	8.2	0.3	4.5
Bihar	66.8	10.0	13.0	3.8	6.5
Gujarat	72.9	3.4	13.0	1.6	9.1
Karnataka	71.0	6.1	19.7	0.4	2.9
Kerala	55.7	4.4	36.8	0.3	2.9
Madhya Pradesh	85.2	7.0	3.4	0.5	3.9
Maharashtra	84.1	6.3	6.1	0.8	2.8
Orissa	71.6	16.8	6.2	1.9	3.5
Punjab	28.7	43.2	20.2	1.6	6.4
Rajasthan	85.5	5.4	4.8	0.5	3.8
Tamil Nadu	62.6	15.3	17.9	1.3	2.9
Uttar Pradesh	62.8	26.1	4.5	1.4	5.2
West Bengal	57.4	11.2	9.5	4.0	17.9
All India	72.3	10.8	11.2	1.1	4.8

2. Urban	walk	bike	bus	train	m-bus	moped	rick'	other
Andhra Pradesh	43.3	22.4	22.5	2.2	0.3	2.4	3.7	3.3
Bihar	39.7	23.2	10.4	3.9	10.0	4.8	2.9	5.2
Gujarat	45.2	21.2	19.5	2.1	0.7	4.0	1.9	5.5
Karnataka	40.0	11.5	39.7	1.6	0.2	2.0	0.8	4.3
Kerala	38.9	10.6	39.8	1.7	0.4	1.4	1.3	5.8
Madhya Pradesh	44.7	36.1	9.1	1.9	0.9	3.3	1.4	2.7
Maharashtra	30.8	11.0	25.0	25.0	0.2	2.0	0.9	5.1
Orissa	23.4	36.3	21.5	1.4	2.0	3.5	8.6	3.3
Punjab	29.3	39.5	14.3	4.0	0.1	6.3	2.8	3.8
Rajasthan	41.0	34.5	9.9	2.0	0.3	4.3	3.1	4.9
Tamil Nadu	36.0	19.8	34.2	4.2	0.3	1.8	0.7	3.0
Uttar Pradesh	41.2	33.2	7.4	2.8	0.4	3.9	7.2	4.1
West Bengal	19.4	8.0	39.3	7.4	1.9	0.5	1.7	21.8
Delhi	9.9	14.4	58.6	4.1	1.1	5.8	1.7	4.6
All India	34.8	19.0	26.3	8.4	0.7	2.7	2.0	6.1

Note: Rickshaw is the sum of the original categories threewheeler, cycle-rickshaw, and human drawn. Other includes tram, car, school college/employees transport, bullock/buffalo cart, horse-drawn cart, other animal drawn cart, animal as carrier, boat (country craft), steamer, motor launch, and others. Of the figure of 21.8 for others in West Bengal above, 15.3 is in the "other" category in the original.

Source: As for Table 4.8 below

more densely distributed in urban areas, the cut off will tend to understate the fraction of trips on foot in urban relative to rural areas.

The overall figures obscure a great deal of diversity over different provinces of the country, and mode choice is clearly heavily influenced by mode availability, by terrain, and by the level of development. Trips on foot account for more than half of all rural trips in all states except the Punjab, where favorable terrain, high levels of income, and good roads are reflected in very high fractions of trips on buses and bicycles. According to Government of India (undated) 79% of villages in Punjab have a metalled road within the village, and 99% have one within 5 kilometers. Similarly 37% of Punjabi villages have a bus stop in the village, and 93% within 5 kilometers. Bicycles also account for high fractions of rural trips in U.P., in Orissa, Tamil Nadu, West Bengal, Bihar, and more surprisingly, in Assam. Policies that emphasize rural road building and provision of bus routes are reflected in the high shares of bus trips in Kerala, Punjab, Tamil Nadu, Karnataka, Gujarat, and Bihar. Kerala also has the generally highest level of provision in India, with 97% of villages connected by metalled roads, and 96% having bus stops in the village. (Note however that villages in Kerala tend to be much larger and more strung out than villages in most other states.) Note finally that a large share of travel in West Bengal uses some mysterious mode that is not among the eighteen specified in the survey.

As is to be expected, there is a greater diversity of available modes in urban areas, and there is greater diversity between different areas. For example, the shape of the Bombay peninsula and the dominance of train travel in Bombay is reflected in a 25% share of train travel in urban Maharashtra. Buses account for as little as 7-10% of urban trips in U.P., Madhya Pradesh,

and Rajasthan, and nearly 40% in Karnataka, Kerala, and West Bengal. The Delhi figure is 58.6% but this is likely to be uniquely inflated by the one kilometer rule; note that Delhi is the only area in these tables that not only contains one of the great cities, but does so to the exclusion of all else. Minibuses account for 10% of trips in urban Bihar, but are of little importance elsewhere. The TRRL have documented the variation in provision of buses versus minibuses in a number of Indian cities, but there is less evidence of their role in these data, perhaps because they refer to a period some years earlier, or because the criterion of "urban" is much broader than the more concentrated cities in the TRRL samples. The one kilometer cut off rule may also help understate the role of paratransit vehicles, though the effect seems unlikely to be large. As casual observation suggests, mopeds account for a sizeable share of urban travel, and, as suggested by a number of commentators, the phenomenon may well have become more important in the years since the survey was taken. Finally, note that urban Bengalis also avail themselves of the same mysterious mode as do their rural compatriots.

Table 4.8 shows the average distances for each of the modes. The rankings are very much the way one would expect. In rural areas, the ranking of distances is walk, bicycle, bus, and train. Note that the average bus trip involves a considerable distance, presumably matching the distances revealed in the "purposes" table. Train trips are even longer, and are also very much rarer. As before, the urban tripping patterns involve a larger number of modes, and the ordering by distance appears to be foot, rickshaw, bicycle, moped, bus, minibus, and train. The greater distances travelled by minibus than by bus suggest that the former play a

TABLE 4.8

Average distance of single mode trips by modes

1. Rural	walk	bike	bus	train	others
Andhra Pradesh	3.3	7.5	24.7	35.9	10.0
Assam	8.3	8.2	15.6	26.8	17.7
Bihar	6.9	14.8	47.4	55.4	18.3
Gujarat	2.6	5.8	20.2	45.3	4.1
Karnataka	8.5	14.6	31.4	40.1	13.7
Kerala	3.1	13.3	12.6	93.7	44.2
Madhya Pradesh	6.5	14.8	36.3	55.8	21.1
Maharashtra	3.7	9.6	32.7	31.8	15.0
Orissa	6.3	10.5	32.1	37.2	34.1
Punjab	2.8	7.7	26.1	48.4	12.7
Rajasthan	4.1	9.3	43.9	56.9	34.0
Tamil Nadu	3.8	7.9	22.1	27.7	14.2
Uttar Pradesh	4.6	12.9	27.6	45.0	19.3
West Bengal	4.1	7.5	15.7	25.0	25.8
All India	4.6	10.3	23.9	39.3	18.6

2. Urban	walk	bike	bus	train	m-bus	moped	r'shaw	other
Andhra Pradesh	2.5	5.1	22.9	62.8	7.9	8.7	3.6	15.2
Bihar	7.0	12.5	30.3	62.9	23.0	20.2	4.0	22.0
Gujarat	2.7	4.8	15.3	68.7	6.0	8.9	3.8	10.7
Karnataka	6.4	9.0	16.0	94.2	34.4	9.4	7.4	22.6
Kerala	2.3	5.0	11.8	27.8	10.5	8.6	4.9	14.5
Madhya Pradesh	5.9	12.2	35.0	97.8	19.9	18.1	12.5	22.1
Maharashtra	3.0	8.7	9.2	20.0	7.2	9.9	8.2	18.0
Orissa	6.9	14.8	38.1	63.9	33.9	39.8	9.8	15.1
Punjab	3.3	5.6	41.5	71.6	19.8	5.0	3.9	9.7
Rajasthan	4.0	5.4	28.3	75.0	14.1	5.7	4.4	11.8
Tamil Nadu	3.2	5.6	16.4	24.0	15.2	8.5	2.8	14.7
Uttar Pradesh	4.3	6.7	24.9	61.4	37.3	11.7	7.9	40.6
West Bengal	2.7	4.7	9.1	21.0	6.9	7.3	5.2	23.0
Delhi	4.7	8.7	12.1	26.1	10.2	11.3	8.4	9.5
All India	3.7	7.2	14.9	26.7	19.6	10.5	6.2	19.7

Source: NSSO/Ministry of Shipping and Transport, Preliminary Tables from the 11th block of the 32nd round, 1977-78, Table 6.

Caution: Some of the distances in the right columns are based on small numbers of sample trips and presumably have large standard errors.

role in linking towns and towns with the surrounding countryside. Note in particular that in urban Bihar, where minibuses account for ten per cent of all trips, the average distance is more than 20 kilometers. The quite long distances associated with trips by train are presumably associated with long-distance intercity and interstate travel, and the averages would be considerably larger if we were to exclude the few cases where there is commutation by rail, as for example in Bombay.

Table 4.9 gives more information on mode choice, albeit indirectly. The table excludes trips on foot, and shows the distribution of the remainder by distance classes, and within distance classes by whether or not the

TABLE 4.9

Distribution of non-walking trips by distance and owned/not-owned
All India: (percent)

	--------rural------			--------urban------		
distance	owned	not	all	owned	not	all
1 - 3	11.48	4.32	15.80	14.36	12.21	26.57
3 - 5	8.85	6.05	14.91	7.98	12.38	20.37
5 -10	12.73	14.12	26.85	7.29	16.67	23.96
10 -15	5.19	7.86	13.05	2.10	6.82	8.92
15 -20	2.20	6.48	8.68	1.19	5.06	6.25
20 -30	1.47	6.71	8.18	1.13	4.77	5.90
30 -50	1.25	5.51	6.75	0.59	3.27	3.86
50-100	0.78	3.28	4.06	0.33	2.53	2.85
100-500	0.23	1.37	1.59	0.09	1.14	1.23
>500	0.02	0.11	0.13	0.02	0.08	0.10
All	44.20	55.80	100	35.07	64.93	100

Source: NSSO/Ministry of Shipping and Transport, Preliminary Tables from the 11th block of the 32nd round, 1977-78, Table 10.

traveller owned the transport equipment. Ownership was also defined to include ownership by a friend or relative when no fare was charged. The table has two main features. The distribution of urban trips over distance

is more skewed towards shorter trips. Secondly, there is a somewhat higher proportion of trips by owned modes in the countryside. If this fact applies to the other countries in this report (and it is quite plausible that it does), and since household expenditure surveys can only hope to collect a fraction of the total costs of transport equipment (even if it is only bullock carts), then our attempts to assess travel patterns by expenditures on travel will tend to understate the amount of rural relative to urban travel, even travel that is not on foot.

Tables 4.10 and 4.11 provide the link between mode choice and expenditure patterns. Table 4.10 shows the actual expenditures per kilometer by mode. Note that there is no attempt to impute expenditures that are not directly incurred at the time of travel, e.g. the depreciation and repair costs of owning and operating a bicycle or the fodder costs for bullocks. Note too

TABLE 4.10

Expenditures per kilometer by mode
All India (Rupees per kilometer)

	rural	urban		rural	urban
train	0.03	0.04	rickshaw	0.08	0.13
tram	**	0.06	bullock cart	0.01	0.02
bus	0.05	0.05	horse cart	**	0.06
minibus	0.06	0.06	other animal cart	0.01	0.02
car	0.06	0.05	animal carrier	0.01	0.02
3-wheeler	0.06	0.12	human power	0.04	0.13
scooter	0.01	0.01	boat	0.01	0.03
special t'port	0.01	0.01	steamer	0.01	0.02
bike	**	0.01	others	0.03	0.03

Source: NSSO/Ministry of Shipping and Transport, Preliminary Tables from the 11th block of the 32nd round, 1977-78. Supplementary table 2.

Notes: Only single mode trips are included. ** indicates that an observation is given in the source but appears to be contaminated. In all three cases, the reported figures are unreasonably large, and are so because there is one even more absurd figure for one particular state, e.g. 2.03 rupees per km. for bicycle travel in rural Andhra, or 4.51 rupees per km. for horse cart travel in rural Haryana. It would not be surprising if these anomalies traced back to individual observations in the raw data.

that some of the figures in the Table are based on very small sample sizes; there are very few rural 3-wheeler trips, for example, nor are bullock carts or direct animal transport common forms of personal transport in cities. Even so, the figures show a coherent and sensible picture. Bus trips work out at about 5 paise per kilometer, both in urban and rural areas. Train costs per kilometer are slightly less, as is to be expected given the very

TABLE 4.11

Fare charged per km by selected mode and distance group
All India (Rupees per kilometer)

1. Rural	5	5-10	10-20	20-3	30-50	>50
bus	0.09	0.06	0.06	0.05	0.05	0.05
minibus	0.22	0.08	0.07	0.06	0.09	0.04
boat	0.04	0.01	0.01	0.04	0.01	*
2. Urban	**5**	**5-10**	**10-20**	**20-3**	**30-50**	**>50**
tram	0.10	0.07	0.04	0.04	0.02	0.05
bus	0.07	0.05	0.05	0.04	0.05	0.04
minibus	0.15	0.10	0.08	0.10	0.10	0.02

Source: NSSO/Ministry of Shipping and Transport, Preliminary Tables from the 11th block of the 32nd round, 1977-78. Supplementary table 3.

much longer distances covered. Minibuses, at 6 paise per kilometer are marginally more expensive than buses, while the various taxi-type vehicles, tongas, rickshaws, and three-wheelers, are substantially more expensive. These numbers can be compared with the reported normal fares for a few of the modes given in Table 4.11. Although these reported fares are high compared with what people appear to actually pay, the discrepancy is not large, and the Table shows the expected inverse relationship between distance and fare per kilometer. For bus, which is by far the most

important of these modes, short trips cost as much as 10 paise per kilometer, but the normal rate of 5 paise is attained for distances longer than 10 kilometers. For minibuses, the gradient is similar (though the sample sizes are smaller), so that short trips are reported to cost 22 paise per kilometer in rural areas and 15 paise per kilometer in urban areas, with longer distance fares about half as much.

Table 4.12 reports respondents assessments of why they chose the mode they did for those journeys where alternatives were available. Over all modes, price is a dominant consideration, with more than a half of modes being chosen mainly on that basis. "Other reasons" are also important,

TABLE 4.12

Reasons for selecting modes
All India
(percent rural-urban)

	cheap	quick	frequent	comfort	other
train	71-73	9-9	3-8	7-6	11-4
tram	74-40	2-14	15-15	5-23	5-8
bus	54-58	21-15	16-18	5-4	5-6
minibus	29-42	24-10	24-8	12-36	11-4
car	19-7	12-27	10-4	42-42	16-19
3-wheeler	22-33	8-27	29-13	17-19	24-8
scooter	32-13	33-44	9-9	15-22	11-12
special	25-51	17-5	12-4	6-21	39-19
bike	64-69	10-9	4-4	5-4	17-13
rickshaw	31-20	13-19	12-19	16-28	28-14
bullock c't	15-13	2-2	5-1	3-14	75-71
horse cart	20-49	8-6	48-11	8-17	15-17
other cart	21-11	10-0	26-22	8-22	35-46
animal	22-18	8-0	0-0	26-13	44-69
human	36-30	8-16	2-12	43-21	11-21
foot	49-54	5-3	1-2	3-3	42-37
boat	42-93	0-3	1-0	2-2	55-1
steamer	85-100	8-0	0-0	0-0	7-0
others	34-28	6-8	6-5	12-7	42-53
all	53-58	11-11	6-9	4-7	26-16

Source: NSSO/Ministry of Shipping and Transport, Preliminary Tables from the 11th block of the 32nd round, 1977-78. Table 14b.

particularly in rural areas, and from the distribution over modes, these other reasons seem to be cases where the mode is connected with work, e.g. special employer or school provided transport, or bullock carts. Trains are chosen largely because they are inexpensive, and this is consistent with the fact that trains cover long distances at one or two paise less per kilometer than do buses. Buses are cheap, or quick, or frequently available, but very rarely comfortable, while minibuses are less cheap and more comfortable, but also quick and frequently available. The bus versus minibus trade-off appears to be one of money for comfort, with time costs held more or less constant. Cars take us even further along the comfort versus cheapness trade-off, although "other" is important here, perhaps reflecting the number of people who have officially provided vehicles of one sort or another. Speed seems to be a less important reason for choosing cars than it is for choosing buses or minibuses, and much less important than for the choice of scooters. Scooters are seen as cheap in rural but not in urban areas, perhaps because a different alternative is being considered in each case. If distances are shorter in towns, so that the bicycle is an effective alternative, scooters would be a relatively expensive alternative. In rural areas, bicycles are less attractive for long trips, so that buses, minibuses, or cars might be the alternatives. Rickshaws are quoted as satisfying almost all the criteria, and human-drawn rickshaws are chosen mainly for their comfort by 43% of their rural users. (There are of course very few of these in the sample.) Reasons for walking are about 50-50 between cheapness and "other"; it is not clear what these other reasons would be, though it is not hard to think of possibilities.

Table 4.13 shows the relationship between trip purpose and the choice of mode, and contains important evidence on differences between urban and rural patterns and on the relationship between transport provision and various types of economic activity. The two most important trip generating purposes, work and school, are distributed very differently over modes in the two sectors. In urban areas, work trips are divided between walk, bicycle, and bus trips, with about a third going to the first and a fifth each going to each of the others. School trips are distributed similarly,

TABLE 4.13

Distribution of modes by trip purposes (percent)

	work	school	hlth	ent	business	shops	social
1. Urban							
walk	35.6	37.2	17.1	27.2	35.1	45.3	10.3
bike	21.8	11.0	6.0	11.1	21.2	19.0	5.1
bus	22.0	35.1	46.2	38.7	24.8	26.0	61.8
train	9.4	5.3	5.5	4.1	8.0	1.9	9.0
minibus	0.6	0.8	0.8	1.8	0.8	1.0	0.6
moped	3.3	1.0	0.7	2.8	2.0	2.3	2.2
rickshaw	1.3	3.2	10.2	9.4	3.5	1.9	4.1
other	6.0	6.4	13.5	4.9	4.6	2.6	6.9
2. Rural							
walk	81.6	70.0	25.8	53.1	45.1	72.1	33.4
bike	9.6	14.7	8.7	10.5	20.6	8.7	8.4
bus	4.2	12.8	51.1	26.5	21.8	14.4	45.8
train	0.7	0.8	1.8	1.4	2.9	0.6	2.7
minibus	0.1	0.2	1.3	0.5	0.9	0.5	0.8
moped	0.2	0.1	0.3	0.5	0.7	0.3	0.4
rickshaw	0.3	0.4	2.5	1.2	1.0	0.4	0.4
other	3.3	1.0	8.5	6.3	7.0	3.0	8.1

Source: NSSO/Ministry of Shipping and Transport, Preliminary Tables from the 11th block of the 32nd round, 1977-78, Table 8.

though some of the bicycle trips are transferred to buses. In the rural areas however, 82% of work trips and 70% of school trips are made on foot, figures that would almost certainly be larger if all trips were included irrespective of length. So while it is true that the numbers of trips to school and to work are rather similar as between rural and urban areas, and are more similar than we originally expected, there is a major difference in the distribution of those trips across modes, with the rural trips making little demand on transport provision or equipment. For trips that are not to school or to the work place, it is still true that there is a greater share of pedestrian trips in the countryside, but the difference is much less marked than for work and school trips. More than a half of rural trips to doctors or health centers are made by bus, a fraction that is higher than that in the towns. Indeed, given that the average distance of rural health trips is nearly 19 kilometers as opposed to 13 kilometers in the urban areas, see Table 4.5 above, it is not surprising that buses are the normal mode. Entertainment trips, social trips and business trips, defined as trips to banks, post offices, etc., as well as those for buying and selling in connection with own-account activities, are all relatively lengthy, and once again buses play an important part, in the countryside as well as the towns. Bicycles are also important, particularly for business trips, where they account for more than a fifth of trips in both sectors. Shopping trips, which, like employment and school trips, are much shorter than business, social or entertainment trips. are once again mostly made on foot in the rural areas, with much less use of buses or bicycles than in towns. A simple way of characterizing these results would be to note that while trip frequencies are similar between town and countryside, and modal choice

is similar for purposes that require trips longer than about 10 kilometers, the shorter trips are nearly always made by foot in the countryside, but by a much wider variety of modes in the towns. There is little in the way of vehicular commutation in the countryside.

From the point of view of transport provision and planning, it is also useful to consider these data in terms of the distribution of purposes for each of the modes. More than three-quarters of urban bus trips are trips to work or school, while a randomly selected bus tripper in the countryside would only have a 35% chance of being en route to school or work, an 8.5% chance of being on a medical trip, a 12% chance of being on a business trip, a 13% chance of being on a shopping trip, and a 13% chance of being on a social visit. Similar patterns apply to other modes, with employment and educational trips accounting for about 75% in the urban areas, and much less in the countryside. For example, more than 19% of rural mini-bus trips are for shopping, while only 17% are for employment. The corresponding urban figures are 3% and 61%. It is these sort of results that account for the conventional wisdom that urban and rural trip patterns are quite different. On board surveys would show very different trip rates and trip patterns for people in rural and urban areas. Household data, on the other hand, show that trip numbers and purposes are rather similar, but that rural household members make little use of vehicles for work and educational trips. It could be said that the conventional view is an adequate description of rural *vehicular* travel. However, to the extent that such a view ignores the very large amount of non-vehicular tripping that takes place in the countryside, there are obvious dangers of under-predicting the amount of vehicular travel

that will be generated as economic development proceeds, as people become better-off, and as transport infrastructure improves.

5. Travel patterns and levels of living

The relationship between household living standards and travel patterns is not easy to document from the survey tables, not because the material was not collected in the survey, but because so few of the relevant relationships were tabulated in the draft tables. However, a number of questions can be addressed, and this subsection presents what evidence there is. The Indian National Sample Survey does not generally collect data on household incomes, believing that such data are inherently unreliable and that the attempt to collect them will compromise the quality of the rest of the survey. Instead, expenditure data are collected in great detail, and household total expenditure (including imputations) divided by household size, or per capita household expenditure (PCE) is routinely used as a measure of household living standards in the same way as has been done in the rest of this report. The average PCE levels by state were reported in Table 4.2 above and will be used below to examine the relationship between travel and PCE at the state level.

The NSS/Ministry of Shipping and Transport tabulations contain a table which presents for six PCE classes the averages of total expenditure per head, travel expenditure per head, and travel expenditure per passenger. From the first two of these, a ratio can be formed that gives some idea of the share of travel expenditure in the household budget and its relation to household living standards. The results are shown in Table 4.14 for rural and urban separately and for each of the large population states. The rural

TABLE 4.14

Shares of travel in total expenditure by PCE class

PCE class	1.	2.	3.	4.	5.	6.	All
			Rural (percent)				
Andhra Pradesh	0.9	0.8	44.3	3.3	2.2	1.8	11.7
Assam	0.0	0.3	0.4	0.4	1.0	1.0	0.4
Bihar	0.0	3.5	0.4	0.9	1.0	1.2	1.1
Gujarat	0.5	1.3	1.5	1.7	2.5	1.8	1.8
Karnataka	7.6	2.6	1.9	2.2	3.3	3.1	2.6
Kerala	2.2	2.3	6.0	3.1	3.2	3.5	3.7
Madhya Pradesh	0.3	0.6	1.2	1.2	1.9	1.7	1.2
Maharashtra	0.6	0.8	1.2	2.4	2.9	35.7	6.0
Orissa	0.0	0.3	0.4	0.5	1.3	0.9	0.5
Punjab	57.0	0.9	1.9	1.8	1.9	1.9	1.9
Rajasthan	5.4	0.8	4.0	12.0	2.1	7.2	7.2
Tamil Nadu	5.2	1.3	2.0	4.7	2.9	2.1	3.0
Uttar Pradesh	0.0	0.8	0.6	1.2	1.5	8.3	2.1
West Bengal	0.3	0.7	1.0	2.0	2.9	2.0	1.6
All India	1.4	1.2	4.9	2.7	2.1	5.4	3.4
All India (est)	0.5	1.2	1.3	2.4	2.1	3.4	2.6
			Urban (percent)				
Andhra Pradesh	0.8	1.3	1.1	1.7	2.7	4.6	2.8
Bihar	0.0	0.5	0.9	1.8	2.2	2.6	1.9
Gujarat	-	1.0	1.0	1.7	2.9	2.1	2.1
Karnataka	1.6	1.2	1.6	2.0	2.8	7.0	3.6
Kerala	5.8	1.3	2.5	2.8	3.1	3.9	3.1
Madhya Pradesh	6.7	1.3	1.9	2.1	2.5	2.3	2.2
Maharashtra	1.7	1.1	2.1	3.2	6.7	4.7	4.6
Orissa	0.0	0.5	0.3	0.6	1.8	3.3	1.6
Punjab	0.0	1.9	2.3	1.4	2.6	1.9	2.0
Rajasthan	0.0	6.0	2.7	2.0	2.3	2.6	2.4
Tamil Nadu	1.2	1.3	2.6	2.3	3.1	3.3	2.8
Uttar Pradesh	0.0	0.7	0.8	1.8	2.5	2.4	2.0
West Bengal	66.9	1.5	3.2	3.9	4.1	3.1	3.6
Delhi	0.0	0.0	2.7	1.4	1.8	1.4	1.5
All India	6.3	1.2	1.8	2.2	3.5	3.4	2.8

The PCE classes are 1. 0-20, 2. 20-40, 3 40-60, 4. 60-100, 5. 100-150, 6. 150 +, all in rupees per month per head.

Source NSSO/Ministry of Transport and Shipping, Table 15. See text for construction of All India (est) rows.

figures clearly contain some anomalies, and the most obvious offenders are underlined in the table. PCE class 1 typically contains rather few households, so that the 57% figure for the Punjab is likely due to the combination of errors of measurement and small sample size. Class 6 for Maharashtra is also small, so that similar considerations may apply. The other two obviously incorrect figures, for class 3 in Andhra and class 4 in Rajasthan are less easily explained, and presumably result from one or more gross errors in the raw data. These figures also distort the All India pattern, and an admittedly crude attempt has been made to correct for the errors in the row labelled All India (est). Corrections were made to the underlying expenditure figures as follows: the Punjab class 1 figure was reduced to zero, since other calculations suggested that there were essentially no recorded trips for this class; the Andhra class 3 figure was reduced by 90%, leaving it still very much higher than its nearest neighbors; the Rajasthan class 4 figure was halved, and the Maharashtra class 6 figure cut by two-thirds. For these last three, the aim was to cut the figures by the smallest possible amount necessary to impute any credibility. Aggregating these into the totals presents further problems since it is impossible from the Tables at our disposal to infer either the numbers of households in each PCE class or the distribution of households over states within each PCE class. The best that was possible was to use the overall distribution of households across states, together with some calculations on the <u>trip</u> shares within states for each expenditure class (see below). Applying these moves the all classes Andhra figure from 11.7 to 3.2, and the All India figures to those shown in the final row of the rural half of the table.

The urban data appear to be better, as is to be expected from the greater frequency of paid travel in urban areas. The one exception is the figure for the poorest class in West Bengal, but again this represents a very small number of people and even fewer sample points. Exclusion of this could remove most of the 6.3 figure in the All India row, so it is best to ignore this figure altogether.

With these corrections, a fairly consistent pattern emerges. Firstly, there is remarkably little difference between urban and rural in the shares of total expenditure devoted to travel. Mean per capita household expenditures is almost 50% higher in urban than in rural areas and the same is true of mean travel expenditures. Secondly, in both urban and rural areas, the share of expenditure on travel appears to rise with the level of overall per capita expenditure. Households with total household expenditure levels of 20-40 rupees per head per month spend a little more than one percent of this on personal travel. In the 60 to 100 rupee class, the share is over two percent, while the highest group, those with PCE of more than 150 rupees per month devote about three and a half per cent of their budget to travel. These figures imply that the total expenditure elasticity of travel is between one and two, a magnitude that is rather larger than that found for the other countries in this study. (See section 4.6 below for a refinement on this estimate.) Note also that this finding is <u>within</u> urban and rural areas considered separately and does not hold <u>between</u> the two regions. Expenditures are higher in urban than in rural areas, but as we have already seen, the share of travel is about the same. Note finally that the elasticity of travel expenditure is far from uniform across states, and that there are several large states where there is no apparent tendency for

the travel share to be larger in, say groups 5 and 6, than it is in, say, groups 2 and 3. Urban Punjab and Rajasthan as well as rural Bihar and Kerala are examples, each of which has a population large enough to count as a fair-sized country.

One of the great frustrations of working with the tabulations of the survey rather than the raw data is the difficulty of assessing the relationship between living standards and the physical characteristics of trips. Given the raw data, nothing would be easier than to tabulate numbers of trips against per capita household expenditure. Attempts to do so from the tabulations have been fraught with difficulties. The same table used to calculate expenditure shares above provides estimates both of travel expenditure per person and travel expenditure per passenger. If one is divided by the other, we obtain an estimate of the number of passengers per person. Such a procedure gives a weighted harmonic mean, where the weights are household travel expenditure per person. More precisely, if a weighted mean is constructed from each household's ratio of persons to passengers where the weights sum to one and are proportional to each household's per capita travel expenditure, and if this weighted mean is reciprocated, we obtain the estimates of passengers per person given in Table 4.15. This detailed description is necessary to understand the figures, the crucial point being that the weighting procedure excludes households that spend nothing on travel. In consequence, the table confounds two effects that would be better separated, the effect associated with the correlation of living standards and passengers per household, and the sample selection effect whereby households are excluded if they spend nothing on travel, so that fewer and fewer households are excluded as we move from low PCE to high

TABLE 4.15

Passengers per person by PCE class
Rural

PCE class	1.	2.	3.	4.	5.	6.	All
Andhra Pradesh	0.4	0.3	0.4	0.5	0.7	0.9	0.5
Assam	-	0.1	0.1	0.2	0.4	0.5	0.2
Bihar	0.0	0.1	0.1	0.1	0.2	0.2	0.1
Gujarat	0.4	0.3	0.4	0.5	0.8	0.9	0.5
Karnataka	0.3	0.2	0.3	0.4	0.7	0.7	0.4
Kerala	0.4	0.4	0.5	0.7	1.0	1.3	0.6
Madhya Pradesh	0.3	0.3	0.4	0.5	0.6	0.8	0.4
Maharashtra	0.3	0.4	0.5	0.6	0.8	1.0	0.5
Orissa	0.0	0.1	0.2	0.2	0.4	0.5	0.2
Punjab	0.6	0.1	0.2	0.3	0.5	0.6	0.4
Rajasthan	0.4	0.3	0.3	0.4	0.7	0.7	0.5
Tamil Nadu	0.5	0.3	0.5	0.7	1.0	1.1	0.5
Uttar Pradesh	0.0	0.2	0.3	0.4	0.5	0.6	0.3
West Bengal	0.2	0.2	0.3	0.4	0.5	0.7	0.3
All India	0.2	0.2	0.3	0.4	0.6	0.8	0.4
			Urban				
Andhra Pradesh	0.3	0.3	0.3	0.4	0.5	0.7	0.4
Bihar	-	0.0	0.1	0.1	0.3	0.4	0.2
Gujarat	-	0.2	0.3	0.4	0.7	1.0	0.6
Karnataka	0.3	0.2	0.2	0.3	0.5	0.9	0.4
Kerala	0.4	0.3	0.5	0.6	0.8	1.3	0.6
Madhya Pradesh	0.2	0.2	0.3	0.4	0.6	0.8	0.4
Maharashtra	0.4	0.3	0.5	0.5	0.8	1.0	0.7
Orissa	-	0.1	0.1	0.1	0.2	0.4	0.1
Punjab	-	0.2	0.1	0.2	0.3	0.5	0.3
Rajasthan	-	0.2	0.2	0.3	0.5	0.7	0.4
Tamil Nadu	0.2	0.2	0.4	0.5	0.7	1.0	0.5
Uttar Pradesh	-	0.1	0.1	0.3	0.5	0.7	0.3
West Bengal	0.3	0.2	0.2	0.4	0.6	0.8	0.4
Delhi	-	-	0.1	0.2	0.3	0.5	0.3
All India	0.3	0.2	0.3	0.4	0.6	0.8	0.4

Source: NSSO/Ministry of Shipping and Transport, Table 15.

Note: these figures exclude households that spend nothing on transport. See the text for more detailed discussion.

PCE group households. While it is almost certainly true that the fraction of households spending something on travel is an increasing function of PCE (see the tables in later chapters), there is no way of estimating the relationship from the tables at our disposal. All we know is that the overall effect must be substantial. Table 4.3 above shows that there are 0.8 or 0.9 travellers per household in the country as a whole, there are about 5 persons per household, and yet Table 4.15 shows 0.4 passengers per person, i.e. more than twice as many per household. This is at least consistent, since it is plausible that households that spend something on travel have twice as many travellers as those that do not, even respecting the very large fraction of trips on foot and by bicycle.

For what it is worth, Table 4.16 shows that among households that spend money on travel, there is a strong positive association between numbers of passengers and per capita household expenditure levels. Households in the top group have PCE levels about three times those in group 2, and they show about four times as many passengers.

The NSSO/Ministry of Shipping and Transport tables contain only one other set of tabulations where there is disaggregation by PCE class. This is a table showing for six selected purposes the share of each in all trips by PCE class. The All India versions of this table are shown in Table 4.16. Although many of the major purposes are excluded (recall from Table 4.4 that nearly 80% of all trips are to work and to school, and both categories are excluded here), it may be that the main "discretionary" purposes are among those given. Once again, attention should be focussed on classes 2 through 6, since class 1 is based on very small samples. Visits to doctors, health clinics and hospitals are positively related to PCE level in rural areas

TABLE 4.16

Percentage of journeys for selected purposes by PCE class

PCE group	1.	2.	3.	4.	5.	6.	All
(i) rural							
health visit	1.4	1.4	1.5	2.0	3.0	3.8	2.1
entertainment	0.4	0.8	1.3	1.3	1.5	1.9	1.3
social visit	3.0	2.8	2.9	3.6	4.3	6.1	3.6
pilgrimage	0.4	0.6	0.6	0.7	0.9	1.0	0.7
educational tour	0.0	0.0	0.0	0.0	0.0	0.1	0.0
health/excursion	0.0	0.0	0.0	0.0	0.1	0.2	0.0
(ii) urban							
health visit	2.3	1.3	1.2	1.1	1.0	1.2	1.1
entertainment	1.2	0.8	0.9	1.2	1.5	1.8	1.4
social visit	1.7	2.3	2.3	2.4	2.5	3.1	2.6
pilgrimage	2.0	0.2	0.7	0.5	0.6	0.5	0.5
educational tour	0.2	0.1	0.0	0.0	0.0	0.1	0.1
health/excursion	0.0	0.0	0.0	0.0	0.1	0.2	0.1

Source: NSSO/Ministry of Shipping and Transport Table 4.

but not in urban areas where they account for a little over one percent of trips at all PCE levels. This is an interesting difference and may reflect the greater distances that need to be covered to obtain health care in the countryside and the greater consequent costs. The share of entertainment trips is a positive function of PCE level and approximately doubles over the threefold increase in PCE levels, both in towns and countryside. Social visits, like health trips, are much more expenditure elastic in rural than in urban areas. If this is a general phenomenon, urbanization not only has the effect of providing access to a greater range of facilities, but it does so in a way that equalizes the distribution of access over income groups.

Note that since Table 4.16 has six purposes and six PCE classes, it is in principle possible to derive the weights by which the first six columns are

aggregated to give the seventh, at least if the matrix is not singular. We have carried out these calculations for All India and for the majority of the states: for a substantial minority the matrix is singular, usually because some of the PCE groups show no trips for any purpose. Unfortunately, the results of these contortions, while showing for each state the distribution of trips by PCE class, do not tell us what we most want to know which is the numbers of trips per household in each PCE class. To complete the calculation, we should also need to know the numbers of households in each PCE class, and this information is not included in the Tables. Even if it were, the chain of calculation would have reached a length and a complexity that would not inspire confidence in the quality of the results. Once again, the required calculations would be straightforward with the raw data.

6. Determinants of travel patterns

Without access to the raw data, it is very difficult to analyze relationships in a way that even begins to do justice to the wealth of information originally collected. However, this section presents some very rough results derived from making comparisons across states, and for a few relationships, across per capita expenditure groups. If there exists a linear relationship between variables at the household level, and if this relationship is the same over all states, then it is possible to aggregate over all households in each state. The original micro relationship will be mirrored at the aggregate level, and the same parameters can be estimated from the raw or from the aggregate data. One problem is that some variables may vary by very little across states although they vary a great deal within

states, household size being a good example. When this happens, it becomes difficult to estimate the effects of the variable, even if it would be very easy to do so at the micro level. In general, grouped estimates are always less efficient than estimators that use the raw data, and it is for variables like household size that the difficulty is most serious.

However, there are other reasons for suspecting that grouping by states is particularly inappropriate for examining travel behavior. Specifically, if the behavioral relationships vary significantly from state to state, the estimated aggregate relationship will be a melange of individual relationships and aggregation effects. Since travel patterns are obviously affected by geography, the dangers are very real. A somewhat more positive way of looking at the problem is to think of it in terms of omitted variables. If all relevant geographical variables were to be included, the aggregation would go through. Since it is impossible to know whether or not this is the case, there will be problems at the aggregate level if there are significant correlations between the included variables and any important geographical variables that have been omitted. The possibility should be constantly borne in mind while interpreting the results.

Even given the difficulties, perhaps the most surprising feature of the results is that very few significant relationships can be found in the state level data. For example, if all 50 states and territories are included, the following relationship is estimated between trips per household, *thh*, per capita household expenditure, *pce*, an urbanization dummy, *urb*=1 for urban, 0 for rural, and average household size, *hhs*

$$thh = \underset{(0.4)}{0.28} + \underset{(1.8)}{0.018}\, pce \quad \underset{(2.0)}{0.29}\, urb + \underset{(0.4)}{0.06}\, hhs \qquad R^2 = 0.10 \quad n=50 \quad ese=0.41 \quad pF=.15$$

where, as for all the regressions, absolute values of t-statistics are reported in parentheses, n is the number of observations, ese the estimated equation standard error, pF is the p-value from the F-test for the significance of the regression as a whole, and the coefficient of multiple correlation, R^2, is given in its uncorrected form. If the regression is restricted to the 28 states with "large" populations, the estimates are

$$thh = \underset{(0.5)}{-0.44} + \underset{(1.6)}{0.025}\, pce - \underset{(0.8)}{0.14}\, urb + \underset{(1.0)}{0.17}\, hhs \qquad R^2 = 0.14 \quad n = 28 \quad ese = 0.30 \quad pF = .29$$

Neither of these regressions is inconsistent with the null hypothesis that there is no relationship at the state level. In the "all territories" version, there is some suggestion of a positive relationship between trips per household and per capita expenditure and a <u>negative</u> effect of the urbanization dummy, so that at a given level of living, there are <u>fewer</u> urban than rural trips. Neither regression lends support to the idea that rural household trip rates are significantly less than urban trip rates once we have allowed for the effect of differential living standards.

Indicators of travel facilities add little to these regressions. Government of India (undated) provides tabulations of basic amenities in Indian villages from the 1977 Economic Census. One of these indicators is the percentage of villages in each territory with a metalled road. From this, a variable, vrd, was constructed by assuming that this indicator took the value of 100% for all urban areas. Adding this to the regression gives

$$thh = \underset{(0.3)}{0.24} + \underset{(1.9)}{0.019}\, pce - \underset{(0.9)}{0.22}\, urb + \underset{(0.5)}{0.07}\, hhs - \underset{(0.4)}{0.001}\, vrd \qquad R^2 = 0.11 \quad n=50 \quad ese=0.42 \quad pF=.26$$

Other facility variables have similarly negligible results. In the Jaipur survey to be reported in Chapter 5 below, there is a significant relationship between <u>distance</u> travelled and income levels. Using the same explanatory variables as above, but with average journey distance as the dependent variable, we find here

$$dist = \underset{(1.6)}{17.3} - \underset{(0.1)}{0.015}\, pce - \underset{(0.05)}{0.16}\, urb - \underset{(0.9)}{1.61}\, hhs + \underset{(1.0)}{0.045}\, vrd \qquad R^2 = 0.12 \quad n=50 \quad ese=5.66 \quad pF=.21$$

There is essentially no relationship here, a result that is repeated when attention is restricted to the 28 large population states.

The analysis of trip rates by purpose yields somewhat more interesting results which are shown in Table 4.17. Per capita expenditure exerts a significantly positive influence on trip rates for education and health, though not on trip rates for entertainment or social visiting. There is a close to significant effect in the employment regression, but this is of little interest since causation clearly runs in both directions. There are significant <u>negative</u> effects of the urbanization variable on both health trips and on shopping trips; the explanation here may well relate to the greater provision in urban areas of these facilities within one kilometer. Household size is significantly related to the numbers of social visits, while a bus stop in the village exerts a detectable effect on the numbers

TABLE 4.17

Regressions of household trip rates by purpose

	const	pce	urb	hhs	facility	R^2	pF	ese
employ't	1.51	0.12	0.97	0.10	-0.02	.065	.57	3.16
	(0.3)	(1.6)	(0.4)	(0.1)	(0.8)			
education	-1.61	0.05	-0.27	0.23	0.00	.185	.04	0.64
	(1.3)	(2.9)	(0.9)	(1.1)	(0.6)			
health	-0.36	0.01	-0.15	0.05	0.00	.315	.00	0.10
	(1.9)	(4.1)	(2.0)	(1.5)	(1.0)			
entert't	0.05	0.00	-0.05	-0.01	0.001	.149	.10	0.05
	(0.5)	(0.3)	(1.4)	(0.5)	(2.0)			
social	-0.32	0.00	-0.12	0.07	0.002	.217	.02	0.11
	(1.6)	(0.0)	(1.5)	(2.1)	(2.3)			
business	0.55	-0.01	-0.05	-0.02	0.001	.096	.33	0.22
	(1.4)	(1.7)	(0.3)	(0.3)	(0.3)			
shopping	1.32	-0.01	-0.81	-0.17	0.007	.340	.00	0.31
	(2.2)	(1.4)	(2.8)	(1.7)	(1.7)			

Note: Facility differs from regression to regression. For employment trips, entertainment trips, social trips, and business trips, facility is the percentage of villages with a bus stop in the village. For education trips, facility is the percentage of villages containing a primary school. For health trips facility is the percentage of villages having a primary health center within five kilometers. For shopping trips, facility is the percentage of villages with a market within five miles. "Business" trips comprise the sum of trips to bank, post-office, etc., and trips connected with selling and buying for own account busi

of both social and entertainment visits. There is no evidence that the presence of a bus service generates more employment trips, though this tells us nothing about the influence of rural bus services on the pattern of rural employment. The regressions shown in Table 4.17 were repeated with trip distances as dependent variables, again disaggregated by purpose. These regressions yielded no significant relationships and are not reported here.

Table 4.18 presents the relationship between mode choice and the usual independent variables for single-mode trips. Since the shares of the modes

TABLE 4.18

Regressions of mode choice

	cons	pce	urb	hhs	f1	f2	R^2	pF	ese
walk	102	-0.84	-2.87	-18.9	0.15	-0.65	.685	.00	15.6
	(6.9)	(2.1)	(0.2)	(3.7)	(0.5)	(2.5)			
bike	-58	0.40	14.0	11.1	-0.50	0.51	.411	.00	11.0
	(2.8)	(1.4)	(1.7)	(3.1)	(2.3)	(2.8)			
bus	-30	-0.03	-17.2	5.5	0.36	0.12	.434	.00	12.8
	(1.3)	(0.1)	(1.8)	(1.3)	(1.4)	(0.6)			
other	-14	0.46	6.0	2.3	-0.01	0.02	.402	.00	7.1
	(1.0)	(2.6)	(1.1)	(1.0)	(0.1)	(0.2)			

Note: the dependent variables are the percentages of single-mode trips accounted for by the four modes. They sum to 100, so that the estimated constants add to 100 while all other parameters sum down columns to zero, apart from possible rounding error. f1 is the percentage of villages with a bus stop in the village, and f2 is the percentage of villages with a metalled road.

add to one i.e. 100 percent, the estimated coefficients sum to zero over modes for each independent variable so that it is easy to see how the modal split changes with the explanatory variables. As levels of living rise, people walk less, they ride on buses about the same, and they redistribute their trips about half and half between bicycle trips and other trips, e.g. taxis and other mainly urban modes. Urban dwellers have a higher percentage of bicycle and other trips and a lower percentage of bus trips, other things being held equal. Larger household sizes are associated with a larger fraction of bicycle trips, so that one additional person would be associated with a nearly 19% reduction in walk trips with most redistributed towards bicycle trips. The availability of a village bus stop causes a minor reallocation of modes from bicycle to bus, while the availability of a metalled road is associated with fewer walk trips and more trips by bicycle. Although there are the obvious difficulties with the aggregation to the

state level, it is far from clear that these regressions do not give an acceptable substitute for the more usual modal split analysis.

Apart from the state level data, it is also possible to make some limited use of the tables that disaggregate by per capita expenditure class. For each state or territory, there are six pce classes, so that with urban and rural separately distinguished, there are 300 possible observations. In practice, only about half of these are usable. The bottom pce class contains few or no trips in most areas and is excluded throughout. It is also necessary to restrict attention to the populous areas of which there are 14 urban and 14 rural as well as to exclude the three remaining "bad" observations that are underlined in Table 4.14 above. In the end, there are 137 remaining observations.

The regression of the budget share devoted to travel on the logarithm of pce and an urban-rural dummy yields

$$\begin{array}{llll} tshare = & -0.0044 + 0.0014\ urb + 0.0088\ \ln(pce) & R^2=.137, pF=.016 \\ & \quad (0.75) \quad (0.56) \quad (4.56) & n=137, ese=0.016 \end{array}$$

so that, once again, there is no significant rural urban differential once differences in living standards have been controlled for. Separate regressions for urban and rural confirm the unimportance of the distinction. Living standards themselves are important and have a positive coefficient in the regression indicating that the share devoted to travel rises with the budget, or that travel is a luxury good. The estimated total expenditure elasticity can be obtained by dividing the ln(pce) coefficient by the budget share and adding unity. Omitting the anomalous data underlined in Table 4.14, the mean value of the travel share is 0.022, with a corresponding

total expenditure elasticity of 1.40, somewhat higher than estimated for the other data sets, but not absurdly so.

The final regressions are contained in Table 4.19 and show the relationships between the trip shares devoted to various purposes and levels of living where, once again, the observations are the shares and pce levels described above. All of the purposes shown have shares that rise with living standards, largely because the omitted categories, including employment and educational trips, have trip rates that are largely independent of household living standards. It is of some interest to note that the shares of entertainment and social visits are those that rise most

TABLE 4.19

Regressions of trip shares by selected purpose

	constant	urb	ln(pce)	R^2/pF	ese
Health	0.708	-1.377	0.655	0.255	1.41
	(1.3)	(5.7)	(3.7)	0.00	
Entertainment	-0.579	-0.407	0.762	0.251	0.97
	(1.6)	(2.4)	(6.3)	0.00	
Social visit	1.445	-1.454	0.951	0.227	1.81
	(2.1)	(4.7)	(4.2)	0.00	
Pilgrimage	0.292	-0.274	0.161	0.080	0.60
	(1.3)	(2.7)	(2.2)	0.00	
Educational Tour	-0.051	-0.004	0.037	0.018	0.19
	(0.7)	(0.1)	(1.6)	0.31	
Excursion or health tour	-0.284	0.001	0.127	0.124	0.24
	(3.2)	(0.0)	(4.4)	0.00	

rapidly with increases in living standards, with trips for health purposes not far behind. The urbanization dummies are mostly negative, once again

reflecting the larger share of trips devoted to the omitted categories in the urban areas.

7. Summary and conclusions

The previous six sections have presented a great deal of empirical information, not all of which is of equal importance or interest. In this final section, there is a brief summary of the findings.

(i) Household trip rates in India appear to be broadly similar between urban and rural areas with about 0.9 urban trippers per household, and 0.8 trippers per rural household, a tripper here being defined as someone who made a trip longer than one kilometer in the last seven days. Regular trips (those that are made at least once per week) are about equal in numbers to irregular trips in rural areas, while in urban areas the ratio is 2:1 in favor or regular trips. Regular trippers make roughly one round trip per day irrespective of sector.

(ii) Most trips are trips to work, and the ratio of trips to work to trips to school (the second most important category) is about 5:1. Other evidence suggest that this ratio is much too large, at least in the urban areas, and it is likely that the survey rule of excluding trips shorter than one kilometer is responsible. After trips to work and school, shopping trips are the most important, followed by social visits, and then trips connected with sales and purchases for own account activities.

(iii) Within each mode, rural trips tend to be longer than urban trips. Pedestrians in rural areas walk further than pedestrians in urban areas, bicyclists ride further, and bus passengers take longer trips. However, because three-quarters of all rural trips are on foot, compared with only 35% in urban areas, the average urban trip is actually longer than the average rural trip.

(iv) Once trips by foot, bicycle, and bus are accounted for, there are relatively few other rural trips. Trains, scooters, minibuses, and rickshaws are of real importance only in the urban areas. Train travel appears to be the most influenced by local availability and topography, as in the large numbers of rail commuters in Bombay.

(v) Minibus fares are about 20% higher than regular bus fares per kilometer and rickshaw type paratransit modes substantially more expensive, with fares that are about twice as much per kilometer. Expenditure per kilometer falls with distance up to about 10 kilometers, after which it is constant. Over very long distances, trains are least expensive per kilometer.

(vi) While tripping numbers and purposes are rather similar between urban and rural, there is very little vehicular commutation in the countryside. In rural areas, more than 80% of work trips and 70% of school and shopping trips are made on foot. Trips for these purposes are over relatively short distances, and all average less than 10km. While rural people walk further, they cannot walk the considerable distances required for access to medical

facilities, for entertainment, for business, and for social visits. For these purposes, the pattern of modal choice is closer to that in the towns, with buses and other vehicles playing a larger role. On board surveys are therefore likely to exaggerate the difference in numbers of trips and purposes between rural and urban areas. The conventional wisdom that rural tripping patterns are radically different from urban tripping patterns is more or less correct for vehicular trips, but there exists a vast reservoir of non-vehicular tripping in rural areas that can presumably switch mode as people get better-off and as the provision of transport improves.

(vii) There is very little difference between urban and rural in the share of the budget devoted to travel. Mean per capita travel expenditures and mean total expenditure per capita are each about 50% higher in the urban areas.

(viii) Health visits are positively correlated with PCE in rural but not in urban areas, as are social trips. Entertainment trips are responsive to living standards in both sectors. Urbanization may therefore equalize access to health and other facilities over groups with different living standards. Household members in the countryside typically have to travel long distances to obtain access to health and business facilities, and longer trips are more expensive.

(ix) Modal choice is systematically related to levels of living. As people become better off, they walk less, they ride bicycles more and they take more trips on rickshaws, minibuses and other mainly urban modes. The share

of trips by bus is more or less independent of living levels. Urban dwellers have a higher percentage of bicycle and other trips and a lower percentage of bus trips, other things being held equal. Larger household sizes are associated with fewer walk and more bicycle trips. The availability of a village bus stop causes a minor reallocation of modes from bicycle to bus, while the availability of a metalled road is associated with fewer walk trips and more trips by bicycle. These patterns are not greatly influenced by the distinction between urban and rural, so that we can expect rising living standards and better road provision to generate increased vehicular traffic in the countryside, as the trips to school and work that already exist are gradually switched from pedestrian to vehicular modes.

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CHAPTER 5

MODELLING THE DEMAND FOR PERSONAL TRAVEL IN JAIPUR, INDIA

0. Introduction

The analysis of this chapter is based on a household survey carried out in Jaipur, India in March and April of 1983. The survey is part of a larger study of the provision of and demand for public transport in medium sized Indian cities, a study being carried out jointly by the Overseas Unit of the British Transport and Road Research Laboratory, and by the Indian Town and Country Planning Organization, the Central Institute of Road Transport, and the Association of State Road Transport Undertakings. A description of the results of the Jaipur survey is given by Maunder (1983b), while Fouracre (1983) gives a good discussion of transport provision in the city. The TRRL team have repeated the Jaipur survey in the cities of Vadodara (Baroda) in Gujarat and Patna in Bihar, and have presented the results in Fouracre (1984, 1985), Maunder (1984, 1985a) with an overview of all three surveys in Maunder (1985b). Since urban travel data are already over-represented in this study, we analyze only the Jaipur data, though in Section 6 below, some brief comparisons are made between Jaipur and the other two cities.

Our main concern here is to present a simple model of personal travel behavior designed to conform with the observed patterns in Jaipur. In particular, given our interest in using expenditure surveys to assess the demand for travel, we are concerned with the links between tripping patterns and travel expenditures as revealed in Jaipur. For these data, it seems that an adequate description can be provided rather simply. Close to ninety percent of all home based trips are either trips to work or trips to school, the latter slightly predominating. Work trips, not surprisingly, are directly related to the number of employees in the household. Essentially,

each worker makes one round trip per day. Similarly, each student makes one round trip per day. However, the number of students per household is not independent of economic status, even given the demographic composition of the household. With the same number of adults and children, poorer households record fewer students than do richer households. Hence, given the relationship between economic status and the proportion of students, numbers of trips can be predicted from the household's income, number of earners, and number of children. Beyond this, it is clear that different types of households make different types of trips, and make them by different modes. The Jaipur data contain very little information on household characteristics, but it is clear that better-off households on average make trips of longer distance, though interestingly, they devote about the same amount of time to each trip. In consequence, richer households travel by faster modes, substituting motor cycles and cars for bicycles, walking, and buses. These faster modes are more expensive, so that travel expenditures rise with income, although the share of income devoted to travel is more or less constant over a broad range. The ownership of vehicles follows the relationship between trip speed and income. Poorer households own no vehicles or own bicycles. As income rises, the proportion of households owning bicycles first rises and then falls as motor-cycles and scooters become more important. In the very highest income groups, a few households own cars. Following through this chain of relationships, and taking into account the few trips that are undertaken for social and leisure purposes, we have a straightforward link between personal travel and personal travel expenditures on the one hand,

and household income and household demographic composition on the other hand. These relationships are documented in the sections that follow.

Section 1 of the paper is a description of the data from the Jaipur survey. While the quality of the data is generally high, some figures are undoubtedly more reliable than others. In particular, the data on tripping are almost certainly more accurate than the data on expenditures, and this has to be borne in mind when assessing our results. Section 2 discusses the basic determinants of the travel patterns, household incomes and demographic composition. We document the distribution of household income in Jaipur, the location of households, and the numbers of earners and students. The relationship between numbers of students and numbers of children is also investigated. Section 3 moves on to an analysis of numbers of trips, and documents the relationships between employment trips and employees, and between student trips and students. Section 4 presents a simple model of the choices of distance, time, mode choice, and vehicle ownership, and uses it to interpret the data. Section 5 draws out the implications of the model and the results for the relationship between household demographics, household incomes, and household expenditure patterns on travel. Finally, section 6 looks briefly at the evidence from the other two cities examined by the TRRL group in an attempt to assess whether the Jaipur results are likely to be generalizable. It concludes with a summary of stylized facts and their implications for policy.

It will be noted from the foregoing summary, as well as from the detailed results below, that we have not found it useful to estimate conventional modal split models for the Jaipur data. Since modal split analysis is currently the jewel in the crown of travel demand analysis, see for example

the surveys by McFadden (1981), Manski and McFadden (1981), and Horowitz (1985), as well as the two recent texts by Ben-Akiva and Lerman (1985) and Train (1986), it is perhaps worth explaining why none of the standard models finds a place in this study. We have no quarrel with the theoretical basis of random utility models of modal choice, and indeed their development over the last two decades has been the one of the outstanding intellectual achievements of travel demand analysis and of applied microeconomics in general. The problems come in the application, particularly to household survey data from cities in developing countries. It is certainly true that (at least some) commuters living in Jaipur have to make a daily choice of travel mode. However, they do so in the context of an equilibrium in which the locational decisions of the household as well as the provisions of transit and paratransit are jointly determined within the general framework of geography, local employment conditions, and the incomes and demographic structures of families. While it is probably impossible to build and estimate a comprehensive model of this urban equilibrium, it is far from clear that focussing all the attention on modal choice is a good strategy. Modal choice equations "explain" choice in terms of transit characteristics and household location, the latter being the main determinant of both mode availability and the travel times to work and to school. But it is clear that in the wider context, household location and mode availability are endogenous variables in the system just as much as is mode choice itself.

Consider a hypothetical example of a city where income levels increase monotonically with distance from the city center, and where mode choice is limited to foot, bicycle, and bus. The poor people living near the center walk to work, the middle classes ride their bicycles, and the better off

ride by bus from the outer suburbs. A modal split analysis would fit these data quite well. For the rich, suburban group, the value of the time needed to walk or to bicycle to the center would be very large, so that buses would be the dominant choice, even if they are relatively expensive. The poor people get essentially free travel by foot at very little time cost, and the middle classes live far enough out for the time costs to make bicycles the preferred choice. But this explanation is essentially trivial; the basic phenomenon is that the rich live further away than do the poor, and the discovery that walking and bicycling are only suitable for relatively short trips is hardly a surprise. In this example, the modal split analysis also puts too much of the explanatory burden on the value of time; people do not walk 20 kilometers to work <u>only</u> because it would take them too long. Indeed, the relatively few studies that have estimated modal split models for cities in developing countries, Kozel (1981) for Bogota, Colombia, and Thobani (1983) for Karachi, Pakistan, find that the value of time spent walking is estimated to be much larger than the wage rate.

In this study we have chosen an alternative approach to modelling personal travel. As with the standard approach, we begin with trip generation, something that seems to be relatively easily explained for Jaipur. However, instead of modelling mode choice in the usual way, we attempt to estimate directly the relationships between household income and demographic composition on the one hand and travel times, travel distances, and travel expenditures on the other. The modal choice is implicit in this process, and we shall make it explicit by estimating a very simple model in which modes are arranged along a single continuum associated with speed, comfort, or other attractiveness. From an econometric point of view, such

modeling can be thought of as an attempt to estimate reduced form relationships. Relative to the earlier travel literature, the analysis has much in common with the "time and expenditure budgets" approach to demand analysis, see in particular Zahavi (1981), Golob, Beckmann, and Zahavi (1981), Tanner (1981), Roth and Zahavi (1981). Although we do not adopt any of the models advocated in these papers, the aims and general motivation are much the same. To quote Golob, Beckmann and Zahavi, (1981, p375), "A major motivation behind this approach involves limiting the number and complexity of the independent variables so that predictions of future conditions can be made without having to rely solely on independent variables which have proven to be difficult to predict in their own right."

1. The survey and the data

Jaipur is a city of some one million inhabitants in the north-westerly state of Rajasthan in India. It has a well-developed system of public transport, with a wide range of alternative modes. In addition to public stage buses, there are cycle and auto-rickshaws, tongas, taxis, and minibuses. There are also special school buses as well as works buses for transporting employees to work. A large proportion of trips are also made by foot, as well as by private means of transportation, mainly bicycles and motor-cycles or scooters. Details of Jaipur's public transport system are given in Fouracre (1983).

The household survey was conducted in March and April of 1983 and collected data on 6315 households, about 3% of the population. Prior to sampling, the city was divided into 19 geographical zones, and households were randomly selected in proportion to the total number of households in

each zone. As with most household surveys in India, refusals to cooperate were rare, and the sample can be taken to be representative. The 19 zones are shown in Figure 1 and will appear below in the analysis. The survey collected information on the characteristics of the household as well as on all home-based trips from the previous day. The restriction to previous day trips is unlikely to be important given that the vast majority of trips are made on a regular daily basis. Confining attention to home-based trips is potentially more troublesome, since it automatically excludes any trips made during the day once the respondent has left home. However, there is a reasonably good match between total transport provision and the figures implied by the survey for all modes except for taxis and rickshaws where there appeared to be more supply than was accounted for by home based trips. Maunder and Fouracre subsequently carried out a small supplementary survey of taxi and rickshaw passengers which suggested that trips that were not home based were perhaps only 10-15% as numerous as home based trips, too little to explain the mismatch, which is now thought to reflect overstatement of supply.

The survey collected information not only on household characteristics and on trips, but also on various forms of expenditures. Data were collected on the number of members of each household, their sex, their employment status, and whether they were "children" or adults. Here, children are defined as males under the age of 22 and females under the age of 19, the object being to separate those who would be permitted concessionary fares on the buses from those who would not. Not only are cheap fares available to "genuine" children, but they are also available to students, of which there are a considerable number in the city. When

necessary, we shall refer to people in this age group as "youths." Total household income is given in rupees per month as is total monthly expenditure on transport, including expenditures on maintaining and operating private vehicles. Households were also asked to supply total household monthly expenditures on each of six categories of consumers' expenditure: food; housing and rent; fuel; public transport; personal vehicles; and total transport modes. These categories are given in ranges, e.g. between 101 and 150 rupees, and not as exact rupee figures. Owners' monthly expenditures on each of cycles, motor-cycles or scooters, and motor cars, were also collected, again in range form. Each of the previous day's trips are categorized by three purposes (employment, educational, or social, leisure, and other, the last including shopping, medical, etc.) and by mode. The distance of each trip and the time taken are also recorded. Information on fares or other costs was not collected. Finally, respondents were asked whether anyone in the household owned a bicycle, a motor-cycle/scooter, or a car.

These data appear to be of high quality, and it is clear that the survey and the coding were carried out with great care and skill. However, in order to interpret the results that follow, as well as the methods we have adopted, the few problem areas need to be pointed out. The first concerns the expenditure data. Given that the survey was primarily concerned with travel, it cannot be compared in scope with a thoroughgoing household expenditure survey with all the associated detail on individual commodity expenditures. Nevertheless the Indian National Sample Survey Office has been collecting household budget data for many years, and it is tempting to make comparisons. The NSS carried out its 38th round consumer expenditure

survey between January and December 1983, and the preliminary results recently became available, Government of India (1985). For urban areas of Rajasthan, the shares of total expenditure devoted to food, to rent, and to fuel were 56.3%, 2.0% and 6.5% compared with, from the Jaipur survey, as shares of total household income, figures of 38.5%, 4.9%, and 4.9%. The preliminary 38th round tabulations do not give figures for expenditures on travel, but the 32nd round figures discussed in Chapter 4 above show that in urban Rajasthan in 1977-78, 2.4% of household expenditure was devoted to travel, as compared with 8.5% of household income in the 1983 Jaipur survey. The All India figures suggest that there has been little change in overall expenditure patterns between the 32nd and 38th rounds, so while there is no direct evidence for Jaipur nor for urban Rajasthan, it seems unlikely that the difference in the transport figures can be attributed to genuine change over time.

In household surveys in poor countries it is typically the case that (recorded) household income is less than (recorded) household expenditure, but it is hard to see how the difference could be large enough to account for the discrepancy in the transport share. Indeed, as we shall see in the next section, there is no evidence that the TRRL income figures are too low. Further, the food share is too low, not too high. Some of this is likely to be the exclusion of consumption of food received as payment in kind. Another part of the explanation may be that, in a survey that focussed so carefully on travel, travel expenditures were over-recorded relative to food expenditures to which little attention was paid. It is also worth noting that the NSSO obtains total expenditure by addition of a very large number of detailed expenditures on foodstuffs. There is some evidence, Bhatta-

charya (1963), that the more detailed the questionnaire the larger the total, and there is some independent support for the NSS estimates, at least for foods where the supply can also be estimated with some precision. It is therefore possible that a single question on food expenditure could produce a substantial underestimation. Since travel patterns and expenditures were recorded in great detail in the TRRL survey, this argument would suggest that the travel data should be relatively trustworthy, and, as will be shown below, further analysis of the travel data lend support to their basic reliability. This leaves unexplained the discrepancy between the NSS and TRRL estimates of the budget share devoted to transport. We shall argue in Section 5 below that the TRRL figures for Jaipur appear to make sense, at least as far as public transport is concerned, so that the discrepancy is most likely a discrepancy in expenditures on maintenance and upkeep of private vehicles, expenditures that are inherently difficult to measure. Moreover, Jaipur is the state capital and largest city of Rajasthan, so that personal travel expenditures there are likely to be larger than in other urban regions of the state. It should also be recalled that the NSS 32nd round data excluded trips less than one kilometer from the survey, so that the 2.4% figure quoted above may be somewhat too low, even for all of urban Rajasthan.

The second problem with the expenditure data is a largely technical one. For analytical purposes, ranges have to be converted to numbers, and the usual procedure (which we have adopted) is to represent a range by its mid-point. This implies that subtotals will not necessarily add to aggregates, and that the quantities entering into our regression equations are known to be measured with error. Note that this is <u>not</u> a fault of the

survey design. The ranges probably give as accurate an indication of the true figures as would questions on the actual expenditures, so that gathering the latter would simply impart a spurious accuracy. There exist econometric procedures for dealing with "interval-measured" data, see for example Ham and Hsiao (1983), but these are cumbersome in practice, and often seem to make little difference to the results. In describing our results, we shall point out those cases where the range-type data appear to be causing problems.

A third issue is an apparent mismatch between ownership and expenditure data. Some households record expenditures associated with the upkeep of vehicles that they do not own, and some owners record no expenditures for upkeep, see Table 5.1 for the data on bicycles and Tables 5.2 and 5.3 for motor-cycles/scooters and for cars respectively. It is possible that these figures are correct; upkeep expenses are not continuous and vehicles are sometimes not used, while non-owners may borrow vehicles and accept responsibility for their upkeep, or may drive vehicles owned by their employers. However the off-diagonal elements in these tables may also indicate errors. Although the anomalies are proportionately large for motor cars, this is a

TABLE 5.1
Ownership of and expenditures on bicycles

	Spenders	Non-spenders	Totals
Owners	4103	82	4185
Non-owners	37	2093	2130
Totals	4140	2175	6315

TABLE 5.2
Ownership of and expenditures on motor-cycles

	Spenders	Non-spenders	Totals
Owners	1793	43	1836
Non-owners	40	4439	4479
Totals	1833	4482	6315

TABLE 5.3
Ownership of and expenditures on motor cars

	Spenders	Non-spenders	Totals
Owners	132	20	152
Non-owners	31	6132	6163
Totals	163	6152	6315

less important category than the other two, and in all cases the absolute size of the off-diagonal elements is probably acceptably small.

We also note a constraint that is placed on us by the nature of the survey. Apart from household income, employment, and minimal demographics, there is very little information in the survey on household characteristics. For example, occupation, education, wage rates, and age are either absent or uncoded, as are the sexes of individual travelers or employees. The result, as far as econometric work is concerned, is a shortage of exogenous explanatory variables. The absence of wage rates and of trip fares makes it difficult to assess the total costs of travel, while the occupational and educational variables, as well as total expenditures rather than incomes, would be useful for sorting out long-run from short-run economic status in the determination of, say, vehicle ownership. As it is, there is an oversupply of jointly endogenous variables, trips, distance, modes, ownership, location, and expenditures. It is easy enough to show that households that live further from the city center on average tend to travel further to work, that trips made on foot tend to be shorter than trips made on cycles or on buses, and that individuals who own motor cycles tend to ride on them. But such relationships are neither very surprising, nor ultimately very interesting. Instead, we must make do with what exogenous variables we have, so that we are confined largely to studying the effects of household income and household composition on travel behavior.

Finally, we should warn the reader that the figures reported here rarely agree precisely with those in the TRRL reports, though we do not believe that there are any major qualitative differences. The reason for the discrepancies is that the data tape was "cleaned" twice, and that there is no way that consistency could be guaranteed. Given the difficulties involved, we found the correspondence between the two sets of figures rather better than expected.

2. Household characteristics in Jaipur

In the following sections, we shall use household income and household composition as the main explanatory variables in determining household travel behavior. This section begins by describing these variables in Jaipur and the interrelationships between them. The distribution of total household incomes are shown in Table 5.4 below, using the income groups employed by Maunder (1983b). Mean household income is reported to be 1209 rupees per month and modal income is 800 rupees; as is usually the case, the distribution of income is positively skewed. Mean per capita income is 269 rupees per month. Once again, these figures can be compared with the data from urban Rajasthan from the preliminary tabulations of the NSS 38th round survey for the same year. Table 1.17U of the latter suggests a modal per capita household expenditure of 175 rupees per month, which, with an average household size in the modal group of 5.05 persons yields an estimate of modal total expenditure of 884 rupees, which is quite close to the TRRL figure. However, the NSSO gives mean per capita household expenditure for urban Rajasthan to be 164 rupees per month (Table 2.17U), which is very much less than the per capita income figure given above. We can only speculate

about the reasons for this discrepancy. Jaipur may be better off than other urban areas in Rajasthan: incomes are likely to be higher than expenditures, especially among the highest income households: and there may have been chance sampling of a few very wealthy households in the TRRL survey.

Note that 31 households, or 0.5% of the total report zero income in the previous month. Some of these observations may be incorrect, but income is volatile over time, relative to, say household expenditure, and it is

TABLE 5.4

Distribution of household incomes

rupees/month	#households	%households
0	31	0.5
1-200	8	0.1
201-500	757	11.9
501-750	1170	18.5
751-1000	1571	24.9
1001-1500	1283	20.3
1501-2000	806	12.8
2001-3000	479	7.6
3001-3500	95	1.5
>3500	115	1.8
totals	6315	100.0

TABLE 5.5

Household expenditures

	Mean expenditure		Mean share		Mean exp/mean inc
Food	423		38.5		35.0
Housing	56		4.8		4.6
Fuel	49		4.9		4.1
Public transport	38		3.4		3.1
Private transport	64		4.3		5.3
-bicycles		9.4		1.1	
-m/c scooters		41.4		2.6	
-cars		9.5		0.5	
Total transport	109		8.5		9.0

likely that a high proportion of households in the lowest income categories do not belong there on a permanent basis. This must be kept in mind when looking at the expenditure patterns of the (apparently) very poorest. Table 5.5 presents a summary of the household expenditure patterns on the commodity groups included in the questionnaire. Column 1 lists mean expenditures, where ranges have been converted to numbers using their mid-points. The category "total transport" is the only one reported directly in rupees; as can be seen, the sum of public and private expenditures from the range data fall a little way short of the separately reported total. Similarly, the sums of the separately reported operating expenses are short of the total for private transport. The second column reports the average over all households of the share of income each devotes to the category. This differs from the third column, which lists the ratios of average expenditure to average income. Since the latter effectively weights individual household shares by household income, column 3 will be larger than column 2 when the share of the good in the budget rises with income (transport), and will be smaller when the share falls at higher income levels (food, housing, or fuel). As stated in section 2, the food share appears to be much too low, and the transport share (possibly) too high.

Total household income, even apart from its volatility, is not an adequate indicator of the economic status of the household since it takes no account of the number of people that are to be supported by that income. A rough and ready correction is to work with per capita household income (*PCY*), though this measure, by weighting all members of the household equally, is likely to understate the resources available to households with large numbers of children. Later, we attempt to be more sophisticated, but

for the moment, we use *PCY* to indicate the relationship between income and other household characteristics. Table 5.6 shows the geographical distribution of *PCY* in Jaipur.

TABLE 5.6

Distribution of *PCY* by zones in Jaipur
(rupees per month)

Zone	*PCY*	Zone	*PCY*	Zone	*PCY*	Zone	*PCY*
10	232(6)	20	237(6)	30	366(5)	40	465(6)
11	455(1)	21	289(6)	31	377(6)	50	323(2)
12	178(9)	22	184(9)	32	328(6)	70	223(4)
13	243(6)	23	194(5)			80	342(2)
14	227(9)						
15	338(3)						
16	258(6)						
17	198(3)						

All zone average= 269

Notes: (i) Figures in parentheses are percentages of households, (ii) Standard errors of means are approximately 10 rupees

Zones 10 through 17 comprise the city center and its immediate environs; apart from the relatively unpopulated (there are only 50 households in the sample) and wealthy zone 11, all but one of these zones have lower than average *PCY*. Zones 20 to 23 are to the west and northwest of the center; the two to the northwest are poor, the two to the west about average. Zones 30, 31, 32, and 40 are areas to the south of the center; all have relatively high <u>per capita</u> income. The remaining three zones are each several kilometers from the center; one, zone 70, is relatively poor, while the others, though above average, are not as well-off as the previous group. There is thus some tendency in Jaipur for better-off households to live at a greater distance from the city center, and for poorer households to locate at or near the center. However, there are many exceptions, and, as we shall

see, tripping distance is by no means straightforwardly related to distance from the center.

Maunder (1983b) gives an origin-destination matrix for employment trips from which it is possible to tell more about residence and employment patterns over the zones. The major destinations for work trips are zones 30, (16% of all work trips), zone 14, (14%), zone 21, (12.5%), zone 20, (9%), followed by zones 31, 15, 40, 12 each with 5 to 6 percent. Although only zones 12, 14 and 15 are located in what would normally be thought of as the city center of Jaipur, only zone 40 is not contiguous to the center, and the major employment zones 20, 21, and 30, are all largely commercial areas that extend from the railway station towards the center. Nearly half of the employment trips that end in zone 14 also originate there, while the corresponding figures for zones 20, 21, and 30 are between 10 and 15%.

The demographic and employment structure of households in relation to *PCY* is shown in Table 5.7. For convenience, we have divided households by semi-deciles, (icosohiles?) i.e. at every fifth percentile. There are therefore 315 or 316 households in each cell. The average household size in the survey is 5.1 persons, of whom 2.3 are children (according to the generous definition of children used here), and 2.8 are adults. Here the correspondence with the NSS 38th round is good; urban Rajasthan has an average household size of 5.30 persons, of whom 2.16 are children, defined by the NSS as persons aged 14 or less. Table 5.6 shows that, on average, each household has 1.4 employees, so the dependency ratio, the ratio of household members to earners, is 3.8. In the average family, two-thirds of those under 22 for males or 19 for females (2.3 in all) are reported as students. Hence, on a simple minded view, the average household would

generate 1.4 employment trips plus 1.5 student trips together with some number of social, leisure, or shopping trips. As we shall see, this simple view is close to being accurate.

The variation of household characteristics with per capita income is worth commenting upon. Columns 2 and 5 show that, at higher levels of *PCY*, households are smaller, largely because they have smaller numbers of children. This phenomenon is essentially definitional; in most household surveys from developing countries, household income increases together with,

TABLE 5.7
Household characteristics in relation to PCY

(1) pctile	(2) PCY	(3) #mems	(4) #empl	(5) 3/4	(6) #child	(7) #stud	(8) 7/6
all	269	5.1	1.4	3.8	2.3	1.5	0.66
5	64	6.0	1.0	5.9	3.5	1.7	0.47
10	97	6.3	1.2	5.5	3.5	1.7	0.50
15	115	6.0	1.2	4.9	3.3	1.6	0.49
20	129	5.9	1.3	4.7	3.1	1.7	0.55
25	141	6.3	1.4	4.5	3.1	1.8	0.58
30	152	5.2	1.2	4.2	2.6	1.4	0.53
35	164	5.5	1.3	4.3	2.7	1.9	0.69
40	176	5.3	1.3	4.2	2.6	1.5	0.60
45	188	5.9	1.5	3.8	2.7	1.6	0.62
50	200	4.8	1.2	3.9	2.1	1.6	0.77
55	219	5.3	1.4	3.7	2.3	1.7	0.73
60	236	5.4	1.5	3.6	2.3	1.7	0.75
65	252	4.7	1.3	3.7	2.1	1.7	0.81
70	276	5.0	1.6	3.2	1.9	1.5	0.80
75	302	4.5	1.4	3.1	1.6	1.4	0.86
80	342	4.7	1.5	3.1	1.7	1.4	0.83
85	392	4.3	1.4	3.1	1.6	1.4	0.90
90	468	4.1	1.5	2.7	1.3	1.1	0.87
95	580	3.6	1.5	2.5	1.1	0.9	0.81
100	917	2.9	1.5	2.0	0.8	0.6	0.81

Key: Pctile is percentile and gives the upper limit of the semi-decile over which the average is taken. PCY is per capita income, #mems is the number of household members, and #empl the number of employees. Col 5 is the dependency ratio, the number of household members per employee. #child is the number of "children," i.e. the number of males aged less than 22 and females less than 19. #stud is the number of students, so that column 8 is the number of students for each youth in the household.

but not as rapidly as total household size. In consequence, per capita household income decreases with household size, particularly with the number of children; since most adults are earners, extra adults do not tend to decrease the per capita total. The Table therefore presents a somewhat misleading picture of the long-run distribution of incomes. Young households in the child-rearing phase will tend to have low per capita income, although their lifetime position may be much more prosperous. It should also be noted that, although there are equal numbers of households in each of the semi-deciles, there are more individuals in the poorer groups. Column 4 of the table shows the numbers of earners per household. Again, not surprisingly, the poorest households have smaller numbers of earners, and correspondingly high dependency ratios, column 5. However, there is little increase in the number of earners per household after the 40th percentile; the better off households have higher incomes not because of a large number of earners, but because of larger incomes per earner.

Perhaps the most interesting column in the Table is the last which shows the ratio within each semi-decile of the average number of students per household to the average number of young people per household. (Note that this ratio cannot be defined on an individual household basis, since some households have no children.) Only half of the young people who live in households in the bottom 15% of the *PCY* distribution are recorded as students, while at the other end of the distribution, there are about equal numbers of youths and students. What we are observing here is not that small children do not go to school; in Jaipur as in other Indian cities, school attendance among primary school children is almost universal. However, beyond elementary education, there is a certain amount of

attrition, so that for the oldest youths considered here, there will be a relatively small percentage in full-time education. Since there is clearly a relationship between household living standards and the propensity to continue in education, and since this relationship is important for determining the relationship between incomes and trips, we attempt to investigate it further.

The most obvious relationship is one in which the probability of a given youth being a student depends on household characteristics, particularly on household income and household size. We write this

$$p^h = \Phi(\beta' x^h) \tag{1}$$

where $\Phi(\ )$ is the distribution function of the unit normal. Note that (1) contains only a household superscript. While it would be desirable to allow the probability to vary by age (so that young children are more likely to go to school than their teenage siblings), we have no data on individual youths within the household. The estimation of (1) is therefore effectively probit with replication, the number of replications being the number of children in the household. A household with n_c youths has n_c "trials" with n_s "successes", the number of students, and $(n_c - n_s)$ failures. The log likelihood function is therefore

$$\log \mathcal{L} = \sum_h [n_s^h \ln\Phi(\beta' x^h) + (n_c^h - n_s^h)\ln(1-\Phi(\beta' x^h))] \tag{2}$$

and our results, reported in Table 5.8 are obtained by maximizing this for various alternative sets of explanatory variables.

Column (1) confirms the figures in Table 5.7; per capita income exerts a strong positive influence on the probability that young people in the household are in full-time education. Column (2) is our first attempt to go beyond this and we allow the components of *PCY*, total household income, the numbers of children, and the numbers of adults to exert separate influences. We expected that household income would enter positively and household members negatively, young people less so than adults reflecting their lower economic costs. However, column (2) shows that adults exert a strong <u>positive</u> not negative effect. Column (3) disaggregates further, distinguishing working from non-working adults. The former have a relatively large negative effect and the latter a positive one. We do not really have enough data to build the more detailed models that might account satisfactorily for these findings.

TABLE 5.8

Probit estimation of student model
(asymptotic t-values in parentheses)

	(1)	(2)	(3)
constant	-.0663	.0661	.1182
	(-3.0)	(1.9)	(3.4)
PCY	.002137	-	-
	(21.6)		
HHY	-	.00424	.00057
		(21.8)	(26.5)
N_a	-	.04592	-
		(4.2)	
N_c	-	-.09149	-.07095
		(-13.7)	(-10.3)
N_e	-	-	-.2887
			(15.9)
$N_a - N_e$			.2035
			(15.5)

3. Numbers and purposes of trips

In the Jaipur survey, trips are home-based trips, so that, for example, an employee leaving home in the morning and returning in the evening would register one employment trip. We shall leave the numbers in this form, so that each of our trips should be interpreted as a round trip. The survey shows that, on average, there are 3.13 round trips per household in total; 1.28 are employment trips, 1.52 are student trips, and only 0.34 trips for social, leisure, or other purposes (henceforth SLO trips). In principle, all trips are included however short, though it is not clear how this was interpreted in practice, especially for some of the "social, leisure, or other" category. On a per capita basis, the average is 0.64 trips per household member, 0.29 employment trips, 0.28 educational trips, and 0.08 SLO trips. By either accounting, SLO trips are the least important category, accounting for only 2148 or 11% of the 19761 trips recorded in total in the survey. As Maunder (1983b) has documented, the number of trips rises both with total household income and with the numbers of members in the household. However, the survey contains enough information to allow us to go beyond simply relating trips to income, and to look at the detailed interactions between trip purpose and the numbers of people in the household who are likely to require such trips. In many important respects, travel is not simply a consumer good that, like food or entertainment, adapts to income, price, and household structure. Travel is frequently a necessary concomitant of employment, so that, for many households, there would be little or no income without some form of travel. The mode of travel, as well as the distances and times spent travelling, are much more amenable to individual choice on economic grounds. But for the generation of trips it

seems appropriate to take a more mechanical approach. Table 5.9 shows the results.

The most striking feature of the Table is that columns 3 and 5 are essentially columns of ones; this is the result that might reasonably have been expected, but it is nevertheless important since it yields the simplest

TABLE 5.9

Numbers of trips by percentiles of PCY

pct	t_e	t_e/n_e	t_s	t_s/n_s	t_o	t_o/n_a	t	t/n
all	1.28	0.98	1.52	1.00	0.34	0.15	3.14	0.64
5	0.96	0.99	1.73	1.00	0.25	0.12	2.94	0.54
10	1.13	1.00	1.81	1.00	0.29	0.13	3.22	0.52
15	1.17	0.99	1.65	1.00	0.24	0.10	3.06	0.50
20	1.15	0.97	1.68	0.99	0.26	0.11	3.10	0.52
25	1.30	0.98	1.81	1.01	0.34	0.13	3.45	0.54
30	1.19	0.98	1.42	1.01	0.30	0.14	2.92	0.54
35	1.19	0.99	1.83	0.99	0.33	0.15	3.35	0.61
40	1.24	0.99	1.57	1.00	0.30	0.14	3.11	0.58
45	1.39	0.98	1.64	0.99	0.38	0.16	3.41	0.57
50	1.16	0.99	1.61	1.00	0.41	0.18	3.18	0.66
55	1.39	0.98	1.71	1.00	0.40	0.16	3.50	0.65
60	1.43	0.98	1.73	1.00	0.39	0.16	3.55	0.65
65	1.18	0.98	1.72	0.99	0.33	0.14	3.22	0.68
70	1.41	0.96	1.54	1.00	0.45	0.18	3.40	0.68
75	1.33	0.98	1.44	1.02	0.38	0.17	3.14	0.71
80	1.45	0.99	1.47	1.00	0.36	0.15	3.28	0.69
85	1.32	1.00	1.37	1.00	0.39	0.17	3.08	0.71
90	1.45	1.00	1.08	0.99	0.36	0.17	2.89	0.74
95	1.44	0.99	0.90	1.01	0.29	0.14	2.63	0.82
100	1.33	0.97	0.66	1.02	0.35	0.19	2.34	0.91

Notes:- The symbols are n, n_a, n_s, and n_e, for numbers of household members, adults, students, and employees; t, t_e, t_s, and t_o for total, employment, educational, and SLO trips. For columns three and five, the figures shown are the means of the ratios for individual households over all households that have non-zero numerators and denominators. Since nearly all households are included, the selection has very little effect. Other means and ratios are calculated over all households in the sample.

possible model of household trips. Essentially, each employee and each student in the household generates one round trip per day. The preponder-

ance in the employment trips of numbers just less than unity presumably reflects the (small) number of employees who did not travel to work on the day prior to the survey. Similarly, there will be some students who did not attend their place of education on that day, together with some who made more than one round trip. But given that, for all practical purposes, employees and students each generate one round trip each, and that 89% of all trips are for employment and educational purposes, the number of trips by each household is essentially known once we know how many employees and students it contains. The behavior of trips in relation to household income and household size is then a consequence of the relationships between income, employees, and students. Table 5.9 shows that the number of employment trips increases with *PCY*. This follows from the fact that households with more employees tend to have higher per capita income, as documented in Table 5.7. The number of student trips, however, falls with per capita income because, although high per capita income households send a larger proportion of their children to school, they have fewer children to start with, essentially because of the definition of *PCY*, see again Table 5.7 and the surrounding discussion. The final category of trips, SLO trips, does appear to respond to income. Table 5.9 shows the average number of such trips at each point in the income distribution, together with the average number per adult. Both measures rise with *PCY*, with the poorer households generating only one such trip for each 8-10 adult days, and the best off doing so almost twice as frequently. Even so, most of the increase is in the poorest half of households; above median *PCY* there is little further increase in the trip frequency. The last columns of the Table show the net result for total household trips. The number of trips per capita

increases with per capita income, since the decline in students and student trips is more than offset by the larger number of employees and employment trips as well as by the increased number of SLO trips.

Table 5.9 only tells us that within income classes the average numbers of employment and student trips matches the average numbers of employees and students. Conceivably, there is a less than perfect match with variation according to some covariate other than per capita income. To test this, we ran descriptive regressions of the ratios of employment trips to employees and student trips to students including a number of plausible explanatory variables. Of a number of regressions run, the following is typical: (t-values are given in parentheses):

$$T_e/N_e = \underset{(99)}{1.012} - \underset{(-1.53)}{.00002\ PCY} - \underset{(-1.28)}{.0002\ DIST} - \underset{(-4.27)}{.0147\ M/F} + \underset{(7.6)}{0.16\ Z11}$$

$$- \underset{(-1.23)}{0.0056\ CYC} - \underset{(-0.29)}{0.0014\ MC} + \underset{(1.85)}{0.0231\ CAR}$$

F=5.316; R^2=.0218; 5745 observations; $r.m.s.e.$=0.14

DIST is the distance in kilometers of the trip, *M/F* is the ratio of male to female adults in the household (the numbers of male and female employees are not available), *Z11* is a dummy for zone 11 (dummies were included for all the other zones, but estimated parameters are small and insignificant and are not reported here), and *CYC*, *MC*, and *CAR* are dummies indicating the presence or otherwise of cycles, motor cycles, or cars in the household. The ideal regression here would be one with an R^2 value of zero, i.e. one in which the ratio of employment trips to employment is unity and unrelated to the other variables. The reported regression is not far from the ideal, though there are a few effects that are apparent. Notably, employees living

in zone 11, the relatively wealthy city-center zone, are more likely to make multiple trips. Similarly, a high ratio of females to males has a significant effect in inducing more trips, presumably because many Indian women in employment will return home in the middle of the workday to ensure that their children are fed and cared for. (Of course the survey data contain no direct evidence on this.) There is no discernable influence of *PCY*, of distance, nor of the ownership of vehicles. These results suggest that, while refinements are possible, there is no evidence to suggest that one trip per employee is not a very good approximation.

A similar regression was run for student trips:

$$T_S/N_S = \underset{(89.9)}{1.024} + \underset{(0.04)}{0.65*10^{-6}\,PCY} - \underset{(-2.83)}{0.0021\,DIST} - \underset{(-2.27)}{0.0051\,MCH/FCH}$$

$$\underset{(-2.24)}{-0.0391\,Z50} - \underset{(-2.72)}{0.0140\,CYC} - \underset{(-0.56)}{0.0028\,MC} - \underset{(-0.58)}{0.0080\,CAR}$$

F=1.676; R^2=.0103; 3904 observations; *r.m.s.e.*= 0.13.

In this regression *MCH/FCH* is the ratio of male to female children in the household; other variables are as before. Now, only Zone 50 has a t-value greater than 2; it also has the (absolutely) largest coefficient. The F-statistic shows that the R^2 is not significantly different from zero at the 1% level and barely so at the 5% level; given the sample size, this is about as close as we are likely to get to an insignificant regression. Hence, once again, the hypothesis of one round trip per traveller, in this case student travellers, is supported by the data.

4. Characteristics of trips

4.1 A simple model of the choice of distance and time

The previous section showed that households in Jaipur have the numbers of their trips determined for them given their numbers of students and employees. However, other dimensions of travel remain to be determined, particularly the choice of mode. One possibility is to take household location as given, together with the modes available at that location, and to estimate a standard modal split model. However, household surveys of the type used here tend to reveal long run decisions of households, and in the long-run, location of the household is just as much a variable to be explained as is choice of trip mode. In this section we develop a very simple and stylized model of location and mode choice focussing on two characteristics, distance of travel and time spent travelling. We assume that there are a large number of available modes, so that, by switching from one to another, the traveller can increase the speed of travel by paying more. Taxis cost more than buses and are faster; private cars cost more than taxis, and again provide faster transport. There is thus a trade-off between time, money, and distance, subject to which the individual chooses location and mode.

Start from the case of a single employee. We characterize preferences by the utility function

$$u = v(d, T-\theta t-h, q) \tag{3}$$

where u is utility, d is distance travelled to work, T is total hours available per day, h is hours spent working, t is time spent travelling to

work, and q is a composite of consumption goods. The consumption, q, and leisure, $\ell = T - \theta t - h$, components of utility are standard, though note that we allow a fraction $(1-\theta)$, $0 \leq \theta \leq 1$, of travel time to count as leisure, so that the loss of leisure from t hours spent traveling is only θt. The inclusion in the utility function of distance d is somewhat more controversial. We assume that living a greater distance from the workplace is beneficial, other things being equal, these other things including the amount of leisure and income available. The basic supposition is that the user cost of housing is lower further from the center, so that the same level of income and leisure can be used to provide a higher standard of living. We realize that the validity of such an assumption has not been well-documented for third world cities, and we use it, pro tem., in the hope that it is of reasonably wide applicability. Of course, living further away imposes costs, particularly a higher amount of time spent travelling, t, so that after working hours h, there is less time left for leisure $T-h-\theta t$. The composite q is assumed to have a unit price; neither this assumption nor the use of a composite is restrictive since we are not concerned with changes in the relative prices of individual consumer goods.

The structure of the model depends crucially on the specification of the budget constraint. We write v for speed, i.e. d/t, and postulate a fare function $f(v)$ which gives the cost per kilometer of travelling at an average speed of v; it is assumed that $f(v)$ is increasing in v. This function can be thought of as summarizing all the details of modes, fares, ownership decisions, and running costs. Formally, $f(v)$ is defined as the minimum cost of travelling at speed v, the minimization being done over all available

modes and ownership patterns. Given this, the budget constraint can be written

$$q + d.f(d/t) = h.w + b \tag{4}$$

where w is the wage rate, and b is non-wage income, most likely taking a value of zero. The choice variables are distance, time travelling, hours worked, and consumption. The exogenous variables are the wage and the fare function. Given the non-linearity of the budget constraint, the solution is not quite the standard textbook one. Consider, however, the first-order conditions:

$$\upsilon_d = \lambda\{f(v) + vf'(v)\} \tag{5}$$

$$\upsilon_\ell = \lambda\theta^{-1}v^2 f'(v) \tag{6}$$

$$\upsilon_\ell = \lambda w \tag{7}$$

$$\upsilon_q = \tag{8}$$

where $f'(v)$ is the derivative of f with respect to v, and υ_d, υ_ℓ, and υ_q are the marginal utilities of distance, leisure, and consumption respectively. The assumption that hours of work are chosen means that the disutilities of travel time and of work are equated, so that, from (6) and (7) we can immediately infer the relationship between speed and the wage,

$$v^2 f'(v) = \theta w \tag{9}$$

This equation can be straightforwardly solved given a specification of the fare function. For simplicity, we take a constant elasticity form, i.e.

$$f(v) = \alpha v^{\eta} \tag{10}$$

so that substitution in (9) gives

$$v = \{\theta w/\alpha\eta\}^{1/(\eta+1)} \tag{11}$$

or, more conveniently,

$$\log v = \kappa + (1+\eta)^{-1}\log w \tag{12}$$

so that trip speed is an increasing isoelastic function of the wage, an implication that is easily tested. Note too that the more rapidly fares rise with velocity, the less rapidly does velocity rise with the wage.

The first order conditions can be rewritten using (11) as

$$v_d = \lambda(1+\eta)\alpha(\theta w/\alpha\eta)^{\eta/(\eta+1)} \tag{13}$$

$$v_\ell = -\theta^{-1}v_t = \lambda w \tag{14}$$

$$v_q = \lambda \tag{15}$$

Note from the comparison of (13) and (14) that the shadow price of travel time is θ times the wage, while that of distance is proportional to a fractional power of the wage since η is greater than zero. Hence, as wages rise, distance becomes cheaper relative to time, which is of course why speed rises. Depending on the shape of preferences, it is possible for

travel time not to change with the wage, with all the effects of higher wages being devoted to additional distance, a phenomenon that has been observed in practice for motorized travellers in developed countries, see in particular Zahavi (1981) and Golob, Beckmann and Zahavi (1981). In general, the model will predict adaptation in both distance and time as the wage changes, though since speed rises with the wage, there will always be a less than proportional increase (or decrease) in travel time with the wage.

To make further progress towards an explicit solution assume a directly additive addilog specification for the utility function so that

$$v_d = \mu_1 d^{(\beta_1 - 1)} \tag{16}$$

$$v_q = \mu_2 q^{(\beta_2 - 1)} \tag{17}$$

where the β parameters, which represent the intensity of preference for each good, must be less than unity to ensure quasi-concavity of the utility function. Conditional on λ, a direct solution is now possible and this yields consumption, distance and hours as double logarithmic functions of the wage rate and the marginal utility of money k. These "Frisch" demand functions, see for example MaCurdy (1981) and Browning, Deaton, and Irish (1985), have been widely used in the study of life-cycle labor supply. In a cross-section of households, the marginal utility λ will vary from household to household, but can be modeled as a function of wages, assets, occupation, and other longer-term characteristics of the household. The Frisch demands are, from (13) to (17),

$$\log d = k_1 + (\beta_1 - 1)^{-1} \log\lambda + \eta/\{(1+\eta)(\beta_1 - 1)\}\log w \tag{18}$$

$$\log q = k2 + (\beta_2 - 1)^{-1} \log\lambda \tag{19}$$

Hence, if $\log\lambda$ is taken to be a function of a vector of household characteristics z together with the wage w, equation (18) becomes

$$\log d = a_1 + z.\xi + \gamma \log w \tag{20}$$

$$\gamma = (1-\beta_1)^{-1} \{\sigma - \eta/(1+\eta)\} \tag{21}$$

and σ is (minus) the elasticity of the marginal utility of money λ with respect to the wage, for simplicity assumed to be a constant. Since equation (12) shows that speed is also given as a double logarithmic function of the wage, we have the very convenient result that all three of log distance, log speed, and log travel time are linear functions of the logarithm of the wage rate and of other characteristics. Equations (20) and (21) also tell us a good deal about the determinants of the wage elasticity of distance. The parameter β_1 measures the strength of the benefits of being further away from the city center. The closer it is to its upper limit of unity, the larger will be the elasticity. The quantity η is the speed elasticity of the fare function; the more that has to be paid to shorten trip times for a given distance, the less elastic will be the distance function. Hence, for example, subsidization of slow public transport and taxation of gasoline with taxes or quotas against private vehicle ownership, will make distance rise less rapidly with the wage and ultimately bring higher wage earners closer to the city center. The

quantity σ is the wage elasticity of the marginal utility of money, something that is very close to the Frisch (1959) parameter ω, the income flexibility of the marginal utility of money, which is usually taken to have a value close to two.

4.2 Trip distances and times in Jaipur

The model of the previous subsection is useful as a guide to behavior in the Jaipur survey. Note however that, as developed, it takes no account of the fact that many households have more than one earner, and that most generate as many or more student trips as employment trips. For multiple earners, some sort of locational compromise is presumably worked out, and in any case the Jaipur data do not distinguish the earnings of individual workers, so we can do little more than look at average employment trips in relation to average household earnings. As to children, while the availability and locations of schools undoubtedly influence household location, the shadow price of children's time is lower than that of their parents, and schools are widely distributed, so that we would expect student trips to adapt to the needs of employment trips, at least as a first approximation.

Table 5.10 shows the characteristics of employment trips for the various geographical zones of Jaipur. On the left-hand side of the Table, the zones are arranged numerically, i.e. in order of increasing distance from the center; on the right hand side, the information is repeated with the zones ordered by average <u>per capita</u> income within them. Not surprisingly, higher numbered zones tend to have longer trip lengths, although there are exceptions. In the relatively wealthy inner zone 11, employment trips are further

TABLE 5.10

Distance, time, and speed of employment trips by zone

Zone	time	dist	speed	Zone	time	dist	speed
10	14	2.0	8.4	12	19	3.2	10.0
11	17	4.3	15.5	22	26	5.2	12.2
12	19	3.2	10.3	23	33	5.0	9.1
13	16	3.6	13.4	17	20	4.0	12.1
14	20	2.9	8.5	70	26	4.0	9.4
15	23	3.1	8.0	14	20	2.9	8.5
16	21	4.7	13.4	10	14	2.0	8.4
17	20	4.0	12.1	20	19	4.2	13.2
20	19	4.2	13.2	13	16	3.6	13.4
21	26	5.8	13.3	16	21	4.7	13.4
22	26	5.2	12.2	21	26	5.8	13.3
23	33	5.0	9.1	50	29	6.9	14.6
30	21	4.5	13.1	32	24	5.4	13.7
31	19	4.5	14.6	15	23	3.1	8.0
32	24	5.4	13.7	80	12	5.6	28.0
40	16	5.7	21.8	30	21	4.5	13.1
50	29	6.9	14.6	31	19	4.5	14.6
70	26	4.0	9.4	11	17	4.4	15.5
80	12	5.6	28.0	40	16	5.7	21.8

Notes: Times are average times in minutes for all home-based employment trips recorded for that zone. Distances are similarly averaged and are given in kilometers. Speeds are kilometers per hour; the figures given are the ratios of the previous two columns multiplied by 60.

than one would expect, while in the outer and atypically poor zone 70, trip lengths are less than for similarly distanced zones, presumably because of employment locations within the zone. Time spent travelling to work tends to increase with distance. Note that this is consistent with time being more or less independent of earnings; each zone has rich and poor households, so that even if the better-off use the faster modes, <u>average</u> time within each zone will still increase with distance from the center. Speed of travel is positively correlated with travel distance, so that, as predicted by the theoretical model, time varies less strongly with distance from the center than does distance travelled. The rank correlation between

zone number and distance travelled is 0.81, between zones and times 0.36, and between distances and times 0.35. When zones are reordered on the basis of *PCY* on the right of the Table, distance still rises as we move downward, presumably because of the effect of income on distance. The rank correlation coefficient between zone *PCY* and distance is 0.40. Now, however, the travel times are no longer positively related to the zone ordering; the rank correlation is -0.35. Hence, speed across zones rises more rapidly with zone *PCY* than does distance travelled, so that, on average, employees in the better-off zones spend less time travelling than do those in the poorer ones.

TABLE 5.11

Trip lengths and times by per capita incomes

pctile	distance			time	dist	speed
	empl	stud	other		all trips	
all	4.3	2.6	4.6	20	3.5	10.4
5	2.7	2.0	3.5	20	2.4	7.2
10	3.0	1.9	3.7	20	2.4	7.2
15	3.0	2.0	3.7	19	2.4	7.8
20	3.5	1.9	4.2	20	2.7	8.3
25	3.3	2.1	4.3	18	2.7	8.8
30	3.7	2.0	3.5	19	2.9	8.9
35	3.6	2.2	3.6	19	2.8	8.8
40	5.0	2.4	3.6	21	3.7	10.7
45	4.0	2.2	4.4	20	3.3	9.6
50	6.1	2.6	5.1	21	3.9	11.1
55	3.9	2.4	4.3	20	3.2	9.8
60	4.6	3.0	5.4	22	3.7	10.4
65	4.1	2.9	4.7	21	3.4	10.0
70	4.0	2.9	4.0	20	3.4	10.3
75	4.2	3.0	4.4	20	3.7	11.3
80	4.6	3.2	8.0	21	4.4	12.6
85	4.7	3.3	4.6	21	4.3	12.2
90	4.4	3.9	4.9	21	4.1	12.1
95	4.1	3.8	5.2	20	3.9	11.9
100	8.2	3.2	4.8	21	5.9	17.1

Table 5.11 shows similar statistics arranged directly by *PCY* rather than by zone. Distance per employment trip is strongly related to *PCY*, rising steadily as we move up the income distribution. The distances travelled by students also increase with *PCY*, as does the average length of social and leisure trips; in consequence, the total of all trips behaves very much as do employment trips. The right-hand side of the Table shows the time, distance, and speed characteristics for all trips. As before, distance and speed increase with position in the income distribution. What is most remarkable about these figures, however, is that, across *PCY* groups, trip time is virtually constant at approximately 20 minutes. All of the adaptation to higher incomes is done through greater distance and faster travel with essentially no effect on travel times.

The change in speed with income is accomplished by a switch in modes. As far as employment trips are concerned, the important modes are walking, cycling, special (i.e. works' buses), regular stage buses, and motor vehicles (including motor cycles, scooters, and motor cars). The shares of trips going to each of these categories at each *PCY* level are shown in Table 5.12, together with a residual category "other", comprising such modes as cycle and auto-rickshaws, taxis, tongas, tempos (light buses), and trains. Given the figures in the earlier tables, these figures contain no surprises. The poorest 5% of households make 40% of their trips to work on foot, compared with only 10% in the highest income classes, and 18% overall. Forty to fifty percent of employment trips are made by cycle; this fraction is fairly constant until the top quartile after which cycles are progressively replaced by motorized vehicles. Rather more than a tenth of employment trips are made by bus at all income levels, though workers who

have access to special works' buses are unlikely to be in the poorest income strata. Trips by motor vehicles increase their share rapidly as income

TABLE 5.12

Mode choice for employment trips

Pctile	Nos[1]	Walk	Cycle	Sp bus	Bus	Mc/car	Other
All	1.28	18	41	2	10	23	6
5	0.96	40	45	0	10	0	5
10	1.13	27	56	1	8	2	6
15	1.17	31	53	1	7	2	6
20	1.15	19	57	1	13	6	5
25	1.30	28	46	1	12	10	4
30	1.19	23	51	1	10	9	7
35	1.19	16	52	1	12	11	8
40	1.24	14	57	1	10	11	7
45	1.39	19	46	2	10	13	10
50	1.16	18	48	3	10	16	6
55	1.38	19	46	1	11	18	5
60	1.43	16	39	1	11	23	10
65	1.18	16	36	2	11	31	4
70	1.41	14	43	3	11	24	4
75	1.33	15	35	2	13	28	8
80	1.45	15	27	4	13	37	5
85	1.32	17	24	5	10	41	3
90	1.45	13	25	5	7	46	4
95	1.44	11	24	5	7	48	5
100	1.33	10	17	2	11	55	3

[1]Numbers of trips per household.

rises, replacing both trips on foot and trips on cycles. As income rises, walkers become cyclists, and cyclists become motor-cyclists or drivers.

The structure of student trips is shown in Table 5.13. On average, some 60% of student trips are made on foot. For the poorest households, the figure is 80%, falling to around 30% at the top of the distribution. Amongst the wealthiest households, 25% of student trips are made by bicycle, but only 10% of the students in the poorest households ride bicycles to school. Like bicycles, all the other modes increase with income, replacing travel on foot. More trips are made by regular bus than by school bus

though both are used with greater frequency by better-off households. Cycle rickshaws are used for about 4% of student trips, a much greater share than for employment travel; as is the case in many Indian cities, parents in Jaipur contract with rickshaw drivers to regularly transport groups of children to school. Note too that some students are old enough to ride motor-cycles or scooters and some are fortunate enough to be driven to and from school.

TABLE 5.13

Mode choice for student trips

Pctile	No[1]	walk	cycle	mc/car	c.rick	sc.bus	bus	tempo	other
All	1.52	60	15	2	4	5	11	3	1
5	1.73	80	10	1	2	2	5	0	1
10	1.81	83	8	0	2	1	5	1	1
15	1.65	81	9	0	1	2	6	1	1
20	1.68	77	10	0	2	2	7	1	2
25	1.81	77	12	0	1	1	7	1	0
30	1.42	74	12	0	2	1	8	2	1
35	1.83	68	13	1	2	3	12	1	1
40	1.57	65	14	0	4	2	10	3	2
45	1.64	69	12	1	5	2	11	1	0
50	1.61	59	15	0	5	5	14	2	0
55	1.71	61	15	1	3	3	12	3	1
60	1.73	49	15	0	5	4	20	5	2
65	1.72	47	20	2	6	5	15	2	2
70	1.54	48	17	0	4	9	16	4	1
75	1.44	45	20	3	5	8	14	2	3
80	1.47	36	25	3	6	9	17	4	1
85	1.37	38	23	4	5	14	11	5	1
90	1.08	36	22	4	6	9	16	6	2
95	0.90	21	24	12	8	13	16	6	2
100	0.66	34	17	11	6	13	13	3	2

[1]Numbers of student trips per household.

The difference between mode structures for employment versus student trips has important implications for the effects of transport policies. Although there are more student than employment trips in Jaipur, 60% of student trips

are on foot, as compared with only 18% of employment trips. Consequently, the majority of student trips are essentially unaffected by price or policy changes, whether fare policies, or alterations in the pricing and distribution of vehicles. By contrast, the majority of employment trips are affected by policy changes, so that it is to employment trips that we must look for the impacts of transport policy.

4.3 Econometric analysis of trip characteristics and vehicle ownership

The descriptive analysis of section 4.2 suggests that the simple model of section 4.1 may not be inappropriate for describing behavior in Jaipur, at least given the limited range of variables at our disposal. However, the model cannot be implemented directly since we have no data on wage rates. Nor is it clear that it makes sense to regard employees as having complete flexibility over hours worked at a fixed wage rate. Even so, the crucial point is that the shadow price of time should rise with individual income with the consequences outlined above for distance, time, and velocity. Table 5.14 shows the results of regressing the logarithms of distance, time, and velocity on the logarithm of household income per employee for employment trips and on the logarithm of per capita income for educational trips. Also included are the numbers of students and employees in an attempt to capture the effects of multiple trippers in each household. For both sets of regressions, the unit of observation is the trip. The left-hand side of the table shows that the elasticity of distance with respect to the income variable is estimated to be one third, both for employment and for educational trips. For employees, the time elasticity is small but negative, so that velocity rises slightly faster than distance with an estimated

elasticity of 0.38. For students, the trip time elasticity is marginally positive, so that student trip velocity rises less fast than distance with an estimated elasticity of 0.28. The number of employees and students exert

TABLE 5.14

Distance, time, and velocity regressions

	EMPLOYMENT			EDUCATION		
dependent	ln*d*	ln*t*	ln*v*	ln*d*	ln*t*	ln*v*
constant	-1.13	3.22	-0.26	-1.11	2.40	0.58
	(-9.3)	(30.1)	(-2.9)	(-13.9)	(32.3)	(10.1)
$\ln(HHY/N_e)$	0.33	-0.05	0.38	-	-	-
	(18.4)	(-3.2)	(29.6)			
ln*PCY*	-	-	-	0.34	0.06	0.28
				(24.2)	(4.9)	(27.4)
N_e	-.002	-.043	.041	-.049	-.011	-.040
	(-0.2)	(-5.3)	(6.3)	(-4.8)	(-1.1)	(-5.3)
N_s	.013	.016	-.002	-.006	-.017	.012
	(2.2)	(2.9)	(-0.6)	(-1.0)	(-3.1)	(2.7)
R^2	.051	.005	.107	.064	.005	.077

only minor influence, though some of the coefficients are significantly different from zero. For example, an additional employee in the family at the same income per employee reduces expected trip time by 4.3% or by less than a minute.

The velocity changes that produce these results are accomplished by travellers switching across modes with accommodating changes in vehicle ownership patterns. We have tried various methods of using these mode switches to document the relationship between velocity and cost per kilometer, the fare function of section 4.1. The problem is once again lack of data, here on expenditures associated with particular trips, (though we do

know something about fares which will be used in Section 5 below.) We know the mode, distance, and time for each trip, but not its cost. We have only a range figure for total household expenditure on transport together with figures for private and public transport. We therefore calculated a measure of total cost per kilometer for each household by dividing total expenditure by total distance travelled on all trips recorded by the household. Similarly, we calculated an average velocity for each household's trips. However, the relationship between the calculated cost per kilometer and velocity turns out to be an inverse one. This is not entirely unexpected given the crudeness of the procedures and the expected influence of errors of measurement. The cost measure involves distance as a divisor which also appears as the numerator in the velocity measure. In consequence, errors in the estimation of distance induce a spurious negative correlation between cost and velocity. If a household overestimates distance travelled, it will record both a high velocity and a low cost per kilometer; the same works in reverse when distance is understated.

The relationship between velocity and modes can be assessed directly. Table 4.15 shows average speed in kilometers per hour separately for educational and employment trips and for all trips together. Only the major modes are shown. These figures are obtained by averaging velocities by mode over all the observed trips of the type concerned. Note that there is good consistency by purpose, and that the rankings of mode by speed is as expected. The high speed of the motor-cycle and car category, which is mostly motor-cycles, reflects the ability of scooters to bypass the more congested areas of the city. The Table suggests that, given the limited data available, the best approach to explaining modal choice is likely to be

one that links income to velocity and thence to type of transport. Since the major modes, i.e. walking, cycling, buses, and private vehicles, are naturally ordered by velocity, a simple model is one that links the prob-

TABLE 5.15
Average speed by mode
(km per hour)

mode	EMPLOYMENT	EDUCATION	ALL
WALK	8.5	7.4	7.6
CYCLE	10.3	10.8	10.5
CYCLE-RICKSHAW	8.5	8.8	8.8
SPECIAL BUS	13.1	13.2	13.0
STAGE BUS	11.1	11.1	11.1
AUTO-RICKSHAW	13.7	12.2	13.4
TAXI	12.5	9.9	12.4
M/C-CAR	18.1	17.9	18.1
ALL	12.0	9.0	10.4

ability of each mode being chosen to the position of the traveller according to a one-dimensional characteristic or unobserved latent variable. One can perhaps think of this in terms of desired velocity, with desired velocity determined by the shadow price of time, but the attractiveness of the modes in terms of comfort and convenience is also positively correlated with velocity. In any case we exploit the ordering to estimate a simple ordered probit model. Define the latent unobservable variable v^h by

$$v^h = x^h.\beta + \epsilon^h \tag{22}$$

where ϵ^h is distributed as $N(0,1)$ and is to be interpreted as a random taste parameter. The quantity v^h can be interpreted either as desired velocity of the individual in household h, or as the position along the "attractiveness"

spectrum in modes to which the household's income and characteristics entitle it. Mode choice is then determined according to the rules:

$$h \text{ chooses walk if } v^h < m_1 \tag{21}$$
$$h \text{ chooses bicycle if } m_1 < v^h < m_2$$
$$h \text{ chooses bus if } m_2 < v^h < m_3$$
$$h \text{ chooses m/c-car if } m_3 < v^h$$

The probabilities associated with (21) are derived from the normal distribution and a likelihood function constructed that can be maximized by standard methods. The m parameters are estimated jointly with the β's, though one of them has to be set at any arbitrary value; here we set $m_1=0$.

Since we are predicting modal choice with primary reference to speed, we use the same explanatory variables as are listed in Table 5.14 above. As is to be expected, income per earner or income per capita once again are the dominant explanatory variables (Table 5.16). The elasticity of the latent variable with respect to income per earner is one half for employment trips and one third for education trips. However, for both types of trip the non-logarithmic income variables yield the better fit, so the first and third columns are the ones to be preferred for prediction. Note that, given the income variables, additional children always <u>downgrade</u> modal choice whereas additional adults <u>upgrade</u> it.

Since ordered probits are somewhat less simple to interpret than are ordinary regressions, we provide in Table 5.17 a set of predicted prob-

TABLE 5.16

Modal choice by ordered probit.

	EMPLOYMENT TRIPS		EDUCATION TRIPS	
constant	0.0187	-2.298	-0.4357	-1.730
	(0.5)	(19.2)	(8.2)	(13.7)
HHY/N_e	0.0011	-	-	-
	(38.5)			
$\ln(HHY/N_e)$	-	0.4958	-	-
		(28.2)		
PCY	-	-	0.0018	-
			(19.6)	
$\ln PCY$	-	-	-	0.3423
				(16.0)
N_a	0.0311	0.017	0.0749	0.0647
	(4.2)	(2.4)	(8.4)	(7.2)
N_c	-0.0594	-0.056	-0.1893	-0.2107
	(7.9)	(7.5)	(19.7)	(22.3)
m_2	1.31	1.25	0.55	0.55
	(68.4)	(68.0)	(41.4)	(41.4)
m_3	1.77	1.67	1.94	1.90
	(80.9)	(80.6)	(52.7)	(53.3)
$2\ln\mathcal{L}$	1796	879	1290	1164

Note: the ordered modes are walk, cycle, bus, and motor-cycle, scooter, or motor car. The parameter m_1 has been set to zero.

TABLE 5.17

Predicted modal choice probabilities

EMPLOYMENT TRIPS			WALK	CYCLE	BUS	M/C-CAR
HYY/N_e	N_a	N_c				
500	2	2	0.30	0.48	0.11	0.10
500	2	4	0.35	0.47	0.10	0.08
1000	2	2	0.14	0.45	0.16	0.24
1000	2	4	0.17	0.47	0.15	0.20
EDUCATION TRIPS						
PCY	N_a	N_c				
100	2	2	0.69	0.16	0.14	0.01
100	2	4	0.80	0.12	0.08	0.00
200	2	2	0.62	0.18	0.18	0.01
200	2	4	0.75	0.13	0.10	0.00

abilities of modal choice for households with selected characteristics. Note that the probabilities add up to 1.00 so that no role is being explicitly assigned to modes other than those listed. Since the modal ordering is based on speed, the missing modes (which are typically responsible for less than 10% of trips) can be thought of as commanding small probabilities in the appropriate place along the spectrum. For employment trips, demographic structure has relatively little influence, and the mode choice is essentially determined by earnings per worker. As we move from 500 rupees to 1000 rupees, the probability of walking falls by about a half, with bus and motor-cycles/scooters increasing their share to compensate. Note that the probability of cycling to work remains relatively constant because as cyclists abandon their vehicles for buses and motor-cycles, they are replaced by pedestrians that have turned into cyclists. With further increases in earnings, and a consequent decline in the probability of walking, the reservoir of potential cyclists will dry up and the probability of cycling will begin to fall with further increases in earnings. For trips to places of education, the share of the pedestrian mode is much higher and is more sensitive to the number of young people in the household than to the level of household income. The presence of additional children at the same level of *PCY* causes the probability of walking to increase. This is probably a result of our inability to control for the <u>age</u> of children; a household with more children typically has a lower average age of children, and younger children are less likely to ride bicycles, the second most popular mode for education trips.

We turn finally to the prediction of ownership patterns. Again, we work with the same basic explanation, from income to speed to modes and finally

to ownership. To cycle typically requires a bicycle, to ride on a motor cycle requires access to one, and so on. Once again therefore, we can use the same ordered probit model to predict probabilities of ownership. There are four ordered ownership states: (i) the household owns no vehicles of any sort, (ii) the household owns one or more bicycles but owns no motor vehicles of any sort, (iii) the household owns a motor-cycle or motor scooter but no car, and (iv) the household owns a car. A household is deemed to "own" if anyone in the household owns the vehicle, which was the question asked in the survey. Note that higher categories in the ranking supercede lower ones; a household with bicycles and a motor scooter is allocated to group (iii). Table 5.18 lists the ordered probit results for various combinations of explanatory variables. As usual the income variables enter positively; the numbers of adults and children have negative effects when income is represented by *HHY*, but enter positively when *PCY* or ln(*PCY*) is used. Hence, at a given per capita income level, extra family members increase the probability of vehicle ownership. The two new variables in the table are intended to capture aspects of long-run living standards (permanent income) not reflected in current measured income; the variable *RMS* is the number of rooms in the house, while *RES* is an indicator of length of residence and takes the value 1 for 0-2 years, 2 for 3-5 years, 3 for 6-10 years, and 4 for more than 10 years. The number of rooms in the house is strongly and significantly positively related to ownership, presumably because families that live in relatively generous accommodation are wealthier than their income alone would indicate. Length of residence has a significant but not very large effect; recent movers are more somewhat more likely to own the various vehicles.

TABLE 5.18

Ordered probit estimates for vehicle ownership.

constant	0.25	0.25	-0.35	-3.34
	(4.8)	(4.2)	(-5.7)	(-22.6)
HHY	0.00082	0.00074	-	-
	(34.3)	(33.3)		
PCY	-	-	0.0021	-
			(26.5)	
ln*PCY*	-	-	-	0.68
				(28.1)
N_a	-	-0.044	0.1520	0.1238
		(-3.3)	(12.5)	(10.5)
N_c	-	-0.029	0.0886	0.0982
		(-3.1)	(9.1)	(10.0)
N_e	-0.26	-	-	-
	(-11.2)			
N_s	0.04	-	-	-
	(3.7)			
RMS	0.14	0.14	0.17	0.17
	(14.0)	(14.6)	(18.0)	(17.5)
RES	-0.04	-0.05	-0.04	-0.06
	(-2.7)	(-3.4)	(-3.1)	(-4.3)
m_2	1.84	1.82	1.76	1.80
	(71.8)	(71.9)	(71.7)	(71.3)
m_3	3.83	3.77	3.52	3.53
	(70.3)	(70.7)	(74.5)	(76.8)
$2\ln\mathcal{L}$	1998	1869	1382	1500

TABLE 5.19

Predicted probabilities of vehicle ownership

HHY	N_a	N_c	No vehicle	Bicycle	Mc	Car
400	2	2	0.26	0.62	0.12	.001
400	2	4	0.28	0.61	0.11	.001
800	2	2	0.18	0.64	0.18	.002
800	2	4	0.19	0.64	0.17	.002
1600	2	2	0.06	0.55	0.37	.012
1600	2	4	0.07	0.57	0.35	.010

Table 5.19 is the counterpart of Table 5.17 and translates the ordered probit results into the predicted ownership probabilities. The figures are calculated for a household living in 2 rooms (more rooms would shift

probabilities towards more ownership), that has lived in its current location for up to 2 years (longer residents would have slightly lower probabilities of owning.) Once again bicycle ownership is relatively insensitive to household income over the relevant range, though it is beginning to fall at the highest *HHY* figures shown and falls quite rapidly beyond that. The main changes with changes in income is the decline in the probability of owning no vehicles and the compensating increase in the probabilities of owning a motor-cycle or a scooter, especially among the high income groups. The probability of car ownership remains very small over the normal range of incomes.

5. Trip patterns and travel expenditures

In this section we turn to an examination of the expenditures that are generated by the tripping patterns described above. The access of people to travel is determined by what travel costs, and the contribution of travel to household budgets is an important element in discussions of pricing and subsidy schemes for public transport. From the point of view of this study, much of our data comes from expenditure surveys that do not report tripping patterns, so that we shall be making inferences about trips based on travel expenditure alone. The Jaipur survey is therefore especially valuable because it allows us to make the link explicitly.

Even so, the data from Jaipur do not contain the full amount of detail that would be necessary to match total travel expenditures to modes, distances, and fares. We have a record of expenditures on running each of cycles, scooters, and cars, together with a total expenditure figure for public transport. The general fare structures for buses and rickshaws in

Jaipur are also available, so that it is possible to make some rough estimates. At the least, these can act as cross checks for the plausibility of the travel expenditure figures, something that is an issue because of the very much larger figures for travel expenditures in the Jaipur survey than in the NSSO figures for urban Rajasthan. Estimating expenditures from trip behavior also allows us to use the models of the previous sections to say something about the likely relationship between travel expenditures and income.

The simplest rough calculation runs as follows. The average household has 5.07 members and thus takes 3.14 round trips per day (Table 5.9, last column.) For all trips taken together, we calculate the average distance to be 3.48 kilometers; so that total distance per household per day is 3.14 * 2 * 3.48 = 21.9 kilometers. Public transport is only used for a fraction of this distance; 38.5% of trips are on foot, 26.3% by bicycle, 12.1% by scooter, motor-cycle, or private car, so that only 23.1% of trips are made by public transport, including the 2.2% ascribed to "other." Buses and minibuses together account for 17.7% of trips, but average distances are much longer than pedestrian trips and somewhat longer than cycle trips, so that they may account for double their trip share in terms of distance, i.e. 35% of 21.9 kilometers, or 7.7 kilometers per household per day. The fare per mile varies with distance travelled, but 12 paise per kilometer would be a representative figure (see also Fouracre and Maunder (1985)), so that daily household expenditure on buses and minibuses would be 92 paise. If there are 6 days per week, and 4.3 weeks per month, this converts to a monthly figure of 24 rupees per household. Cycle rickshaws account for 0.17 daily (single) trips per household, so that if trips average 2 kilometers at

50 paise per kilometer, the total monthly household expenditure on cycle rickshaws would be another 4-5 rupees per month. The only remaining category of public transport is the "other" mode, and some of this is by auto-rickshaw, which is an expensive mode, costing around one rupee per kilometer. Even so, it is hard to imagine that auto-rickshaws account for more than another 4 or 5 rupees per month per household, so that we reach a total expenditure per month on public travel of 32-34 rupees per month, compared with the reported total figure of 34 rupees. The closeness of these figures is undoubtedly coincidental and there are likely to be various offsetting errors, but it seems unlikely that the figure of 34 rupees is wildly off the mark. The figure represents 2.8% of average household total income, though given the skewness in the distribution of income, and our uncertainties about the mean, a figure of 4.75% of modal household income may be taken as more representative.

Expenditure on public transport is not the same at all levels of income, and the main mechanisms can be seen from the analysis of the previous sections. As households become better off, they generate more trips, partly because social and leisure trips are income elastic, and partly because a higher fraction of the members of better-off households remain longer in full-time education. Mode choice also changes with income, and as income increases, some individuals that were previously pedestrians or cyclists will ride buses or mini-buses, though some bus passengers will also move up to private modes, mostly motor scooters. The net effect of all this is that expenditures on public transport rise with income, but not as fast, so that while public transport expenditures account for over 5% of income amongst low income households (with income between 200 and 500 rupees per month),

the share falls smoothly with income to about 2% of income amongst those households with 2000 or more rupees per month. (It is possible to find some very low income households in the survey with very much larger ratios of travel expenditure to income, and indeed there are several households that record travel expenditure but no income. Always supposing that income is accurately reported, the zero figure is clearly transitory so that no significance should be attached to it. For any population with variable incomes, particularly over a short sample period, it will always be possible to find some with very high ratios of expenditures to income, especially for regular expenditures that must be met independently of the fluctuations in income. A rich entrepreneur may have zero or little income in one particular month, but will continue to spend in the usual manner.)

For the average household, the larger share of travel expenditure is on private modes, on the running costs of cycles, scooters, and cars. The total reported figure per household is 64 rupees per month which breaks down into 41 rupees per month for scooters and motor-cycles, and 9.5 rupees each for bicycles and for cars. These averages depend on both the running cost per vehicle and the ownership levels, so that while bicycles are much cheaper to run than cars, more than 65% of all households own a bicycle and less than one per cent own cars. In contrast to the case for public transport, we have no way of cross-checking these private expenditure estimates, though we suspect that, because of the irregularity in many of the outlays, these expenditures are inherently more difficult to measure accurately. It is also likely that the major discrepancy between the NSS and TRRL figures (if there is a discrepancy) can be attributed to these figures. It is very easy to believe that the NSS underestimates maintenance

and fuel expenditures, though that in itself is no validation for the particular figures given here. A private travel expenditure of 64 rupees is 5.3% of mean household income, so that, if expenditures on public transport are added, total travel expenditure accounts for about 8% of the budget, a figure that is a good deal larger than the NSS figure, as well as those obtained from the expenditure surveys in the next four chapters.

Whatever the final verdict on accuracy of the estimates, it is clear that the theory predicts that private expenditures will rise rapidly with incomes, and the data confirm the fact. In the case of public transport, the effects of higher income on the generation of trips and on shifting modal choice towards buses and rickshaws was offset by the drift of richer individuals away from public transport towards scooters and cars. For private modes, there is no such offset, so that even though expenditures on bicycles may rise very little with income, the motorized private modes will absorb a steadily increasing share of income. For the poorest households in Jaipur, those with incomes up to about 1000 rupees per month, private transport expenditures account for between 3 and 4% of income, while for households above 1000 rupees, the share rapidly increases to about 7%. In consequence of the offsetting trends of private and public travel the total travel budget lies between 8% and 10% of income over a wide range, and rises only very slowly (if at all) from poorer to richer households.

These relationships between travel expenditures and incomes can be summarized by means of the regression equations shown in Table 5.20; these are similar to regressions that we shall employ extensively in the next four chapters. The dependent variable in all cases is the share in household income of the type of travel expenditure indicated, private, public, or all.

The independent variables are the logarithm of per capita household income *PCY*, the demographic structure of the household by sex and by age, and dummies that divide household into those living "far" from the city center, those living at "middle" distance, and those living "near", this last group not being shown in the Table because it is the base group. In addition, in the regressions on the right hand side of the Table, a dummy variable is added that indicates whether or not the household owns a motor vehicle, either a scooter, motor-cycle, or car. These regressions are thought of as short-run regressions, since they model expenditures conditional on the ownership of the vehicle, while the regressions on the left-hand side of the

TABLE 5.20

Regressions of travel expenditure as a share of income

	LONG RUN			SHORT RUN		
	PUBLIC	PRIVATE	ALL	PUBLIC	PRIVATE	ALL
constant	31.2	-9.13	20.8	31.4	-9.63	20.5
	(19.)	(10.)	(10.)	(19.)	(11.)	(10.)
log(*PCY*)	-4.66	2.05	-2.23	-4.50	1.64	-2.49
	(17.)	(14.)	(6.6)	(16.)	(11.)	(7.2)
# males <22	-0.82	0.31	-0.50	-0.77	0.17	-0.50
	(5.9)	(4.0)	(2.9)	(5.5)	(2.3)	(3.3)
# males 22-55	0.21	0.15	0.36	0.28	-0.02	0.26
	(0.9)	(1.3)	(1.3)	(1.2)	(0.1)	(0.9)
# males >55	-0.07	0.24	0.77	-0.07	0.24	0.77
	(0.2)	(1.0)	(1.4)	(0.2)	(1.0)	(1.4)
# females <19	-0.95	0.22	-0.73	-0.91	0.13	-0.78
	(6.5)	(2.7)	(4.1)	(6.3)	(1.6)	(4.4)
# females 19-50	-0.50	0.52	-0.05	-0.46	0.42	-0.12
	(2.1)	(4.1)	(0.2)	(1.9)	(3.3)	(0.2)
# females >50	-0.64	0.62	-0.11	-0.61	0.54	-0.16
	(1.5)	(2.6)	(0.2)	(1.5)	(2.3)	(0.3)
far	0.25	0.77	0.97	0.28	0.68	0.27
	(0.6)	(3.2)	(1.8)	(0.6)	(2.9)	(1.7)
middle	-0.30	1.62	1.69	-0.27	1.55	1.64
	(0.9)	(9.4)	(4.3)	(0.9)	(9.2)	(4.2)
own motor v.	-	-	-	-1.57	4.06	2.45
				(3.8)	(18.)	(4.8)
R^2	.0450	.0496	.0109	.0472	.0983	.0145

Table, the long-run regressions, omit the ownership variable, so that the effect of the other variables operating through ownership is ascribed directly to those variables themselves. A brief rationale for this procedure, which is used repeatedly in the next four chapters, is given in the econometric appendix to Chapter 2. Note that, within each set of regressions, the sum of the private and public should be the total. This is only roughly true in the Table since the three magnitudes were measured independently in the survey, and therefore do not add up exactly in the raw data.

The results provide a more precise statement of the general trends outlined above. In both the short-run and long-run regressions, increases in per capita income increase the share of the budget devoted to private travel and decrease that devoted to public travel. Other things equal, the latter effect outweighs the former, so that total expenditure rises less fast than income, and the travel share falls. The long-run elasticity of public travel expenditure is lower than the short-run elasticity, and the opposite is true for private expenditures, both phenomena reflecting the positive effects of income on ownership. However, the income coefficients are not as different between short and long-run regressions as will be the case for several of the other countries examined below. The demographic variables show some interesting patterns. Young people of both sexes have negative coefficients in the public transport regressions both in the short and long-runs. Note that <u>per capita</u> income is being held constant, so that the negative effect is due to the fact that most of the trips by young people, particularly children, are trips to school, and more of these are on foot or by bicycle than is the case for employment trips. In consequence, households with more children and fewer adults within the same total

membership have less public travel expenditure, and this is what the regressions tell us. Similarly, substitution of adult females for males will decrease expenditures on public transport, but increase expenditures on private transport. The former is presumably related to lower numbers of female employees; the latter is harder to explain, though it may be connected to women's preference for scooters over bicycles (which are hard to ride while wearing a sari.) All of the demographic coefficients in the public travel regressions are larger in short run than in the long run regressions, while the opposite is true in the private transport regressions. Clearly, at constant per capita income, additional household members of all types make it more attractive to own a motor vehicle, because the fixed costs can be spread over more people and more trips, so that in the long-run the additional trips generated by more people are partially switched to private modes. Hence, although the expenditure regressions are only a summary of the detailed behavior that lie beneath, many of the phenomena discussed in earlier sections of this chapter can be detected in the results.

6. Summary and policy implications

6.1 Is Jaipur special?

Although we have devoted a long chapter to the city of Jaipur, our interest is in the general patterns revealed, rather than the details of one particular city and one particular transport system. The TRRL Overseas Unit has repeated its Jaipur survey for two other Indian cities of similar size, Vadodara, (population 0.744 million) the second city of Gujarat, and Patna, (population 0.916 million), the capital of Bihar. While it would take too

much space to repeat the Jaipur study for each of the other two surveys, it is worth noting the similarities and differences in the three environments before coming to strong conclusions based on Jaipur alone. The summary that follows is based on Maunder (1985b).

The three cities differ in average standards of living, with average per capita income in Vadodara about 20% higher, and that in Patna about 50% higher than in Jaipur. Just as importantly, they have very different systems of transport provision, which is the reason they were chosen for study by the TRRL. Public transport in Vadodara is provided very largely by conventional buses, in Patna by autorickshaw bus services and a taxi system consisting largely of cycle rickshaws, while Jaipur, as we have seen, is characterized by a mixture of a large number of different modes. Both Patna and Vadodara are more spread out than is Jaipur so that trips take more time and cover longer distances. However, in spite of these differences in income, in provision, and in geography, the general travel patterns in all three cities are very similar. Household sizes are very similar in the three cities, and so are the numbers of employment and educational trips. Average trip distance rises with income in all three cities, though trip times are largely independent of income. In spite of the radically different mode provision in the three cities, the average speed per trip is almost identical across the cities and rises with household income in exactly the same way in all three. Walk trips account for much the same fraction of all trips in the three cities. The share of the budget devoted to travel is split about 2:1 in favor of private modes, the share of expenditure on public transport falls steadily with income, and the total travel share is roughly constant with income at between 8% and 10%. More

than 65% of households own bicycles in both Jaipur and Vadodara, though the figure is a little less in Patna. Car ownership is less than 0.5% in Jaipur and Vadodara, but around 4% in Patna, presumably reflecting the higher income levels in that city.

The major difference between the cities lies in the numbers of social, leisure, and other trips. As we have seen, these account for a very small fraction of the total trips in Jaipur, while in the other two cities, social and leisure trips account for a full third of all trips. There is no obvious explanation for this difference, though we suspect that some of it is more apparent than real. It is clear from Chapter 4 above that it is extremely difficult to evolve a satisfactory working definition of trips that do not have clearly defined purposes, so that it is conceivable that the same questionnaire was interpreted differently in the different locations with more short distance local trips included in Vadodara and Patna than in Jaipur. Certainly, a higher proportion of such trips in the other two cities are taken on foot, and in the Jaipur data all distances are coded as one kilometer or more, though it is not clear whether this is merely rounding, or whether some short trips were excluded. Judging by the results in Chapter 4, the Jaipur figures for other trips seem very low and those from Vadodara and Patna very high. But the NSS figures are themselves suspect, so it is hard to come to any firm conclusion.

This rather superficial inspection suggests that the model and results discussed above should apply relatively well to the other two cities, if only with the proviso that the role of social and leisure trips needs closer examination than it was given. Since social and leisure trips are likely to be more discretionary than either educational or employment trips, and the

evidence in Chapter 4 above tends to support this, trip generation is likely to be more elastic with respect to income than is recognized in the earlier parts of this chapter. A full resolution of the issues awaits the sort of survey data discussed in Chapter 3.

Apart from the evidence from the other Indian cities, we have found relatively little with which to compare our results. While there exists a great volume of evidence on tripping patterns from cities in the developed world, there is much less from poor countries. Kozel (1981) reports the results of a study of modal choice in Bogota, Colombia based on a 1972 household survey. The report does not contain the sort of tabulations that permit a close comparison with the results from Jaipur, but Kozel reports a per person trip rate of 1.25 per day, which is identical to that for Jaipur. It is also clear from her modal split results that the time required to reach the workplace is the major determinant of mode choice between walking and taking a bus, something that is again consistent with the model developed for Jaipur. Bogota has very much larger numbers of households that own cars, 12% or more, and the transit provision is again different, with conventional buses and busetas (charter minibuses) accounting for nearly three-quarters of mode choice. The results are consistent with the supposition that the rich live further away from the center than do the poor, and while the relationship between travel times and incomes is not reported, it is certainly the case that the rich have higher average travel speeds. Thobani (1983) reports a modal split analysis for Karachi, Pakistan, but his survey is stratified in a way that makes it very unrepresentative of the city as a whole, so it is not possible to compare the stylized facts with those from Jaipur. Heraty (1980) describes travel

patterns in Kingston, Jamaica, in the late 1970's. Again, it is hard to compare the results, though it appears that the fraction of income devoted to travel is about 12%, quite close to the Indian city figures, though the fraction is said to decline with income. Finally, the study by Eastman and Pickering (1981) of Kuala Lumpur in Malaysia shows that the share of transport expenditure in income is about 10% and varies little with income, though once again the survey is heavily stratified and it is not clear the extent to which the results hold for the city as a whole. In Kuala Lumpur, travel times once again appear to be more or less independent of household incomes. While all of this evidence is very incomplete, and far from fully comparable, none of it suggests that Jaipur is very different from other cities in the developing world.

6.2 Implications of the Jaipur results

Just as the analysis of this chapter has been limited by the available data from the Jaipur survey, so are the implications limited by our ignorance of those elements of behavior not illuminated by the survey. The results that we have documented tell us a good deal about the relationships between income, family composition and various types of travel and vehicle ownership patterns. These relationships determine, at least to the first order of approximation, the consequences for real income distribution of changes in the prices and costs of the various kinds of travel. What we know much less about are the consequences of price and fare changes on the travel patterns themselves. Even so, our results tell a fairly simple story of personal travel patterns in Jaipur that is suggestive of the way in which

policy initiatives are likely to operate. In particular, we note the following more or less related points:

1. Almost 90% of trips are trips to work or trips to school. There is little or no evidence of what might be labelled "luxury" or "pleasure" tripping. Taxes levied on personal travel are therefore taxes on work or taxes on going to school. This conclusion may not extend much beyond Jaipur; results from other cities suggest a larger number of "social and leisure" trips. However, note that, in spite of the name, these trips include everything that is not a work or school trip, and many of these other trips are hardly discretionary, pleasurable, or luxurious; see for example the further breakdown of trips in Chapter 4 above.

2. Expenditure on travel grows at much the same rate as does household income, partly because the number of trips increases. But much the more important reason is that the characteristics of trips change with household income. Taxation of travel is therefore likely to cause substitution towards cheaper and slower modes rather than any reduction in the number of trips (see also 3 below). Higher taxation thus imposes time costs as well as money costs on travellers. A tax that raised the cost of <u>all</u> paid-for transport by the same proportionate amount would be neither regressive nor progressive in its incidence but rather distributionally neutral.

3. Our results show that the number of trips per household is extremely well predicted by supposing that each employee and each student makes one round trip per day. It is implausible that this relationship between trips

and household structure would be altered by changes in fares or other transport policy. Of course, whether an individual finds it worth his or her while to become an employee or a student is not ultimately independent of the cost of transport. One of the most important effects may be on the costs of finding work for those without it; search usually involves transport. Even here, relocation is an alternative and, in general, we would expect policy to have a much larger effect on the nature of trips than on their number.

4. Although just over half of all trips are trips to school, 60% of school trips are made on foot, and 75% either on foot or by bicycle. Only 18% of trips to work are on foot, with another 41% by bicycle. Consequently, the impact of changes in fares or in fuel prices will be felt largely by employees. Note too the importance of bicycles for personal travel and the consequent importance of policies that affect their price, usability, and maintenance. The role of bicycles appear to extend beyond Jaipur to other "second-order" cities in India; for the four very large cities, buses may be relatively more important and bicycles less so. Finally, and at least in Jaipur, subsidization of public transport does very little for the poorest households. Very poor people walk to work, if they have work, and their children walk to school, if they go to school.

5. We have had some success in modelling both modal choice and vehicle ownership by ordering the alternatives according to velocity (or according to attractiveness, which comes to much the same thing) and then placing households along the spectrum according to their incomes and household

composition. To the extent that this is a valid representation of the way things actually work, we should expect price changes to act in much the same way, i.e. to move households along the ownership and modal choice spectrum. Hence, if gasoline becomes more expensive, bicycles will be substituted for motor cycles, motor cycles for motor cars, and time for gasoline. If, by contrast, bus fares rise, there will be substitution in both directions, towards both "superior" modes (motor cycles and motor cars) and "inferior" modes (bicycles and walking). Without data on fares, we cannot estimate the size of these effects, but it would not be hard to design a reasonable simulation model based on the results that we have been able to obtain.

6. Note finally the long-term effects of fare policies and gasoline pricing on location. Increases in the cost of "non-free" travel makes steeper the relationship between cost-per-kilometer and velocity, thus reducing velocities (with consequent shifts towards slower modes and lower levels of vehicle ownership) and ultimately causing individuals to locate closer to their workplaces.

PART THREE: HOUSEHOLD EXPENDITURE ON TRAVEL

CHAPTER 6

TRAVEL PATTERNS IN TUNISIA 1979-80

0. General Background

The household expenditure survey on which the analysis is based was carried out in Tunisia in 1979-80. At that time, the Tunisian population comprised some 6.2 million people, or 1.1 million households, of which 5957 were included in the survey. Tunisia is generally listed as a middle-income, oil exporting economy. In 1980, it had a GNP per capita of $1120 in 1980 US dollars; from 1960-80 the average growth rate was 4.8% per annum, although more recent rates are higher. By 1981, some 53% of the population was classed as urbanized, compared with 47% in 1975 and 36% in 1960.

The analysis of expenditures on travel will be carried out with reference to a number of factors, amongst which the most important are the distribution of the population over regions and by degree of urbanization, levels and patterns of household total expenditures, and the structure of households, particularly in relation to numbers of workers and students. We begin with a description of these variables, moving on to travel demand once the background is clear.

For the purpose of the survey, Tunisia is divided into four regions, the North East (which contains Tunis and other major towns), the predominantly rural North West, Central and South. We shall work throughout with three levels of urbanization, referred to in the survey as "Grandes Villes", "Communes Urbaines" (smaller towns) and "Regions Rurales". Table 6.1 gives the joint distribution of households by region and by urbanization for the population as a whole. Table 6.2 does the same for the 5957 households in

the sample. The sampling probabilities do not differ greatly from cell to cell, but there is some over-representation of rural areas, particularly in

Table 6.1

Distribution of Households by Region
and by Level of Urbanization
Population: Tunisia 1979-80: Percent

	All Tunisia	G.V.	C.U.	R.R.
All	100	25	30	45
North East	34	18	7	9
North West	17	0	4	12
Center	26	2	10	14
South	23	5	8	10

Note: G.V. is "Grandes Villes," C.U. is "Communes Urbaines," and RR "regions rurales."

Table 6.2

Distribution of Households by Region
and by Level of Urbanization
Sample: Tunisia 1979-80: Percent

	All Tunisia	G.V.	C.U.	R.R.
All	100	17	27	55
North East	29	13	6	10
North West	20	0	5	15
Center	29	1	9	19
South	22	3	6	12

the center and north-west, at the expense of north-eastern cities. All the results given below are based (as far as possible) on reweighting sample figures to reflect population magnitudes. Where this has not been possible, we say so, though in no case do we believe the results are seriously misleading.

The household survey measures all expenditures as annual flows in dinars (the exchange rate over the period was approximately 0.42 dinars to the U.S. dollar). We use household per capita total expenditure (PCE) on non-durable goods as our main indicator of household living-standards. Mean values of PCE for each of the population cells is given in Table 6.3. Generally, PCE levels are highest in the cities (though price differences are likely to offset some of this) and lowest in the rural areas; similarly the north-east is more prosperous than the north-west, with the center and south lying between. Much of the advantage of the north-east is because of the higher

Table 6.3

Mean per Capita Household Expenditure
By Region and By Level of Urbanization
(dinars/per person/per annum)

	All Tunisia	G.V.	C.U.	R.R.
All	292	445	327	184
North East	379	471	351	212
North West	198	-	305	158
Center	247	428	329	164
South	283	358	316	219

income cities that are located there, but the general ranking persists even when urbanization is controlled for. These rankings are not unexpected. What is somewhat more surprising is that higher levels of PCE are not generally associated with higher levels of inequality. For example, the standard deviation of the logarithm of PCE is 0.72 in the Grande Villes, 0.70 in the Communes Urbaines, and 0.74 in the Regions Rurales. For total household expenditure, the corresponding standard deviations are 0.69, 0.73 and 0.77, showing inequality decreasing with level of urbanization; similar

results are obtained using other measures of inequality, see also Table 6.7 below. There is therefore no evidence in this Tunisian survey that urbanization is associated with the existence in the cities of large groups of both very poor and very rich households.

Table 6.4 summarizes the data on household size and on household activity levels, with special attention to numbers of workers and of students since these are among the most important determinants of tripping patterns. In the current context, we see that, as in many developing countries, household

Table 6.4

Household Size and Activities

	Means			
	All Tunisia	G.V.	C.U.	R.R.
Household Size	5.92	5.55	5.73	6.25
Active Members				
Female	0.31	0.23	0.32	0.34
Male	1.33	1.25	1.26	1.43
Total	1.64	1.48	1.58	1.77
Students				
Primary	0.99	1.00	1.09	0.91
Secondary	0.28	0.49	0.33	0.13
Tertiary	0.02	0.05	0.02	0.00
Total	1.29	1.53	1.44	1.05

size is lower where urbanization is higher. Participation rates in total or by sex cannot be inferred from our version of the survey tape since we do not have data on numbers of males, of females, or of children. Even so, the ratio of workers to household members (or equivalently the dependency ratio) is essentially the same in the cities, towns and countryside. School attendence is relatively low in the countryside with one student to every

five non-students as compared with a one to three ratio in the grandes villes and communes urbaines. The discrepancies are even larger for secondary school students and virtually all tertiary education students live in the grandes villes.

1. Travel Expenditure in Total

Since we have no natural units in which to measure the qualities of travel obtained by different households, and since we know that the cost in money and time of fulfilling travel-related needs will certainly vary from household to household, it is more useful to focus on the share of transport expenditures in the total budget, rather than to look at raw expenditures in dinars. As discussed in Chapter 2, the budget share provides locally valid approximations to the welfare costs and benefits of price changes. The assumption of constant expenditure shares is also the natural starting point for forecasts of travel budgets; the implicit unit outlay and price elasticities are unlikely to be correct but are more attractive as a null hypothesis than zero elasticities.

Table 6.5 shows the composition of non-durable household expenditures by the three levels of urbanization. These figures are means of the shares for individual households, not the shares obtained by dividing mean expenditure on each good by mean total expenditure. The latter type of shares are effectively weighted by the outlays of each household and are thus biased toward the consumption patterns of the rich. Durable goods, including the purchases of cars, motorcycles, scooters and bicycles, are excluded because, at the individual household level, such purchases arise only by an accident of timing and so introduce into the data an element of noise that has little

Table 6.5

Household Expenditure Patterns

Mean Budget Shares: Percent

	All Tunisia	Grandes Villes	Communes Urbaines	Regions Rurales
Food	53.3	43.7	49.9	60.8
Housing	20.5	27.3	24.1	14.3
Clothing	8.23	7.58	8.36	8.50
Health	5.64	6.51	5.96	4.96
Transport	3.06	4.23	2.23	2.96
Leisure	7.09	8.28	7.14	6.41
Miscellaneous	2.21	2.47	2.24	2.04

to do with steady state expenditure levels. We discuss purchase figures later; for the present we note that overall they are close to one-sixth of other travel expenditures. It should also be noted that no allowance is made in the figures for user cost of durables, except for housing, imputed rents of which are included. This will tend to understate the travel expenditures of those households that own cars. As is to be expected given the relative levels of PCE, food shares decline from rural through towns to urban areas, though the share of food and housing together varies very little. The transport share is (unsurprisingly) highest in the grandes villes; more interestingly, it is lowest in the communes urbaines, not in the countryside. Presumably, the intermediate category avoids both the high frequency travel patterns of the cities and the high cost, low frequency trips of the countryside, but these data do not allow a direct examination of the conjecture.

Table 6.6, taken from La Consommation et les Depenses des Menages en Tunisie (1965-68) is included for comparison and gives overall patterns from the previous Tunisian survey in 1965-8, as well as those for neighboring

Morocco and Algeria (although the latter unfortunately does not give travel as a separate category), together with France in 1950 and 1956. The transport figures here include purchases so that it appears that the transport share has been increasing in Tunisia, presumably in reaction to increasing urbanization (though note that moves to communes urbaines from rural will tend to reduce travel shares, but if the former is a staging post for the grandes villes, it is the rural/urban difference that is important).

Table 6.6

Structure of Consumption in
Tunisia, Morocco, Algeria and France

Mean Budget Shares: Percent

	Tunisia	Morocco 1959-60			Algeria		France	
	1965-8	Urban	Rural	All	Urban	Rural	1950	1965
Food	50.3	59.7	75.9	70.2	45.7	60.4	49.0	37.2
Clothing	13.2	7.6	8.1	7.9	5.3	7.0	14.9	11.6
Housing	19.3	18.5	5.3	10.0	12.3	7.1	13.3	17.4
Medicine	4.3	4.9	2.3	3.2	14.6	8.0	5.9	10.6
Transport	2.8	2.5	1.7	1.9			5.4	5.8
& Communication					22.1	17.5		
Leisure & Other	10.1	6.8	6.7	6.8			11.5	14.8
Total	100	100	100	100	100	100	100	100

Travel in Tunisia accounts for about the same share of the budget as it does in Morocco, but is a good deal less than in France.

In some respects, Tables 6.5 and 6.6 mislead by aggregating over all households. Although it is true that the average Tunisian travel budget share is 3.06%, more than 35% of all households spend nothing on travel, so that by contrast, for those who spend something, the average share of the budget is 4.69%, not 3.06%. Although those who spend nothing on travel may

(and usually will) make trips (on foot or by bicycle for example) and although they would be affected by some aspects of travel policy (e.g. by the building of a new road, or by non-marginal changes in fares or prices), they are impervious to a wide range of policy changes. It is therefore important to know who they are, what their incomes are, and where they live. Subsidization of a bus lines may be argued for because it helps the rural poor, but if the rural poor spend very little on buses in any case, the policy is unlikely to be a good way of helping them. On the other side, looking at aggregate shares, including zero shares, tends to understate the impact of price changes for those who do travel, even though it gives a correct picture for a randomly selected household for which we do not know whether it spends anything on travel or not.. We therefore spend some time looking separately at those who do not travel before looking at the amounts spent on travel by those who do.

Patterns of expenditure are generally much clearer if the size of the total budget is controlled for. In the following tables, we therefore disaggregate by twelve total expenditure classes. In order to interpret these classes, it is useful to bear in mind the figures on the distribution

Table 6.7

Quartiles of Total Non-Durable Expenditure
by Urbanization Level (dinars per annum)

	All Tunisia	Grandes Villes	Communes Urbaines	Regions Rurales
1st Quartile	669	1073	835	493
2nd Quartile	1138	1664	1308	816
3rd Quartile	1862	2621	2077	1339
IQR /Median	1.05	0.93	0.95	1.04
Mean	1493	2147	1657	1024

of total expenditures given in Table 6.7. These figures essentially reproduce earlier information, but are essential for reading the later tables. For example, a budget level of 1000 dinars would place a household above the 6th decile in the rural areas but below the 25th in the cities. To the extent that prices are higher in the latter, relative as well as absolute budget levels are useful in making behavioral comparisons.

The distribution of travel expenditure in relation to the total budget is given in Tables 6.8 and 6.9. These tables reveal a number of useful stylized facts about Tunisia that are worth investigating further and comparing with data from other countries: -

(i) The proportion of households in each expenditure class that spends nothing on travel declines as the expenditure level rises. Apart from the very poorest group in the grandes villes, and the very richest groups in the other two sectors (where omitted running costs of vehicles and other understatements are likely to be important), the relationship is monotonic.

(ii) Although 35% of Tunisian households are estimated to spend nothing on personal travel, only 19% of households in the grandes villes spend nothing. Even in the countryside and the communes urbaines, where presumably a larger number of trips can be taken on foot, only 36% and 48% respectively show no travel expenditures.

(iii) The share of the budget devoted to travel generally increases as the total budget increases, travel being one of the commodities taking up the resources released by the decline in food shares. Evidently, there is a disretionary consumption element in travel

Table 6.8

Distribution of Households by Total Expenditure Level and
Share of Budget Devoted to Travel
All Tunisia

Expediture Level	0	0-4%	4-10%	10-20%	>20%	Mean
<250	72.2	10.8	10.5	4.1	2.4	2.14
250-500	57.0	3.3	14.4	4.4	0.9	2.20
500-750	44.0	34.5	15.6	4.5	1.4	2.55
750-1000	39.7	37.5	16.0	5.8	1.1	2.68
1000-1250	34.6	40.7	19.0	5.0	0.8	2.74
1250-1500	28.8	39.8	23.2	7.0	1.3	3.36
1500-2000	25.1	48.0	19.7	5.7	1.7	3.17
2000-2500	23.4	45.6	22.2	6.3	2.5	3.65
2500-3000	16.9	49.4	23.7	8.9	1.1	3.85
3000-4000	16.7	50.6	19.4	10.6	2.7	4.35
4000-5000	7.5	45.8	22.4	18.8	5.6	6.00
>5000	14.5	42.3	22.4	16.8	3.9	5.14
All	35.2	38.5	18.4	6.3	1.6	3.06

Grandes Villes

<250	24.8	54.8	0.0	20.4	0.0	4.08
250-500	40.5	34.5	14.3	7.4	3.3	3.66
500-750	39.4	27.7	23.9	5.4	3.6	3.68
750-1000	32.4	35.9	20.7	9.8	1.2	3.48
1000-1250	23.7	43.6	29.3	3.5	0.0	3.00
1250-1500	14.8	44.3	28.1	9.9	2.9	4.51
1500-2000	16.6	55.6	21.0	5.0	1.7	3.38
2000-2500	15.2	43.6	30.5	8.2	2.6	4.41
2500-3000	5.8	48.4	33.6	12.2	0.0	4.46
3000-4000	8.7	56.4	18.3	11.8	4.8	5.31
4000-5000	5.6	38.8	25.3	24.8	5.6	6.81
>5000	4.4	41.9	28.5	19.1	6.1	6.51
All	18.6	44.6	25.0	9.3	2.5	4.23

Table 6.9

Distribution of Households by Total Expenditure Level
and Share of Budget Devoted to Travel

Communes Urbaines

Expenditure Level	Zero	0-4%	4-10%	10-20%	>20%	Mean
<250	85.7	6.0	8.3	0.0	0.0	0.85
250-500	75.8	10.5	12.9	0.8	0.0	1.13
500-750	68.0	22.0	5.9	3.5	0.7	1.35
750-1000	56.9	32.1	8.9	2.1	0.0	1.34
1000-1250	50.6	31.5	11.7	4.9	1.2	2.13
1250-1500	45.4	32.8	19.0	2.6	0.2	2.24
1500-2000	40.4	38.4	15.8	4.9	0.5	2.31
2000-2500	33.7	45.1	13.9	4.9	2.5	2.92
2500-3000	25.7	46.0	19.3	6.3	2.7	3.60
3000-4000	26.5	41.4	18.2	13.0	0.9	3.94
4000-5000	11.8	62.6	12.6	4.4	8.6	4.76
>5000	29.1	40.3	14.5	15.0	1.1	3.44
All	47.9	33.3	13.2	4.5	1.0	2.23

Regions Rurales

	Zero	0-4%	4-10%	10-20%	>20%	Mean
<250	71.2	10.3	11.3	4.4	2.9	2.32
250-500	53.8	25.5	14.8	5.1	0.9	2.35
500-750	36.2	40.7	17.2	4.7	1.1	2.71
750-1000	32.4	41.0	18.4	6.5	1.6	3.17
1000-1250	28.0	46.5	18.5	6.1	0.9	3.08
1250-1500	23.5	43.1	23.3	9.0	1.0	3.55
1500-2000	18.9	49.7	21.8	6.9	2.6	3.76
2000-2500	19.3	49.4	23.5	5.6	2.3	3.69
2500-3000	17.5	56.5	17.4	8.6	0.0	3.40
3000-4000	19.8	53.1	25.2	1.9	0.0	2.39
4000-5000	9.9	52.9	24.9	12.3	0.0	3.79
>5000	28.3	55.8	9.3	6.6	0.0	1.88
All	36.0	38.6	18.0	5.9	1.4	2.96

expenditures that becomes increasingly important as households become better off.

(iv) The whole distribution of expenditure shares shifts upward as total outlay increases.

(v) Most households that spend anything on travel spend on it less than 4% of their total regular budget for non-durable goods. Even so, 26.3% of households overall, and nearly double that in cities, spend more than 4% of their budgets. An estimated 7.9% of households, i.e. 85,000 households containing more than half a million people spend more than a tenth of their total outlay on travel.

(vi) Although the fraction of households spending nothing on travel steadily decreases with levels of total expenditure, the fraction of households spending a large fraction of their budgets does not rise steadily with levels of living. In the cities and in the countryside, there are substantial fractions of quite poor households that report spending more than 10% of their budgets on travel.

(vii) The direct comparison of cities and countryside is of interest since we have so little data on rural travel and so much on urban. Although less is spent in rural areas, roughly 3% as opposed to 4% of the budget, such expenditures are still significant. Two thirds of households spend money on travel, and for those who do, their expenditure averages about 4.5% of their budget. Among rural households, 7.4% spend more than 10% of their budgets, and over a quarter spend more than 4% on travel. We shall comment on

the modal structure of these rural expenditures below, but these Tunisian data are essentially silent on the trip structure underlying these figures.

2. The Structure of Travel Expenditures

Total travel expenditures tell us who spends anything on travel and who does not, and the overall budget share is a guide to the consequences of very general policy changes. For example, a change in fuel prices without changes in subsidy patterns would raise all travel costs roughly proportionately so that Tables 6.8 and 6.9 would detail who would be hurt and by how much. However, most policy changes (and most existing distortions) affect the prices of different travel modes in different ways, so to assess the effects we must look to the structure of expenditures within the travel budget. Hence we divide travel expenditures into two broad groups, private and public. To these is added purchases of vehicles (cars, motorcycles and bicycles), an item which is dealt with separately and is not included either in total household expenditure or in total travel expenditures. Private expenditure is therefore the recurrent costs of private vehicles and is divided into three subgroups: annual expenditures (licenses, insurance, etc.), maintenance of vehicles, and running costs (gas, oil, etc.). Six categories of public transport expenditures are distinguished. In rough order of importance, these are car hire (i.e. fares for riding in privately-owned paratransit vehicles), buses, taxis, season-tickets, train and other. Table 6.10 shows how these various categories add up to account for the total. Purchases of vehicles are also shown (expressed as a fraction of total expenditure for convenience, although they are not included in the

total), as are fractions of households owning cars. As we shall see, the ownership of a vehicle exerts a major influence on household expenditure patterns. Table 6.10 shows that vehicle ownership and the associated expenditures are much more frequent in the cities than in either of the

Table 6.10

The Structure of Travel Expenditures
(Shares of total non-durable expenditures)

	All	Grandes Villes	Communes Urbaines	Regions Rurale
Total	3.06	4.22	2.23	2.96
Private	0.92	1.88	0.78	0.48
Annual outlays	0.17	0.39	0.14	0.06
Maintenance	0.25	0.45	0.23	0.16
Running costs	0.48	1.03	0.40	0.22
Other	0.02	0.01	0.01	0.04
Public	2.14	2.34	1.45	2.48
Season-tickets	0.11	0.25	0.09	0.04
Taxi	0.20	0.35	0.10	0.18
Bus	0.52	1.10	0.30	0.35
Car hire	1.19	0.42	0.87	1.83
Train	0.11	0.22	0.09	0.07
Other	0.01	0.00	0.01	0.01
Vehicle purchases	0.56	1.00	0.64	0.21
Cars	0.25	0.62	0.18	0.03
Motor cycles	0.28	0.35	0.43	0.15
Bicycles	0.03	0.03	0.03	0.03
Ownership Proportions				
Cars	15.8	25.4	14.5	11.4

other two regions. Public transport, by contrast, takes up about the same share of the budget in the countryside as in the cities, while households in communes urbaines spend only a little more than half as much. The modal structure of public transport is very different between cities and countryside. In the latter, and in the communes urbaines, most expenditure is for

hire fares rather than for formal bus routes, while in the cities, bus fares account for half the expenditures, with most of the rest accounted for by season tickets, train fares and taxis.

It is also useful to look at the figures in Table 6.10 in relation to total expenditure levels. The detailed figures are not reported here but the salient facts are these: -

(i) In all three sectors, the share of the budget devoted to public transport is essentially the same at all expenditure levels, although there is some decline among the very rich. Private transport expenditures, however, grow steadily as a share of total expenditure. It is this growth that is responsible for the fact that the transport share as a whole increases with total expenditure.

(ii) Within public transport, bus is the dominant mode in the cities, especially amongst the poor. The very lowest income groups in the cities devote on average 4% of their (very low) total expenditure level to bus fares alone. By the first quartile, this share has fallen to 1.2% and declines gently thereafter to below 1%. In the communes urbaines, and in the countryside, buses are less important (fares are always less than half of one percent of THE), relative to car hire which, in the rural areas, takes up nearly two per cent of the budget for the poorest households remaining around one and three-quarters per cent for virtually all. In the communes urbaines, the share is smaller at less than 1% but it is still the most important mode and the share remains more or less constant as expenditure rises.

(iii) Expenditures on taxis and season tickets are most important in the cities. The very poor do not record such expenditures but thereafter,

they are a rising share of the total, to some extent replacing bus fares. Above the third quartile, they begin to be replaced by private modes.

(iv) Among households who spend a large fraction of their outlay on transport, the distinction between public and private modes is particularly interesting. The proportion of households spending more than 10% of their total outlay on private modes tends to rise monotonically with total household expenditure. More than half of such households are located in the cities and of these nearly two-thirds have total household expenditures of more than 3,000 dinars per annum, putting them in the top decile country-wide. In contrast, households spending more than 10% of total household expenditure on public transport are concentrated at the lower end of the income distribution. More than half are located in rural areas; they appear to rely mainly on hired transport and not only include the least well off but also a substantial proportion of households as total expenditure rises to around 1500 dinars. About a quarter of the households who spend more than 10% of their budgets on public travel live in the cities; bus users account for the households at the lowest total expenditure levels, but as the total expenditure rises there is a tendency for these households to switch to more expensive public modes. It is also interesting that in the communes urbaines these households tend to be in the second quartile of the total expenditure distribution and include few of the very poor who presumably travel by foot.

3. Regression results for expenditures and ownership

Further description of the survey results becomes very clumsy if we confine ourselves to cross-tabulations. Variables other than total outlay and urbanization are important determinants of travel patterns, but the effects can only be clearly detected if the major variables are controlled for. To do this, albeit crudely, we turn to regression analysis so that partial as well as total correlations can be seen.

We first present the determinants of the probability of car ownership. For convenience, the formulation used was logit rather than probit. Hence,

Table 6.11

Car Ownership Logistic Regression

	Coefficient	χ^2	Key
CONST	-2.71	281.8	regression constant
THE	0.0004	173.6	total household expenditures
NFW	-0.96	1.9	# of female workers
NMW	0.07	2.0	# of male workers
NCP	0.04	1.3	# of children in primary school
NCH	-0.08	1.9	# of children in secondary or tertiary education
GVNE	-0.68	18.5	grandes villes in north east
GVC	-0.87	6.2	grandes villes in center
GVS	1.45	62.5	grandes villes in south
CUNE	-0.85	18.5	communes urbaines in north east
CUNW	-0.73	11.3	communes urbaines in north west
CUC	-0.78	19.9	communes urbaines in center
CUS	-0.36	4.0	communes urbaines in south
RNE	-1.04	31.1	rural areas in north east
RNW	-0.20	2.0	rural areas in north west
RC	-1.08	42.4	rural areas in center
PATPON	0.88	14.9	employer
INDEP	0.48	9.2	self-employed
OUVRIER	0.57	15.4	laborer
EMPLOYEE	1.26	60.5	wage earner
SALARIE	0.75	1.3	salaried employees
AIDEFAM	1.85	6.9	family worker

Model χ^2 = 675.73 Degrees of Freedom = 21

Note: The model was estimated using unweighted data.

the parameters shown in Table 6.11 represent the derivative with respect to each explanatory variable of the log odds in favor of owning a car. As is to be expected, the level of total household expenditure is the dominantexplanatory variable. The coefficient suggests that an increase in total household expenditure of 1200 dinars, say from just below the first quartile to just above the third quartile, would raise the log odds by 0.53, and the probability of ownership from, say, 0.25 to 0.38. Additional male workers and primary school children have a positive effect on vehicle ownership, female workers and school children have negative coefficients; all of these effects, however, appear to be rather weak. The regional and urbanization dummies indictate that the probability of owning a vehicle is greatest in the south, especially in the cities. Adopting rural south as the base, the probability of ownership is slightly lower in the communes urbaines and significantly lower in the rural north-east and center. The concentration of private modes in the south presumably reflects a relatively low supply of public transport in that region. The base for employment status of the head of household incorporates persons not working, (a small group of) apprentices and persons for whom occupations are unknown, accounting, in all, for about 16.5% of the sample. The probability of owning a vehicle is greater for all other groups, and is surprisingly large for wage-earners and family workers.

Tables 6.12 and 6.13 show the short-run and long-run travel regressions; i.e. Table 6.12 conditions on the ownership dummy and Table 6.13 does not. The responses are not inconsistent with the basic interpretation. For example, from Table 6.12 we can calculate the total expenditure elasticities; for transport as a whole, for private transport and for public

Table 6.12

Short-run Travel Regressions

Shares in total expenditures of:

	--ALL---	--TYPE------		---------- PUBLIC MODES----------				
	Transport	Private	Public	Buses	Hires	Taxis	Seasons	Trains
CONST	.54	-1.5	2.1	.48	1.4	.06	.09	-.004
	(1.2)	(-5.5)	(5.3)	(2.5)	(4.7)	(0.7)	(1.0)	(-.0)
LN PCE	.33	.28	.05	-.06	.06	.04	-.01	.02
	(4.1)	(5.8)	(0.8)	(1.9)	(1.1)	(2.8)	(-.9)	(1.3)
NFW	.20	.04	.16	-.01	.08	.01	.06	.01
	(2.2)	(0.8)	(2.1)	(-.1)	(1.3)	(0.4)	(3.9)	(0.7)
NMW	.04	-.13	.17	.11	.09	-.003	-.001	-.03
	(0.7)	(-3.5)	(3.2)	(4.5)	(2.2)	(-.3)	(-.1)	(-2.2)
NCP	-.06	.02	-.08	-.04	-.03	.01	-.01	-.01
	(-1.2)	(0.8)	(-1.9)	(-2.3)	(-0.9)	(1.3)	(1.1)	(-.9)
NCH	.20	-.01	.21	.03	.08	-.01	.13	-.01
	(2.5)	(-0.2)	(3.1)	(0.9)	(1.4)	(-1.0)	(9.1)	(-.1)
MVD	4.6	5.4	-.84	-.33	-.34	-.05	-.05	-.09
	(28.1)	(56.0)	(-6.2)	(-5.0)	(-3.2)	(-1.5)	(-1.6)	(-2.3)
GVNE	.41	.74	-.33	.72	-1.4	.07	.25	.12
	(1.8)	(5.4)	(-1.7)	(7.8)	(-9.7)	(1.6)	(6.0)	(2.2)
GVC	-.40	.11	-.51	1.1	-1.7	.07	-.07	.12
	(-0.9)	(0.4)	(-1.3)	(6.1)	(-5.8)	(0.9)	(-0.9)	(1.2)
GVS	.76	-.10	.87	1.8	-1.2	-0.4	.05	.34
	(2.4)	(-0.6)	(3.3)	(13.9)	(-5.9)	(-0.6)	(0.8)	(4.7)
CUNE	-.89	.11	-.99	.22	-1.1	-.19	.15	-.02
	(-3.2)	(0.7)	(-4.3)	(2.0)	(-6.1)	(-3.6)	(3.0)	(-0.4)
CUNW	-1.3	.30	-1.6	-2.0	-1.3	-2.0	-.07	.25
	(-4.0)	(1.6)	(-5.9)	(-1.6)	(-6.4)	(-3.3)	(-1.2)	(3.4)
CUC	-.50	.21	-.71	.25	-.70	-.24	.03	-.01
	(-2.0)	(1.4)	(-3.4)	(2.5)	(-4.2)	(-5.2)	(0.6)	(-0.2)
CUS	-1.4	-.19	-1.2	-.002	-1.0	-.14	.003	-.01
	(-5.3)	(-1.2)	(-5.4)	(-.0)	(-5.9)	(-2.9)	(.06)	(-0.1)
RNE	.61	.33	.28	.79	-.55	-.09	.10	.07
	(2.4)	(2.1)	(1.3)	(7.6)	(-3.2)	(-1.8)	(2.0)	(1.2)
RNW	-1.0	-.13	-.91	-.26	-.50	-.12	-.03	.02
	(-4.4)	(-0.9)	(-4.5)	(-2.7)	(-3.2)	(-2.6)	(-.6)	(0.3)
RC	.96	.42	.54	.02	.77	-.15	-.05	-.02
	(4.1)	(3.0)	(2.8)	(0.2)	(5.1)	(-3.4)	(-1.1)	(-0.3)
El. at mean	1.1	1.3	1.0	0.9	1.1	1.2	0.9	1.2

NOTE: All Coefficients x 100

KEY: LN PCE = log of per capita household expenditure, MVD = dummy (1) if vehicles owned. For other definitions, see Table 6.11.

Table 6.13

Long-run Travel Regressions

Shares in total expenditures of:

	--ALL---	--TYPE------		---------- PUBLIC MODES----------				
	Transport	Private	Public	Buses	Hires	Taxis	Seasons	Trains
CONST	-1.6	-4.1	2.5	6.3	1.6	.08	.11	.04
	(-3.4)	(-12.)	(6.4)	(3.4)	(5.3)	(0.9)	(1.3)	(0.4)
LNPCE	.86	.91	-.04	-.10	.02	.04	-.02	.01
	(10.2)	(15.5)	(-.7)	(-3.1)	(0.3)	(2.6)	(-1.3)	(0.7)
NFW	.20	.04	.16	-.01	.08	.01	.06	.01
	(2.1)	(0.7)	(2.1)	(-0.2)	(1.3)	(0.4)	(3.9)	(0.6)
NMW	.18	.04	.14	.10	.08	-.005	-.003	-.03
	(2.3)	(0.5)	(2.8)	(4.1)	(2.0)	(-0.4)	(-0.3)	(-2.4)
NCP	.05	.15	-.10	-.05	-.04	.01	-.01	-.01
	(0.9)	(4.2)	(-2.4)	(-2.6)	(-1.1)	(1.1)	(-1.3)	(-1.1)
NCH	.21	0	.21	.03	.07	-.01	.13	-.01
	(2.5)	(0.1)	(3.0)	(0.9)	(1.4)	(-1.0)	(9.1)	(-0.6)
GVNE	.06	.32	-.27	.75	-1.4	.07	.25	.12
	(0.2)	(1.9)	(-1.4)	(8.1)	(-9.5)	(1.7)	(6.1)	(2.4)
GVC	-.94	-.53	-.41	1.2	-1.7	.08	-0.7	.13
	(-2.0)	(-1.6)	(-1.1)	(6.3)	(-5.6)	(1.0)	(-0.8)	(1.3)
GVS	2.2	1.6	.61	1.7	-1.3	-.05	.03	.31
	(6.6)	(6.9)	(2.4)	(13.3)	(-6.5)	(-0.9)	(0.5)	(4.4)
CUNE	-1.4	-.47	-.90	.25	-1.1	-.18	.16	-.01
	(4.6)	(-2.3)	(-3.9)	(2.3)	(-5.9)	(-3.5)	(3.1)	(-0.2)
CUNW	-1.6	-.14	-1.5	-.18	-1.3	-.19	-.06	.26
	(-4.9)	(-0.6)	(-5.6)	(-1.4)	(-6.3)	(-3.2)	(-1.1)	(3.5)
CUC	-.93	-.29	-.64	.28	-.67	-.24	.03	-.01
	(-3.5)	(-1.6)	(-3.0)	(2.8)	(-4.1)	(-5.2)	(0.7)	(-0.1)
CUS	-1.5	-.41	-1.2	.01	-1.0	-.14	.005	-.002
	(-5.6)	(-2.1)	(-5.3)	(0.1)	(-5.8)	(-2.9)	(0.1)	(-0.0)
RNE	.16	-.21	.37	.83	-.52	-.08	.10	.08
	(0.6)	(-1.1)	(1.7)	(8.0)	(-3.1)	(-1.7)	(2.1)	(1.4)
RNW	-1.0	-.09	-.92	-.26	-.50	-.12	-.03	.02
	(-4.0)	(-0.5)	(-4.6)	(-2.7)	(-3.2)	(-2.6)	(-0.6)	(0.3)
El. at mean	1.3	2.0	1.0	0.8	1.0	1.2	0.8	1.1

KEY: See Tables 6.11 and 6.12. All coefficients x 100

transport, the estimates are (at the mean) 1.1, 1.3 and 1.0 respectively. Since vehicle ownership itself responds to changes in per capita expenditure levels, long-run elasticities are higher for those categories that are positively affected by vehicle ownership, and lower for those that are negatively affected. Similar patterns of short-run versus long-run responses can be seen for the coefficient on the number of male workers in the household. Once again, it is the strong effect on vehicle ownership that accounts for the differences in parameter estimates between Tables 6.12 and 6.13.

In reading these tables it is helpful to note that since total transport is the sum of public and private, columns 2 and 3 add to column 1. Similarly, public transport is the sum of five modes shown plus an unimportant "other" category so that columns 4 to 8 approximately sum to column 3. Hence, looking along rows reveals how the structure (as well as total) of travel demand responds to changes in the variable concerned. Taking PCE first we see that better-off households spend a larger share of their outlay on travel, an increase that is almost totally (in the short run, and more than totally in the long run) accounted for by the luxury nature of private travel expenditures. Among the public modes, taxis and hiring tend to replace buses amongst better off households. The next group of variables show the impact of work and education patterns on travel expenditures. From Table 6.12, extra workers, male or female, have a similar effect on the public travel share, as do extra high school children. Primary school children cause little impact on the budget, presumably because primary schools are relatively close to residences and therefore do not involve paid trips. Extra male workers, conditional on car ownership status, cause a

switch from private to public transport; in the long run such workers tend to lead to higher probabilities of car ownership. These results are clearly consistent with fixed trip patterns in relation to work and higher education. The public modes associated with these trips are of some interest. The additional public share associated with male workers goes to buses and to hires, presumably the former in the towns and the latter in the countryside. Hires are also associated with extra female workers and high school children, but there is no effect on bus fares, only on season tickets. Presumably there is some explanation for this anomaly.

The regional dummies are of interest in assessing how much of the regional variations in patterns remain once the other variables, particularly PCE, have been controlled for. Notably, most of the variations in the share of private transport over regions and levels of urbanisation are explained by the other variables, although there is still a significant positive dummy for grandes villes in the south. Otherwise, public transport tends to be low in the communes urbaines; the grandes villes are heavy on buses, the rural areas on hiring, and neither is very important in the communes urbaines, hence the difference.

Chapter 7

Travel Expenditures in Thailand 1975-76

0. General Background

The household expenditure survey on which this chapter is based is the socio-economic survey collected from November 1975 to October 1976. At that time the population of Thailand was about 43 million people, living in about 7.8 million households, of which 11,292 households were sampled. Thailand is generally classed as a middle income country; per capita GNP in US dollars was $380 as of mid 1976, and the growth rate of per capita GNP between 1960 and 1976 averaged 4.5% per annum. The area of Thailand is about 514 square kilometers, with a terrain that varies from the mountainous north-east, to the central plain, to the long coastal peninsula that makes up most of southern Thailand. The population is predominantly rural; only 17% of the population lived in urban areas as of 1975. During the seventies the proportion of the population employed in agriculture declined slowly from 80 to 77%.

Household expenditures on travel will be analyzed in terms of household characteristics, percentiles of per capita expenditure, region, level of urbanization, and occupation of household head. In the sample, target households were stratified by region, amphoe (or district) and level of urbanization. In the analysis below, and except where otherwise specified, all results have been reweighted to reflect the population as a whole. We shall also discuss the breakdown of transport expenditures by mode and by local and non-local destinations. In the regressions, the demographic composition of the household and level of education are also considered. We begin with a discussion of some of these background variables.

For the purposes of the survey Thailand is divided into five regions:

North, Northeast, Central, South, and Bangkok. There are three levels of urbanization: Municipal Areas, Sanitary Districts, and Villages. These are meant to correspond to "the urban core, the suburban fringe, and the rural hinterland". Table 7.1 shows the distribution of community types across regions. Overall, 72% of households live in villages. In the North and

Table 7.1

Distribution of population by region and by urbanization
(percentages)

	All	Municipal area	Sanitary district	Village
North	23.1	7.3	11.8	80.9
North East	32.6	5.3	10.0	84.7
Central	19.3	8.2	16.9	74.9
South	12.8	13.0	10.5	76.5
Bangkok	12.3	67.1	21.6	11.3
All	100.0	14.9	13.2	71.8

Northeast, which are the most rural, the proportion in villages is over 80%. Bangkok makes up 55% of the urban areas of Thailand, and contains 12% of all households. However, even in the Bangkok area, 11% of households live in villages.

Table 7.2 shows household characteristics by region and community type. In general, household characteristics for Bangkok are representative of those for municipal areas as a whole, while those in the North and North East are like those for all villages. However, the table shows that there are other effects that are not simply explained by the urbanization types in the region. For example, the biggest difference in family size is between

Table 7.2

Household characteristics by region and community type

	All	N	NE	C	S	B	MA	SD	V
# children	2.3	2.1	2.8	2.2	2.3	2.0	1.9	2.1	2.5
# adults	3.1	3.0	3.1	3.1	2.9	3.7	3.5	3.1	3.0
# members	5.5	5.0	5.9	5.3	5.2	5.6	5.4	5.2	5.5
# earners	2.7	2.7	3.0	2.8	2.3	2.2	2.1	2.4	2.9
Mean PCE	363	310	271	424	372	598	628	446	292
SD ln(PCE)	.63	.58	.57	.55	.63	.56	.59	.60	.56
THE	1736	384	1430	1965	1664	2916	2877	2047	1441
SD (THE)	1337	1038	1015	1296	1167	1940	1930	1516	956
% Chinese	5.3	1.3	1.5	3.9	4.2	26.4	27.0	6.0	0.7

North and North East, two regions which are both very rural. Looking at community types, we see that family size is quite similar in municipal areas and villages but lower in sanitary districts. However, household composition differs considerably between the three areas. Village households have most children and fewest adults, while in the urban municipal areas the situation is reversed. Villages also have the highest number of earners per household, while municipal areas have the least. Note that in the villages there are approximately equal numbers of adults and earners, either because everyone works irrespective of age, or because there are child earners making up for older adults that do not earn. By contrast, in the urban areas, there are less than two earners for every three adults. Living standards are highest in urban areas, and lowest in the villages, whether measured by per capita or by total household expenditure. Inequality, as measured by the standard deviation of the logarithm of total household expenditure per capita (ln PCE), is highest in sanitary districts and lowest in villages, though total household expenditures is most widely dispersed in

urban areas. Ethnic Chinese are the second largest cultural group in Thailand, and although they make up only 5.3% of households they are highly concentrated in urban areas; twenty-seven percent of urban households are Chinese, while the proportion is only 0.7% in the villages.

Turning to the analysis by region, the largest households are in Bangkok and the North East. Households in Bangkok have a higher than average number of adults while those in the North East have an unusually high number of children. Even so, the number of earners per household is lowest in the South and in Bangkok, and higher than average in the North East and Center. The ranking of regions in terms of greatest to least household per capita expenditure (PCE) is Bangkok, Center, South, North, and North East. Total household expenditure (THE) and the standard deviation of THE follow the same pattern. Inequality is greatest in the South and lowest in the Center and in Bangkok. Households of Chinese origin are concentrated in Bangkok.

Table 7.3 gives the breakdown of the population by percentiles of per capita expenditure, region, and community type. The PCE brackets shown are those for <u>all</u> of Thailand, a convention that will be followed throughout the chapter. Mean PCE for each percentile group is also shown. About 55% of the households in the lowest decile of PCE live in the North East and another 27% in the North. Virtually none of this group is located in Bangkok. By contrast, the two top deciles of the household PCE distribution are concentrated in Bangkok and in the Central Region. In the South the distribution of households by per capita expenditures is similar to the national distribution. Since most Thai households are located in villages, the majority in each rank group are located there, except at the very top of the distribution. Of the top 5% of households, just over a half are urban.

Reading down the columns shows how expenditures are distributed within regions and areas. Village households are more heavily distributed towards

Table 7.3

Distribution of PCE by Region and Community Type
percentages or Baht per capita

	REGION					URBANIZATION			ALL
Pctile	N	NE	C	S	B	MA	SD	V	PCE
1-5	27.0	57.2	4.6	11.1	0.2	0.4	3.8	95.8	94.8
6-10	27.2	54.0	5.5	12.3	0.9	1.3	5.6	93.1	124
11-20	28.0	52.9	7.3	10.1	1.7	2.2	7.8	90.0	153
21-30	27.1	43.4	13.8	12.5	3.2	3.8	9.5	86.6	186
31-40	30.7	38.2	14.8	12.4	3.8	4.6	9.8	85.7	218
41-50	25.3	33.5	20.0	13.9	7.4	7.9	12.6	79.5	254
51-60	23.6	26.4	26.7	14.2	9.2	10.8	13.9	75.3	298
61-70	21.6	22.1	27.2	14.0	15.2	17.4	16.1	66.5	354
71-80	17.5	20.4	28.1	13.2	20.7	23.9	18.8	57.3	431
81-90	16.5	17.5	25.4	13.4	27.3	33.5	19.4	47.1	558
91-95	12.0	16.7	26.6	11.1	33.6	42.2	20.8	37.0	759
96-100	13.3	12.2	22.2	14.9	37.5	50.7	19.5	29.8	1372
#Households	2604	367	2174	1447	1391	1685	1495	8112	11292

Notes:-Rows add to 100 across regions and across types of municipality. The national population is equally distributed across deciles so that a regional distribution that matches the national distribution appears as equal numbers down a column; this is approximately the case for the South. N, NE, C, S, and B, are North, North East, Central, South, and Bangkok respectively. MA, SD, and V stand for municipal areas, sanitary districts, and villages. PCE is measured in Baht per head; at the time of the survey one Baht was about 5 cents U.S.

the bottom of the national distribution and urban households more heavily towards the top. Not unexpectedly, the sanitary districts are in an intermediate position with fewer rich households than urban areas and fewer poor households than villages.

The next two tables show the occupation of household heads by PCE groups, and the distribution of occupations over regions and community types. The

Table 7.4

Occupation of HH Head by PCE Group (percentages)

PCE Percentile	In-Act	Prof Tech	Adm& Exec	Clerical	Sales	Services	Agri-cult.	Prod.	Total &%
1-5	9.1	0.5	0.4	0.0	0.6	0.5	82.3	6.6	566
	4.7	0.9	2.4	0.0	0.4	0.7	6.8	2.4	5.0
6-10	5.8	0.3	0.0	0.3	1.1	0.1	83.5	8.9	564
	3.0	0.5	0.0	1.0	0.7	0.2	6.9	3.2	5.0
11-20	7.9	0.3	0.1	0.1	1.8	0.6	80.5	8.7	1129
	8.1	0.9	1.7	0.7	2.3	1.9	13.3	6.3	10.0
21-30	8.6	0.6	0.1	0.2	2.9	1.2	76.5	10.0	1132
	8.8	1.9	1.8	1.6	3.7	3.6	12.7	7.3	10.0
31-40	8.8	0.5	0.1	0.3	2.9	1.3	75.1	10.9	1125
	9.0	1.8	1.7	2.2	3.8	3.9	12.4	7.9	10.0
41-50	10.1	0.9	0.6	0.2	5.4	1.5	68.9	12.6	1127
	10.3	2.9	7.1	1.6	6.9	4.6	11.4	9.1	10.0
51-60	11.6	1.3	0.7	0.8	5.4	1.6	64.2	14.5	1132
	12.0	4.3	8.7	5.8	7.0	5.1	10.6	10.6	10.0
61-70	9.2	1.8	0.9	1.7	11.1	4.1	54.7	16.6	1128
	9.5	6.0	11.3	12.1	14.2	12.7	9.0	12.1	9.99
71-80	10.7	5.2	1.0	2.2	11.9	5.5	46.3	17.2	1130
	11.1	17.9	12.4	16.3	15.3	17.1	7.7	12.6	10.0
81-90	12.0	5.2	1.4	3.3	16.8	6.6	35.9	19.0	1130
	12.3	18.0	17.6	23.8	21.6	20.4	5.9	13.8	10.0
91-95	15.3	9.0	2.1	4.4	18.4	8.9	24.3	21.5	564
	5.8	5.3	13.0	15.8	11.8	13.8	2.0	7.8	4.99
95-100	10.3	7.2	3.5	5.3	19.3	10.3	15.3	18.8	565
	5.3	29.5	22.4	19.2	12.4	16.0	1.3	6.9	5.01
# Households		330	89	155	879	365	6829	1550	11292
% Households		2.9	0.8	1.4	7.8	3.2	60.5	13.7	100

occupation groups come from the three-digit codes of the Standard Classification of Occupations for Thailand used in the Labour Force Survey. More than 60% of household heads are employed in agriculture, and a further 22%

are engaged in either production or sales. Of the poorest PCE decile, 83% are in agriculture, and 8% in production. In the top 10%, there are only about 11% engaged in agriculture, while 13% are professional, technical or managerial and 10% are in services. Of those households in the bottom decile, 14% are headed by agricultural workers and 6% by production workers. By way of contrast, only about 1% of those in sales, clerical, service or professional and technical are in the lowest decile of PCE. The North East and the North are the most agricultural regions. However, even in Bangkok, 10% of household heads list agriculture as their main occupation. Production workers are concentrated in Bangkok where 30% fall into this category. The North East is the least industrial and only 8% of heads there are production workers. Sales, clerical, service, and professional and technical workers also tend to be concentrated in Bangkok and to be relatively scarce in the northern regions. The distribution of occupations by level of urbanization is what one would expect: agriculture is predominantly a village activity, while the other activities are located in municipal areas and to

Table 7.5

Occupation of HH Head by Region and Community Type

	N	NE	C	S	B	MA	SD	V	All
Inactive & Stud.	8.1	7.7	11.2	10.2	15.5	15.4	11.1	8.3	9.7
Prof & Tech	2.4	2.3	3.3	3.3	4.7	7.0	3.8	1.9	2.9
Admin & Mgt.	0.6	0.6	0.7	0.9	1.8	1.9	1.0	0.5	0.8
Clerical	0.8	0 6	1.1	0.9	5.5	5.7	2.0	0.4	1.4
Sales	4.9	4.7	6.2	8.4	23.3	28.0	12.2	2.8	7.8
Service	2.6	2.0	2.2	3.1	9.4	10.2	5.0	1.5	3.2
Agriculture	67.5	73.9	62.3	59.7	9.8	3.9	42.8	75.5	60.5
Production	13.2	8.3	13.1	13.6	30.2	28.0	22.2	9.2	13.7

some extent in the less urban sanitary districts. Clearly, the differences in PCE across regions and community types are at least partially due to the this distribution of occupations.

2. Travel Expenditure in Total

In this section we focus on the mean share of transport in total expenditures. Table 7.6 shows the composition of non-durable household expenditures in relation to household per capita expenditure. As in other chapters, these figures are the means of individual shares, not the shares computed by dividing mean expenditures by the number of households. Travel is defined net of vehicle purchases, since the infrequent and lumpy nature of these purchases does not reflect long-run expenditure levels. The mean share of

Table 7.6

Shares of Household Expenditures by PCE Group

	Food	Altb	Clft	Hous	Fuel	Hsgd	Med	Tnsp	Ent	Educ	Other
All	59.8	4.5	10.2	2.0	4.9	3.0	6.2	4.0	2.8	1.2	1.5
1-5	76.4	3.7	4.5	0.1	6.2	1.5	4.1	1.8	0.8	0.4	0.4
6-10	73.7	4.1	6.1	0.3	5.4	1.8	4.0	2.1	1.3	0.5	0.6
11-20	69.8	.3	7.9	0.4	5.0	2.4	4.9	2.4	1.7	0.5	0.6
21-30	67.0	.6	8.4	0.6	5.0	2.6	5.6	2.9	1.9	0.6	0.8
31-40	64.5	4.4	9.6	0.7	4.7	3.2	6.1	3.0	2.1	0.7	0.9
41-50	61.7	4.4	10.6	1.0	4.8	3.5	6.0	3.5	2.4	1.0	1.1
51-60	59.7	4.6	11.7	1.3	4.7	3.1	6.2	3.8	2.6	1.2	1.2
61-70	55.9	4.6	12.1	2.1	4.8	3.4	6.7	4.2	3.2	1.6	1.4
71-80	52.3	4.5	12.2	2.9	4.9	3.5	7.3	5.4	3.5	1.8	1.8
81-90	49.9	4.5	12.6	3.8	4.9	3.5	7.0	5.2	4.2	2.2	2.3
91-95	45.5	4.9	11.9	5.5	4.6	3.1	7.8	6.7	4.8	2.5	2.7
96-100	39.1	5.2	11.5	7.5	4.5	3.6	7.2	8.4	5.3	1.9	5.7

Note:- "Altb" is alcohol and tobacco, "clft" clothing and footwear, "hous" housing, "hsgd" household goods, "Med" is medical, "tnsp" transport, "ent" entertainment, and "educ" is education.

expenditure devoted to personal travel is 4.0% and it rises with total outlays from 1.8% to 8.4% of the budget.

Table 7.7

Expenditure levels and budget shares of transport by PCE, region, and community type

	N	NE	C	S	B	MA	SD	V
1-5	7.8 (1.2)	13.6 (1.9)	11.2 (1.5)	21.8 (2.9	- (-)	25.5 (3.5)	5.0 (0.8)	13.1 (1.8)
6-10	8.6 (1.2)	18.5 (2.1)	18.9 (2.1)	35.0 (4.1)	50.2 (4.0)	30.1 (2.7)	18.7 (1.8)	18.0 (2.1)
11-20	17.7 (1.9)	25.4 (2.5)	23.4 (2.4)	34.5 (3.5)	46.0 (3.3)	43.3 (2.9)	22.2 (2.0)	24.1 (2.5)
21-30	24.5 (2.2)	35.6 (3.0)	33.8 (2.6)	53.6 (4.4)	65.3 (4.1)	51.6 (3.4)	32.4 (2.6)	34.2 (2.9)
31-40	30.1 (2.5)	42.4 (3.0)	36.3 (2.7)	50.0 (4.1)	61.5 (4.0)	60.4 (4.0)	38.6 (2.7)	38.3 (3.0)
41-50	49.2 (3.3)	52.2 (3.4)	46.0 (2.9)	63.1 (4.2)	97.3 (4.7)	78.3 (3.9)	62.5 (3.7)	51.5 (3.4)
51-60	57.1 (3.6)	63.3 (3.9)	56.0 (3.2)	67.6 (4.3)	110 (4.9)	91.1 (4.1)	68.1 (4.0)	60.5 (3.7)
61-70	61.5 (3.4)	104 (5.0)	86.0 (4.2)	73.2 (4.2)	110 (4.4)	95.0 (4.0)	90.1 (4.5)	83.2 (4.2)
71-80	117 (5.8)	96.2 (4.4)	122 (5.2)	140 (6.2)	153 (5.7)	153 (5.5)	128 (5.4)	112 (5.3)
81-90	114 (4.9)	157 (5.2)	123 (4.5)	129 (5.2)	201 (6.1)	174 (5.4)	175 (5.8)	122 (4.8)
91-95	225 (6.4)	296 (7.8)	232 (6.4)	138 (5.3)	284 (7.0)	273 (6.7)	159 (5.1)	276 (7.7)
96-100	344 (8.1)	520 (8.7)	384 (7.8)	370 (8.1)	569 (9.0)	485 (8.3)	476 (7.9)	410 (8.9)
All	60.3 (3.2)	66.1 (3.4)	104 (4.1)	92.8 (4.7)	224 (6.0)	207 (5.6)	122 (4.5)	66.5 (3.6)

Note:- Figures in parentheses are shares: * denotes small cell size.

Table 7.7 shows the mean household expenditures on travel as well as their shares in the budget for each region and community type. For the shares, the overall pattern is that shares vary directly with the level of urbanization so that they are highest in municipal areas, next highest in sanitary districts and lowest in villages. However, for the lowest four deciles, households in villages show higher shares than households in sanitary districts. For the top 5%, villagers have the highest shares. Shares generally rise with PCE, although they do so most clearly in the villages and the sanitary districts. In the urban areas, shares are relatively high, even for the poorest households and do not rise by very much until we reach the top twenty percent of the population. The absolute level of travel expenditures is generally highest in municipal areas and lowest in villages and once again, there are regional patterns that are independent of the level of urbanization in each region. For example, Bangkok has higher shares than do municipal areas in general, even though Bangkok includes some sanitary districts and villages. We investigated this finding further and found that in Bangkok villagers and households in sanitary districts have higher shares of public and local transport than households in similar communities in other parts of the country, presumably because people who live there travel to the central district of Bangkok. Bangkok is also the region with the highest share of expenditures going to travel. Next comes the South, where settlements are strung out along a narrow peninsula.

Table 7.8 gives the percent of the population spending various shares on transport by community type and by PCE decile. Twenty-four percent of Thai households spend nothing on travel, a fraction that is a little lower in the

urban areas (19%). The percent of households spending more than 20% of their expenditures on travel rises with income in all areas. Only 0.3% of Thai households in the lowest semi-decile fall into this category. There

Table 7.8

Fractions of households spending various shares on transport by community type

Pctle	e	0%	0-10%	10-20%	>20%	0%	0-20%	10-20%	>20%
		MUNICIPAL AREAS				SANITARY DISTRICTS			
0-5		42.5	57.5	0	0	70.9	29.1	0	0
5-10		56.9	34.1	9.1	0	53.2	41.5	4.3	1.0
10-20		36.9	40.7	7.0	0	40.0	56.9	3.1	0
20-30		41.4	49.0	8.8	0.8	33.1	61.2	3.8	1.9
30-40		32.8	56.7	7.5	3.3	39.8	53.7	4.7	1.8
40-50		27.8	63.9	7.9	0.4	34.0	56.4	6.2	3.4
50-60		28.0	62.2	8.8	1.1	25.4	65.0	7.6	1.9
60-70		25.8	64.0	9.4	0.7	22.6	66.1	9.2	2.1
70-80		17.3	66.7	13.1	2.8	20.9	63.5	10.0	5.6
80-90		14.8	68.9	12.6	3.8	12.7	71.8	11.3	4.3
90-95		14.5	64.2	17.5	3.9	13.2	73.4	11.0	2.1
95-100		10.9	58.0	21.4	9.6	12.1	64.9	13.5	9.5
All		19.3	63.7	13.4	3.6	25.3	63.2	8.3	3.3
		VILLACES				ALL THAILAND			
0-5		48.0	48.6	3.1	0.3	48.8	47.9	3.0	0.3
5-10		41.6	54.1	2.9	1.5	42.4	53.1	3.1	1.4
10-20		29.9	66.3	3.5	0.3	30.8	65.3	3.6	0.3
20-30		26.7	67.4	4.9	0.9	27.9	66.1	5.0	1.0
30-40		26.3	67.9	4.9	1.0	27.9	66.0	5.0	1.1
40-50		20.2	72.8	5.7	1.4	22.5	70.0	5.9	1.5
50-60		20.1	72.7	5.5	1.8	21.7	70.5	6.2	1.7
60-70		15.0	73.7	8.5	2.9	18.1	70.8	8.8	2.4
70-80		13.2	72.5	11.6	2.8	15.6	69.4	11.7	3.3
80-90		16.6	70.3	9.8	3.3	15.2	70.1	11.1	3.6
90-95		8.0	68.2	14.2	9.6	11.8	67.7	14.9	5.6
95-100		8.8	61.9	16.9	12.6	10.5	60.5	18.5	10.5
All	24.8	67.5		6.3	1.9	23.7	66.3	7.6	2.3

were no sample households of the lowest 5% in urban areas or sanitary districts who had travel shares of greater than 10%. However, for the lowest decile, about four percent of both urban and village households spend more than ten percent of their budget on travel. In general, the proportion spending more than 10% of their budgets on travel is highest in municipal areas and lowest in villages. However, for the top 10%, this percentage is greater in villages than in sanitary districts, largely because the rate of change of travel shares with respect to PCE is highest in the villages. Table 7.9 shows the fractions spending various shares by region. The incidence of zero expenditures is highest in the North, and lowest in the South and in Bangkok. Similarly, the highest proportion of shares over 10% are in the South and in Bangkok, and the lowest are in the

Table 7.9

Fractions of households spending various shares by region

	0%	0-10%	10-20%	>20%
North	31.8	60.8	5.6	1.9
North East	22.8	69.2	6.0	2.0
Central	23.8	66.4	7.6	2.2
South	18.2	69.8	9.6	2.4
Bangkok	16.8	65.1	13.8	4.3

North and North East. The transport shares for households with non-zero expenditures can be computed by dividing the shares shown in Table 7.7 by the percent who do spend on transport (1-(number shown in Table 7.8)/100). Since poorer groups tend to have higher proportions of zero shares, adjusting for zero expenditures raises shares of low PCE groups relatively more than shares of high PCE groups. When we only consider those households that record some expenditure on travel, shares in sanitary districts are

greater than those in villages for all but the bottom 5% and the top 10%. Among households in the fifth and seventh deciles, sanitary district shares exceed those of households in urban areas. However, the ranking of shares across regions is the same for households that spend on travel as it is for all households, though it is generally true that regional differences are weaker when non-spenders are removed. Hence, a significant part of the difference between regions is accounted for by the fraction of households that spend nothing on travel rather than by differing behavior among those that do.

3. Travel Expenditures by Mode

In this section, shares spent on travel are disaggregated into private and public modes. Public modes are sub-divided into local and non-local modes where local modes include local bus, taxi, samlor (auto-rickshaw), boat, ferry, and other, while non-local modes include train, air, non-local bus, ship and other non-local. The largest shares of private transport are accounted for by purchases of gasoline, by repairs and parts, and by annual payments (such as license fees). Table 7.10 shows the shares of expenditure on public and private travel with the former divided between local and non-local travel. The patterns are shown by region and by community types, and in order to save space, at three levels of PCE, the bottom and top deciles and the mean of the middle three.

As is to be expected, the share of public transport is highest among urban households. For the poorest households, shares of the budget devoted to public transport are higher in villages than in sanitary districts, but the relationship is reversed for better-off households. If those households

spending nothing are excluded, the average shares in sanitary districts are greater than those in villages. For the top decile budget shares of public transport are greatest in municipal areas and lowest in sanitary districts.

Table 7.10

Distribution of travel shares by type, by PCE, and by region

PCE percentile	public	local	n-local	pvt	public	local	n-local	pvt
	All Thailand				Villages			
1-10	1.9	1.0	0.9	.06	1.9	1.0	0.9	.05
30-60	2.6	1.8	0.9	0.8	2.6	1.7	0.9	0.8
90-100	3.6	2.2	1.4	4.0	3.6	1.7	1.9	4.9
All	2.9	1.9	1.0	1.2	2.7	1.6	1.1	0.9
	Sanitary Districts				Municipal Areas			
1-10	1.1	0.8	0.4	0.2	2.6	2.1	0.5	0.5
30-60	2.7	1.8	0.8	0.9	3.3	2.8	0.5	0.7
90-100	3.4	2.1	1.3	3.3	3.8	2.7	1.1	3.7
All	3.0	2.1	1.0	1.5	3.6	2.8	0.7	2.1
	North				North East			
1-10	1.1	0.4	0.7	.03	2.0	1.0	0.9	.05
30-60	2.0	1.2	0.8	1.1	2.9	2.0	0.9	0.5
90-100	3.5	1.6	1.9	4.0	3.8	2.3	1.6	4.6
All	2.1	1.2	0.9	1.1	2.8	1.8	1.0	0.6
	Center				South			
1-10	1.7	1.1	0.6	.04	3.4	2.2	1.3	.06
30-60	2.2	1.3	1.0	0.7	3.2	2.0	1.2	0.9
90-100	3.1	1.6	1.4	4.3	3.9	1.3	2.6	3.0
All	2.6	1.6	1.0	1.5	3.4	1.9	1.5	1.3
	Bangkok							
1-10	1.1	1.1	0.0	0.9				
30-60	3.9	3.7	0.2	0.7				
90-100	3.9	3.3	0.6	4.0				
All	4.1	3.7	0.4	1.9				

A more detailed tabulation than those given here shows that the share of public transport rises with household per capita expenditure until the top 30% of households after which it flattens out as expenditure is switched to private modes. In general the share of local expenditures exceeds that of non-local. In municipal areas this is true for every group, but in sanitary districts the poorest 5% and the second decile have shares of non-local transport that are twice as great as shares of local. In villages the ratio of non-local to local shares is higher for most groups than in other communities, and non-local exceeds local for the top decile. Local travel expenditures dominate expenditures on non-local travel by 4:1 in the urban areas, but only by 2:1 in the sanitary districts, and 1.6:1 in the villages. Poor rural households spend the same share of their budget on non-local travel as do middle-income rural households, but have much lower shares of local travel. As income levels rise further, the share devoted to local travel remains constant and that devoted to non-local travel expands. Given the dominance of rural households in the country as a whole, these patterns imply that for the whole country, households in the poorest decile have the highest ratio of non-local to local travel expenditures, a ratio which at first falls and then rises as PCE grows. All of this is consistent with the view that there is little high frequency low distance <u>paid</u> tripping in rural areas, and that most rural tripping to work and to school is done on foot. By contrast, even poor rural households must make some non-local trips, these cannot be made on foot, and so require the outlay of cash. The fact that such expenditures are not very income elastic, at least in the low ranges of the income distribution suggests that these non-local trips may be largely concerned with own-account activities rather than with social

visits, but that is only a guess. Similarly, the higher income elasticities of non-local travel among richer households suggests a greater role for social visits among those households.

The share of the budget devoted to private expenditures rises quite steeply with expenditure, especially at the very top of the distribution. For the bottom four deciles, shares are highest in urban areas followed by shares in villages and sanitary districts. More surprisingly, for households in the top decile the budget share of private transport is highest in villages. In between, shares tend to be highest in sanitary districts and lowest in municipal areas. Gasoline, repairs and parts and annual payments make up 92% of the private share. Villagers tend to have a higher ratio of repairs and parts to gasoline shares than the other areas, perhaps because of road conditions.

The level of transport expenditures can be derived by multiplying expenditures derived from Table 7.7 by the shares shown in Table 7.10. Expenditures on public transport are highest in municipal areas for every group. Up to the fourth decile public transport expenditures for village households exceed those for households in sanitary districts while for the remaining 60% of households the pattern is the reverse. Mean expenditures on private transport in municipal areas exceed those in sanitary districts or villages for the bottom 40% of the population, while for higher levels of PCE, the pattern is more mixed. For the very highest PCE group, the level of expenditures on private transport is highest in the villages.

The pattern of budget shares for public transport by region corresponds closely to the regional pattern of total transport shares described in Table 7.7. For Bangkok, the share of non-local trips is negligible for all PCE

groups. The South and North East, the two areas with the next highest transport shares, also have the highest ratio of non-local to local shares. In the regions outside Bangkok, the ratio of non-local to local shares tend to be highest for the top and bottom deciles of PCE. The North East and South have the lowest shares of private relative to public transport. In all regions, the share of private is less than the share of public except for the top decile in the North, North East and Center, and the top semi-decile in Bangkok. The absolute levels of expenditure can again be derived from comparison with Table 7.7. The pattern of expenditures is consistent with that described above, except that the North has a higher ratio of non-local to local expenditures than the North East. Expenditures on travel are highest in Bangkok for every category except non-local where they are highest in the Center.

If we look at modes of public transport in more detail, we find that for both local and non-local travel, bus is by far the dominant mode (Table

Table 7.11

Public transport modes by region and area
(budget shares)

Local	All	N	NE	C	S	B	MA	SD	V
Bus	1.5	1.0	1.5	1.3	1.3	3.0	2.1	1.7	1.3
Taxi	.04	.01	.01	.01	.01	.26	.19	.04	.01
Samlor	.08	.04	.07	.02	.13	.17	.43	.06	.01
Boat	.05	.02	.03	.09	.02	.15	.01	.13	.05
Ferry	.01	.01	0	0	.05	.05	.01	.02	.01
Other	.17	.13	.15	.16	.45	.02	.06	.10	.21
Non-local									
Train	.10	.09	.09	.05	.21	.06	.19	.10	.07
Air	0	0	0	0	.01	.02	.02	0	0
Bus	.83	.74	.94	.86	1.1	.33	.48	.82	.90
Ship	.02	.01	0	.08	.04	.01	.01	.04	.02
Other	.04	.09	.01	.02	.12	.01	.03	.01	.05

7.11.) Of the 1.9% budget share devoted to local public transport, 1.5%, or nearly 80% of the total is spent on buses. Of the non-local share of 1.0% of the budget, 0.83% is accounted for by bus fares. Buses are the dominant mode even at higher income levels; for the top decile 73% of local and 74% of non-local travel expenditure is on buses. Among these higher income households, there is some expenditure on taxis and samlors for local travel, particularly in Bangkok, and on trains for non-local travel, particularly in the South. Although there is some variation by level of urbanization, buses are the most important mode in all three levels distinguished here.

In terms of regional variation, the highest shares and expenditures on local buses are in Bangkok, and in the North East, while the lowest are in the North. Taxis are virtually non-existent outside Bangkok. In contrast, samlors have the highest expenditures and shares in Bangkok and the South, but are also used in other regions. (It is possible that minibuses that provide a shared taxi service were counted as local buses rather than as taxis, and that this accounts for the absence of taxis outside Bangkok. Fouracre and Maunder (1977) report that this type of taxi service is the dominant form of public transport in Chieng Mai, North Thailand). Shares and expenditures on non-local buses and on trains, are highest in the South.

Table 7.12 shows the fractions of households spending various shares on public and private for all of Thailand. The pattern for public transport is quite similar to the pattern for total transport that was discussed above, although the fraction of households spending nothing is higher, and is increasingly so for the very top expenditure groups. The fraction spending nothing declines with expenditures from 50% for the bottom groups to 30% for

Table 7.12

Fractions of households spending various shares on public and private expenditures

	Public				Private			
Pctile	0%	0-10%	10-20%	>20%	0%	0-10%	10-20%	>20%
0-5	50.6	46.4	2.7	0.3	97.1	2.9	0	0
5-10	44.7	50.9	3.1	1.4	95.8	4.1	0	0.1
10-20	34.3	62.4	3.0	0.3	93.3	6.3	0.4	0.0
20-30	31.6	63.6	4.1	0.7	89.4	9.7	0.6	0.4
30-40	32.0	63.8	3.8	0.3	86.5	12.0	0.9	0.6
40-50	27.8	67.6	3.7	0.9	84.1	13.9	1.4	0.6
50-60	27.8	67.8	3.7	0.7	80.2	17.2	1.9	0.8
60-70	24.3	69.3	5.3	1.0	78.4	18.3	2.5	0.9
70-80	22.6	69.0	7.3	1.1	73.7	21.9	2.8	1.6
80-90	23.0	70.2	5.8	1.0	70.3	24.1	3.7	1.9
90-95	23.1	69.6	6.0	1.4	65.1	24.6	6.6	3.7
95-100	27.7	63.5	7.0	1.8	57.8	24.4	10.6	7.2
All	29.7	64.9	4.6	0.8	81.5	15.1	2.2	1.2

the top, while the percent spending more than 10% of their budget rises from 3% to 9%. Only 18.5% of households spend anything on private transport, though the fraction rises rapidly among the best-off households. In the lowest expenditure groups 97% of households record no expenditure on private transport, a fraction that falls to 58% for top 5% of the distribution.

Table 7.12 can also be used in conjunction with Table 7.10 to compute expenditure shares for those households that record positive travel expenditures. Removing the non-spending households doubles the budget share of public transport for households in the poorest 5% of the PCE distribution. Shares of the other groups also rise, but by less. For private shares, the exclusion of zero expenditures has a much more dramatic effect, since there are many fewer households that record any expenditures on private travel. Excluding the non-spenders, the ratio of private to

public shares starts at 0.5, rises to 1 at around the second decile, and increases to 2 at the top of the PCE distribution. For the shares including zero expenditures this ratio does not approach one until the ninth decile reflecting the fact that households that do spend on private modes tend to spend relatively large amounts.

4. Vehicle Ownership

Table 7.13 shows ownership of vehicles by PCE, level of urbanization and

Table 7.13

Fractions of households owning vehicles: percent

	None	Bicycle	M/cycle	Car	Oxcart
All	64.8	28.1	9.6	3.8	10.8
North	56.1	37.9	10.4	1.7	21.7
North East	70.6	24.8	5.4	2.6	11.6
Center	51.9	39.5	14.7	4.7	10.1
South	67.5	20.8	15.0	2.9	0.4
Bangkok	76.6	9.0	6.4	11.1	.05
Municipal Areas	61.2	20.5	16.8	11.9	0.3
Sanitary Districts	59.5	31.6	12.1	5.7	6.4
Villages	65.4	29.2	7.8	1.9	13.8
Percentiles of PCE					
0-5	83.3	15.9	1.2	0.0	9.4
5-10	80.1	19.1	0.9	0.0	13.8
10-20	76.3	22.4	2.3	0.0	13.8
20-30	69.9	26.6	4.4	0.6	14.6
30-40	67.2	29.3	6.1	0.9	12.5
40-50	61.5	32.3	7.4	1.2	17.8
50-60	60.4	34.4	8.8	1.8	10.5
60-70	57.7	33.6	12.9	3.3	8.6
70-80	56.6	33.6	13.8	5.2	10.1
80-90	55.9	28.6	19.4	8.6	4.8
90-95	53.3	26.1	21.3	12.6	4.8
95-100	50.5	20.4	21.6	23.8	2.6

Note: The category "none" does not take account of oxcarts, so that a household is included in the first column if it does not have at least one of the list, bicycle, car, motor-cycle. The other columns show fractions of household possessing at least one of the vehicles listed, so that a household owning a bicycle, a motor-cycle and two oxcarts would appear (once) in the three relevant columns.

region respectively. The table shows the proportion of households that report ownership of bicycles, motor-cycles and cars, together with the proportion of households that own none of the three. Note that ownership of one vehicle does not preclude a household from owning another, so that the percentages across the rows add up to more than 100. The final column shows the fraction of households owning oxcarts. We do not know how important these are in Thailand for personal transportation, but large numbers of households own them, particularly in the villages, and the figures are given for completeness. The ownership of boats is not shown; only 1.9% of households own them.

The table shows that 65% of households do not own a cycle, a motorcycle or a car; 92% of these households do not own an oxcart either so that nearly 60% of households own no vehicle at all. Even among the top 5% of households, there are 50% who own no cycles, motorcycles or cars. In all, 28% of households own bicycles. The percentage that do so rises with PCE for the bottom half of the population and then falls. The fraction owning motorcycles rises with PCE throughout the distribution. The percentage owning cars rises much more sharply with levels of living and jumps very sharply, from 13% to 24% between the nineteenth and twentieth semi-deciles. The top 5% are about equally likely to own a cycle, a motorcycle or a car, while lower in the distribution, bicycles are the most commonly owned vehicle. After bicycles, oxcarts are the second most commonly owned vehicle and 10.8% of all households own at least one. Oxcart ownership peaks in the fourth decile, but only shows a rapid decline in the top two deciles. The data also allow us to examine patterns of multiple ownership though these are not shown in the table. In the top deciles, substantial fractions of households

owning bicycles also own motor cycles and even cars, so that the fraction of households owning only bicycles falls much more rapidly with PCE than is shown in the table. For example, 8.3% of households in the ninth decile own a bicycle and a motor cycle. Hence, we can identify a hierarchy of ownership whereby households first buy a bicycle, adding a motor-cycle as they move up the income distribution, and with car ownership as the ultimate possibility.

The central panel of the table shows that 65.4% of village households do not own a bicycle, motor cycle or car, though 92% of them own oxcarts. Perhaps surprisingly in view of the relatively high levels of PCE in urban areas, 61% of urban households do not own vehicles. Villages and sanitary districts have the highest proportions that own cycles, while municipal areas and sanitary districts have the highest proportions owning motor cycles and cars. As one would expect, the fraction owning oxcarts is minuscule in urban areas, and largest in villages. In terms of regions, the highest proportions owning no vehicles are in Bangkok, the Northeast, and the South. The analysis above suggests that in Bangkok and the South public transit is relatively well developed, while in the North East it may be poverty that precludes ownership. The percentages owning cycles are highest in the North, Center and North East, while the fraction owning motorcycles is highest in the South, Center, and North. Bangkok has the highest fraction owning cars. Oxcarts are most used in the North, and used very little in Bangkok or the South.

Table 7.14 shows the results of estimating probit models for the ownership of cycles, motor cycles, and cars. In the probits, the variable that is being explained is the probability of ownership, so that the analysis

Table 7.14

Probit models for vehicle ownership

	Car		Motor-cycle		Bicycle	
	est	t	est	t	est	t
const	-14	10	-12	12	-8.3	11
ln(PCE)	2.8	6.8	2.7	8.2	1.7	6.9
ln(PCE)sq	-.13	4.0	-.16	6.2	-.12	6.0
# Males <=15	.23	8.4	.09	4.4	.00	0.2
# Males 15-55	.20	6.5	.25	10.	.13	6.4
# Males >55	.29	4.1	.25	4.7	.15	3.5
# Females <=15	.19	6.9	.09	4.5	-.02	1.3
# Females 15-55	.21	7.2	.17	7.2	.13	6.7
# Females >55	.21	3.4	.18	3.9	.09	2.4
Head's age	.01	2.3	-.01	4.3	.00	1.7
# earners	-.09	3.3	-.04	2.0	.01	0.9
# scholars	.02	1.0	.01	0.5	.15	9.7
Thai	-.15	2.1	-.32	5.5	-.11	2.0
N Upper	.08	0.8	1.3	16	1.8	21
N Lower	-.18	1.5	.96	11	1.9	23
NE Upper	-.00	0.0	.75	8.8	1.6	19
NE Lower	.04	0.4	0.7	8.5	1.2	15
C West	.08	0.7	1.3	15	2.1	23
C Mid	-.13	1.2	0.8	8.9	1.5	17
C East	.26	2.1	1.1	12	1.5	17
S Upper	-.21	2.0	1.0	13	1.2	14
S Lower	-.43	2.3	1.5	16	1.6	16
Bangkok Suburbs	-.06	0.5	-.36	2.9	.70	7.4
Bangkok Fringe	-.56	3.3	-.21	1.3	.49	4.4
Municipal Areas	-.18	2.2	.00	0.0	.01	0.2
Sanitary Dist's	-.01	0.1	.01	0.1	.08	2.2
Head's Edcn 0	-.37	3.1	.08	0.8	.10	1.2
KG	-1.7	0.2	-1.4	0.2	-1.7	0.5
Elem	-.33	3.3	.00	0.0	.17	2.1
Sec	-.07	0.7	.07	0.8	.08	0.9
Wife's Edcn 0	-.66	5.2	-.42	3.8	-.25	2.3
KG	-1.4	0.1	-1.8	0.2	-2.5	0.4
Elem	-0.5	3.6	-.26	2.4	-.09	0.8
Sec	.14	1.0	-.02	0.2	-.24	1.8
Agriculture	-.62	6.0	-.12	1.6	.15	2.6
Production	-.24	1.8	.01	0.1	.15	1.7
Professional	.03	0.2	.40	3.9	.12	1.3
Sales	-.14	1.6	.22	3.0	.16	2.5
Services	-.32	2.4	.16	1.7	-.08	0.9
Clerical	-.14	0.9	.29	2.5	.26	2.4
Government Em	-.06	0.4	-.06	0.6	.14	1.6
Private Em	-.07	0.6	-.32	3.7	-.12	1.8
Employer	1.06	7.4	.12	1.0	.01	0.0
Own account	.66	5.4	-.12	1.4	-.06	0.9

Table 7.14 (continued)

	Cars	Motorcycles	Bicycles
# Owners	638	1374	3170
# Non-owners	10713	9977	8181
2*logL (d.f.)	1790 (54)	1883 (54)	2011 (54)

Notes to Table 7.14: Thai is a dummy that indicates if the household is of Thai ethnicity; most households that are not of Thai ethnicity are Chinese. The regional dummies are self-explanatory. Central Bangkok is the omitted region. Education levels are none, kindergarten, elementary, and secondary, with post-secondary as the omitted group. Occupational groups are agriculture, professional and technical, production, sales, services, and clerical. Employment status is government employee, private sector employee, employer, or own-account worker; the omitted category is economically inactive. Seasonal dummy variables were also included for each of the months in the survey; these are not shown although several attracted significant coefficients, presumably because of the way in which the sample was designed.

shows how the probability is affected by the independent variables in the table. The great virtue of such analysis is that it is possible to examine the influence of a great many variables at once, and to make some attempt to disentangle their separate effects. The results should therefore be interpreted as extending the descriptions in the cross-tabulations by allowing us to control for many different influences.

The results show that the probability of ownership is predicted to increase with PCE for all three vehicles. Although for all three vehicles the coefficient on the square of the logarithm of PCE is negative, only for bicycles is the second derivative of the probability of ownership with respect to PCE negative in the relative range. At a given level of PCE, an increase in the number of people in the household increases the probability of ownership of any one of the vehicles except for the negative but insignificant effect of young females on the ownership of bicycles. Although additional adult males increase the probability of each type of ownership by more than do additional adult females, the differences are not statistically significant. In a likelihood ratio test where we restrict the coefficients

on each age group to be the same for males and females, the χ^2-test statistics for cars, motorcycles and cycles are 2.6, 7.7 and 3.0 respectively, none of which are significant at reasonable levels. For the 15-55 age group, the male and female probit coefficients are very close for cars and for bicycles, but in the motor cycle equation, the coefficient is significantly larger for men. Surprisingly, additional earners are estimated to decrease the probability of owning a car or a motor cycle, though note that PCE levels are being held constant. The age of the household head has a slight negative impact on motor cycle ownership and a small positive one on car ownership, while a large number of students increases cycle ownership. Thais are somewhat less likely to own any vehicle than other ethnic groups.

Relative to the control region of Bangkok center, people in the same PCE group are more likely to own cars in Center East. People are less likely to own a car in the Bangkok fringe area and in the South while households outside Bangkok are more likely to own a motor cycle or a cycle than those in the control. One of the more surprising findings of this analysis is that once PCE is controlled for, households in urban areas are <u>less</u> likely to own a car than households located in villages. The fact that actual expenditures on private modes are highest in urban areas is therefore most likely due to the concentration of high PCE families in these areas.

Households headed by those who have an elementary education or less, are less likely to own cars than the control group of households headed by a person with post-secondary education. But those headed by a person with elementary education are more likely to own cycles. Households with spouses with no education are less likely to own any vehicle. If the spouse has elementary education the probability of car or motor cycle ownership

remains lower than the control. The fact that the education of the head and spouse have separate effects is interesting in itself. It is possible that an educated spouse is more likely to travel, or that the education of the spouse is an indicator of economic well-being that is independent of the head's education. Among the occupations, households headed by those in agriculture and services are least likely to own a car. Households with professional, technical and managerial heads are most likely to own motor cycles followed by those with heads whose occupations are in the clerical, sales or service sectors. Private sector employees are least likely to own motorcycles, while employers and own account employees are most likely to own cars. The control group for occupation was the "inactive" category, while that for employment status of head was "inactive and/or unemployed."

5. Travel Regressions

Tables 7.15 and 7.17 show short-run and long-run travel regressions for all of Thailand. In both cases the dependent variables are the budget shares of various travel types. The short-run regressions include dummies for vehicle ownership so that the effects of the other variables are estimated conditional on fixed ownership patterns. By contrast, in the long-run regressions, the ownership dummies are omitted so that ownership is implicitly changing with the exogenous variables. In these regressions, the effects of changes in the exogenous variables can be thought of as being the sum of two components, the direct effect of the variable holding ownership fixed, and the indirect effect that operates through induced changes in ownership patterns. When reading these tables it is helpful to note that except for rounding errors, column 1 is equal to the sum of columns 2 and 3,

while columns 4 and 5 sum to column 3. The last three columns represent subsets of expenditures on local and private, so they do not sum to any other column. Local buses, taxis, and gasoline are included separately because they make up the largest shares of local and private expenditures. Table 7.16 shows short-run regressions for each community type. In each case the columns marked "public" and "private" should sum to the column marked "travel".

We begin our discussion with the results of the country wide short-run regressions shown in Table 7.15. The nonlinearity of the PCE response is best represented graphically, and Figure 1 at the end of the Chapter shows the behavior of total, private and public shares with respect to ln PCE. Ninety-five percent of sample households have ln PCE less than 6.5, so that over most of the sample, shares increase with the logarithm of PCE, albeit at a decreasing rate. (Recall that vehicle ownership is being held constant.) Even so, the effect on private shares is somewhat larger than the effect on public ones: the elasticities of private and public travel expenditures with respect to total expenditures are 1.8 and 1.4 respectively when evaluated at the mean shares. Within public transport the largest effects are on taxi and non-local expenditures, while the lowest elasticity is for local bus travel, the basic mode. The expenditure elasticity of taxi with respect to PCE is about twice as great as the expenditure elasticity for local buses, and about the same size as the elasticity for gasoline. In conformity with our earlier discussion, note that the derivative of the share of local expenditures with respect to the logarithm of PCE declines with PCE, while that for non-local travel does not.

Table 7.15

Short-run travel regressions

	Travel	Private	Public	Local	Non-local	Local bus	Taxi	Gasoline
Constant	-23.1	-11.8	-11.3	-8.9	-2.4	-8.2	1.7	3.4
	(8.7)	(6.3)	(5.7)	(5.9)	(1.7)	(6.2)	(5.7)	(2.7)
ln(PCE)	7.4	3.9	3.5	3.3	0.3	3.3	-0.6	-1.2
	(8.3)	(6.1)	(5.3)	(6.6)	(0.5)	(7.6)	(5.8)	(2.9)
{ln(PCE)}sq	-0.5	-0.3	-0.2	-0.2	.02	-0.3	0.1	0.1
	(6.2)	(4.7)	(3.8)	(5.6)	(0.5)	(7.1)	(6.5)	(3.7)
Males	0.1	0.2	-.02	-0.1	.05	-0.1	.01	.04
0-15	(2.4)	(4.0)	(0.5)	(2.2)	(1.6)	(2.9)	(0.9)	(1.5)
15-55	0.4	0.1	0.3	0.1	0.2	0.2	.01	0.1
	(5.7)	(2.6)	(5.3)	(3.4)	(3.7)	(4.9)	(0.7)	(3.7)
>55	0.4	0.1	0.3	0.2	.06	0.2	.01	0.1
	(2.6)	(1.2)	(2.3)	(2.4)	(0.7)	(2.3)	(0.3)	(1.8)
Females	0.1	0.2	-.04	-0.1	.01	-0.1	.01	0.1
0-15	(2.4)	(4.6)	(1.1)	(1.7)	(0.3)	(2.6)	(1.3)	(2.1)
15-55	0.4	.004	0.4	0.2	0.1	0.2	0	0.1
	(4.8)	(0.1)	(6.4)	(5.1)	(3.4)	(4.6)	(0.0)	(1.4)
>55	0.2	-.03	0.2	0.1	0.1	0.1	0	0.1
	(1.4)	(0.3)	(2.2)	(1.3)	(1.7)	(1.0)	(0.2)	(1.1)
head's age	-.02	-.01	-.01	-.01	-.001	-.01	0	0
	(3.0)	(2.0)	(2.1)	(2.5)	(0.3)	(2.8)	(0.5)	(1.4)
# earners	-0.1	-.02	-0.1	-.01	-0.1	-.04	0	-.04
	(2.0)	(0.5)	(2.3)	(0.3)	(2.9)	(1.3)	(0.1)	(1.5)
# student	.01	-0.2	0.2	0.2	-0.3	0.2	0	0.1
	(.13)	(4.1)	(4.1)	(6.4)	(1.0)	(6.6)	(0.5)	(3.8)
Thai	0.4	0.3	0.2	0.3	-0.1	0.5	.04	0.1
	(1.9)	(1.7)	(1.0)	(2.2)	(0.9)	(4.2)	(1.8)	(0.9)
Head	-0.3	-0.5	0.1	0.3	-0.2	0.3	-0.1	-0.1
no education	(1.0)	(2.0)	(0.6)	(1.6)	(0.9)	(1.7)	(2.6)	(0.7)
el. education	-0.2	-0.4	0.2	0.3	-0.1	0.3	-0.1	-0.1
	(0.6)	(1.9)	(1.0)	(1.9)	(0.6)	(1.8)	(3.0)	(0.6)
kind.education	-1.6	-0.5	-1.1	-2.5	1.4	-1.8	-0.4	-0.5
	(0.3)	(0.2)	(0.3)	(0.9)	(0.5)	(0.7)	(0.6)	(0.2)
sec. education	.03	-0.5	0.5	0.4	0.2	0.4	-0.1	-0.2
	(0.1)	(2.1)	(2.1)	(1.9)	(0.9)	(2.2)	(2.5)	(1.3)
spouse	-0.1	-0.7	0.6	0.4	0.2	0.2	0.1	-0.3
no education	(0.3)	(2.3)	(1.8)	(1.5)	(0.9)	(0.9)	(1.9)	(1.4)
el. education	-0.3	-0.8	0.4	0.1	0.3	-0.1	0.1	-0.3
	(0.7)	(2.4)	(1.3)	(0.5)	(1.2)	(0.3)	(2.1)	(1.3)
kind. education	-2.9	-0.6	-2.2	-1.7	-0.6	-1.8	0.2	-0.3
	(0.5)	(0.1)	(0.5)	(0.5)	(0.2)	(0.6)	(0.2)	(0.1)
sec. education	-0.6	-1.1	0.5	0.5	-.01	0.4	0.1	-0.1
	(1.1)	(2.7)	(1.1)	(1.5)	(0.0)	(1.5)	(0.9)	(0.2)
head occupation	0.8	0.3	0.5	0.2	0.3	0.1	.03	0.3
agriculture	(3.6)	(1.9)	(3.1)	(1.9)	(2.2)	(1.1)	(1.2)	(2.7)
production	0.6	0.3	0.3	-0.1	0.4	-0.2	.03	0.2
	(1.9)	(1.3)	(1.3)	(0.4)	(2.1)	(1.4)	(0.9)	(1.6)

Table 7.15 (continued)

	Travel	Private	Public	Local	Non-local	Local bus	Taxi	Gasoline
technical,	1.8	0.5	1.2	0.4	0.8	0.3	.01	0.4
professional	(4.7)	(2.0)	(4.5)	(2.1)	(3.9)	(1.6)	(0.3)	(2.1)
sales	1.0	0.2	0.8	0.7	0.1	0.5	0.1	0.3
	(4.0)	(1.1)	(4.3)	(4.7)	(1.0)	(3.7)	(2.9)	(2.8)
services	0.8	0.2	0.6	0.4	0.1	0.2	.03	0.4
	(2.3)	(0.9)	(2.2)	(2.2)	(0.7)	(1.4)	(0.8)	(2.3)
clerical	1.4	0.6	0.8	0.5	0.4	0.3	.05	0.6
	(3.0)	(1.7)	(2.4)	(1.8)	(1.4)	(1.4)	(0.9)	(2.6)
government	-1.3	-0.8	-0.5	-0.4	-0.1	-0.2	-0.1	-0.5
employee	(3.9)	(3.4)	(2.0)	(1.9)	(0.7)	(0.9)	(3.0)	(3.0)
private	-0.8	-0.5	-0.3	-0.1	-0.2	.01	-0.1	-0.2
employee	(3.2)	(2.9)	(1.5)	(0.9)	(1.2)	(0.1)	(2.3)	(2.0)
employer	-0.7	-0.4	-0.3	-0.3	-.07	-0.1	.05	-0.1
	(1.6)	(1.2)	(1.0)	(1.1)	(0.3)	(0.6)	(1.0)	(0.4)
own account	-0.9	-0.4	-0.6	-0.5	-0.1	-0.3	-.04	-0.2
	(3.6)	(2.0)	(2.9)	(3.2)	(0.7)	(2.6)	(1.3)	(1.8)
N upper	-1.1	-0.5	-0.7	-1.5	0.8	-1.9	-0.2	-0.4
	(3.8)	(2.2)	(3.0)	(8.9)	(5.0)	(13)	(6.7)	(2.9)
N lower	-1.1	-0.2	-0.9	-1.7	0.9	-2.0	-0.2	-0.2
	(3.6)	(1.1)	(3.8)	(10)	(5.2)	(13)	(6.7)	(1.3)
NE upper	-0.9	-0.7	-0.2	-1.2	1.0	-1.5	-0.2	-0.6
	(3.0)	(3.3)	(1.0)	(7.1)	(6.0)	(10)	(6.8)	(4.3)
NE lower	-0.7	-0.7	.03	-0.8	0.9	-1.2	-0.2	-0.6
	(2.3)	(3.4)	(0.1)	(5.1)	(5.4)	(8.6)	(7.1)	(4.5)
C West	-1.5	-0.8	-0.7	-1.8	1.0	-2.1	-0.3	-0.7
	(4.5)	(3.4)	(2.9)	(9.2)	(5.6)	(13.)	(6.6)	(4.1)
C Mid	-1.1	-0.7	-0.4	-1.1	0.7	-1.5	-0.2	-0.4
	(3.4)	(3.3)	(1.5)	(6.3)	(4.4)	(9.9)	(6.8)	(2.9)
C East	-1.3	-0.6	-0.7	-1.3	0.6	-1.5	-0.2	-0.3
	(3.9)	(2.4)	(3.0)	(7.1)	(3.2)	(9.2)	(6.5)	(2.1)
S upper	-0.3	-0.6	0.3	-0.8	1.1	-1.6	-0.3	-0.6
	(1.2)	(2.9)	(1.2)	(4.9)	(6.6)	(11)	(7.4)	(4.4)
S lower	0.3	-0.2	0.5	-1.5	2.0	-1.9	-0.2	-0.3
	(0.8)	(0.8)	(1.8)	(7.1)	(9.8)	(10)	(4.5)	(1.8)
Bangkok	0.4	-0.6	1.0	1.0	0.1	0.3	.03	-0.2
suburb	(1.3)	(2.4)	(4.1)	(5.1)	(0.3)	(1.8)	(0.9)	(1.5)
Bangkok	.04	.04	-.003	0.1	-0.1	-1.0	-0.2	0.1
Fringe	(.08)	(0.1)	(.01)	(0.3)	(0.3)	(4.3)	(4.2)	(0.6)
Municipal	-1.1	-0.8	-0.4	-0.1	-0.3	-0.5	.02	-0.3
Area	(5.3)	(5.1)	(2.3)	(0.8)	(2.4)	(4.8)	(1.0)	(2.6)
Sanitary	-0.5	-0.2	-0.3	-0.2	-0.1	-0.2	-.01	-0.1
District	(3.2)	(1.9)	(2.6)	(2.6)	(0.9)	(2.1)	(0.4)	(0.9)
Own car	7.5	9.4	-1.9	-1.5	-0.4	-1.1	-0.1	5.6
	(27)	(49)	(9.3)	(9.7)	(2.7)	(8.4)	(2.7)	(44)
Own motor cycle	2.9	3.9	-1.0	-0.6	-0.5	-0.4	-.03	2.5
	(16)	(32)	(8.0)	(6.0)	(4.7)	(4.6)	(1.3)	(30)
Own bicycle	-0.3	.01	-0.3	-0.1	-0.2	-.002	.01	-0.1
	(2.4)	(0.1)	(3.3)	(1.5)	(2.9)	(.03)	(0.8)	(2.5)

Table 7.15 (continued)

	Travel	Private	Public	Local	Non-local	Local bus	Taxi	Gasoline
Elasticity wrt ln PCE*	1.5	1.8	1.4	1.3	1.5	1.2	2.3	1.4
F statistic for lnPCE terms	161.0	76.4	77.5	45.3	34.6	34.3	33.5	22.5

Notes: Dummy variables for seasons, i.e. for each month from January 1976 to September 1976, were included but are not shown.

*evaluated at mean share of total expenditure (mean lnPCE=5.7)

At any given level of PCE, additional males and females under 15 have a small positive impact on total expenditures, all of which is on private modes; indeed the budget share devoted to local travel, especially local bustravel, falls somewhat. (Note that adding people to the household while holding PCE constant involves giving the household additional resources.) An additional person of working age has a positive effect on travel shares, mostly in the form of an increase in the budget share of public transport. Of this, and for men, about one third is devoted to local travel (essentially local bus) and two-thirds to non-local travel, while for women the proportions are reversed. It is reasonable to suppose that larger households are better off than small households with the same level of per capita expenditure, so that their members may be able to afford non-local travel more readily. However, this does not by itself explain the fact that the additional non-local travel is associated with additional men and not to the same extent with additional women, though the prevalence of female servants may be relevant. Additional men between 15 and 55 also have a positive impact on the share of gasoline, even when car and motor-cycle ownership levels are controlled for. Additional males over 55 have almost

the same effect on shares as males between 15 and 55, while females in the same age group have smaller effects, larger confined to public transport. In general the results show that larger households have higher travel shares than smaller households when both have the same level of expenditure per head.

Households with older heads spend rather less on both private and public transport. Age of household head has a negative effect on total, public and private transport. A household headed by a 60 year old male would devote nearly a full percentage point less of its budget to travel than would a household headed by 20 year old. Surprisingly, the same level of PCE associated with more earners implies <u>less</u> travel expenditure by the household as a whole. (Recall that larger numbers of earners also lowered the probability of vehicle ownership.) Higher numbers of students have a negative effect on private shares, and an off-setting positive effect on public shares, mostly in the form of an increase in expenditures on local buses. Thai households spend higher budget shares on local and especially on local bus than those of other ethnicities. Of the seasonal effects (not shown in the Tables) the largest is that for November 1975. The increase in shares is split about one quarter private and three quarters public; the latter is divided fairly evenly between local (mostly buses) and non-local. There is a smaller positive effect in December 1975, which in addition to the effects described above also includes an increase in gas expenditure. In the spring, there are higher than normal expenditures on total transport, public and non-local and lower than normal expenditures on local travel. Expenditures on public transport, local and non-local buses are low in July and August. These negative effects as well as the positive one in November

Table 7.16

Short-run travel regressions by level of urbanization

	Municipal Areas			Sanitary Districts			Villages		
	Travel	Private	Public	Travel	Private	Public	Travel	Private	Public
Intercept	-11.4	-6.3	-5.2	-64.5	-47.7	-16.8	-16.6	-5.2	-11.4
	(1.9)	(1.5)	(1.1)	(10)	(10)	(3.6)	(3.9)	(1.8)	(3.6)
ln(PCE)	3.2	1.5	1.7	20.8	15.2	5.7	5.3	1.5	3.8
	(1.7)	(1.2)	(1.2)	(10)	(10)	(3.9)	(3.7)	(1.5)	(3.5)
{ln(PCE)}sq	-0.1	-.05	-0.1	-1.6	-1.2	-0.4	-0.3	-0.1	-0.3
	(0.9)	(0.5)	(0.7)	(9.5)	(9.6)	(3.2)	(2.4)	(0.6)	(2.6)
Males	-.02	0.2	-0.2	0.1	0.1	-.04	0.2	0.1	.02
0-15	(0.2)	(2.5)	(2.5)	(0.5)	(1.1)	(0.4)	(2.3)	(2.9)	(0.4)
15-55	0.3	0.1	0.2	0.6	0.1	0.4	0.5	0.2	0.3
	(2.7)	(0.9)	(2.6)	(3.2)	(1.1)	(3.4)	(4.0)	(2.3)	(3.2)
>55	0.2	-0.1	0.3	0.7	0.6	0.1	0.5	0.2	0.3
	(0.7)	(0.7)	(1.6)	(1.9)	(2.2)	(0.4)	(2.0)	(1.1)	(1.7)
Females	0.1	0.2	-0.1	0.1	0.2	-0.1	0.1	0.2	-.03
0-15	(1.0)	(2.7)	(1.2)	(0.7)	(1.6)	(0.6)	(1.9)	(3.3)	(0.5)
15-55	0.2	-.02	0.2	0.3	-0.1	0.4	0.5	0.1	0.4
	(1.9)	(0.3)	(2.8)	(1.7)	(0.7)	(2.9)	(4.0)	(1.0)	(4.5)
>55	0.3	0.3	.01	-0.3	-0.3	.01	0.2	-.03	0.3
	(1.1)	(1.5)	(0.1)	(0.9)	(1.2)	(.02)	(1.3)	(0.2)	(2.0)
head's age	-.004	.003	-.01	-.004	-.01	.01	-.02	-.01	-.01
	(0.4)	(0.3)	(0.9)	(0.3)	(1.1)	(0.7)	(2.7)	(2.1)	(1.7)
# earners	0.1	.02	0.1	-0.1	.005	-0.1	-0.2	-0.1	-0.1
	(1.3)	(0.3)	(1.4)	(0.8)	(0.4)	(1.2)	(2.3)	(1.0)	(2.2)
# students	0.1	-0.2	0.3	.05	-0.1	0.2	-.01	-0.2	0.1
	(1.0)	(2.4)	(3.5)	(0.4)	(1.1)	(1.6)	(0.1)	(2.6)	(2.3)
Thai	0.4	.04	0.4	2.1	1.3	0.9	-0.7	-0.3	-0.4
	(1.7)	(0.2)	(2.1)	(4.2)	(3.4)	(2.3)	(1.4)	(0.9)	(1.1)
Head no educ	-0.5	-0.1	-0.4	0.1	0.4	-0.3	-0.2	-1.0	0.7
or k'garten	(1.1)	(0.4)	(1.0)	(0.1)	(0.7)	(0.5)	(0.4)	(2.5)	(1.8)
elem education	-0.2	-.01	-0.2	-0.2	0.2	-0.4	-0.1	-0.9	0.8
	(0.5)	(.04)	(0.7)	(0.3)	(0.3)	(0.7)	(0.3)	(2.5)	(2.0)
secondary ed'n	-0.1	.05	-0.1	-0.5	-0.6	.01	0.6	-1.0	1.6
	(0.2)	(0.2)	(0.4)	(0.7)	(1.0)	(0.0)	(0.8)	(2.2)	(3.1)
spouse no ed'n	-.04	-1.2	1.1	-1.0	-1.4	0.3	0.2	-0.1	0.3
or k'garten	(0.1)	(3.2)	(2.8)	(1.0)	(1.9)	(0.5)	(0.2)	(0.1)	(0.4)
elem education	-0.2	-1.2	1.0	-1.5	-1.6	0.1	-.01	-0.1	0.1
	(0.3)	(3.2)	(2.6)	(1.5)	(2.3)	(0.2)	(0.0)	(0.2)	(0.1)
secondary ed'n	-0.3	-1.0	0.8	-1.7	-2.1	0.4	-0.1	-0.8	0.7
	(0.4)	(2.4)	(1.7)	(1.5)	(2.5)	(0.5)	(0.1)	(0.9)	(0.7)
head's occ'n	1.1	0.7	0.4	1.2	0.9	0.3	0.7	0.1	0.6
agriculture	(2.0)	(1.7)	(1.0)	(2.6)	(2.6)	(0.8)	(2.1)	(0.6)	(2.4)
production	0.3	0.4	-0.2	-0.5	-0.1	-0.4	1.0	0.2	0.7
	(0.6)	(1.4)	(0.5)	(0.7)	(0.2)	(0.8)	(1.9)	(0.7)	(1.9)
professional	0.8	-0.2	1.0	2.6	1.8	0.8	2.1	0.7	1.4
technical	(1.8)	(0.5)	(2.9)	(3.0)	(2.8)	(1.2)	(3.1)	(1.5)	(2.8)
sales	0.7	0.1	0.6	1.1	0.4	0.7	1.7	0.4	1.4
	(2.1)	(0.3)	(2.4)	(2.1)	(1.0)	(1.8)	(3.4)	(1.1)	(3.6)

Table 7.16 (continued)

	Municipal Areas			Sanitary Districts			Villages		
	Travel	Private	Public	Travel	Private	Public	Travel	Private	Public
services	0.1	-0.2	0.3	1.2	0.3	0.9	1.2	0.7	0.5
	(0.2)	(0.7)	(1.0)	(1.8)	(0.5)	(1.9)	(1.7)	(1.4)	(0.9)
clerical	1.0	0.2	0.8	1.3	0.2	1.1	2.4	2.0	0.3
	(2.0)	(0.5)	(2.1)	(1.4)	(0.3)	(1.6)	(2.0)	(2.4)	(0 4)
govt employee	-1.0	-.01	-1.0	-1.5	-0.8	-0.7	-1.7	-1.6	-0.2
	(2.2)	(0.0)	(2.9)	(2.0)	(1.5)	(1.2)	(2.8)	(3.6)	(0.3)
private emp-	0.6	-.01	-0.5	-0.5	-0.5	.01	-0.8	-0.6	-0.2
loyee	(1.4)	(0.1)	(1.8)	(1.0)	(1.4)	(0.0)	(2.0)	(2.1)	(0.7)
employer	-1.1	0.1	-1.3	1.3	2.3	-1.0	-0.6	-1.5	0.9
	(2.0)	(0.3)	(2.9)	(1.4)	(3.2)	(1.4)	(0.8)	(2.8)	(1.5)
own account	-1.1	.01	-1.1	-0.4	-0.4	-.02	-0.9	-0.4	-0.5
	(2.8)	(0.1)	(3.7)	(0.7)	(1.0)	(0.0)	(2.2)	(1.5)	(1.6)
N upper	-0.3	-0.1	-0.2	-0.9	-0.2	-0.7	-1.3	0.1	-1.4
	(0.7)	(0.4)	(0.5)	(1.9)	(0.7)	(1.9)	(2.5)	(0.2)	(3.5)
N lower	-1.1	-0.1	-0.9	-2.1	0.1	-2.2	-1.0	0.3	-1.3
	(2.3)	(0.4)	(2.6)	(3.7)	(0.2)	(5.2)	(1.8)	(0.9)	(3.3)
NE upper	-1.2	-0.1	1.0	0.8	-0.2	-0.6	-0.8	-0.1	-0.7
	(2.5)	(0.4)	(2.8)	(1.6)	(5.0)	(1.8)	(1.6)	(0.4)	(1.8)
NE lower	-0.1	-0.5	0.4	-0.2	0.5	-0.7	-0.7	-0.2	-0.5
	(0.3)	(1.9)	(1.4)	(0.4)	(1.4)	(2.0)	(1.4)	(0.6)	(1.3)
C west	-2.0	-0.7	-1.3	-1.5	-0.4	-1.1	-1.5	-0.3	-1.2
	(3.4)	(1.8)	(2.7)	(2.8)	(1.0)	(2.8)	(2.6)	(0.7)	(2.8)
C mid	-1.7	-1.0	-0.7	-1.3	-0.2	-1.1	-0.9	-0.2	-0.7
	(3.8)	(3.1)	(2.1)	(3.2)	(0.8)	(3.6)	(1.7)	(0.5)	(1.8)
C east	-2.5	-0.3	-2.2	-0.9	0.2	-1.1	-1.3	-0.2	-1.1
	(4.3)	(0.8)	(4.9)	(1.1)	(0.3)	(1.8)	(2.3)	(0.5)	(2.7)
S upper	-0.6	-0.6	-.01	-1.3	-0.1	-1.1	-0.2	-0.1	-0.1
	(1.6)	(2.3)	(0.0)	(2.5)	(0.3)	(3.2)	(0.4)	(0.2)	(0.3)
S lower	-0.1	0.2	-0.3	-2.0	0.3	-2.4	0.2	0.1	0.2
	(0.1)	(0.6)	(0.8)	(1.8)	(0.4)	(2.9)	(0.4)	(0.1)	(0.4)
Own car	7.5	9.3	-1.8	5.9	7.9	-2.0	8.2	10.	-1.8
	(23.)	(40.)	(7.1)	(11.)	(19.)	(4.9)	(16.)	(28.)	(4.7)
Own motor-cycle	2.3	3.3	-0.9	2.4	3.5	-1.1	3.2	4.3	-1.1
	(8.5)	(17.)	(4.4)	(6.0)	(12.)	(3.6)	(12.)	(24.)	(5.5)
Own bicycle	-0.5	-0.3	-0.2	-0.3	-.03	-0.3	-0.2	0.1	-0.3
	(2.0)	(1.7)	(1.1)	(1.2)	(0.1)	(1.5)	(1.2)	(0.7)	(2.2)
elasticity	1.3	1.4	1.2	1.5	1.8	1.4	1.5	2.0	1.4
F statistic	29.0	16.2	11.4	73.7	58.2	19.3	141	127	30.0

Notes: Dummy variables for seasons, i.e. for each month from January 1976 to September 1976, were included but are not shown.

might be due to the Buddhist vassa (similar to Christian lent) which runs for three months between July and October and which is followed by a month marked by celebrations. The downturn in travel shares during the summer months could also be the result of monsoon conditions.

There appears to be little evidence against the null hypothesis that educational levels of either head or spouse have no effect on travel expenditures. However, if we ignore the insignificance of the figures, the absolute numbers suggest that expenditures rise with educational levels for males and fall for females except for those with post-secondary education. (Post-secondary education is the omitted category for both males and females.) Most of these effects are confined to private rather than public transport, and it appears that the control group of highly educated males spends more on taxis than do other groups.

Households whose heads are economically inactive are the control group for the occupational and employment variables; and all other occupational groups except for production workers spend larger shares on travel than does this base group. Other things equal, the groups that spend the most on travel, largely on public modes, are professional, technical and managerial workers, clerical workers, sales workers and service workers. Households with professional heads spend more on non-local travel, as do, to a lesser extent, households with heads engaged in agriculture, production, or clerical jobs. Those with heads in the sales and service sectors also have significantly larger expenditures on local public transport. Conditional on vehicle ownership, all groups spend more on gasoline than do the economically inactive, with clerical workers spending the most. Households with heads who are government employees spend less on travel in total, and on all

modes of travel than do other occupational groups; on average they spend a full 1.3% less of their budgets than even the economically inactive group; many government servants in Thailand are provided with official transport, and this may be reflected in the results. Private sector employees and own account workers also show low travel outlays, both in total and in detail, though less so than government employees.

Households in the North, North East, and Central areas spend less on travel than do households in the other regions, including the base region which is taken to be central Bangkok. In the North Eastern region, the shortfall is mostly in private transport, while in the Center and North expenditures on both public and private transport is low. All areas away from Bangkok have higher expenditures on non-local travel than do the Bangkok areas, and this is true independently of urbanization level which suggests that at least some non-local travel is to the capital, and that there is relatively little long distance travel from Bangkok back to the rest of the country. By contrast, and even controlling for the level of urbanization, expenditures on local public transport (mostly local bus) are lower in all areas than in Bangkok, in most cases by sizeable amounts, i.e. between one and two percent of total budgets. Expenditures on local travel reach their peak in the Bangkok suburbs.

Given these regional effects, the two urbanization dummies show the differences in patterns between municipal areas, sanitary districts, and villages, the last being the omitted category. Everything else equal, i.e. PCE, region, and so on, the share of the budget devoted to travel <u>falls</u> with level of urbanization. The larger part of this shift is accounted for by expenditures on <u>private</u> transport, which are 0.8% of the budget lower in

municipal areas than in villages. However, expenditures on public transportation are also lower in municipal areas and sanitary districts than in villages. Some of this is accounted for by less non-local travel in urban areas than in villages, but expenditures on local buses are also significantly lower in both municipal areas and sanitary districts than in the villages. While raw travel expenditures are higher in the urban areas, these results suggest that the difference can be ascribed to income and regional variables, and not to the level of urbanization itself. Once other variables are controlled for, increased urbanization appears to reduce expenditures on personal travel. As in the case of India, rural travel appears to be an important phenomenon in Thailand.

The ownership dummies for cars and motorcycles show the patterns that one might expect. Those who own cars or motorcycles spend a larger share of their budget on travel, with the additional expenditure on their private travel more than offsetting the reduction in expenditure on public travel. Owners of these two types of vehicles evidently use them as a substitute for public transport on both local and non-local trips. In contrast to car and motorcycle ownership, a bicycle saves more on public transport than it costs to run (or than respondents report that it costs to run), so that the ownership dummy has a small negative effect on total travel expenditures. Perhaps more surprisingly, bicycle ownership cuts expenditures on non-local travel by more than it cuts expenditures on local travel.

Table 7.16 shows the short-run regressions for public and private travel expenditures disaggregated by level of urbanization, while Table 7.17 discards the ownership dummies in an attempt to describe the long run travel patterns. In many respects these tables repeat the results of the All

Thailand short-run regressions in Table 7.15, so that in our discussion, we focus on differences from the patterns outlined above. By and large, the results are consistent as between national and regional results, though some additional insights can be gained by looking at such differences as do exist.

In Table 7.15, the total expenditure elasticities of all travel, public travel and private travel were given as 1.5, 1.4, and 1.8 respectively. In Table 7.16, these figures repeat themselves for sanitary districts, while in the villages, the elasticity of private travel expenditure is estimated to be a little higher, at 2.0. Both public and private transport expenditures have lower total expenditure elasticities in the urban areas, so that the elasticity of total personal travel falls to 1.3. The demographic effects are not very different from region to region, although the positive effects of additional adults, especially men, are stronger outside the urban areas. The negative effects of age and of additional earners are discernable only in the villages, not in urban or intermediate areas. Additional students switch expenditures from private to public transport in each of the areas, as they do in the All Thailand regressions, though the estimates are not statistically significant in the sanitary districts. Thai ethnicity had a small, but not significant positive effect on travel expenditures in the All Thailand regressions, and this turns out to be due to a much larger positive effect in sanitary districts. In the municipal areas, the variable has a small insignificant positive effect, while in villages it is negative and insignificant. We have no explanation for this finding.

The positive seasonal effects for November are strongest in villages and weakest in sanitary districts, while the other positive effects for Decem-

ber, March and May are only statistically significant in the villages. The positive seasonal effects in the months preceding and following the monsoon are largest in the villages, which lends some support to the hypothesis that these coefficients reflect the effects of the monsoon on disrupting travel patterns.

Disaggregation by level of urbanization sheds some further light on the effects of education. For the household head, the control group, those with post-secondary education, spend substantially more on private and less on public transport than do those with lower levels of education, but the phenomenon is only observed in the villages. In urban areas, a similar phenomenon is observed with variations in the educational attainment of the spouse, but not with that of the household head. In sanitary districts, the households with spouses in the highest educational group have high levels of expenditure on private transport, but unlike their counterparts in the urban areas, there is no apparent offset to expenditure on public transport. Once again, these are a "facts" that do not appear to be readily rationalized.

Most of the occupational effects are relatively even across the country though the additional expenditure by professional, technical, and managerial workers on both public and private transport does not exist in urban areas. Households headed by employers were not significantly different from the control households in the All Thailand regressions, but in these equations, such households spend markedly less on public transport in urban areas, private transport in the villages, and <u>more</u> on private transport when they live in sanitary districts.

Given the fact that urbanization levels are very different in different regions it is not surprising that there are some interactions between the

area and urbanization dummies. Even so, the effects are more or less consistent with the national figures, although, for example, travel expenditures are much lower in sanitary districts in the North than they are in villages or municipal areas in that region. Similarly, the fact that transport patterns are low in Center east is almost entirely due to very low travel expenditures in the urban areas. The coefficients on vehicle ownership are quite similar across areas, though the private expenditures associated with car ownership are somewhat lower in sanitary districts.

The aggregate equations that are described above represent a weighted average of the equations from the three community types. Since households in Thailand live predominantly in villages, the aggregate equations most closely resemble the village regressions. A surprising result is that the regressions for travel shares in municipal areas and villages are often the two that are most like one another. The regressions for sanitary districts differ more from the aggregate equations and from those for the other two community types.

Table 7.17 shows r all Thailand. The corres-
ponding regression not shown, but differences
between the aggreg ity regressions will be
discussed below. ons differ from the
short-run ones in re of ln PCE in the
private regression an in the short-run
regressions. This share of private
transport increase range of PCE: compare
Figure 2 with Figure 1. The total expenditure elasticity of private travel
is correspondingly larger in the long run regressions, 2.8 in Table 7.17 as

end of chapter

7.40

Table 7.17

Long-run travel regressions

	Travel	Private	Public	Local	Non-local	Local bus	Taxi	Gasoline
Constant	-21.4	-10.6	-10.8	-8.9	-1.9	-8.3	1.7	4.3
	(7.7)	(5.0)	(5.4)	(6.0)	(1.3)	(6.4)	(5.6)	(3.1)
ln(PCE)	6.3	2.7	3.6	3.4	0.2	3.5	-0.6	-2.0
	(6.8)	(3.8)	(5.4)	(6.8)	(0.4)	(7.9)	(5.7)	(4.2)
{ln(PCE)}sq	-0.3	-0.1	-0.2	-0.3	.02	-0.3	0.1	0.3
	(3.8)	(0.8)	(4.4)	(6.3)	(0.5)	(7.7)	(6.3)	(6.4)
Males	0.3	0.3	-0.1	-0.1	.04	-0.1	.004	0.1
0-15	(4.7)	(7.5)	(1.4)	(3.1)	(1.2)	(3.7)	(0.7)	(5.0)
15-55	0.7	0.5	0.2	0.1	0.1	0.1	.004	0.4
	(8.9)	(8.3)	(3.6)	(2.0)	(2.9)	(3.8)	(0.5)	(8.8)
>55	0.8	0.6	0.1	0.1	.01	0.1	.002	0.4
	(4.7)	(5.0)	(1.2)	(1.4)	(0.2)	(1.6)	(0.1)	(5.2)
Females	0.3	0.3	-0.1	-0.1	-.002	-0.1	.01	0.2
0-15	(4.7)	(7.9)	(1.9)	(2.5)	(0.1)	(3.3)	(1.1)	(5.5)
15-55	0.6	0.3	0.3	0.2	0.1	0.1	-.003	0.2
	(7.8)	(5.6)	(4.8)	(3.8)	(2.7)	(3.5)	(0.3)	(6.3)
>55	0.4	0.2	0.1	0.1	0.1	.03	-.01	0.2
	(2.8)	(2.3)	(1.5)	(0.7)	(1.3)	(0.5)	(0.3)	(3.3)
Head's age	-.02	-.01	-.01	-.01	0	-.01	0	-.01
	(3.3)	(2.5)	(1.8)	(2.3)	(0.1)	(2.7)	(0.5)	(2.1)
# earners	-0.3	-0.2	-0.1	.02	-0.1	-.02	.001	-0.1
	(4.1)	(4.0)	(1.5)	(0.5)	(2.6)	(0.6)	(0.2)	(4.7)
# students	.04	-0.1	0.1	0.2	-.04	0.2	-.003	-0.1
	(0.7)	(2.3)	(3.5)	(6.0)	(1.4)	(6.3)	(0.5)	(2.4)
Thai	0.1	-0.2	0.3	0.3	-.07	0.5	.05	-0.2
	(0.3)	(1.1)	(1.7)	(2.8)	(0.6)	(4.6)	(1.9)	(1.6)
Head no educ'n	-0.6	-0.8	0.2	0.3	-0.1	0.3	-0.1	-0.3
	(1.7)	(3.0)	(0.8)	(1.9)	(0.8)	(2.0)	(2.6)	(1.8)
kind. education	-2.4	-1.5	-0.9	-2.3	-1.5	-1.7	-0.3	-1.1
	(0.5)	(0.4)	(0.2)	(0.8)	(0.5)	(0.7)	(0.6)	(0.4)
elem. education	-0.5	-0.8	0.3	0.4	-0.1	0.3	-0.1	-0.4
	(1.7)	(3.4)	(1.3)	(2.3)	(0.6)	(2.2)	(2.9)	(2.2)
sec. education	-.02	-0.5	0.5	0.4	0.2	0.4	-0.1	-0.2
	(0.0)	(2.0)	(2.1)	(2.0)	(0.8)	(2.3)	(2.5)	(1.3)
Spouse no educ'n	-1.4	-2.3	1.0	0.6	0.3	0.4	0.1	-1.3
	(2.9)	(6.4)	(2.8)	(2.5)	(1.3)	(1.7)	(2.2)	(5.2)
kind. education	-4.1	-2.3	-1.8	-1.4	-0.4	-1.6	0.2	-1.3
	(0.6)	(0.5)	(0.4)	(0.4)	(0.1)	(0.5)	(0.2)	(0.4)
elem. education	-1.4	-2.2	0.7	0.4	0.4	0.1	0.1	-1.1
	(3.0)	(6.0)	(2.2)	(1.4)	(1.5)	(0.4)	(2.4)	(4.8)
sec. education	-0.5	-0.9	0.5	0.5	-.001	0.4	0.1	.04
	(0.8)	(2.1)	(1.1)	(1.4)	(0.0)	(1.5)	(0.8)	(0.1)
Head's occup'n	0.4	-0.2	0.6	0.3	0.3	0.2	.03	-.004
agriculture	(1.8)	(1.0)	(3.6)	(2.5)	(2.4)	(1.7)	(1.4)	(0.0)
production	0.4	0.1	0.4	-.03	0.4	-0.2	.03	0.1
	(1.3)	(0.4)	(1.5)	(0.2)	(2.2)	(1.2)	(0.9)	(0.7)

Table 7.17 (continued)

	Travel	Private	Public	Local	Non-local	Local bus	Taxi	Gasoline
professional	2.1	1.0	1.1	0.4	0.7	0.2	.01	0.7
technical	(5.5)	(3.4)	(4.0)	(1.8)	(3.6)	(1.3)	(0.2)	(3.4)
sales	1.2	0.5	0.8	0.7	0.1	0.4	0.1	0.5
	(4.5)	(2.2)	(3.9)	(4.4)	(0.7)	(3.5)	(2.8)	(3.7)
services	0.6	-.004	0.6	0.5	0.1	0.3	.03	0.2
	(1.7)	(0.0)	(2.4)	(2.4)	(0.8)	(1.6)	(0.9)	(1.3)
clerical	1.3	0.5	0.8	0.5	0.3	0.3	.05	0.5
	(2.6)	(1.2)	(2.3)	(1.8)	(1.3)	(1.4)	(0.9)	(2.1)
govt. employee	-1.5	-1.0	-0.5	-0.3	-0.1	-0.1	-0.1	-0.6
	(4.2)	(3.7)	(1.9)	(1.8)	(0.7)	(0.8)	(2.9)	(3.3)
private employee	-0.9	-0.7	-0.2	-0.1	-0.1	.03	-0.1	-0.3
	(3.4)	(3.3)	(1.2)	(0.7)	(1.0)	(0.2)	(2.3)	(2.5)
employer	0.9	1.7	-0.8	-0.6	-0.2	-0.4	.03	1.2
	(2.0)	(4.8)	(2.4)	(2.4)	(0.8)	(1.7)	(0.6)	(5.0)
own account	-0.6	.02	-0.6	-0.5	-0.1	-0.4	-.04	.01
	(2.2)	(0.1)	(3.2)	(3.6)	(0.7)	(2.9)	(1.4)	(0.1)
N upper	-0.5	0.6	-1.1	-1.7	0.6	-2.0	-0.2	0.2
	(1.7)	(2.3)	(4.8)	(10.)	(3.9)	(14.)	(6.9)	(1.1)
N lower	-0.8	0.4	-1.2	-1.9	0.7	-2.1	-0.2	0.1
	(2.5)	(1.6)	(5.2)	(11.)	(4.3)	(14.)	(6.8)	(0.9)
NE upper	-0.5	.01	-0.5	-1.3	0.8	-1.6	-0.2	-0.2
	(1.6)	(0.1)	(2.3)	(8.0)	(5.2)	(11.)	(7.0)	(1.3)
NE lower	-0.2	.03	-0.2	-1.0	0.7	-1.3	-0.2	-0.2
	(0.7)	(0.1)	(1.1)	(5.9)	(4.7)	(9.2)	(7.2)	(1.2)
C west	-0.8	0.4	-1.2	-2.0	0.8	-2.3	-0.3	.04
	(2.3)	(1.5)	(4.9)	(11.)	(4.4)	(14.)	(6.9)	(0.2)
C mid	-0.9	-0.3	-0.6	-1.2	0.6	-1.6	-0.2	0.2
	(2.8)	(1.2)	(2.5)	(6.9)	(3.7)	(10.)	(6.8)	(1.3)
C east	-0.7	-0.4	-1.1	-1.5	0.4	-1.6	-0.2	0.2
	(2.0)	(1.5)	(4.4)	(8.1)	(2.3)	(9.9)	(6.6)	(1.3)
S upper	.03	.01	.02	-0.9	1.0	-1.7	-0.3	-0.3
	(0.1)	(0.1)	(0.1)	(5.6)	(5.9)	(11.)	(7.5)	(1.6)
S lower	1.0	0.8	0.1	-1.7	1.8	-2.0	-0.2	0.3
	(2.5)	(2.8)	(0.5)	(8.0)	(9.0)	(11.)	(4.7)	(1.5)
Bangkok suburbs	0.3	-0.7	1.0	1.0	.04	0.3	.04	-0.3
	(1.0)	(2.5)	(4.0)	(5.1)	(0.2)	(1.9)	(1.0)	(1.7)
Bangkok fringe	-0.1	-0.1	-.005	0.1	-0.1	-1.0	-0.2	.02
	(0.3)	(0.4)	(0.0)	(0.4)	(0.4)	(4.2)	(4.1)	(0.1)
Municipal area	-1.2	-0.8	-0.4	-0.1	-0.3	-0.5	.03	-0.3
	(5.4)	(4.9)	(2.3)	(0.7)	(2.4)	(4.7)	(1.1)	(2.7)
Sanitary	-0.5	-0.2	-0.3	-0.2	-0.1	-0.2	-.01	-0.1
district	(3.2)	(1.7)	(2.6)	(2.6)	(0.9)	(2.1)	(0.4)	(0.9)
Elasticity	1.7	2.8	1.3	1.2	1.4	1.1	2.1	2.5
F-statistic	308	285	46.6	30.9	24.4	31.6	30.0	177

opposed to 1.8 in Table 7.15. Note also the expenditure elasticity of gasoline which is 2.5 in the long-run regressions and 1.4 in the short-run equivalents. The elasticities for the other, public modes are very much the same in Table 7.17 as in the earlier Tables.

Additional household members tend to increase private transport expenditures by more in the long-run than they do in the short-run. This result is consistent with the fact that larger households with the same level of per capita income are better off, and that the effect of such higher welfare levels is to increase private travel expenditures at fixed levels of ownership and also to increase the probability of ownership. The (puzzling) negative effect of additional earners on private travel is magnified in the long-run regressions by the additional effects of earners on the probability of car ownership, although, as before, the effects seem confined to the villages. The effects of education are generally much stronger in the long-run than in the short-run regressions. Households with spouses with no education or elementary education have lower travel shares than the control group. The effect in Table 7.16 whereby such households in urban areas substitute public for private travel is greatly magnified in Table 7.17. Households headed by professional, technical and managerial workers spend even more on private travel in the long run than in the short run. Those with own account workers as heads have lower expenditures on private travel in the short-run regressions, but in the long-run this effect disappears. Households headed by employers have higher expenditures on total travel, on private travel and on gasoline and lower expenditures on public transport and on local modes.

6. Summary of stylized facts

The Thai data set analyzed in this chapter is one of the richest examined in this report; in particular, regional and sectoral variations provide a wide variety of travel behavior to be studied, and the survey collected a great deal of information on travel expenditures of various types, as well as good data on vehicle ownership. The major findings are as follows:-

(i) Thai households spend about four percent of their budgets on personal travel. Shares vary directly with level of urbanization, from 3.6% rural to 5.6% urban, and are highest in Bangkok. The share also increases with household living standards, from about 2% among the poorest households to about 8% among the best-off.

(ii) The total expenditure elasticity of travel expenditures is estimated to be about 1.7. The elasticity appears to be somewhat lower in urban areas than in rural or intermediate areas.

(iii) More than three-quarters of all Thai households spend <u>something</u> on personal travel, a fraction that does not vary very much with level of urbanization. It rises to 83% in Bangkok, to 80% in urban areas as a whole, but is still fractionally over 75% in the countryside.

(iv) Among households that do spend something on travel, the fractions of the budget devoted to it vary less across sectors than do the unconditional budget shares. Even so, some differences between urban and rural remain.

(v) Few households spend more than 10% of their budgets on travel, and those that do so are relatively wealthy households who are spending on private travel. In the poorest decile, three to four percent of households spend more than 10% of their budgets. There is no evidence that substantial numbers of very poor households are forced (or choose) to spend large

fractions of their budgets on travel.

(vi) Relatively few households (19%) record any expenditure on private transport, while most spend something (70%) on public transport, mostly buses. Those who spend on private transport are concentrated among the better-off.

(vii) Of the four per cent of the budget that goes to travel, three-quarters is on public travel and one quarter on private. This 3:1 ratio over the whole country is increased to 4:1 in the villages, and is less than 2:1 in the cities. The total expenditure elasticities of private and public transport are estimated to be 2.8 and 1.3 respectively, or 1.5 and 1.4 if ownership of vehicles is held fixed as per capita household expenditure increases.

(viii) Expenditure on public transport can be divided into expenditures on local and on non-local expenditures. Local travel is predominant in the cities, with a ratio of expenditures of 4:1 in urban areas as a whole, and 8:1 in Bangkok. In villages, the ratio is only 3:2 in favor of local travel, and is 2:1 in the intermediate sanitary districts. There is some evidence of interactions with living standards, particularly in rural areas. The poor spend little on local travel but almost as much as middle income groups on non-local travel, while middle income households spend about the same fraction of their budgets on local travel as do high income households, but much less on non-local travel. This evidence suggests that non-local travel is a necessity at low income levels, and a luxury at higher incomes, perhaps associated with a change of purpose from business to social. The total expenditure elasticities of local and non-local travel expenditures are estimated to be 1.2 and 1.4.

(ix) Bus accounts for most expenditure on public travel, more than 80% overall. There is some expenditure on taxis and auto rickshaws in the urban areas, particularly Bangkok, and some expenditures on train fares, particularly in urban areas in the South. Even in these regions, bus is the dominant form of travel.

(x) Two thirds of households do not own a bicycle, a motor-cycle, or a car. Less than thirty percent of households own a bicycle, ten percent own a motor-cycle, and about four percent own cars. There is a very marked regional variation in vehicle ownership. As is to be expected, car ownership is heavily concentrated in urban areas, particularly in Bangkok. However, ownership of bicycles and motor-cycles is much higher away from Bangkok. Forty percent of households in the North and Central regions own bicycles, twenty-five percent do so in the North Eastern and Southern regions, while less than ten percent of households in Bangkok own a bicycle. Motor-cycle ownership, at 5-6% is also low in Bangkok, but is as high as 15% in the South and Center.

(xi) About 11% of households, mostly rural and in the North of the country, own an oxcart. We have no way of telling how their possession contributes to personal travel, but they tend to be owned by relatively poor households, and they may make a contribution to the travel needs of the rural poor.

(xii) At low income levels, increases in living standards are associated with increased probabilities of owning all vehicles. However, the probability of owning an oxcart falls after PCE reaches the first quartile, and that of owning a bicycle begins to fall among the top quartile.

(xiii) The low levels of bicycle and motor-cycle ownership in Bangkok are not explained by any of the social and demographic variables included in our

regressions. By contrast, the high levels of car ownership are attributed to high income levels in Bangkok rather than to any city-specific effect. (xiv) Transport expenditure itself is affected by a number of socio-demographic factors. Additional people increase travel expenditures provided the level of per capita total expenditures is left constant. Age of household head decreases expenditures, and there is some evidence of differences by sex. Changing females into males within a household would increase non-local travel, usage of private vehicles given ownership, and ultimately ownership itself. This sex bias appears to be stronger in the countryside than in the towns. Government employees spend significantly less on transport, perhaps because they are supplied with official transport. There are discernible seasonal effects on transport expenditure. (xv) The socio-demographic variables seem capable of accounting for the sectoral differences in expenditures. When everything else is allowed for, particularly income levels, household composition, age, and occupation, the differences in mean travel shares between urban and rural are fully accounted for. There is no evidence of differences between urban and rural in the processes generating personal travel expenditures. Once again, the Thai results suggest, as did those from India, that the folklore tends to exaggerate the differences between urban and rural travel patterns.

Chapter 8

Travel Expenditures in Hong Kong 1979-80

0. General Background

The household expenditure survey on which the analysis is based was carried out in Hong Kong in 1979 and 1980. At that time, the population of Hong Kong was about 5 million people, or 1.04 million households, of which 7653 were included in the survey. Of these, 4236 households responded, or 55.4% of those approached. Hong Kong is generally characterized as a middle income oil importer and as a major exporter of manufactured goods. In 1979 per capita GNP in U.S. dollars was $3760 U.S.; from 1960 to 1970 the growth rate was 2.4% per annum, while from 1970 to 1979 it was 7.9% per annum. Hong Kong is 90% urban and the survey was confined to urban households. The land area is 1059 square kilometers spread over the mainland and 236 islands.

The analysis of expenditures on travel will be carried out with reference to a number of factors. Amongst the most important are the geographical distribution of households by census area, levels of per capita household expenditures, the demographic structure of households, and types of housing (public or private). In the sample design target households were stratified by census area, type of housing and time period. We begin with a description of the background variables.

For the purposes of the survey, Hong Kong is divided into four census areas: Hong Kong Island (HKI), Kowloon (K),New Kowloon (NK), and the New Territories (NT). These areas are indicated on the map, Figure 8.1. The survey included all urban areas of Hong Kong. While all of HKI, K and NK were sampled, only the areas indicated by shading on the map were sampled in the New Territories. The distribution of households across census areas is

as follows: Hong Kong Island 27.5%, Kowloon 23.1%, New Kowloon 32.7%, New Territories 16.7%. Hong Kong was further divided into 22 survey districts, which were then subdivided according to public or private housing types. In all, 38 strata were defined. In what follows, all survey data have been weighted so as to reflect population magnitudes.

The household survey measures the total of household expenditures in $HK per biweekly expenditure period. The exchange rate over the period was approximately $(US)0.20 to the H.K. dollar. As usual, we use per capita household expenditure on non-durable goods as the main indicator of household living standards. Semi-deciles of per capita expenditure for all Hong Kong are shown in Table 8.1. Both the end-point and the mean are shown for each interval. Differences between semi-deciles are quite small until after the 85th percentile when they become substantial. Comparison of the end point and the mean of the top group indicates that the top expenditure of

Table 8.1

Percentiles of per capita household expenditures

($HK per capita)

Pctile	Maximum	Mean	Pctile	Maximum	Mean
0-5	155.6	128.7	55-60	418.0	401.5
5-10	184.1	170.4	60-65	450.8	433.4
10-15	209.6	196.6	65-70	493.4	469.1
15-20	229.0	218.8	70-75	544.5	521.1
20-25	248.0	239.5	75-80	612.1	575.2
25-30	266.6	258.3	80-85	719.2	665.4
30-35	287.7	277.0	85-90	896.4	798.8
35-40	309.7	298.1	90-95	1257.4	1047.5
40-45	331.1	321.1	95-100	89093.8	3270.8
45-50	357.0	344.0			
50-55	387.5	371.8	All		551.1

$HK 89093.8 is very much an outlier. The Table shows that mean per capita expenditure was $551, that the bottom 10% of households received about 5% of total PCE, and that the bottom 20% received 13%. Table 8.2 shows the geographical distribution of per capita expenditure by census area. It is

Table 8.2

Distribution of PCE by Census Area

	HKI	K	NK	NT
1st Quartile	288.9	281.9	233.6	210.5
Median	420.8	410.3	321.0	284.9
3rd Quartile	695.3	643.5	456.3	427.7
4th Quartile	89093.8	3926.1	6209.6	3564.0
Mean PCE	854.7	548.9	393.0	357.6
SD(lnPCE)	0.78	0.64	0.54	0.54

Note:- If the top expenditure for HKI is excluded, the 3rd quartile becomes 694.4, the 4th 24788, the mean 680.3, and the standard deviation of log PCE 0.74.

generally the case that Hong Kong Island is better off than Kowloon, which itself has substantially higher levels of PCE than New Kowloon and the New Territories. The degree of inequality also varies by census area. The standard deviation of ln(PCE) is greater in Hong Kong Island than in Kowloon, and greater in Kowloon than in either New Kowloon or the New Territories. This pattern persists when we exclude the outlier mentioned above, though mean PCE and the standard deviation of ln(PCE) on Hong Kong Island are considerably reduced.

The survey results may be biased due to non-response, since wealthier people are less likely to respond. However, a supplementary survey of non-respondents did not reveal any differences in household characteristics

between those who did and those who did not respond. Households receiving public assistance, (who may well be the poorest group), were excluded from the survey. Table 8.3 shows variations in some household characteristics

Table 8.3

Summary of Household Characteristics

	All	HKI	K	NK	NT
% of households	100	27.5	23.1	32.7	16.7
Ave hh size	4.5	4.3	4.1	4.8	4.8
Ave # of earners	2.9	2.9	2.8	3.1	2.9
Ave # non-earners	1.6	1.4	1.4	1.6	1.9
ratio non to earners	0.6	0.6	0.6	0.6	0.8
% in public housing	37.8	15.6	5.8	67.0	61.3
hh in public housing as % of all hh	37.8	4.3	1.3	21.9	10.2

by census area. Household size is slightly larger in NK and NT. Nevertheless, the ratio of non-earners to earners is constant at 0.6 in HKI, K and NK, and only slightly higher in NT at 0.8. The most striking aspect of the table is the high concentration of public housing in NK and NT. More than three quarters of the households in public housing live in these areas. More than 60% of the households in NK and NT live in subsidized housing.

Table 8.4

Household characteristics by housing type

	hhs	#earn	#non	ratio	PCE-rent	PCE
Public	5.2	3.2	2.0	0.7	295.4	309.7
Private	4.0	2.7	1.3	0.6	514.2	711.6

Key: hhs is average household size, #earn is average number of earners per household, #non is average number of non-earners per household, ratio is the average ratio of non-earners to earners, PCE-rent is total household non-durable expenditure excluding rent, and PCE is total household per capita expenditure on non-durables.

Table 8.4 explores the housing issue further and compares household characteristics across housing type. Family size is 20% higher for households in public housing, but the dependency ratio is only slightly higher, while per capita total expenditures are less than half those of households living in private accommodation. Difference in per capita non-rent expenditures are less, but still substantial. Data on the sexes of the earners or on students are not displayed because they were not collected in the survey.

1. Travel Expenditures in Total

In this section we focus on the share of transport in total household budgets. Table 8.5 shows the composition of non-durable household expenditures by per capita expenditure groups. These figures are the means of the

Table 8.5

Structure of household expenditures by PCE rank
(Mean shares)

Pctile	Food	Housing	Fuel	Alc	Cl&F	Misc	Travel	Servs
00-05	61.2	10.9	5.0	3.4	3.3	4.6	4.7	6.9
05-10	60.0	12.0	4.5	2.9	3.4	5.0	4.6	7.6
10-20	57.0	12.5	4.0	3.1	5.1	5.2	4.9	8.2
20-30	53.9	13.5	3.7	2.8	4.7	6.0	5.3	10.1
30-40	51.4	14.0	3.6	3.2	5.4	5.9	6.4	10.0
40-50	49.7	15.6	3.6	2.9	6.7	5.1	5.5	11.0
50-60	47.8	17.8	3.3	2.8	6.8	5.6	6.0	10.0
60-70	45.9	18.0	3.0	2.7	7.4	6.1	6.1	10.8
70-80	40.7	21.4	3.1	2.6	8.1	6.1	5.9	12.1
80-90	37.3	22.7	3.0	2.2	9.9	6.1	5.5	13.2
90-95	33.4	28.7	2.4	2.2	8.3	6.6	5.2	13.4
95-100	22.5	37.5	2.1	1.2	8.9	6.5	7.7	13.6
All	47.2	18.0	3.4	2.7	6.6	5.7	5.7	10.6

Notes: Housing includes rent, fuel is fuel and light, Alc is alcohol and tobacco, CL&F is clothing and footwear, Travel excludes purchases of vehicles, and Servs is services. Shares are the means of shares of individual households within the decile or semi-decile, and total household non-durable expenditures is the base

shares of individual households, not the shares computed by dividing mean expenditures on the group by the mean of total household expenditures. Travel is defined net of vehicle purchases since the random timing of these purchases would introduce an element of spurious noise into the data. The mean share of transport overall is 5.7% and it increases only slowly with the level of household per capita expenditures. By way of contrast the shares spent on housing and on clothing and footwear triple between the lowest and the highest expenditure groups while, in accordance with Engel's Law, the food share falls from more than 60% to less than a quarter of the household budget. The mean food share of 47% reflects how much better off is Hong Kong than are Tunisia, Thailand, or Sri Lanka, the other countries from which expenditure surveys are analyzed in this report.

As we have seen, the poor live predominantly in the outlying areas; hence, they must spend a comparatively large share of their expenditures on travel. This conclusion is supported by Table 8.6 which displays household consumption patterns by census area. Mean shares of necessities such as

Table 8.6

Structure of household expenditures by census area
(Mean shares)

Area	Food	Housing	Fuel	Alc	Cl&F	Misc	Travel	Servs
HKI	41.4	24.0	3.5	2.1	7.0	5.9	5.3	10.8
K	43.5	25.0	3.1	2.4	6.0	5.2	4.6	10.2
NK	52.5	10.3	3.6	3.2	6.9	5.9	6.7	11.0
NT	52.0	13.4	3.6	3.2	6.0	5.8	5.8	10.1

Notes: see notes to Table 8.5 above.

food and fuel and light are higher in New Kowloon and in the New Territories which is what one would expect given the relative poverty of these areas.

The share of housing is about half as large in NK and NT as in HKI or K, reflecting the prevalence of subsidized housing in the outlying areas. The share of transport is highest in NK and NT, and while this must partly reflect greater distances traveled by people living in these areas, there is also a mechanical effect, whereby the housing subsidies and consequent low budget shares for housing inflate the others shares.

The budget shares given in the Tables are for all households, whether or not they spend anything on travel. Excluding households that spend nothing would make little difference since there are few such households; for all of Hong Kong, only 2.2% of households reported no expenditures on travel. Table 8.7 shows the breakdown of the percent of households spending various

Table 8.7

Fractions of households by PCE rank spending various budget shares on travel

Pctile	Shares					
	0	0-5	5-10	10-15	15-20	>20
00-05	9.5	58.3	23.2	4.2	4.2	0.6
05-10	3.6	54.8	27.7	11.5	1.8	0.6
10-20	3.1	52.2	35.0	8.0	0.8	1.0
20-30	2.1	46.4	40.1	9.0	2.1	0.3
30-40	2.4	43.6	38.9	12.5	1.2	1.4
40-50	2.2	49.2	34.8	11.2	1.9	0.7
50-60	1.5	43.7	39.1	9.5	4.9	1.5
60-70	1.2	46.0	40.1	8.4	1.9	2.4
70-80	1.4	46.1	35.8	10.1	3.3	3.3
80-90	1.3	49.4	32.4	11.2	3.0	2.8
90-95	2.1	52.9	32.0	10.3	1.2	1.6
95-100	0.6	45.5	29.2	12.2	5.3	7.2
All	2.2	48.0	35.2	10.0	2.6	2.0

shares on transport. Only among the poorest 5% of the population is there a significant fraction (9.5%) spending nothing on transport. It is also true that there are very few poor people who allocate more than 20% of their

expenditures to transport. The fraction spending greater than 10% of their budget rises very slowly from 9.0% for the lowest group to 13.1% for the second highest group, and then jumps to 24.7% for the top 5%. More generally, at all levels of living, more than three quarters of households spend something on travel but less than 10% of their budget.

Table 8.8 gives the breakdown of mean shares on travel by per capita

Table 8.8

Budget shares by PCE rank and census area

Pctile	HKI	K	NK	NT
00-05	3.6	0.9	5.1	5.7
05-10	4.6	1.9	5.7	4.9
10-20	4.4	3.1	6.0	5.2
20-30	4.4	4.8	6.3	5.0
30-40	5.6	6.9	6.8	6.3
40-50	5.0	3.8	6.2	6.5
50-60	5.6	4.3	7.8	6.0
60-70	5.2	5.4	7.1	6.6
70-80	5.0	4.8	7.9	7.3
80-90	5.3	4.7	6.7	6.0
90-95	4.8	4.7	6.8	5.3
95-100	8.2	6.3	8.5	7.7
All	5.3	4.6	6.7	5.8

expenditure groups and census areas. The percentiles of PCE in this table are those for Hong Kong as a whole, even though the columns are disaggregated by area, and this procedure will be used to define brackets throughout the chapter. The general pattern is that expenditure shares are highest in NK followed by NT, HKI, and K in descending order. For the poorest 5% shares are highest in NT, while for the highest 5% shares are higher in HKI than in NT. As for Hong Kong as a whole, there is a tendency in each of the areas for the travel share to rise slowly with levels of living. However, while the very poorest spend relatively little on travel and the richest

spend a good deal, the budget share devoted to travel is remarkably constant over the vast bulk of the PCE distribution.

2. Travel Expenditures by Mode

There is a varied menu of transport modes available in Hong Kong, though buses are by far the most commonly used. In 1979 there were 2770 franchised buses and coaches, and 2795 non-franchised private buses and private light buses. The non-franchised buses are used primarily for tourist sightseeing, transport of factory workers, and school buses. There were also 4350 mini-buses. Fares on buses are determined by route distance. In 1979 there were 8760 licensed taxis, 163 double-decker trams (with 20 single-deck trailers), 92 ferry vessels, a funicular cable tramway and a diesel railway running from Kowloon to Canton. A subway system, the Mass Transit Railway (MTR), began operations in October 1979, and by mid 1980 it was carrying a million passengers a day. At the end of 1979 there were 260,928 registered private vehicles and 634,791 driver's licenses.

Table 8.9 shows, by census area, the mean shares of these various modes in the per capita budget. Shares spent on public light buses are about twice as high in NK and NT as in HKI and K. Expenditures on the MTR occur mainly in K and NK, and trams are only non-negligible in HKI and K budgets. The analysis that follow aggregates modes into five groups: buses (bus, public light bus), taxi, other (MTR, school bus, ferry, tram, other fares), private (repairs and parts, fees, gas) and air. In Table 8.9, and in the same order, these groups account for 2.7%, 0.9%, 1.1%, 0.8% and 0.1% of total household expenditures. Buses, taxi, and other are the three public modes. Private, measures the recurrent costs of vehicle ownership.

Table 8.9

Budget shares on various modes by census area
(Percentages of total expenditure)

Area	Bus	Plb	Taxi	MTR	SB	Ferry	Tram	Oth	R&P	Fees	Gas	Air
All	1.4	1.3	0.9	0.4	0.1	0.2	0.1	0.3	0.1	0.5	0.2	0.1
HKI	1.5	0.9	0.9	0.1	0.1	0.2	0.2	0.2	0.1	0.6	0.3	0.2
K	1.1	0.9	1.1	0.3	0.1	0.1	0.0	0.3	0.1	0.4	0.2	0.2
NK	1.7	1.6	0.9	0.8	0.1	0.2	0.0	0.3	0.1	0.6	0.2	0.1
NT	1.4	2.2	0.9	0.1	0.1	0.2	0.0	0.3	0.0	0.4	0.3	0.0

Notes: Modes, where not obvious, are as follows: Plb is public light buses, MTR is the mass transit authority (subway), SB is school bus, Oth is other fares, R&P is repairs and parts, fees are expenditures for drivers licenses, parking, etc., gas is expenditures on gasoline, and air is expenditure on air tr vel. Share of a mode in total expenditure is not the same as the product of the share of the mode in travel expenditures and the share of travel expenditure in total expenditure; allowance has to be made for households spending nothing on travel.

Air is left as a separate category because an airline ticket is likely to be a large, non-recurrent expenditure, and because only very few households will ever spend anything on air travel.

Table 8.10 shows the mean shares of the transport budget spent on the five modes for all Hong Kong. The share of private expenditures rises with income, while the share of public transport falls. Actual mean expenditures rise with PCE for taxi, other, air and private modes. Expenditures on buses rise up to the 7th decile and then decline with PCE. Most of the increase in private expenditures and shares occurs between the nineteenth and twentieth semi-deciles, i.e. at the very top of the income distribution. Within public transport, the share of buses falls with income from 76% to 16%, while the share of taxis rises from 6.8% to 23.6%. Air travel is only a large share of travel (7.7%) among the top 5%. More is spent on buses than on any of the other modes by all but the top 10% of the PCE distribution. The overall picture is therefore one in which private

Table 8.10

Mean expenditures and budget shares by mode and PCE rank
Budget shares in brackets below expenditures

All Hong Kong

Pctile	Bus	Taxi	Other	Private	Air
00-05	24.5	2.3	8.8	0.2	0.0
	(75.7)	(6.8)	(16.1)	(1.5)	(0)
05-10	33.4	3.6	7.7	0.8	0.0
	(73.0)	(5.8)	(16.9)	(4.4)	(0)
10-20	38.4	8.6	8.4	1.4	0.0
	(70.0)	(13.7)	(13.9)	(2.4)	(0)
20-30	44.7	10.3	13.0	3.1	0.6
	(64.7)	(13.9)	(17.7)	(3.1)	(0.7)
30-40	51.9	12.9	16.9	9.1	0.2
	(63.3)	(12.5)	(18.8)	(5.1)	(0.3)
40-50	46.2	16.9	16.5	14.7	1.0
	(53.9)	(16.2)	(22.1)	(7.3)	(0.4)
50-60	54.3	17.4	22.8	13.3	0.8
	(54.5)	(15.6)	(22.6)	(6.8)	(0.5)
60-70	56.2	22.9	17.2	16.6	3.1
	(56.8)	(17.2)	(16.5)	(7.4)	(2.1)
70-80	47.8	26.0	21.8	30.9	2.4
	(48.9)	(19.9)	(19.1)	(11.3)	(0.8)
80-90	44.7	34.8	24.2	41.5	4.8
	(43.0)	(22.7)	(20.5)	(12.0)	(1.7)
90-95	39.0	45.9	24.5	50.7	8.9
	(34.7)	(27.5)	(20.1)	(15.3)	(2.3)
95-100	25.8	69.1	34.2	260.3	113.6
	(16.0)	(23.6)	(10.9)	(39.8)	(7.7)
All	44.6	21.0	17.8	28.7	7.4
	(55.2)	(16.5)	(18.3)	(8.7)	(1.3)

transport replaces public transport as income rises, while even within public transport, people switch from the slower, cheaper, and less comfortable buses to taxis which are faster, more comfortable and more expensive.

Tables 8.11 through 8.14 display the same information by census area. The major differences by modes of travel are the following:

1) For buses, the poorest have the lowest shares in HKI and the highest in

K. Actual mean expenditures for this group are lowest in K and highest in NT. In NK and NT the top 5% spend almost twice as much of their travel budget on buses as their counterparts in HKI and K. Mean expenditures follow the same pattern. For the middle income ranges the shares are similar across areas. Mean expenditures are highest in NT and NK and lowest in K.

Table 8.11

Mean expenditures and budget shares by mode and PCE rank
Budget shares in brackets below expenditures

Hong Kong Island

Pctile	Bus	Taxi	Other	Private	Air
00-05	21.4	4.2	2.2	0.2	0.0
	(67.9)	(14.7)	(10.7)	(6.7)	(0)
05-10	37.2	4.4	5.5	1.4	0.0
	(65.4)	(3.4)	(29.0)	(2.2)	(0)
10-20	39.1	5.6	9.1	0.4	0.0
	(65.4)	(16.8)	(16.3)	(1.5)	(0)
20-30	42.7	6.5	10.6	1.3	1.0
	(65.5)	(9.6)	(22.2)	(1.8)	(1.0)
30-40	41.6	6.9	16.2	5.7	0.0
	(66.5)	(7.7)	(22.6)	(3.2)	(0)
40-50	38.6	12.5	16.0	14.8	0.4
	(53.9)	(13.1)	(27.0)	(5.8)	(0.2)
50-60	55.9	17.4	21.4	7.4	1.4
	(51.0)	(14.0)	(29.1)	(5.0)	(0.8)
60-70	47.1	25.7	16.1	9.8	2.0
	(52.1)	(20.4)	(19.1)	(4.3)	(4.1)
70-80	54.7	25.6	20.0	15.6	1.2
	(51.9)	(19.8)	(19.2)	(8.1)	(1.0)
80-90	50.9	37.9	22.9	38.3	4.4
	(45.4)	(19.7)	(22.4)	(11.1)	(1.3)
90-95	45.1	46.6	18.0	56.8	4.9
	(40.1)	(29.8)	(13.4)	(15.3)	(1.5)
95-100	23.2	64.5	37.9	326.7	152.3
	(14.1)	(17.5)	(10.0)	(46.3)	(12.1)
All	43.5	24.6	18.6	46.8	16.5
	(50.7)	(16.3)	(20.5)	(10.3)	(2.2)

Table 8.12

Mean expenditures and budget shares by mode and PCE rank
Budget shares in brackets below expenditures

Kowloon

Pctile	Bus	Taxi	Other	Private	Air
00-05	5.6	0.7	0.3	0.1	0.0
	(92.1)	(3.3)	(2.1)	(2.5)	(0)
05-10	11.0	1.1	2.7	0.7	0.0
	(82.2)	(2.3)	(9.3)	(6.2)	(0)
10-20	29.2	6.0	4.7	1.9	0.0
	(62.0)	(16.9)	(17.3)	(3.7)	(0)
20-30	26.7	12.4	14.7	0.2	1.3
	(59.4)	(20.1)	(18.4)	(0.3)	(1.8)
30-40	61.4	26.8	14.1	0.3	0.0
	(58.1)	(23.2)	(16.6)	(2.2)	(0)
40-50	26.6	14.7	10.1	10.1	0.4
	(47.6)	(21.2)	(24.1)	(6.9)	(0.2)
50-60	38.0	10.7	13.3	3.9	0.3
	(58.8)	(17.0)	(19.5)	(4.7)	(0.1)
60-70	37.9	19.2	18.5	11.0	5.7
	(53.1)	(17.7)	(19.7)	(7.7)	(1.8)
70-80	34.4	26.4	18.9	31.4	0.0
	(45.6)	(25.2)	(17.8)	(11.4)	(0)
80-90	39.6	40.0	23.1	27.7	7.6
	(40.6)	(30.8)	(15.6)	(9.8)	(3.2)
90-95	35.2	57.0	27.1	38.1	2.9
	(29.1)	(31.3)	(24.6)	(13.9)	(1.1)
95-100	23.4	78.1	31.2	151.7	93.4
	(14.0)	(35.4)	(12.7)	(28.3)	(9.6)
All	33.9	25.9	16.5	22.9	7.8
	(49.2)	(22.9)	(18.0)	(8.4)	(1.5)

2) The share of travel expenditures devoted to taxis is highest in K, except for the poorest 10% and the top 5% of households. For the wealthy, the share of taxis is highest in NT. In general, mean expenditures are highest in K and HKI, and lowest in NT and NK. However, among the top 5% mean expenditures are highest in NT and K.

3) There is a good deal of noise in the mean shares of private expenditures, possibly because the survey missed some of the recurrent expenditures

connected with vehicle ownership, and possibly because of the relatively small sample sizes when disaggregation is done both by decile and census area. However, shares for the lowest 50% tend to be highest in NT. For the middle 50-90% they are highest in NT and NK. For the nineteenth semi-decile the share is highest in NT, while for the top 5%, the share is highest on HKI. Actual expenditures are also higher in NT for the bottom half of households. From 50 to 95% they are highest in NK. For the top

Table 8.13

Mean expenditures and budget shares by mode and PCE rank
Budget shares in brackets below expenditures

New Kowloon

Pctile	Bus	Taxi	Other	Private	Air
00-05	24.2	1.8	13.7	0.2	0.0
	(70.8)	(5.0)	(23.5)	(0.7)	(0)
05-10	37.4	4.7	14.1	0.8	0.0
	(70.2)	(8.8)	(18.5)	(2.5)	(0)
10-20	40.2	9.0	12.5	1.1	0.0
	(70.9)	(11.2)	(16.2)	(1.7)	(0)
20-30	48.9	11.4	18.4	4.7	0.1
	(60.2)	(15.3)	(21.1)	(3.3)	(0.2)
30-40	58.4	12.0	20.4	13.3	0.4
	(61.2)	(11.2)	(19.8)	(7.1)	(0.7)
40-50	60.7	15.4	21.6	12.4	1.2
	(57.5)	(13.8)	(20.8)	(7.5)	(0.4)
50-60	69.6	25.9	34.0	24.9	0.2
	(52.3)	(15.7)	(22.8)	(9.1)	(0.1)
60-70	68.3	24.7	20.1	29.9	4.3
	(58.6)	(15.0)	(14.7)	(10.0)	(1.7)
70-80	52.4	28.3	29.0	45.9	5.4
	(46.0)	(15.5)	(22.5)	(14.3)	(1.7)
80-90	44.6	34.5	31.8	69.1	2.6
	(39.1)	(21.9)	(22.4)	(15.4)	(1.1)
90-95	37.1	35.3	31.2	65.1	26.8
	(35.7)	(18.2)	(24.2)	(15.9)	(6.0)
95-100	35.7	59.2	34.1	293.8	26.1
	(26.2)	(16.8)	(12.9)	(41.8)	(2.4)
All	51.5	18.1	22.1	25.6	2.6
	(57.4)	(13.8)	(20.0)	(8.1)	(0.8)

Table 8.14

Mean expenditures and budget shares by mode and PCE rank
Budget shares in brackets below expenditures

New Territories

Pctile	Bus	Taxi	Other	Private	Air
00-05	32.4	2.6	7.7	0.2	0.0
	(81.0)	(6.7)	(11.7)	(0.6)	(0)
05-10	42.2	3.0	2.9	0.5	0.0
	(79.1)	(4.7)	(7.9)	(8.3)	(0)
10-20	42.2	12.3	4.5	2.1	0.0
	(78.0)	(13.0)	(5.5)	(3.5)	(0)
20-30	55.5	9.8	5.3	4.8	0.5
	(75.5)	(9.9)	(8.2)	(6.2)	(0.3)
30-40	42.5	10.6	12.4	13.1	0.0
	(68.7)	(12.7)	(12.2)	(6.4)	(0)
40-50	46.5	30.0	12.5	24.2	1.9
	(51.7)	(22.3)	(15.6)	(9.8)	(0.7)
50-60	49.2	11.6	18.5	15.6	2.4
	(57.2)	(15.7)	(16.7)	(8.6)	(1.9)
60-70	70.0	19.5	12.3	10.7	0.0
	(65.6)	(15.1)	(12.0)	(7.3)	(0)
70-80	59.9	18.3	16.7	36.6	6.7
	(59.7)	(14.2)	(12.5)	(13.2)	(0.6)
80-90	37.8	12.4	15.6	29.5	3.2
	(49.9)	(12.8)	(22.6)	(13.9)	(0.8)
90-95	32.4	11.9	24.7	42.4	9.6
	(32.9)	(23.6)	(20.3)	(20.6)	(2.6)
95-100	47.8	93.1	10.2	74.7	0.0
	(26.0)	(40.5)	(5.1)	(28.4)	(0)
All	47.8	14.1	10.4	13.0	1.2
	(66.7)	(13.4)	(11.8)	(7.6)	(0.4)

semi-decile expenditures are highest in HKI and NK and lowest in NT.

4) The share of other expenditures, is particularly low for the bottom 5% in K, and high for the same group in NK. The share of other is low overall in NT, perhaps because of lack of access to other modes. Actual expenditures are lowest overall in NT and highest in NK.

To summarize: As expenditures rise, household members in all four census areas spend less of their travel budget on buses, and more on taxis and

private transport. In NT and NK, household members switch to private transport at lower income levels than is the case in K or HKI, though the share of the budget devoted to buses remains high even among the relatively well-off, perhaps because of a lack of alternative modes. For all but the top 5% the dominant mode is bus, at least in terms of expenditures. Among the wealthy, the dominant mode is private in HKI and NK, and taxi in K and NT.

The fractions of households making any use at all of the various modes can be assessed from Table 8.15 which shows the per cent of households spending either zero or more than 20% of their travel budget on buses, taxis, and private modes for all Hong Kong. Even among the lowest 5%, there

Table 8.15

Percentages of households spending various shares of their travel budgets on buses, taxis, and private transport.

Pctile	----Buses------		-------Taxis------		Private transport	
	zero	>20%	zero	>20%	zero	>20%
00-05	5.9	90.1	74.3	14.5	84.2	4.6
05-10	5.6	88.8	66.9	13.8	75.0	5.0
10-20	4.8	91.5	56.2	21.0	73.7	3.7
20-30	4.3	89.0	50.4	24.5	72.8	3.5
30-40	2.2	88.9	46.1	23.4	67.2	7.0
40-50	5.6	83.9	42.9	30.0	64.6	10.0
50-60	3.7	85.5	37.7	29.0	60.1	12.1
60-70	1.5	83.7	33.5	32.3	57.5	12.9
70-80	4.3	78.2	30.2	34.0	52.3	18.1
80-90	3.9	68.9	24.9	44.9	46.4	24.3
90-95	9.2	55.2	23.9	47.3	44.8	29.7
95-100	17.0	21.5	18.3	33.4	19.6	64.4
All	5.2	77.4	39.5	30.3	58.5	16.4

Note: The total number of households is slightly different from that in Table 8.7 because the information in this table was not available for a small number of households. This accounts, for example, for the "fact" that 9.5% of the 0-5 group spend nothing on travel of any sort but only 6% of the group spend nothing on buses.

are only 6% who spend nothing on buses. This fraction drops off quite slowly for the higher expenditure groups, then rises to 9% and 17% for the top two categories. The fraction spending greater than 20% of their travel budget on buses declines slowly from 90% to 55%, and then drops to 22% for the top group. The proportion spending nothing on taxis drops smoothly from 74% to 18% as total expenditures rise. The fraction spending greater than 20% on taxis rises up to the second highest group, and then falls as the top 5% switch to private modes. The fraction of households spending nothing on private modes falls from 84% to 45% and then to 20% for the highest expenditure group. Correspondingly, the fraction spending more than 20% of their travel budget on private travel rises gently from 5% to 30%, and then doubles between the penultimate and ultimate expenditure brackets.

Unfortunately there is no direct measure of vehicle ownership in the survey. While purchases are recorded, these are highly irregular and tell us very little about the underlying ownership patterns. The survey reports whether or not there is household expenditure on a driving licence and on car insurance. As we have already reported, there are three times as many driver's licenses as registered vehicles in Hong Kong. Hence we have chosen to use the non-zero expenditure on car insurance as an indicator of vehicle ownership. We realize that this is not a perfect measure even of car ownership, and it excludes ownership of bicycles, motor cycles, and other vehicles. Furthermore the simple correlation in the sample between a dummy variable for owning a driver's licence and a dummy for car insurance is only 0.4; this is consistent with the supposition that there are many licensed drivers who do not own cars. However, the figures given below are in apparently close agreement with those given in Transpotech (1985, Table 5.5.)

Table 8.16 shows the percent of households with non-zero expenditures on car insurance by PCE and census area. The pattern is consistent with the

Table 8.16

Fractions of households recording car insurance payments

Pctile	Hong Kong	HKI	K	NK	NT
00-05	0.0	0.0	0.0	0.0	0.0
05-10	0.3	0.0	0.0	0.8	0.0
10-20	1.4	0.0	0.3	1.3	3.2
20-30	1.7	0.0	0.0	2.3	3.9
30-40	3.2	0.7	0.0	4.8	6.3
40-50	5.8	5.8	7.0	3.5	9.5
50-60	7.2	5.6	4.4	10.3	8.3
60-70	4.8	3.0	5.7	5.0	6.4
70-80	8.8	6.3	5.3	14.9	11.0
80-90	12.6	12.8	11.0	14.8	11.0
90-95	18.8	20.5	16.4	16.7	30.0
95-100	47.3	53.0	36.2	52.3	37.3
All	7.9	10.4	7.3	6.8	6.4

analysis of shares of private modes given above, and which showed residents of NT and NK turning to private travel at lower income levels than was the case in HKI or K. For the bottom 70% of the sample, the percent spending anything on car insurance tends to be greatest in NT with Nk close behind. In the next two deciles the percentages are highest in NK, while for the top 10% they are highest in HKI. Even in the ninth decile, only 12.6% of households record any expenditure on car insurance, though nearly half of those in the top twentieth of the distribution do so.

3. Summary Regression Results

Tables 8.17 and 8.18 show what we label short-run and long-run travel regressions. The former includes the dummy for car insurance, interpreted as a dummy variable for the presence of a motor car in the household.

Table 8.17

Short-run travel regressions

	All T'pt	Private	Public	Buses	Taxis	Other	Air
constant	-12.2	-3.4	-11.2	-1.7	-9.3	-0.1	2.4
	(4.0)	(1.9)	(4.7)	(1.0)	(8.0)	(0.1)	(2.4)
ln(PCE)	4.3	1.0	4.4	1.4	2.7	0.3	-1.1
	(4.6)	(1.8)	(6.0)	(2.8)	(7.5)	(0.8)	(3.5)
$\ln(PCE)^2$	-0.3	-0.1	-0.3	-0.2	-0.2	-.03	0.1
	(3.9)	(1.4)	(6.0)	(3.8)	(5.8)	(1.0)	(4.7)
Earners	0.5	.04	0.5	0.4	-.02	0.1	-.03
	(6.2)	(1.0)	(7.8)	(10.)	(0.7)	(2.1)	(1.0)
Non earners	-.02	-.04	-.00	-.04	0.1	-0.1	.02
	(0.4)	(1.2)	(0.1)	(1.0)	(3.4)	(2.2)	(1.2)
HKI	-0.3	0.1	-0.3	-0.4	-0.2	0.2	.03
	(1.2)	(0.5)	(2.0)	(3.2)	(1.8)	(2.3)	(0.5)
K	-0.5	-0.1	-0.5	-0.7	0.1	0.1	0.1
	(2.2)	(0.7)	(2.7)	(5.7)	(1.1)	(1.5)	(0.7)
NK	0.4	0.2	0.2	0.4	-.04	0.6	.03
	(2.1)	(2.1)	(1.0)	(3.9)	(0.6)	(8.2)	(0.5)
one man	0.5	0.1	0.6	1.2	-0.5	-.04	-0.2
	(1.2)	(0.5)	(2.0)	(5.5)	(3.6)	(0.3)	(1.9)
one woman	-1.2	-0.2	-0.9	-0.3	.05	-0.6	-0.1
	(2.1)	(0.6)	(2.1)	(1.0)	(0.2)	(3.0)	(0.7)
head + spouse	0.3	0.2	0.5	0.3	0.1	-.00	-.02
	(0.8)	(1.0)	(1.9)	(1.9)	(1.0)	(0.0)	(0.2)
head + child	.03	-0.2	0.4	0.5	-0.1	-0.1	-0.1
	(0.1)	(0.6)	(0.8)	(1.7)	(0.6)	(0.3)	(0.7)
head + 2 children	-0.5	-0.7	0.2	0.3	-0.3	0.2	-0.1
	(1.0)	(2.2)	(0.5)	(1.2)	(1.7)	(1.0)	(0.4)
head + 3 children	0.9	-0.2	1.1	0.2	0.5	0.4	-.02
	(2.3)	(1.0)	(3.8)	(1.2)	(3.3)	(2.6)	(0.1)
head, spouse + child	0.1	-0.1	0.2	0.1	0.2	-0.1	0.1
	(0.5)	(0.8)	(0.8)	(0.6)	(1.6)	(0.9)	(0.9)
head, spouse +>2 child	-.00	-0.1	.05	.03	-.01	.04	.00
	(0.0)	(0.4)	(0.2)	(0.2)	(0.1)	(0.4)	(0.0)
head, children, others	-0.5	-0.1	-0.3	-0.2	-0.2	.04	-.01
	(1.3)	(0.4)	(1.2)	(0.8)	(1.4)	(0.3)	(0.5)
head, spouse, ch+others	0.1	-0.3	0.4	0.2	0.1	.04	-0.1
	(0.2)	(1.7)	(1.8)	(1.3)	(1.4)	(0.4)	(0.7)
head + others	0.6	0.1	0.4	0.6	-.03	-0.2	0.2
	(1.9)	(0.3)	(1.5)	(3.2)	(0.2)	(1.3)	(1.6)
Public housing	1.9	0.2	1.6	1.3	0.3	.02	0.1
	(11.)	(1.9)	(12.0)	(14.1)	(4.1)	(0.3)	(1.1)
Car insurance	5.4	7.0	-1.8	-1.1	-0.5	-0.2	0.2
	(20.4)	(45.7)	(8.9)	(7.4)	(5.4)	(2.2)	(2.9)
Elasticity	1.1	0.7	1.2	0.6	1.3	0.9	2.1
F-test lnPCE	16.7	5.5	18.3	32.6	93.9	1.4	49.6

Notes: See Table 8.18.

Table 8.18
Long-run travel regressions

Dependent variable is share in total expenditure of:

	All T'pt	Private	Public	Buses	Taxis	Other	Air
constant	-13.1	-4.6	-10.8	-1.5	-9.2	-0.1	2.4
	(4.1)	(2.1)	(4.5)	(0.9)	(7.9)	(0.1)	(2.4)
ln(PCE)	3.9	0.5	4.5	1.5	2.7	0.3	-1.1
	(4.0)	(0.7)	(6.2)	(2.9)	(7.6)	(0.9)	(3.5)
$\ln(PCE)^2$	-0.2	0.1	-0.4	-0.2	-0.2	-.03	0.1
	(2.4)	(1.5)	(6.6)	(4.3)	(6.2)	(1.2)	(4.9)
Earners	0.5	0.1	0.5	0.4	-.02	0.1	-.03
	(6.1)	(1.0)	(7.6)	(9.9)	(0.7)	(2.1)	(1.0)
Non earners	0.1	0.1	-.05	-0.1	0.1	-0.1	.03
	(1.7)	(2.9)	(1.0)	(1.8)	(3.0)	(2.4)	(1.5)
HKI	-0.4	-0.2	-0.3	-0.3	-0.1	0.2	.03
	(1.8)	(1.0)	(1.7)	(2.9)	(1.6)	(2.3)	(0.4)
K	-0.7	-0.4	-0.4	-0.7	0.1	0.1	.04
	(3.1)	(2.4)	(2.2)	(5.3)	(1.4)	(1.6)	(0.6)
NK	0.4	0.2	0.2	-0.4	-.04	0.6	.03
	(2.0)	(1.6)	(1.0)	(3.9)	(0.5)	(8.2)	(0.5)
one man	.02	-0.5	0.7	1.3	-0.5	-.02	-0.3
	(0.0)	(1.7)	(2.4)	(5.9)	(3.3)	(0.2)	(2.0)
one woman	-1.9	-1.1	-0.6	-0.2	0.1	-0.6	-0.1
	(3.3)	(2.9)	(1.5)	(0.5)	(0.6)	(2.8)	(0.9)
head + spouse	-0.1	-0.6	0.6	0.4	0.2	.01	-.04
	(0.2)	(2.7)	(2.3)	(2.3)	(1.3)	(0.1)	(0.5)
head + child	-0.3	-0.7	0.5	0.6	-0.1	-0.1	-0.2
	(0.5)	(1.6)	(1.0)	(1.9)	(0.4)	(0.2)	(0.8)
head + 2 children	-0.7	-0.9	0.3	0.4	-0.3	0.2	-0.1
	(1.4)	(2.5)	(0.7)	(1.3)	(1.6)	(1.1)	(0.5)
head + 3 children	0.5	-0.7	1.2	0.3	0.5	0.4	-.03
	(1.3)	(2.6)	(4.2)	(1.5)	(3.6)	(2.8)	(0.3)
head, spouse + child	-0.2	-0.5	0.3	0.2	0.2	-0.1	0.1
	(0.5)	(2.5)	(1.2)	(1.0)	(1.9)	(0.8)	(0.8)
head, spouse +>2 child	-0.3	-0.4	0.1	0.1	.01	.05	-.01
	(1.1)	(2.3)	(0.7)	(0.6)	(0.1)	(0.5)	(0.1)
head, children, others	-0.7	-0.4	-0.3	-0.1	-0.2	.04	-0.1
	(1.8)	(1.4)	(0.9)	(0.6)	(1.3)	(0.3)	(0.6)
head, spouse, ch+others	-0.1	-0.4	0.4	0.2	0.2	.05	-0.1
	(0.3)	(2.3)	(2.0)	(1.4)	(1.6)	(0.5)	(0.8)
head + others	0.2	-0.4	0.5	0.7	.01	-0.1	0.2
	(0.7)	(1.9)	(2.0)	(3.6)	(0.1)	(1.2)	(1.5)
Public housing	1.8	0.1	1.7	1.4	0.3	.02	0.1
	(9.9)	(1.0)	(12.0)	(14.1)	(4.1)	(0.3)	(1.1)
Elasticity	1.3	3.1	0.9	0.7	1.3	0.9	2.1
F-test lnPCE	79.2	144.6	26.5	64.2	79.9	3.3	68.4

Notes: All variables from HKI on are dummy variables equal to 1 if the descriptor is true. The elasticity is the total expenditure elasticity at the mean, and the F for joint significance of the two PCE terms.

Hence, while Table 8.18 is to be interpreted as showing the total effects of the regressors on travel expenditures, including the eventual effects that work through changes in car ownership, Table 8.17 shows the same effects holding car ownership fixed. The numbers are not inconsistent with this interpretation. The penultimate rows of each table show the total expenditure elasticities of each form of travel. In Table 8.17, the short-run elasticities of expenditures on travel, private travel, and public travel are estimated to be 1.1, 0.7 and 1.2 respectively (evaluated at the mean shares of total expenditures). The corresponding long-run elasticities in Table 8.18, which attempt to take into account effects on vehicle ownership, are estimated to be 1.3, 3.1, and 0.9. Long-run elasticities are higher for total travel and for private travel, and lower for public travel reflecting the substitution of private for public transport with vehicle ownership as real incomes rise. In general, most differences in parameter estimates between the two tables can be accounted for by the underlying relationship between vehicle ownership and the regressors.

In reading these tables, it is helpful to note that total transport is the sum of private, public and air, so that the parameter estimates in column 1 are the sum of those in columns 2, 3 and 7. Similarly, expenditure on public transport is the sum of expenditures on buses, taxis and others, so that column 3 is equal to the sum of columns 4, 5 and 6. Hence, to take an example from Table 8.17, holding PCE and other factors constant, an additional earner in the household will increase the total budget share devoted to travel by half a point, and essentially all of this goes to public transport, 0.5 as opposed to 0.04. The additional expenditure is split four to one between buses and other modes. Table 8.18 shows that, for

this variable, not conditioning on car ownership makes very little difference, although the effect on private transport is a little larger.

Figure 8.2 at the end of the Chapter shows the estimated relationship between (the logarithm of) PCE and the shares of expenditure devoted to public and private transport, as well as their sum. (Note that total travel is equal to this sum plus air travel.) The graphs are calculated from Table 8.18, the long-run regressions, so that the shares reflect the changing patterns of car ownership as PCE increases as well as the direct effects of PCE itself. The figure shows that the budget share of public transport increases slowly with PCE for relatively poor households, but declines rapidly for better-off households. The share of the budget going to private transport increases steadily, as does the total share of travel in the budget.

As we have already seen, the number of earners increases expenditures on public transport, largely buses, in both the short and long runs. The number of non-earners increases the share devoted to taxis and decreases the share devoted to other under both time horizons while, in the long-run regressions, the presence of non-earners also increases the share devoted to private modes. The explanation of these effects is not immediately obvious, given that expenditures and family composition are controlled for elsewhere in the regression. One possibility is that households with large numbers of non-earners are wealthier than those with few, so that the number of non-earners is a proxy for wealth.

The dummy for car insurance in the short run regressions has the expected sign: positive in the travel, private, and air equations, and negative in all the equations representing public modes. The area dummies are also consistent with the cross tabulations presented above. Relative to the omitted

area of NT, households in HKI spend smaller shares on public modes, especially buses, but correspondingly more on the other category. Households in K spend lower shares on travel, and on public modes, particularly buses. Households in NK spend slightly larger shares on travel, on private modes, on other, and on buses. In the long-run the results are similar except that households in K spend significantly lower shares on private modes.

For the demographic variables, the control household for which there is no dummy variable is composed of a head, a spouse, and two children. Relative to this group, single men are more likely to take public modes, especially buses, in the short-run. They are less likely to take taxis. Single women are significantly less apt to have a large travel share, or to use public modes, or other. Among the remaining household groups, the big difference in the short-run is between those with a head only, and those which include a head and spouse, or a head and other adults. Households with a head and two children are significantly less likely to spend large shares on private modes than the control. Heads with three or more children spend larger shares on transport, and on public modes, particularly on taxis and other. The composition of travel expenditures for the other groups is not significantly different from the control, except that households with a head and other adults spend a larger share on buses. In the long-run, the pattern is similar except that most households are less likely to spend large shares on private modes than those in the control group. Those least likely to spend on private modes are, (in decreasing order): single women, a head and two children, a head with any other number of children, and a head and spouse or a single man. This pattern may reflect a dichotomy between female-headed, and male-headed households. Unfortunately, it is not

possible to determine the sex of the household head from the survey data.

The last variable considered here is a dummy that is equal to one if the household is in public housing and is zero otherwise. In both the short and long-run this coefficient is positive and significant for shares on travel, public buses, and taxis even though total expenditure, area, and household composition are controlled for in the regression. One possibility is that households in public housing receive subsidized housing, the value of which is not fully incorporated into their PCE figures. To test this hypothesis we ran the same regressions with the logarithm of per capita non-rent expenditure and its square as independent variables in place of ln(PCE) and its square. The coefficients on the public housing dummy were remarkably similar to those reported above. The only difference was that the coefficient on taxi was reduced to about 0.1, and was not significant in the short-run regressions. We also tested to see whether including 21 dummies for the census districts (rather than 3 dummies for census areas) would weaken the effect of housing type. Once again the coefficients were close to those reported above, except that the housing dummy became significant in the short-run private regression. Finally, we used both effective expenditures and the 21 district dummies in a set of regressions. In the equations for total travel and for taxi, the coefficients on the housing dummy were somewhat smaller than those reported above. In the short-run taxi equation it was not significant. In the long-run private equation the coefficient was negative (-.3) and significant. It therefore appears that housing type has a strong effect on travel shares which cannot be ascribed to either the subsidy effect or to the effects of the geographical areas in which public housing is located.

We were somewhat surprised that the number of children did not seem to have any effect on shares, even given the somewhat artificial variables that we have to use to represent household composition. Interactions between the logarithm of PCE and the household composition dummies were added, in order to try to isolate further the pure effect of household composition. The results did not add anything to the story given above.

Table 8.19 shows the results of estimating a logit model for the presence of non-zero expenditure on car insurance. The results are broadly consistent with those described above. Higher per capita expenditures increase the likelihood of a household purchasing car insurance. The number of earners has a positive effect, but the number of non-earners has an effect four times as large. When other factors are controlled for, households in HKI, NK and K are less likely to purchase car insurance than

Table 8.19

Logistic model for car insurance dummy

	coeff	χ^2		coeff	χ^2
constant	-29.9	68.8	head+spouse+c	-0.6	6.4
ln PCE	6.2	38.7	head+s+>2c.	-0.1	0.5
ln PCE^2	-0.3	15.6	head+c+others	-0.3	0.7
earners	0.1	3.9	head+s+c+others	-0.2	0.6
non-earners	0.4	50.2	head+others	-1.3	15.2
HKI	-0.7	12.4	ec. inactive	-0.4	0.3
K	-0.5	6.6	professional	0.4	0.2
NK	-0.1	0.4	managerial	-0.1	.03
one man	-1.5	12.9	clerical	-0.2	0.1
one woman	-2.1	14.7	sales	-0.4	0.2
head+spouse	-0.9	10.5	services	.04	0
head+child	-1.2	4.4	laborers	-0.6	0.5
head+2c.	0.3	0.5	public housing	-.02	.01
head+>2c.	-1.1	4.3			

Model Chi-squared is 987 with 26 d.f., compared with critical value at 5% of 3.2. Likelihood ratio test of joint significance of both PCE terms gives a chi squared of 507. Unlike the other regressions, this logit was estimated using data unweighted for sample stratification.

households in the control, NT. Households that are least likely to purchase insurance are, in order, single women, single men, a head and others, a head and 1 or 3 or more children, and a head and spouse. Occupational categories did not have any impact on the probability of purchase, nor did the dummy for public housing. Note that, as for the other countries, there is essentially no possibility of being able to estimate a structural model of vehicle ownership on the one hand and transport expenditures on the other. Even if it were plausible to suppose a priori that the occupational variables affected ownership but did not influence mode choice conditional on ownership, the results in Table 8.19 would imply that such restrictions would not be sufficient to identify the model.

4. Summary of empirical findings

The territory of Hong Kong has the highest living standards of any of the locations studied in this report. It has a per capita income level some ten times greater than that of the poorest country, Sri Lanka, and other indicators, such as the share of household budgets devoted to food, confirm this relative affluence. It is also predominately urban, and the survey used here was confined to urban households. In consequence, the patterns of travel expenditures are those of an affluent urban community, at least by the standards of developing countries. The survey we have analyzed reveals the following main facts:-

(i) Households in Hong Kong devote some 5.7% of their total expenditures to travel, a fraction that excludes purchases of vehicles from both numerator and denominator. Although this fraction increases from 4.6% among the poorest 5% of the population to 7.5% for the top 5% of the distribution,

only the very wealthy spend more than 5% of their budgets, so that, for the vast majority of households, the share devoted to travel is approximately constant independent of living standards. We estimate the total expenditure elasticity of total travel expenditures to be 1.1 conditional on car ownership, or 1.3 unconditionally, so that the econometric analysis suggests that there is some increase in the share with the budget.

(ii) In Hong Kong, in contrast to Jaipur and the model used to describe the Jaipur results, richer households tend to be located closer to the center, particularly on Hong Kong Island, while many poorer households live in the New Territories or New Kowloon, typically at some considerable distance from the center. In consequence, the highest budget shares devoted to travel are observed in New Kowloon and the New Territories.

(iii) In this urban and relatively affluent environment, only two percent of households report no expenditure on travel. Even in the poorest decile of per capita total household expenditure, only 10% of households spend nothing on travel.

(iv) As in the other chapters, there are few households, particularly poor households, that spend large fractions of their budgets on travel. Only 9% of households in the lowest decile report travel expenditures in excess of ten percent of their total household expenditure. In higher deciles, more households are in this category, until nearly a quarter of the households in the top semi-decile devote more than ten percent of the budget to travel, but this is mostly on private modes, and is clearly a voluntary consumption decision by affluent households.

(v) There is a wide range of transport modes in Hong Kong. Even so, buses account for 55% of personal travel expenditures, with taxis taking up

another 17% Private modes, excluding vehicle purchase, take up 9% of the budget. For the poorest households, about 75% of travel expenditures are bus fares, a figure that falls to 35% for households in the top decile. Over the same range, taxi fares rise from 7% to almost a quarter of the budget, and expenditure on private modes from a negligible fraction to 28% of the budget. The absolute level of expenditure on buses rises with levels of living up to the 70th percentile, and thereafter falls. The constancy of the travel share over much of the income distribution is therefore a consequence of a falling share of public transport being replaced by a rising share of private. Within public transport, there is a further switch from buses towards taxis. In the two most distant regions, New Territories and New Kowloon, the switch to private transport takes place at lower income levels than is the case in Hong Kong Island or Kowloon, though the share of expenditures accounted for by bus fares remains high at all income levels.

(vi) Ninety-five percent of households record some expenditure on bus fares. Among the poorest this fraction is 94%, it rises to 98.5% at the seventh decile, then falls again to 83% in the top five percentiles. Sixty percent of households record taxi expenditures, but only 42% register any expenditure on private modes.

(vii) About eight percent of Hong Kong households own cars, a fraction that is a little higher (10%) on Hong Kong Island. Car ownership reaches nearly 50% among the top five percentiles, and about one third in the top decile as a whole. Once income level is allowed for, car ownership levels are lower in Hong Kong Island and Kowloon than elsewhere. Household composition influences car ownership with the presence of children predisposing towards ownership, while single person households, or households with a head and

children but no spouse are particularly unlikely to own a car. We could detect no effects of occupation on car-ownership status.

(viii) We estimate total expenditure elasticities for various travel modes as follows: in the short-run, i.e. holding car-ownership constant, public transport expenditures have an elasticity of 1.2. private 0.7, bus 0.6, and taxi 1.3. When car ownership is allowed to adjust, the elasticity of private travel rises to 3.1, while that of public transport falls to 0.9. The long run elasticity for bus travel is estimated to be 0.7 and that for taxis, at 1.3, is the same as in the short run. Given per capita total household expenditure, additional earners generate additional travel expenditure, particularly on buses. When other factors are allowed for, most of the geographical distribution of total travel shares is accounted for, though there is still a small negative effect for Kowloon. However, there are still effects of area on the distribution across modes, with travellers from New Kowloon and the New Territories relying more heavily on buses. Households living in subsidized public housing spend more on travel, and this appears not to be a mechanical effect of the reduction in total expenditure and in housing expenditure that results from the subsidy.

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Chapter 9

Travel expenditures in Sri Lanka, 1980 to 1981

0. General Background

The Sri Lankan Labour Force and Socio-economic Survey was carried out by the Department of Census and Statistics in four rounds from May 1980 through April 1981 and sampled 10,368 households. Data were collected on household demographic and labour force characteristics, expenditures, and sources and amounts of income. Expenditure data were collected only in rounds three and four (October to December 1980 and January to April 1981) and the analysis is therefore limited to those 5035 households that were sampled during that period. These households represent a population estimated to comprise 3.02 million households and 15.6 million people. The survey documentation, however, reports 3.06 million households. The difference arises because we deleted 147 households; three because their expenditure data did not seem sensible and the rest because they appeared to be duplicates. The reason for this duplication is unclear, although we suspect that these households may have been duplicated in an attempt to replace households that dropped out of the survey. Expenditure data were collected using interviews, with recall periods which varied from the previous week for food, to the preceding month for travel, to the previous year for durables. Whatever the reporting period, all figures are quoted in rupees per month.

According to standard measures, Sri Lanka is a very poor country. The national accounts report that mean annual per capita expenditure in 1980 was Rupees 4,000, or approximately US$250 at the 1980 exchange rate of $0.064 for one rupee. Using the survey data we compute mean PCE to be only R2,682. Part of the discrepancy is because our definition of PCE excludes the

"noisy" expenditures, i.e. durables, large medical expenses, and large expenditures on ceremonies. Durables, however, make up only 4% of total expenditures, so a large discrepancy remains between the national accounts data and the survey figures, again see Bhalla and Glewwe (1985) and Thomas (1986) for a discussion. We have no way of telling which figure is correct, or whether either one is, though there is little doubt that the expenditure figures in the survey are too low. There is nothing that we can do about this, except to hope that understatement is roughly proportional to true expenditures, so that relationships involving logarithms will be unaffected. Thomas (1986) compares the survey estimates of total consumer expenditure and its composition with figures for 1976 and 1978 published by the Sri Lankan Central Bank and finds that, in spite of the apparent underestimation of the total, the shares of expenditure devoted to food and to transport look very similar in the two sources.

The growth rate of per capita GNP between 1960 and 1980 was 0.2% per annum. Relative to other countries with similar levels of PCE, Sri Lanka is noted for a low level of inequality, a high level of health services, low infant mortality (44/1000), high life expectancy (66 years), and a high level of education (85% of adults are literate).

The sample is stratified according to district, and "sector." Two of these sectors, rural and urban, are standard, while the third, the estates sector, is specific to Sri Lanka. The estates are largely, though not exclusively, tea estates, and those who live and work there are of Indian Tamil origin. They are ethnically distinct not only from the Sinhalese who make up the majority of the rest of the population of the island, but also from other Tamils who have been an established minority for many centuries.

Although workers on the estates are provided with housing of sorts, conditions and standards of living are poor, and health and life-expectancy indicators are worse than for other groups. In the survey, 18% of households are urban, (slightly more than the population share) and 6% work on estates. We report results weighted by the inverse of the sampling probability, although the effects of weighting are not very great. The breakdown of the island by sectors will prove to be important in the analysis below as will the standard decomposition by deciles and semi-deciles of PCE.

Table 9.1 summarizes income, expenditure and demographic data for the whole island and for each sector. Mean PCE is highest in urban areas and lowest on the estates, while inequality is inversely related to PCE across sectors.

Table 9.1

Household characteristics by sector: Sri Lanka 1980-1

	All	Urban	Rural	Estates
Mean PCE	255.5	322.5	241.7	218.6
Standard Deviation (lnPCE)	0.52	0.61	0.50	0.42
Household size	5.2	5.4	5.1	4.6
# adults	3.2	3.5	3.2	2.9
# children	1.9	1.9	2.0	1.8
0 - 5	0.7	0.7	0.7	0.7
5 -15	1.2	1.2	1.3	1.1
# students	0.9	0.9	0.9	0.5
# earners	1.6	1.5	1.6	2.1
total h'holds (millions)	3.016	0.567	2.267	0.183
(percent)		18.8%	75.2%	6.1%

The standard deviation of ln PCE is 0.419 on the estates and 0.608 in urban areas. More detailed tabulations of the PCE distribution show that there are relatively few of the poorest households in the urban areas, and re-

latively many on the estates, while the reverse is true for the top third of the distribution. Household size is lowest on the estates, is larger in urban than in rural areas and most of this intersectoral difference is attributable to variation in the numbers of adults in the household since the number of children is relatively constant across sectors. The number of earners is highest on estates and lowest in the cities, so that the ratio of earners to adults is much higher on the estates than in the other two sectors. The ratio of students to children aged 5-15 is 0.7 in urban and rural areas but is only 0.5 on the estates. (Of course all children this age are not students and not all students fall in this age group.)

Table 9.2 shows the distribution of households by industry of household head and by sector. Although the industry data are missing for 22% of households, we use this rather than occupational data because the latter,

Table 9.2

Distribution of primary industries of household heads by sector

	All	Urban	Rural	Estate
Agriculture	38.7	8.2	43.0	80.1
Manufacturing	6.6	9.6	6.2	1.5
Distribution	8.3	17.4	6.6	0.8
Transportation	4.1	8.3	3.4	0.7
Finance	0.8	2.1	0.5	0.0
Social sector	8.2	14.2	7.2	1.7
Other	11.3	11.1	12.2	1.1
Missing	22.0	29.1	20.9	14.2
Total	100	100	100	100

although available, appear to be unreliable. The major industries are (in decreasing order of employment) agriculture, other, distribution, services, and manufacturing. Other includes all industries that were not "adequately defined" in the survey, including the informal sector), as well as energy,

construction and mining. Distribution, services, and finance are primarily urban industries. Manufacturing only accounts for 9.6% of urban heads, while 8% of urban heads list agriculture as their industry of employment. Agriculture predominates in the rural areas, followed by other, services, and distribution. The percent of heads in manufacturing is only a little lower than in urban areas at 6.2%. On the Estates, 80% list agriculture as their industry and it is very likely that most of the 14% in the "missing" category are also in the agricultural sector.

Table 9.3 displays mean shares of household expenditures by PCE for the whole of Sri Lanka, and Table 9.4 gives the same information by sector. As usual, the shares given in the Tables are the means of the individual budget

Table 9.3
Expenditure shares by PCE group: All Island

Pct	Food	Alc	Hous	Fuel	Cloth	Rec	Med	Comm	Other	Travel
1-5	76.6	3.7	3.7	8.0	2.5	0.6	1.4	0.0	2.1	1.4
6-10	75.4	3.9	3.6	7.5	2.8	0.8	1.9	0.1	2.1	1.9
10-20	75.8	4.1	3.5	6.9	3.0	0.8	2.0	0.0	2.0	1.8
20-30	74.4	4.6	3.6	6.9	3.3	0.8	2.1	0.0	2.3	2.0
30-40	73.9	4.4	3.7	6.5	3.6	1.0	2.3	0.1	2.3	2.2
40-50	72.8	4.5	4.2	6.5	3.7	1.1	2.5	0.1	2.3	2.2
50-60	71.8	4.7	4.0	6.1	3.8	1.4	2.9	0.1	2.5	2.7
60-70	69.7	5.0	4.5	6.2	4.6	1.5	2.9	0.1	2.7	2.9
70-80	67.9	4.7	4.9	6.0	4.5	1.9	3.1	0.1	3.2	3.8
80-90	64.6	5.2	5.8	5.4	5.0	2.5	3.5	0.1	3.4	4.5
90-95	59.2	5.6	7.1	5.2	5.4	2.9	3.7	0.2	4.4	6.3
95-100	49.2	4.3	10.1	4.1	5.6	3.8	3.8	0.5	7.4	11.0
All	70.2	4.6	4.6	6.3	4.0	1.5	2.7	0.1	2.9	3.2

Key:- Alc is alcoholic beverages, Hous is housing, Cloth is clothing, Rec is recreation, Med is medical, Comm is communication.

shares, not the shares of average expenditure on the good in average total expenditure. The decile limits for PCE are defined at the "All Island"

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Table 9.4

Expenditure shares by PCE group and sector

Pct	Food	Alc	Hous	Fuel	Cloth	Rec	Med	Comm	Other	Travel
					URBAN AREAS					
1-5	77.9	2.7	4.4	9.0	1.3	0.3	1.2	0.0	2.0	1.1
6-10	75.8	3.3	4.4	8.2	2.5	0.6	1.2	0.0	2.3	1.7
10-20	76.6	3.3	4.6	6.3	2.9	0.7	1.6	0.0	1.9	1.9
20-30	74.9	3.8	5.0	6.6	2.4	0.5	2.0	0.0	2.4	2.3
30-40	74.0	3.7	5.2	6.4	2.9	1.2	2.0	0.1	2.4	2.1
40-50	72.9	4.8	4.9	6.6	3.0	1.7	2.1	0.1	1.9	2.1
50-60	71.6	4.0	5.4	6.0	3.4	1.8	2.4	0.1	2.4	2.9
60-70	68.4	4.1	6.0	6.0	4.7	2.1	2.7	0.2	2.7	3.1
70-80	67.4	3.8	7.1	5.0	2.8	2.1	3.1	0.2	3.8	4.7
80-90	62.1	4.7	8.3	4.9	4.8	3.0	3.7	0.2	2.7	5.6
90-95	56.8	4.9	10.3	4.3	5.4	4.2	3.4	0.3	3.8	6.5
95-100	45.6	2.5	15.5	3.8	5.3	4.3	3.4	0.8	7.2	11.5
All	66.7	3.9	7.4	5.7	3.7	2.2	2.6	0.2	3.2	4.4
					RURAL AREAS					
1-5	76.6	3.7	3.5	7.8	2.6	0.7	1.4	0.0	2.2	1.4
5-10	75.2	4.1	3.4	7.5	2.9	0.9	2.0	0.1	2.0	2.0
10-20	75.8	4.1	3.3	7.5	3.0	0.8	2.0	0.0	2.0	2.0
20-30	74.4	4.7	3.4	6.9	3.2	0.8	2.1	0.0	2.3	2.0
30-40	73.7	4.4	3.6	6.5	3.6	1.1	2.4	0.1	2.3	2.3
40-50	72.7	4.3	4.2	6.5	3.8	1.1	2.7	0.1	2.3	2.3
50-60	71.8	4.6	3.9	6.2	3.9	1.3	3.1	0.1	2.5	2.6
60-70	69.8	5.0	4.2	6.2	4.6	1.5	2.9	0.1	2.8	2.9
70-80	67.7	4.8	4.4	6.3	4.8	2.0	3.2	0.1	3.1	3.6
80-90	65.1	5.2	5.0	5.6	5.0	2.4	3.4	0.1	3.7	4.3
90-95	60.2	6.1	5.3	5.7	5.3	2.2	3.9	0.2	4.8	6.3
95-100	51.3	5.6	6.4	4.2	5.8	3.4	4.1	0.2	7.8	10.9
All	70.8	4.7	4.1	6.4	4.0	1.4	2.7	0.1	2.8	3.0
					ESTATES					
1-5	73.2	5.9	4.0	7.8	4.1	0.1	1.9	0.0	1.9	1.1
5-10	78.3	2.4	4.0	5.9	3.0	1.1	2.0	0.0	2.2	1.2
10-20	75.1	5.2	3.6	7.7	3.0	1.0	1.5	0.0	1.9	0.9
20-30	73.4	5.2	3.7	6.7	5.0	0.8	1.8	0.0	2.1	1.4
30-40	75.7	5.1	3.2	6.5	3.9	0.6	1.8	0.0	2.3	0.9
40-50	74.0	5.8	2.9	6.6	4.4	0.6	1.6	0.0	2.0	2.1
50-60	72.1	7.6	2.1	6.2	4.4	0.8	2.2	0.1	2.3	2.2
60-70	72.5	7.3	3.0	6.2	4.8	0.7	2.1	0.1	2.0	1.4
70-80	72.5	5.7	2.6	5.9	5.7	0.9	2.4	0.1	2.1	2.1
80-90	70.8	8.7	3.2	5.6	5.0	0.6	2.2	0.1	2.1	1.6
90-95	71.1	3.6	2.7	4.9	7.9	1.3	2.4	0.5	3.0	2.5
95-100	58.1	4.8	3.8	6.6	7.9	4.9	3.6	0.1	3.6	6.6
All	73.3	5.9	3.1	6.5	4.5	0.9	2.0	0.1	2.1	1.6

level and are applied without change to each of the sectors; it is therefore only in Table 9.3 that there are ten percent of households in each of the decile bands. For the Island as a whole, the mean share of the budget devoted to food is 70%, a figure that is very high by international standards and that is in line with Sri Lanka's low level of per capita income. The food share varies inversely with PCE across the three sectors, and except for the poorest households in the estates, inversely with PCE within sectors. The poorest households in the estates sector spend 75-80% of their budgets on food, while, at the other end of the distribution, the average food share is less than half of total expenditure amongst the top five percent of the population in urban areas. Of the other goods shown in the Table, alcohol accounts for about 4% of the budget at all levels of PCE, while expenditure on fuel appears to be a necessity, with a share that declines from 8% of the budget amongst the poorest households to some 4% amongst the best off. The other goods, including travel, all increase their shares as levels of living increase, except for the employer supplied housing on the estates where shares remain constant. Even medical expenses appear to be a luxury good in Sri Lanka, and increase their share from 1.4% of the budget to 3.8% as we move up the expenditure distribution.

On average, households in Sri Lanka are estimated to spend 3.2% of their total budget on travel. This share, at 4.4%, is higher in the urban areas, though even in rural areas households spend 3% of their budgets on travel. Transport expenditures are much lower on the estates, and comprise only 1.6% of the budget. In all three sectors, the share devoted to travel increases as we move up the PCE distribution, so that households in the top 5% of the expenditure distribution spend 11% of their budgets on travel as compared

with 1.4% for households in the bottom 5% of the distribution. While these values are from the two extremes of the distribution, the increase in the travel share appears to be fairly steady as PCE rises.

2. Travel expenditures in household budgets

Table 9.5 breaks down mean travel shares into public and private modes.

Table 9.5

Budget shares on private and public travel by sector

Pctile	Private	Public	All	Private	Public	All
	ALL ISLAND			URBAN AREAS		
1-5	0.00	1.36	1.36	0.00	1.11	1.11
6-10	0.05	1.85	1.90	0.00	1.73	1.73
10-20	0.03	1.75	1.78	0.01	1.85	1.86
20-30	0.05	1.96	2.01	0.00	2.32	2.32
30-40	0.10	2.06	2.16	0.00	2.13	2.13
40-50	0.12	2.11	2.23	0.03	2.03	2.06
50-60	0.19	2.46	2.65	0.02	2.88	2.90
60-70	0.12	2.73	2.85	0.04	3.04	3.07
70-80	0.46	3.31	3.77	0.71	4.01	4.72
80-90	0.76	3.76	4.52	1.75	3.83	5.58
90-95	2.28	4.00	6.29	2.44	4.02	6.45
95-100	7.13	3.84	11.0	8.28	3.15	11.5
All	0.64	2.56	3.21	1.44	2.92	4.37
	RURAL AREAS			ESTATES		
1- 5	0.00	1.42	1.42	0.00	1.09	1.09
5-10	0.06	1.91	1.97	0.00	1.20	1.20
10-20	0.04	1.82	1.86	0.00	1.88	0.88
20-30	0.06	1.96	2.02	0.06	1.30	1.36
30-40	0.13	2.19	2.32	0.00	0.92	0.92
40-50	0.15	2.13	2.28	0.00	2.08	2.08
50-60	0.25	2.39	2.64	0.00	2.21	2.21
60-70	0.15	2.74	2.89	0.00	1.42	1.42
70-80	0.42	3.22	3.64	0.00	2.10	2.10
80-90	0.46	3.85	4.31	0.00	1.62	1.62
90-95	2.27	4.04	6.31	0.00	2.48	2.48
95-100	6.58	4.30	10.9	1.62	5.00	6.62
All	0.49	2.55	3.04	0.05	1.59	1.65

On average, households spend about 2.6% of their budget on public modes and only 0.6% on private modes of travel. In the urban sector mean shares on private travel are essentially zero up to the 7th decile, after which they rise rapidly especially in the top decile. In rural areas, there is some small amount devoted to private travel in the 2nd to 9th deciles. Among the top ten percent of households, the share devoted to private travel rises rapidly but remains smaller than in the urban areas. On the estates, there are no recorded expenditures on private shares except for the top 5%, and even for these households the shares are much smaller than for the other two sectors.

The mean share of expenditures on public travel rise with PCE from about 1% to about 4% of the budget, although the rise levels off and shows some decline at the top end of the PCE distribution, at least in the urban and rural areas. On the estates shares are lower than the other two sectors for all groups except the top 5%. However, public modes account for almost all personal travel expenditures on the estates and the share of the budget devoted to public transport rises steeply among the best-off estate households.

The distribution of households spending nothing on transport is analyzed in Table 9.6. Twenty-five percent of Sri Lankan households spend nothing on any form of personal transport, and of the remainder, less than one in ten records any expenditure on private modes of transport. However, it should again be noted that there is general evidence of under-reporting of expenditures in the survey, and since expenditures on private transport are often irregular and hard to measure without a great deal of care, there may be more private expenditures than appears from these results. However, there

is little doubt of the broad result, that private transport is not very important in Sri Lanka except for a small number of the best-off households.

Table 9.6

Percentages of households recording zero expenditure on travel

	----ALL TRAVEL---				--PRIVATE TRAVEL--				---PUBLIC TRAVEL--			
Pctile	All	U	R	E	All	U	R	E	All	U	R	E
0-5	51	69	49	43	100	100	100	100	51	69	49	43
5-10	39	54	36	33	99	100	99	100	39	54	36	33
10-20	31	38	29	49	98	97	98	100	32	40	29	49
20-30	32	36	32	31	98	100	98	98	33	36	32	34
30-40	29	32	25	51	98	100	97	100	29	32	26	51
40-50	27	38	25	27	97	99	96	100	28	38	26	27
50-60	24	30	24	14	95	98	93	100	25	31	25	14
60-70	22	19	22	34	96	98	95	100	24	21	24	34
70-80	16	17	16	21	93	92	93	100	17	18	17	21
80-90	14	18	12	38	89	83	90	100	17	22	14	38
90-95	9	11	7	23	80	81	80	100	13	20	9	23
95-100	6	7	5	11	62	53	66	89	16	22	11	22
All	25	26	24	34	93	89	94	99	27	30	25	34

A great many households also record no expenditure on public transport, though the fraction of such households declines steadily with the household's rank in the PCE distribution. Among the poorest five percent, about half the households spend nothing on public transport, a fraction which is <u>higher</u> in the urban areas, presumably because it is possible to walk or to ride bicycles for short local trips. At the median of PCE, three quarters of households incur some expenditure on public transport; again the fraction is somewhat lower in the urban areas than elsewhere. Among the best off households, 85% use public transport, and since for this group there is a sizeable proportion recording private transport expenditures, more than 90% of households in the top decile spend something on travel. Perhaps most

importantly from the point of view of analyzing rural travel, the survey records positive travel expenditures for between a half and two thirds of households in the bottom decile in both rural and estates. These households represent the poorest of the rural poor in one of the poorest nations on earth, yet the majority still choose (find it necessary?) to spend money on transportation.

If Tables 9.5 and 9.6 are taken together, we can see the distribution of travel expenditures among those households that spend something on travel. For such households, the shares of the budget devoted to travel are greater in urban areas than in either rural areas or the estates. Since rural trips may well be longer and more expensive than urban trips, this evidence suggests that they are also relatively infrequent. Since so very few households spend anything on private travel, the shares of the budget devoted to private travel are very much larger among households that spend anything than they are among the population at large.

Table 9.7 shows the fractions of households spending greater than 10% of their budget on transport. The figures for the estates sector are not shown; households spending more than ten percent of their budget on travel are rare in that sector, and the size of the estates sample is not big enough to give acceptably accurate estimates of very small numbers. The same problem is present to a much lesser degree in the urban areas, and shows up in the form of an apparently volatile relationship between decile rank and the fraction spending more than ten percent, particularly in the lower deciles. Looking at the right hand side of the table, we see that about 4% of all households spend more than ten percent of their budget on public travel, and that the fraction doing so increases fairly rapidly with

Table 9.7

Fractions of households spending more than ten percent on travel

	ALL TRAVEL			PUBLIC TRANSPORT		
Pctile	All	Urban	Rural	All	Urban	Rural
0- 5	0.4	2.7	0.0	0.4	2.7	0.0
5- 10	1.3	0.0	1.6	0.9	0.0	1.1
11- 20	1.2	1.7	1.3	1.2	1.7	1.3
20- 30	2.5	1.5	2.9	2.5	1.5	2.9
30- 40	2.5	0.0	3.2	2.2	0.0	2.8
40- 50	3.1	2.3	3.3	2.6	2.3	2.7
50- 60	4.1	5.9	3.9	3.9	5.9	3.6
60- 70	3.9	1.2	4.7	3.5	1.2	4.2
70- 80	8.8	13	8.3	6.7	9.2	6.5
80- 90	11	16	10	7.4	7.5	7.8
90- 95	18	15	21	8.7	6.8	10
95-100	32	35	32	6.1	3.6	8.4
All	6.3	9.8	5.8	3.8	4.2	3.9

level of PCE, from less than 1% in the bottom decile to about 7% in the top decile. Adding in expenditures on private travel changes the picture only in the top deciles, where expenditure on such modes becomes important and we find as many as one third of households spending more than ten percent of their budget on travel. There is no evidence in these data that substantial numbers of the poorest households spend large shares of their budgets on personal transport.

The survey results allow some disaggregation of expenditures by mode of travel, and the main results can be summarized verbally. As is to be expected, most expenditure on public transport is attributable to bus fares. For the island as a whole, 87% of household expenditure on public travel goes on buses with a further 7% spent on trains and 5% on taxis. This pattern changes very little with household standards of living or by sector. Even for the top decile of the PCE distribution, bus fares account for 80%

of total expenditures on public transport, with the remaining 20% going mostly to trains (10%) and taxis (7%). In urban areas, 81% of public transport is attributable to buses, 7% to taxis, and 11% to trains, so that households in urban areas behave similarly to households in the top decile for the country as a whole, at least as far as public transport is concerned. In the rural areas, nearly 90% of public transport expenditures is spent on bus fares, with the remainder split almost equally between trains and taxis. The estates sector has too little recorded expenditure on transport for the splits to be estimated with any real precision, though it is clear that bus, once again, is by far the dominant mode. The reporting of expenditures on private transport allows us to distinguish between gasoline and oil on the one hand and "other" expenditures on the other, though it should be noted that the latter is far from being a comprehensive measure of the other costs of operating private vehicles. For the country as a whole, 60% of private expenditures are on gasoline and oil, and 40% on other. However, there is a considerable difference in the split between urban and rural areas; in the former, the split is 3:1 in favor of gas and oil, while in the rural areas expenditures are evenly spread between the two categories. If the "other" category means anything, these ratios may reflect higher vehicle usage in the cities, or higher maintenance costs in the countryside.

3. Vehicle Ownership

Table 9.8 shows vehicle ownership by PCE group. It is immediately clear why there is so little expenditure on private transport in Sri Lanka; there are very few vehicles other than bicycles. Only 1.6% of households own a motorcycle, a fraction which is

Table 9.8

Vehicle ownership by PCE

Pctile	No vehicle	Bicycle	Motorcycle	Car
0 - 5	95.4	4.6	0.0	0.0
5 - 10	89.5	10.5	0.0	0.0
10- 20	86.3	13.5	0.0	0.2
20- 30	82.5	17.4	0.2	0.2
30- 40	80.5	19.3	0.2	0.2
40- 50	76.9	23.0	0.6	0.2
50- 60	71.0	28.8	0.6	0.0
60- 70	65.6	33.6	1.0	0.6
70- 80	63.9	34.5	1.4	1.8
80- 90	61.9	36.0	3.7	2.5
90- 95	53.1	40.4	5.4	5.0
95-100	47.9	35.8	11.3	22.9
All	73.3	25.1	1.6	1.9

actually exceeded by the fraction owning motor cars, 1.9%. More than a half of the households that own either a car or a motor cycle live in urban areas. A quarter of Sri Lankan households own bicycles, a fraction that is much the same in urban and rural areas, though on the estates, only 2.4% of households own cycles. Since durable good ownership is partly a matter of economic status, this is further evidence of the very low living standards on the estates sector. The fraction of households that do not own either a bicycle, a motor cycle, or a car falls from over 95% in the bottom 5% of the PCE distribution to less than a half in the top 5%. Most of the difference is accounted for by bicycle ownership, which rises from 5% of households in the bottom 5% of the distribution to 36% of households in the top 5%. Fifteen percent of households in this top PCE group also enjoys the ownership of a motor car.

Table 9.9 shows probits for vehicle ownership for all Sri Lanka. This analysis is designed to estimate the relationship between the probabilities

of ownership and various possible explanatory variables. The probits shown in Table 9.9 are estimated on the raw data without any reweighting for the stratification, so that the fractions of households owning in the penultimate row are very slightly different from those shown in Table 9.8. The decision whether or not to weight will make little difference to the results if the relationship being estimated is homogeneous across strata, something that is being assumed in any case by estimating a pooled regression.

Since very few households own cars or motor cycles, it is perhaps the probit analysis for bicycle ownership that is most interesting. Even so, we show the results for all three vehicles. The most important variable that determines ownership of all three vehicles is the level of per capita expenditure. As PCE increases, so does the probability of ownership. For motor cycles and for bicycles the coefficients on the log of PCE are both individually and jointly significant; for cars they are jointly significant. Note that in all three probits, the coefficients on the square of PCE are negative, but this does <u>not</u> mean that the rates at which the probabilities of ownership increase are diminishing functions of PCE. Each probability has the form $\Phi(\beta.x)$ where Φ is the cdf of the normal distribution, and straightforward differentiation shows that a negative coefficient on a quadratic term is consistent with both a positive and negative second derivative of the probability with respect to the variable, with a positive effect being more likely when the probability of ownership is low.

Conditional on the level of <u>per capita</u> household expenditure, the probability that a household owns any type of vehicle tends to increase with the number of adults and number of small children in a household. Again at fixed PCE levels, and with fixed numbers of household members, the prob-

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Table 9.9
Probit regressions for vehicle ownership

Independent variables	Motor car beta	Motor car t	Motor cycle beta	Motor cycle t	Bicycle beta	Bicycle t
Constant	-10.23	1.8	-15.98	3.3	-19.48	11.1
ln(PCE)	0.61	0.3	3.69	2.5	5.60	9.2
ln(PCE)**2	0.08	0.6	-0.22	1.8	-0.43	8.0
Characteristics of Household						
# adults	0.20	3.0	0.11	1.8	0.12	5.1
# children aged						
0 - 5 yrs	0.40	4.7	0.24	3.2	0.13	4.5
5 - 10 yrs	0.28	3.4	0.06	0.7	0.07	2.3
10 - 15 yrs	0.18	1.4	0.12	1.1	0.03	0.7
# males	-0.06	0.8	-0.02	0.3	0.06	2.7
# earners	0.03	0.4	0.01	0.1	-0.00	0.1
# students	-0.08	0.9	-0.02	0.3	0.07	2.3
Characteristics of Household Head						
Age/10	0.16	0.5	-0.19	0.7	0.04	0.4
(Age**2)/1000	-0.19	0.6	0.14	0.5	-0.07	0.7
Dummy(1) if						
Sinhalese	-0.06	0.4	-0.08	0.6	-0.29	5.5
Primary education	-0.16	0.5	0.10	0.3	0.14	1.9
Secondary education	-0.03	0.1	0.19	0.7	0.26	3.5
Higher education	0.29	0.9	0.59	2.0	0.39	4.3
Landowner	0.02	1.6	0.01	1.0	0.01	1.9
Employer	0.60	2.7	0.48	2.1	0.07	0.5
Sector of Employment						
Agriculture	0.30	1.3	-0.39	2.0	0.07	1.2
Finance	0.57	1.6	0.26	0.9	-0.26	1.1
Distribution	0.50	2.1	-0.27	1.3	0.09	1.2
Manufacturing	0.53	2.0	0.04	0.2	0.02	0.3
Transport	0.71	2.8	-0.40	1.4	0.12	1.2
Social	0.49	2.1	-0.09	0.5	0.01	0.1
Distance (miles/100) to						
Market	-0.12	0.3	-0.39	1.1	0.13	1.4
Primary school	0.21	0.9	-0.42	0.5	-0.10	0.5
Secondary school	-1.51	2.3	-0.29	0.6	-0.08	0.7
Dummy(1) if Household						
Rural	-0.02	0.1	-0.00	0.0	0.31	5.4
Estate	-0.50	0.7	-1.93	1.0	-1.02	6.8
Enum. in Round 4	0.12	0.9	0.02	0.2	0.10	2.3
% HH owning	1.95		1.61		24.23	
-2*lnLR	460.26		250.11		771.39	

Notes to Table 9.9: 5035 observations; -2*lnLR=likelihood ratio test against regression with constant only, under null distributed as Chi-squared with 29 degrees of freedom. See Table 9.10 for definitions of variables.

ability of bicycle ownership tends to be higher in households with more males and more students. Interestingly, bicycle ownership is more likely if there are students in urban household while the probability rises with the proportion of males in the rural areas.

Ownership of all three vehicles is estimated to be positively related to the educational level of the household head although, given the small numbers of households that own either cars or motorcycles, the effects are only statistically significant for bicycles and for the best educated group for the ownership of motor cycles. Employers are significantly more likely to own a car or motor cycle. Households with heads working in the distribution, manufacturing, transport and services sector are more likely to own a car and those in the agricultural sector to own a motor cycle. Occupational effects vary both across sectors and modes: they are strongest in the urban sector which is hardly surprising given the predominance of agricultural households in the rural and estates areas. (See Table 9.2) In the towns, agricultural and transport workers are particularly likely to own cycles, while the same is true of distribution and services workers in the rural sector.

One important result that the table does <u>not</u> snow is any significant independent effect of sector on car or motor cycle ownership. The fact that most of these vehicles are owned in the urban areas is explained by the presence, in the cities, of most of the better off households and not by any sector specific effect. Bicycles, however, are more likely to be owned by rural households and less likely to be found on the estates. Notice that the proportion of households owning cycles in the urban and rural sectors is roughly equal. Since ownership tends to increase with PCE, we would expect

this proportion to be lower in the rural areas : hence the positive coefficient on the rural dummy in the regression. Similarly, the negative coefficient on the estates dummy indicates that the probability of owning a bicycle there is even lower than would be predicted on the basis of PCE alone.

Finally, the dummy for Sinhalese ethnicity is significantly negative in the country-wide regression. The effect is (absolutely) twice as big in the rural sector relative to the urban areas. On the estates, however, the effect is positive. This probably reflects the fact that the only Sinhalese on the estates are managers so that the variable may be a proxy for employer status. By contrast, the Tamil minority in the rest of the island tends to be relatively economically advantaged compared with the Singhalese majority.

4. Regression Results

Short-run and long-run travel regressions for the whole island are shown in Tables 9.10 and 9.11. As usual, the former contain dummy variables indicating vehicle ownership whereas the latter do not. The corresponding elasticities of travel expenditures with respect to PCE are summarized in Table 9.12; these are also given separately for each sector based on separate sector regressions which are not shown. In both the short and long run regressions, the budget share of travel increases with the logarithm of PCE and does so at an increasing rate. This steepening slope is largely a reflection of the very rapid rise in expenditures on private travel among the wealthiest households. The relationship between public transport and PCE is quite different; although it is positive for most of the population,

Table 9.10

Short run travel regressions

Share of total expenditure spent on:

Independent Variables	All Travel beta	All Travel t	Private beta	Private t	Public beta	Public t	Bus beta	Bus t	Train beta	Train t
Constant	51.50	11.0	60.06	16.9	-8.05	2.5	-8.62	2.9	0.85	0.8
ln(PCE)	-21.02	12.6	-23.70	18.7	2.47	2.1	2.69	2.6	-0.27	0.7
ln(PCE)**2	2.19	14.5	2.33	20.3	-0.12	1.1	-0.16	1.7	0.03	0.9
Characteristics of Household										
# adults	0.26	3.6	0.18	3.3	0.08	1.7	0.06	1.4	0.01	0.4
# children aged										
0 - 5 yrs	0.03	0.3	0.14	2.0	-0.12	1.8	-0.11	1.9	-0.01	0.6
5 - 10 yrs	0.31	3.3	0.30	4.2	0.01	0.2	-0.03	0.4	-0.01	0.3
10 - 15 yrs	-0.05	0.4	0.17	1.8	-0.22	2.5	-0.23	2.9	0.01	0.5
# males	0.06	0.8	0.02	0.3	0.04	0.8	0.05	1.0	0.00	0.3
# earners	-0.00	0.0	-0.22	3.2	0.21	3.3	0.21	3.7	0.01	0.6
# students	0:00	0.0	-0.11	1.5	0.11	1.6	0.08	1.4	0.02	0.9
Characteristics of Household Head										
Age/10	-0.31	1.0	-0.28	1.2	-0.02	0.1	0.11	0.6	-0.07	1.1
(Age**2)/1000	0.06	0.2	0.14	0.6	-0.09	0.4	-0.21	1.2	0.09	1.3
Dummy(1) if										
Sinhalese	0.23	1.4	-0.08	0.6	0.32	2.8	0.50	4.8	-0.19	5.3
Primary education	0.18	0.9	-0.05	0.3	0.22	1.6	0.20	1.7	0.03	0.8
Secondary education	0.68	3.2	-0.15	0.9	0.81	5.4	0.75	5.6	0.14	2.9
Higher education	-0.10	0.3	-1.28	5.9	1.16	5.8	0.85	4.7	0.19	3.0
Landowner	0.04	3.1	0.04	3.8	0.00	0.4	0.00	0.5	0.00	0.4
Employer	1.25	2.5	1.31	3.4	-0.08	0.2	-0.06	0.2	-0.17	1.5
Sector of employment										
Agriculture	-0.34	2.0	0.30	2.2	-0.62	5.1	-0.63	5.8	-0.00	0.1
Finance	0.91	1.2	-0.61	1.1	1.49	2.8	1.51	3.2	0.04	0.2
Distribution	0.39	1.5	-0.06	0.3	0.44	2.4	0.20	1.2	0.20	3.4
Manufacturing	0.45	1.6	0.08	0.4	0.38	1.9	0.18	1.0	0.13	2.1
Transport	0.70	2.0	0.24	0.9	0.46	1.9	0.21	1.0	0.23	3.0
Social	0.38	1.4	-0.24	1.1	0.65	3.4	0.61	3.6	0.06	1.1

(Table 9.10, Short run travel regressions, continued)

Independent Variables	All Travel beta	t	Private beta	t	Public beta	t	Bus beta	t	Train beta	t
Distance (miles/100) to										
Market	0.39	1.4	0.09	0.4	0.27	1.3	0.31	1.7	0.05	0.8
Primary school	-0.62	1.6	-0.24	0.8	-0.36	1.3	-0.41	1.7	-0.01	0.1
Secondary school	-0.40	1.3	-0.12	0.5	-0.28	1.3	-0.22	1.1	-0.07	1.1
Dummy(1) if Household is:-										
Rural	0.31	1.7	0.09	0.7	0.21	1.6	0.28	2.4	-0.06	1.4
Estate	-0.01	0.0	0.11	0.4	-0.12	0.5	0.00	0.0	-0.10	1.4
Enum. in Round 4	-0.11	0.9	0.15	1.5	-0.26	2.8	-0.22	2.7	-0.02	0.6
Owns car	8.30	15.8	10.80	27.2	-2.65	7.2	-2.01	6.1	-0.38	3.3
Owns m/cycle	3.20	5.9	3.98	9.8	-0.74	2.0	-0.78	2.3	0.12	1.0
Owns bicycle	0.13	0.8	0.41	3.4	-0.28	2.5	-0.40	4.1	0.10	2.9
Eqn std error	1108.74		840.02		775.97		694.51		243.57	
F statistic	64.10		90.42		19.25		17.81		4.85	
F (PCE)	278.9		321.1		53.0		43.6		2.6	

Note: 5035 obs; F(PCE) tests for joint significance of coefficients on PCE. Higher education is defined as household head having at least 'O'levels; excluded group are household heads with no education. Sector of employment is dummy(1) if HH head employed in that sector; excluded sectors are constuction, mining energy, those not defined in survey and those missing. All coefficients are multiplied by 100.

Table 9.11

Long run travel regressions

Share of total expenditure spent on:

Independent	All Travel		Private		Public		Bus		Train	
Variables	beta	t	beta	t	beta	t	beta	t	beta	t
Constant	70.77	15.3	84.15	22.7	-13.15	4.1	-11.99	4.2	-0.19	0.2
ln(PCE)	-28.75	17.4	-33.44	25.4	4.59	4.1	4.17	4.1	0.11	0.3
ln(PCE)**2	2.96	19.9	3.30	27.8	-0.34	3.3	-0.32	3.5	-0.00	0.1
Characteristics of the household										
# adults	0.34	4.7	0.30	5.0	0.05	1.0	0.03	0.6	0.01	0.5
# children										
0 - 5 yrs	0.13	1.4	0.28	3.8	-0.16	2.5	-0.14	2.5	-0.01	0.6
5 - 10 yrs	0.40	4.1	0.42	5.4	-0.02	0.3	-0.06	0.9	-0.01	0.4
10 - 15 yrs	0.01	0.1	0.26	2.5	-0.25	2.8	-0.25	3.2	0.01	0.5
# males	0.02	0.3	-0.03	0.5	0.05	1.0	0.05	1.1	0.01	0.5
# earners	0.06	0.8	-0.14	1.9	0.19	3.0	0.19	3.4	0.01	0.5
# students	-0.02	0.3	-0.14	1.8	0.11	1.7	0.08	1.4	0.02	1.0
Characteristics of the household head										
Age/10	-0.36	1.2	-0.34	1.4	-0.01	0.0	0.12	0.6	-0.07	1.1
(Age**2)/1000	0.08	0.3	0.17	0.7	-0.09	0.5	-0.22	1.2	0.09	1.3
Dummy(1) if										
Sinhalese	0.19	1.1	-0.15	1.1	0.36	3.1	0.54	5.2	-0.20	5.6
Primary education	0.13	0.6	-0.11	0.7	0.24	1.7	0.21	1.7	0.04	0.8
Secondary education	0.62	2.8	-0.21	1.2	0.82	5.4	0.74	5.5	0.14	3.1
Higher education	0.19	0.7	-0.88	3.8	1.05	5.2	0.73	4.1	0.20	3.2
Landowner	0.05	3.5	0.05	4.4	0.00	0.1	0.00	0.2	0.00	0.4
Employer	2.33	4.5	2.71	6.5	-0.42	1.2	-0.34	1.1	-0.19	1.7
Sector of employment										
Agriculture	-0.35	1.9	0.30	2.1	-0.63	5.1	-0.64	5.8	-0.00	0.1
Finance	1.46	1.9	0.07	0.1	1.36	2.6	1.41	3.0	0.02	0.1
Distribution	0.50	1.8	0.09	0.4	0.39	2.1	0.16	1.0	0.19	3.3
Manufacturing	0.52	1.8	0.16	0.7	0.36	1.8	0.17	0.9	0.13	2.0
Transport	0.77	2.2	0.35	1.2	0.43	1.7	0.18	0.8	0.22	2.9
Social	0.43	1.5	-0.17	0.8	0.64	3.3	0.60	3.5	0.06	1.0

(Table 9.11, Long run travel regressions, continued)

Independent Variables	All Travel beta	t	Private beta	t	Public beta	t	Bus beta	t	Train beta	t
Distance (miles/100) to										
Market	0.31	1.0	-0.00	0.0	0.29	1.4	0.32	1.8	0.05	0.8
Primary school	-0.62	1.5	-0.24	0.7	-0.36	1.3	-0.40	1.6	-0.01	0.1
Secondary school	-0.46	1.5	-0.19	0.8	-0.25	1.2	-0.20	1.0	-0.07	1.1
Dummy(1) if Household is:-										
Rural	0.21	1.1	-0.02	0.1	0.22	1.7	0.27	2.3	-0.05	1.1
Estate	-0.15	0.4	-0.11	0.4	-0.03	0.1	0.10	0.5	-0.12	1.6
Enum. in Round 4	-0.10	0.7	0.18	1.7	-0.27	2.9	-0.23	2.8	-0.02	0.5
Eqn std error	1141.74		912.34		780.80		698.63		243.98	
F statistic	56.77		58.20		18.74		17.29		4.65	
F (PCE)	496.1		662.6		38.9		30.0		2.5	

Notes: See Table 9.10

Table 9.12

Travel elasticities at sample means

	All	Urban	Rural	Estates
Long Run				
Travel	1.98	2.03	1.92	1.79
Private	4.44	3.96	4.57	*
Public	1.38	1.10	1.43	1.65
Bus	1.33	1.07	1.37	1.71
Taxi	1.88	1.61	1.92	*
Train	1.49	1.11	1.75	*
Short Run				
Travel	1.82	1.80	1.79	1.94
Private	3.26	3.04	3.32	*
Public	1.46	1.21	1.51	1.64
Bus	1.42	1.19	1.45	1.69
Taxi	1.99	1.87	1.98	*
Train	1.44	1.02	1.79	*

the slope is diminishing rather than increasing. Table 9.12 shows the elasticities for each mode and in each sector. Overall, travel has a country-wide short-run elasticity of 1.8, rising to 2.0 if we allow for the effects of income operating through increased vehicle ownership. For public transport, which is by far the most important for nearly all households, the short run elasticity is 1.5 and very slightly less than that in the long-run. Bus is the dominant mode for public transport, and the elasticities of expenditures on bus fares are therefore very similar to those for public transport as a whole. There is some evidence that travel elasticities are rather lower in the cities than in the countryside, and that they are highest in the estates, all of which is consistent with declining elasticities for public transport as PCE increases. Even so, all of Sri Lanka is sufficiently poor so that the total expenditure elasticities of all forms of travel are greater than unity. Expenditure elasticities for taxi and train travel are both greater than those for bus travel, with train

travel apparently the most elastic. Unlike the other modes, travel by train does not appear to be less elastic in the long run, so that it is not adversely affected by vehicle ownership. Since the only vehicle that is widely owned is the bicycle, the effects of ownership on mode choice are going to be confined to short-haul modes. Indeed, the regressions in Table 9.10 show a significant positive effect of bicycle ownership on train travel as opposed to the significantly negative effects for buses and for public transport as a whole.

With PCE held constant, the share of the budget devoted to private and, to a lesser extent, public travel increases with the number of adults in the household. As the number of children increases, households tend to shift from public to private modes although total travel shares rise and by a significant amount in the case of children aged 5 to 10 years. On the other hand, the presence of additional students or additional earners in the household entails a switch from private to public transport as the latter is used, after walking, as the primary means of getting to work and school. Even at fixed ownership levels, households with an employer as head spend more on private travel, and the effect is magnified in the long run when we take into account the high probability of ownership for employer headed households. Budget shares devoted to public transport, both buses and trains, tend to increase with the educational level of the household head; private transport shares tend to fall. Combining these two effects, it turns out that households with heads who have received no education devote the lowest share of their budgets to travel, and those with pre-'O' Level secondary education the most.

The tables also show that the industrial occupation of the household head has predictive value for household travel expenditures both across modes and in aggregate. For heads in agriculture private travel expenditures are high while expenditures on public transport are low to the extent that total travel expenditure is low. If the head is in services, expenditures on bus fares are high and the expenditure on private transport low. In finance, expenditures on bus fares, on public transport and on total travel are high, while for distribution, manufacturing, and transport, public transport and train fares are high. For heads in transportation total expenditures are also relatively high. Once again, the sectoral split has very little effect on travel patterns once the other variables are taken into account. There is a marginally significant positive effect of the rural dummy on bus expenditures, but the hypothesis of no sectoral effects overall could easily be accepted.

5. Summary of main results

Sri Lanka is the poorest of the locations studied in this report. Average per capita household expenditure was around $250 per annum at the time of the survey, and the fact that about 70% of household expenditures was devoted to food confirms the very low material living standards on the island.

(i) In spite of the low levels of living three-quarters of all households reported some expenditure on personal travel, nearly all of which was by public modes. Only seven per cent of households reported any expenditure on private modes of travel.

(ii) Travel expenditures comprised about 3.2% of all household expenditures

on non-durable goods, a fraction that increases with the living standards of the household. We estimate that the total expenditure elasticity of personal travel in Sri Lanka to be around 2, and that for public transport (of which 87% is by bus) to be about 1.5. The share of the budget devoted t travel is somewhat higher in the cities, 4.4% as opposed to 3.0% in rural areas, and appears to be somewhat less elastic with respect to living standards. However, these differences are not reflected in significant dummy variables in the travel regressions, so that per capita expenditure and the other factors allowed for seem capable of explaining the differences between urban and rural behavior.

(iii) There is no evidence from Sri Lanka that an inordinate number of the poorest households spend large shares of their budgets on travel.

(iv) Vehicle ownership levels are very low in Sri Lanka. Less than two per cent of households own either a motor-cycle or a car, and only a quarter of households own a bicycle. Ownership levels are strongly related to living standards, although the educational level of the household head also plays a role.

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