Transport Economics
2nd Edition

Kenneth J. Button

Professor of Applied Economics and Transport
Loughborough University
and
VSB Visiting Professor of Transport and the Environment
Tinbergen Insititute, Free University of Amsterdam

Edward Elgar

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3 The Demand for Transport

3.1 The demand for transport

Chapter 2 looked at the interrelationship between land-use patterns and transport; it thus offered some insights into a few of the factors influencing the demand for transport services. In this chapter the factors which influence demand for transport are considered in more detail. In particular, the previous chapter laid stress on the derived nature of the demand for the vast majority of transport services, and it is this feature of demand which explains another characteristic of the transport market.

One of the most pronounced characteristics of the demand for transport, for instance, is its regular fluctuation over time. In urban areas, the demand for road space and public transport services is markedly higher in the early morning and late afternoon than during the rest of the day; in the inter-urban context the demand for passenger transport fluctuates regularly over a year with high seasonal peaks, while with international freight transport (especially shipping) there are long-term cycles in demand. This tendency for peaks and troughs in the demand for transport is a reflection of fluctuations in the demand for the final products made accessible by transport services. In general, people wish to go on holiday in the summer; hence the seasonal peak in the demand for coach, rail and air services, while business finds it helpful to operate standard hours (that is, from 'nine-to-five') with the consequential concentration of commuter traffic. Longer-term fluctuations in the demand for shipping services reflect the state of business cycles in the trading nations – at the nadir of such cycles demand slumps, at the zenith it is extremely buoyant.

Despite these regular fluctuations, it has been suggested (for example, by Thomson, 1974) that over time, and in another sense, there has been a remarkable stability in the demand for travel, with households, for example, on average making roughly the same number of trips during a day albeit for different purposes or by different modes. There may be more leisure travel, but there are fewer work trips and greater use is now made of air transport and the motor-car at the expense of walking and cycling. It is suggested that this situation reflects the obvious fact that there is a limit to the time people have available for travel, especially if they are to enjoy the fruits of the activities at the final destinations.

More recent work on travel time budgets indicates that the situation is more complicated than this and that the constancy suggested above should be subjected to a much closer inspection. In the United Kingdom, for example, there is ample empirical evidence (see Gunn, 1981) that average travel times have increased steadily over the past quarter of a century. Explanations are difficult to find but one suggestion is that this is the result of rising incomes and that the constant time budget implied by Thomson only holds for *each income* group. Thus people are moved from low income groups with low travel time budgets to higher income groups with associated higher travel time budgets. Some time ago, Goodwin (1973) showed that at the aggregate level time expenditure on travel per head increases roughly proportionally to income. Such findings emphasise the importance of time as well as conventional variables in travel demand analysis and, as we see in the following chapter, considerable emphasis is placed upon the role that time costs play in transport decision-making.

Given this rather general, aggregate background it is now relevant to look in much more detail at the actual influences and motivations which affect travel and transport-related demand. It seems appropriate to begin by considering the simple demand function.

3.2 The factors which influence travel demand

It is generally considered that the demand for a commodity (D_a) is influenced by its price (P_a), the prices of other goods ($P_1, P_2 .... P_n$) and the level of income (Y):

$$D_a = f(P_a, P_1, P_2, ... P_n, Y) \tag{3.1}$$

While this simple framework holds for transport, as for all other goods and services, there are refinements and detail which need to be highlighted if one is to gain an understanding of the way the transport market operates. The individual terms in the above are, in fact, not simple variables but rather represent complex compounds of several interacting factors. Price, for instance, is not simply the fare paid but must embrace all the other costs involved in obtaining the transport service (of which 'time costs', as we noted above, are generally held the most important), while it may not be total income which influences travel demand by individuals but rather income in excess of some threshold subsistence level. Further, there is the need to be very clear on what exactly it is which is being demanded: is it a trip *per se* or is it something more specific than this, for example, a bus trip or a journey over a particular route? Quandt and Baumol (1966) have gone so far as to suggest that it is not transport at all which is being demanded but rather a bundle of transport services. (We look at this idea more fully in the context of forecasting in Chapter 9.)

These types of problems and issues are clearly difficulties which cannot be entirely circumvented in a general discussion of the influences affecting transport demand, but they should be borne in mind as we move on to look in more detail at some of the items contained in the demand function set out as equation 3.1.

The price of the transport service

As has been suggested above, the price of transport embraces considerably more than the simple money costs paid out in fares or haulage fees. In transport modelling and quantitative work these other components of price (that is, time costs, waiting, insecurity, etc.) may be combined to form a generalised cost index of the type we discuss in Chapter 4, but here we concentrate on money prices and, in particular, on the sensitivity of transport users to the price of transport services.

Generalisations are obviously difficult, especially across all modes of transport, but in many cases it seems clear that price changes within certain limits have relatively little effect on the quantity of travel or transport services demanded. The demand for cargo shipping is, for example, very inelastic, in part because of

the lack of close substitutes for shipping services, in part because of the inelastic nature of the demand for the raw materials frequently carried, and in part because of the relatively small importance of freight rates in the final selling price of cargoes.

Studies of urban public transport in the 1970s covering a variety of countries also indicate relatively low price elasticities with a direct fare elasticity of around –0.3 being considered normal. Smith and MacIntosh (1974) looking at British municipal bus undertakings, for instance, produce figures ranging from –0.21 to –0.61, but the majority fall at the lower end of the spectrum. McGillivany's (1970) suggestion of a figure of around –0.2 for bus trips in San Francisco and Lave's (1970) finding of a direct fare elasticity of –0.11 for transit trips in Chicago imply the fare elasticity in the United States may be slightly lower than in the UK. In Canada an elasticity of –0.33 has for some time been used as a rule of thumb by operators. More recent studies, mainly from the 1980s, surveyed by Goodwin (1992) tend to produce similar figures to Smith and MacIntosh although highlighting the fact that the short term elasticities found in 'before and after' studies of fare change are in the order of a third of the size of longer term elasticities covering a reaction time in excess of five years. Something of a rogue result, however, was obtained in the econometric study of bus and underground use in London during the late 1980s by Gilbert and Jalilian (1991) – see Table 3.1 – which suggests long run elasticities exceeding unity for buses and approaching unity for the underground; rail demand elasticity at the more 'normal' low value.

Table 3.1
Estimated long-run price elasticities

	Prices			
	Bus	*Underground*	*British Rail*	*Non-travel*
Bus	–1.318	0.897	0.193	0.229
Underground	0.356	–0.688	0.211	0.120

Source: Gilbert and Jalilian (1991)

The effect of price change on private car transport must be divided between the effect on vehicle ownership and that specifically on vehicle use. Most UK studies of car ownership indicate an elasticity of about –0.3 with respect to vehicle price and –0.1 with respect to petrol price (Mogridge, 1978). American empirical work suggests a rather higher sensitivity (the Chase Econometrics Associates (1974) model, for example, implies a -0.88 purchase price elasticity and a –0.82 fuel price elasticity), but responsiveness is still very low. For car use, all the evidence suggests an extremely low fuel price elasticity in the short term (see Table 3.2) which may be attributed to changing patterns of household expenditure between vehicle ownership and use and people's perception of motoring costs. Early findings were brought together by Bendtsen (1980) in a series of international comparisons. He finds that petrol price elasticity of demand for car use to be –0.08 in Australia for the period from 1955 to 1976; –0.07 in Britain for 1973/4; –0.08 in Denmark for 1973/4 and –0.12 for 1979/80, and –0.05 in the USA for the period from 1968 to 1975. A slightly greater degree of sensitivity is observed in seven studies covering the UK, US and Australia examined more recently by Oum *et al.* (1992) which yield car usage elasticities in the range –0.09 to –0.52.

Table 3.2
Traffic elasticities with respect to petrol price (expressed as absolute values)

	Explicit		*Ambiguous*
	Short run	*Long run*	
Time series	–0.16 (0.08, 4.00)	–0.33 (0.10, 4.00)	–0.46 (0.40, 5.00)
Cross section	....	0.29 (0.06, 2)	–0.50 (n.a., 1)

Note: Figures in parenthesis indicate one standard deviation and the number of quoted elasticities.
Source: Goodwin (1992)

If we move to the other extreme of the transport market and look at airline operations the evidence is that demand is slightly less elastic (Table 3.3) with long-term demand (estimated from cross-sectional data) emerging as elastic. What these coefficients, and indeed, those cited above relating to other modes often disguise are quite significant differences in the elasticities for different groups of traveller and between individual services. Table 3.4, for instance, presents the results of an investigation of air travel across the North Atlantic conducted by Mutti and Mural (1977). The general impression is of price inelasticity but there is obvious variability between routes. Examinations of internal air traffic within the United States, however, produce much more varied results. Brown and Watkins (1968) and Gronau (1970) show a remarkable degree of consistency by producing price elasticities of –0.85 and –0.75 respectively but Jung and Fujii (1976) came to a somewhat different conclusion, namely, 'The empirical evidence suggests that demand for air travel for distances under 500 miles in the south east and south central portions of the US is price elastic.'

The difficulty with many statistics on demand sensitivity is, therefore, that they are elasticities averaged over several groups. In fact, the price elasticity of transport, as with the price elasticity of other goods, should ideally be set in a specific context. In the case of transport four broad types of classification are important.

(1) Trip purpose. There is an abundance of evidence that the fare elasticity for certain types of trips is much higher than others. Business travel demand in particular seems to be relatively more insensitive to changes in transport price than other forms of trip. Kraft and Domenich (1970) found that public transport work trips exhibited a fare elasticity of –0.17 in Boston (USA) compared with –0.32 for shopping trips. These figures conform closely to those found by London Transport in this country. If we focus on the work that has looked at air traffic, Mutti and Mural (1977) attribute part of the variation they found in fare responsiveness on the North Atlantic to the fact that 'we expect personal travel to be more price elastic than business travel'. Straszheim (1978) subsequently provides confirmation of this view and isolates elasticities for different types of service. In particular he concludes, 'First class fares can be raised and will increase total revenue ... The demand elasticity for standard economy service is about unity, and highest

for peak period travel ... The demand for discount and promotional fares is highly price elastic....'. Oum *et al.* (1986) came to identical conclusions when looking at more recent North American data. Quite clearly, therefore, it is dangerous to attempt to analyse transport demand without considering the specific type of trip being undertaken.

Table 3.3
Demand elasticities of air passenger travel (expressed as absolute values)*

	Time series	*Cross-section*	*Others*†
Leisure travel	0.40-1.98, 1.92	1.52	1.40-3.30, 2.20-4.60
Business travel	0.65	1.15	0.90
Mixed or unknown	0.82, 0.91, 0.31-1.81 1.12-1.28, 1.48	0.76-0.84, 1.39, 1.63 1.85, 2.83-4.51	0.53-1.00, 1.80-1.90

* Based on 16 studies.
† Includes studies with unknown data sources
Source: Oum *et al.* (1992)

Table 3.4
Demand elasticities for air travel on the North Atlantic 1964–74 by country (expressed as absolute values)

Market	*Income elasticity*	*Fare elasticity*
United States	2.15	–0.99
United Kingdom	4.38	–0.40
Netherlands	1.77	–0.28
Italy	2.00	–0.72
Germany	2.71	–0.19
France	2.03	–0.14
Total	1.89	–0.89

Source: Mutti and Mural (1977)

(2) The methods of charging. Users of different forms of transport (or, sometimes, different services of the same mode) are often confronted with entirely different methods of payment. Consequently, their perception of the price of a journey may differ from the actual monies expended. Sherman (1967), for example, has suggested that motorists perceive very little of the true overall price of these trips because they base decisions on a limited concept of short-run marginal cost. As Harrison and Quarmby (1969) put it in a predecimal summary of the situation, 'Including fuel, oil, maintenance, tyres and mile-dependent depreciation, most private cars show a marginal cost of between 4d and 7d a mile. Various empirical methods indicate "perceived" costs of between 2d and 4d a mile (in the period 1966-9).' Users of public transport, on the other hand, are usually made much more aware of the costs of their trip-making by the requirement to purchase a

ticket, usually prior to beginning their journeys. Nevertheless, given the range of season tickets (which permit bulk-buying of journeys over a specific *route*) and 'travel card' facilities (which permit bulk-buying of journeys over a specified *network*), the distinction is not a firm one. The empirical findings are also not very helpful. White's (1981) review of the empirical information available on travel cards, for example, points to a much lower price elasticity for travel card systems than for conventional single ticket cash payment systems.

(3) The time period under consideration. As with other purchasing decisions, people confronted with a change in transport price may act rather differently in the ultra-short run, the short run and the long run. Immediate reaction, as graphically illustrated by Goodwin (1992) in his survey of elasticities, in the ultra short term, to a public transport fare rise may be dramatic, with people, almost on principle, making far less use of services, but over a longer period they may soften and their resolve weaken with the result that the longer-run elasticity is much lower than ultra short-term observations would suggest. The ultra short-term elasticity may, therefore, be extremely high but short-lived. This type of situation may be less common than is sometimes thought and, indeed, the reverse response may result in the slightly longer period. In the short term, for example, people may appear relatively unresponsive to a price change either because they do not consider it a permanent change or because technical constraints limit their immediate actions. The demand for private car transport following the dramatic rise in oil prices in the 1970s provides an illustration of this latter type of phenomenon. The situation is well summarised by Mogridge (1978):

> We have seen in the effects of the oil crisis a very clear demonstration that the short-run effects of price are not at all the same as in the long-run. In the short run, people try to continue doing what they were doing before; in the long run they adjust their behaviour. In the short run, the price elasticity of petrol is low, 0.1; in the long run it is taken up by an adjustment in car size.

Similarly, when considering the effect of general rises on commuter travel costs, the necessity of having to make journeys to work is likely to result in minimal changes in travel patterns in the short term but over a longer period relocations of either residence or employment may produce a more dramatic effect. This implies that one must take care when assessing elasticity coefficients, and it is useful to remember that cross-sectional studies tend to offer estimates of long-run elasticity while time-series studies reflect short-term responses.

(4) The absolute level of the price change. Elasticities are generally found to increase the longer the journey under consideration. This should not be seen simply as a function of distance but rather a reflection of the absolute magnitude of, say, a 10 per cent rise on a £5 fare compared with that on a £500 fare. It is also true that longer journeys are made less frequently, and thus people gather information about prices in a different way. Additionally, they often tend to involve leisure rather than business travel; this suggests that distance may be picking up variations in trip purpose. In the air transport market, for example, DeVany (1974) found that price elasticity rose from –0.97 for a 440 mile trip in the USA to –1.13 for a 830 mile trip. For similar journeys Ippolito (1981) found the respective elasticities to be –0.525 and –1.0.

While it is important to treat elasticities with care because of these type of aggregation issue, there is a further reason for counselling caution when considering such parameters. There are a number of statistical methods employed to calculate

elasticities and these can influence the values obtained. In some instances these difference are related to the time span of the elasticity being studies; some techniques being mainly used for short term elasticity estimation while others are more suited to cross-sections and thus long-term elasticity calculations. The intention here is not to go into the technicalities of the various modelling frameworks, although some discussion of this is to be found in Chapter 9, but rather to highlight what seem to be the two main trends. First, if aggregate data are used, for instance looking at demand for an entire railway, then, although it is far from universally true, elasticities *tend* to be higher than from 'discrete choice' type models using data at the individual traveller level. Second, even within a particular modelling framework (be it involving the use of aggregate data or disaggregate data) the exact mathematical form of the equation used influences the elasticity calculated. Table 3.5 provides some general guidance to these effects with respect to estimated elasticities of demand for rail freight transport.

Table 3.5
Demand elasticities for rail freight transport (expressed as absolute values)

Commodities	*Log-linear*	*Aggregate logit*	*Translog*	*Discrete choice**
Aggregate commodities	1.52 0.34–1.06	0.25–0.35, 0.83	0.09–0.29, 0.60	n.a.
Chemicals	n.a.	0.66	0.69	2.25
Fabricated metal products	n.a.	1.57	2.16	n.a.
Food products	0.02, 1.18	1.36	2.58, 1.04	n.a.
Iron & steel products	n.a.	n.a.	2.54, 1.20	0.02
Machinery	n.a.	0.16–1.73	2.27–3.50	0.61
Paper, plastic & rubber products	0.67	0.87	1.85	0.17–0.09
Petroleum products	n.a.	n.a.	0.99	0.53
Stone, clay & glass products	n.a.	2.03	n.a.	0.56
Transport equipment	n.a.	n.a.	0.92–1.08	2.68
Wood & wood products	0.05	0.76	1.97, 0.58	0.08

* Disaggregate data
Source: Oum *et al.* (1992)

Income levels

While there is ample evidence that transport is a normal good in the sense that more is demanded at higher levels of income, this generalisation does not apply to all modes of transport nor to all situations. As was seen in the data set out in Table 1.10 income exerts a positive influence over car ownership decisions (a point returned to in section 3.6), but this in turn has produced an inverse relationship with public transport use. As incomes have risen and, with them, car ownership has become more widespread, public transport has in many situations proved to be an inferior good. Gwilliam and Mackie (1975) suggest that the long-run elasticity of demand with respect to income is of the order –0.4 to –1.0 for urban public transport trip-making in the United Kingdom. Gwilliam and Mackie argue that although car ownership rises with income and hence some trips are diverted from public transport there is still a limited off-setting effect inasmuch as wealthier households make more trips in total.

The income elasticity of demand for many other modes of transport is seen to be relatively high. Table 3.1 has already revealed elasticities in the range 1.77 to 4.38 for North Atlantic air travel, while Taplin (1980) suggests a figure of the order of 2.1 for vacation air trips overseas from Australia. By its nature air travel is a high-cost activity (the total costs involved are high even where mileage rates are low) so that income elasticities of this level are to be expected.

As with price, income changes exert somewhat different pressures on transport demand in the long run compared with the short. In general, it may be argued, a fall in income will produce a relatively dramatic fall in the level of demand, but as people readjust their expenditure patterns in the long term the elasticity is likely to be much lower. Looking at the responsiveness of car-ownership levels to income changes, British and US studies suggest a short-term income elasticity of between 2.0 and 4.5 while in the long run it appears to fall to around 1.5 (see Button *et al.*, 1982, for a survey). However, as with price elasticities, the relationships between long- and short-term effects are not completely clear cut. Reza and Spiro (1979), for example, produce an estimate of 0.6 for the short-run income elasticity of demand for petrol rising to 1.44 in the long run. If one assumes that petrol consumption is a proxy for trip-making, then one could attempt to justify this in terms of a slow reaction to changing financial circumstances – a reluctance, for example, to accept immediately the consequences of a fall in income. In fact, the situation is likely to be more complex than this since the long run may embrace changes in technology, and possibly locations, that alter the fuel consumption–trip-making relationship. Thus these figures may still be consistent with the initial hypothesis regarding the relative size of short- and long-run income elasticities of demand for *travel*.

There is a growing literature on the possibility of a constant travel income budget akin to the travel time budget mentioned in section 3.1 (see Gunn, 1981) with households tending to spend a fixed proportion of their income on transport. Zahavi (1977), for example, when examining data from a wide sample of urban transport users, noticed that the proportion of disposable income spent on cars by car-owning households at any income level appears to be approximately constant at a given moment of time. (UK data suggests a proportion of around 15.5 per cent - slightly larger for low incomes – for the period 1971–75.) The evidence for bus transport is less clear, but Mogridge (1978) suggests that while the proportion of disposable household income spent on bus travel seems to rise with income, a constant proportion still emerges if adjustments are made for the number of people in each household. In the longer term there is evidence at the aggregate level that over the past 25 years or so there has been a steady increase in the overall proportion of income or disposable income allocated to travel in the UK. (This contrasts to a more or less constant proportion in Canada and the United States.) This may, though, be explained in terms of rising income levels but constant proportional travel budgets within each income group. The general conclusion about the idea that some overall budget mechanism governs individual travel decisions, however, must be that, to date, the evidence available still leaves many questions unanswered and the theory is still largely unproved.

The price of other transport services

The demand for any particular transport service is likely to be influenced by the actions of competitive and complementary suppliers. (Strictly speaking, it is also influenced by prices in all other markets operating in the economy but, with the possible exceptions of the land market, which was discussed in Chapter 2, and

electronic communications, the importance of these is less great.) We have already touched upon the importance of motoring costs *vis-à-vis* the demand for public transport services and more is said on this topic later in the chapter. Moreover, there are the cross-price effects between modes of public transport. Table 3.6 presents the results from a number of different studies looking at elasticities of demand (both own fare and cross-fare) for transport in Greater London during the period 1970–75. The variation in results generally reflects the adoption of alternative estimation procedures and time-lag allowances. One of the more interesting points is the almost total insensitivity of the demand for urban car use to the fare levels of both bus and rail public transport modes. This fact, which has been observed in virtually all studies of urban public transport, is the main reason that attempts by city transport authorities to reduce or contain car travel by subsiding public transport fares have, in the main, proved unsuccessful.

Table 3.6
Greater London estimated Monday-Friday fare elasticities (1970–75)

		With respect to	
Study	*Elasticity of*	*Bus*	*Rail*
Fairhurst and Morris (1975)	Bus	–0.60	0.25
	Rail	0.25	–0.40
Glaister (1976)	Bus	–0.56	0.30
	Rail	1.11	–1.00
Collings, Rigby and Welsby (1977)	Bus	–0.405	n.a.
Lewis (1978)	Peak road traffic	0.025	0.056

Source: Glaister and Lewis (1978) which contains full references to the studies cited.

Table 3.5 suggests that there is likely to be more switching of demand between public transport modes as a result of one changing its fare structure than between that mode and private transport. More recent work on cross elasticities between public transport modes (see again Table 3.1), however, has thrown up somewhat different results with the indication, in particular, that bus travel in London is more sensitive to underground fares – this may reflect the capacity problems the latter was suffering in the late 1980s.

In other transport markets the cross-elasticity of demand may be higher, both between operators of the same mode of transport and between modes themselves. Recently, price reduction in non-conference shipping lines has attracted considerable traffic away from the cartel carriers. Similarly, scheduled airlines have experienced a contraction of demand as reduced–rate operators have entered the market.

Evidence on the cross-price elasticity of complementary transport services, such as feeder links to longer distance trunk hauls, is scant. The expansion of the motorway network has, by reducing motorway travel costs, certainly increased the demand for certain feeder roads while at the same time reducing it on competing routes. The exact implications of such network effects are much more difficult to trace out than changes in modal split but, in practical terms, are important features of the transport system.

Tastes
One of the items which influences equation 3.1 and not mentioned to date, but which is often included in elementary discussion of demand, is the 'catch-all' variable, tastes. While there may be circumstances when such a term could and, indeed, should be included in the demand function, in general, tastes are more likely to influence the actual *form* of the demand equation. Consequently, a change in tastes may be seen to affect the relationships between demand and the explanatory variables rather than result in some movement along a demand curve following the pattern of an established relationship.

The economic meaning of 'tastes' is seldom made clear, but in practice it seems to embrace all influences on demand not covered by the previous headings. Over time tastes in transport certainly have changed. Burrell (1972), for instance, has emphasised the increased car orientation of society in private transport while in freight transport the changing structure of the national economy (especially the switch from basic heavy industry to light industry producing high value, low weight products) has shifted the emphasis from price to other aspects of transport service. Both of these changes must to some extent be related to rising standards of living. With more wealth and greater free time there is likely to be an enhanced desire to benefit from the greater freedom and flexibility offered by private transport. A change in location patterns is also possible with larger residential plots away from urban centres now becoming attractive.

Another aspect of 'taste' concerns inertia and asymmetry in decision-making (Goodwin, 1977; Banister, 1978). This has two implications. First, there may be discontinuities in the demand curve for transport, or at least parts of the demand curve reflect almost total insensitivity to price changes, as a result of habit and inertia on the part of individuals and firms. It may be explained in some cases quite simply by the fact that there are costs involved in seeking out information about alternatives and continuing as before is thus the rational response until more major price changes occur. Second, there may be cases where responses are not symmetrical; a ratchet effect exists whereby the reaction to a price fall is not the same as the reaction to an identical price rise. Limited empirical work has been done on such 'path dependencies' although Blase (1980) did find evidence of asymmetries in travel behaviour in the context of fuel price variation and, more recently (Table 3.7), Dargay (1993) has provided further support for this across a number of national studies.

Table 3.7
Long-run price elasticities of fuel consumption

	Reversible model	*Irreversible model*	
	Price rises and falls	*Price rise*	*Price fall*
France	–0.96	–0.80	–0.45
Germany	–0.33	–0.44	–0.02
UK	–0.40	–1.50	–0.10
US	–0.46	–0.67	–0.31

Source: Dargay (1993)

Rather more effort has been put into the question of service quality. It is noticeable, for example, from empirical studies that public transport demand is

sensitive to changes in service quality, especially to any reduction in the speed or frequency of services. Again this fact reflects the decreased importance attached to the purely monetary dimension. Market research in the West Midlands, for example, revealed that only 27.1 per cent of people felt that keeping fares down would be the greatest improvement to local public transport; the remainder looked for service quality improvements, for example, 14.6 per cent for greater reliability, 10.4 per cent for higher frequency, 10.4 per cent for more bus shelters, 10.0 per cent for cleaner vehicles, etc. (see Isaac, 1979).

An extensive survey by Lago *et al.* (1981) examined a wide range of international studies concerned with urban public transport service elasticities. The general conclusion that services will generate less than proportional increases in passenger and revenue (that is, $E_s < 1$) would seem to contradict the above findings but this may be misleading. To begin with the survey looks at a number of service quality attributes in isolation rather than at a package of service features. It also admits that many of the services sought by potential public transport users are qualitative rather than quantitative and, hence, are not amenable to the types of analysis reviewed. The survey also highlights the fact that service quality is far more important when the initial level of service is poor; the general elasticities found for peak period ridership, for instance, are much lower than those for the off-peak. The evidence presented suggests that service headway is one of the more important service variables; the studies examined indicates an elasticity of the order of –0.42 compared with, for example, –0.29 for in-vehicle bus travel time.

Table 3.8
Service features consignors require from road hauliers (%)

Factor	*Local*	*Intraregional*	*Trunk*
Vehicle suitability	43	45	69
Quick delivery	29	36	2
Prompt collection	10	12	14
'Good reputation'	15	5	1
Access to handling facilities	8	4	-
Condition of vehicles	-	-	8

Source: Price Commission (1978)

The available evidence suggests that today low price is also no longer the dominant determinant of freight modal choice. In a survey conducted in the UK by the Price Commission (1978), for instance, it was found that only in 52 per cent of cases did consignors elect to use the cheapest road haulage operator available for local trips, 77 per cent for intraregional trips and 64 per cent for trunk-hauls. Many were so unconcerned about finding the lowest price that competitive quotations were not sought. The answers given to the Price Commission in a more recent survey are reproduced in Table 3.8. The emphasis placed upon vehicle suitability is seen to reflect customer concern about such factors as weather protection, systems for securing loads and compatibility of vehicle with product. These are concerns unlikely to have been of paramount importance when heavy industry dominated the economy but are of much more concern for the more modern, high-technology firms (Button, 1988). These firms are increasingly turning to 'just-in-time' production methods whereby inventories are kept to a minimum. To optimise such processes reliability of supply is vital and companies are willing to pay the additional financial costs which this may entail (Schneider, 1985).

To some extent extending from this, many industrialists prefer to use their own vehicle fleets rather than engage public hauliers despite considerable cost disadvantages. The reasons for this utilisation of high-cost transport are similar to those used by other consignors who select between hauliers (see Table 3.9). Once again it is service quality which dominates the decision process, consignors seeking reliability, control and speed in preference to a low price. Of course, this should not be interpreted to mean that price is of no consequence but rather that its importance has diminished over time as the nature of industrial production has changed.

Table 3.9
Reasons for the maintenance and use of an own-account fleet

Factor	*Score*
Reliability	14.9
Control	13.0
Customer relations	9.4
Speed of delivery	9.2
Flexibility	7.8
Costs v. prices	7.4
Ability of 'own account' to meet timing constraints	6.6
Price is subordinate to service considerations	6.5
Specialised capability	5.5
Speed of response	5.1
Adaptability	3.6
Consistency	3.5
Avoidance of damage or contamination	3.4
Security	2.6
Other (not financial)	1.1
Other (financial)	0.5
	100.0

Source: UK Department of Transport (1979)

3.3 The notion of a 'need' for transport

The demand function indicates what people would buy given a particular budget constraint, but it is often argued that allocation of resources on this basis results in inequalities and unfairness because of differences in household income or other circumstances. There are, thus, some advocates of the idea that transport services, or at least some of them, should be allocated according to 'need' rather than effective demand. The concept of need is seldom defined (or at best rather imprecisely so, see Williams, 1974), but seems to be closely concerned with the notion of merit goods - that is, needs 'considered so meritorious that their satisfaction is provided for through the public budget over and above what is provided for through the market and paid for by private buyers' (Musgrave, 1959). The idea is that just as everyone in a civilised society is entitled to expect a certain standard of education, medical cover, etc., so they are entitled to enjoy a certain minimum standard of transport provision.

One can point to a number of transport policy initiatives over time which are based upon this idea. The 1930 Road Traffic Act in the UK, for example, introduced, besides other things, road service licences into the bus industry which embraced the notion of *public need*. The Traffic Commissioners interpreted this to mean the provision of a comprehensive network of services for an area irrespective of the effective demand for specific routes. Licences were granted on this basis and operators cross-subsidised the unremunerative services with revenue from the more profitable ones. More explicit were the social service grants given to the railways under the 1968 Transport Act whereby 222 services were subsidised for social reasons, once again despite deficit effective demand for their services. Additionally, the government has, for many years, provided both capital and operating cost subsidies to assist the shipping and air services to the remoter islands of Scotland. The subsidies given by local authorities to bus services, both urban and rural, under the 1985 Transport Act are also meant to ensure that transport services meet the needs of the local community. There has also been a considerable growth of dial-a-ride systems in London and other cities, initially seen as an alternative to conventional public transport but since the mid-1970s as meeting the needs of the elderly and handicapped (Sutton, 1987). In a different context, the 1978 Airline Deregulation Act in the USA provided subsidies for services to small communities (the Essential Air Service Program) and the 1987 National Transportation Act in Canada provided explicitly for subsidies to 'essential' air services in the northern part of the country.

This notion of need rather than effective demand raises two important issues. Firstly, exactly what is the nature of 'need' in reality, and secondly, if one accepts that the concept has some operational meaning, how can it be incorporated into economic analysis? We look at these two questions in turn.

The need for adequate transport provision stems from the idea that people should have access to an acceptable range of facilities (Stanley and Farrington, 1981). It is, therefore, essentially a 'normative' concept. Transport is seen as exerting a major influence on the quality of the lives of people and a certain minimum quality should be ensured. The UK policy document *Transport Policy* (UK Department of Transport, 1977) emphasised this view of mobility: 'The social needs for transport also rank high – the needs of people to have access to their work, shops, recreation and the range of activities on which civilised society depends.' Defining the exact level of mobility in this context is difficult, but it is helpful to look at the groups who, for one reason or another, seem in need of transport services in addition to those that would be forthcoming in the market.

The most obvious group is the poor who cannot afford transport. Transport expenditure forms a substantial part of a household budget and, consequently, those on the lowest income must make fewer trips, shorter trips or trips on inferior modes of transport. A major problem is that as income levels rise, in general, there is a tendency towards higher car ownership leaving only depleted and expensive public transport facilities for those at the lower end of the income distribution. A household with a car tends, for instance, to make on average about 300 fewer bus journeys a year than comparable households without a car. But there are also wider issues, in that this change in the transport sector has implications for population distribution. In particular, higher car ownership in rural areas, and the resultant reduction in the *demand* for local public transport, has put pressure on rural bus and rail services. Between 1970 and 1974 the National Bus Company, which is responsible for most rural stage services in England and Wales, reduced its bus kilometres by 7 per cent. This, in turn, has been seen as one of the causes of rural depopulation. The question then arises as to whether society, in general, needs a balance between urban and rural society.

While inadequate income poses one problem, there are other groups in society that are often felt to need assistance. The old, infirm and children are obvious examples where irrespective of income, effective demand may be felt an inadequate basis upon which to allocate transport resources. The available evidence suggests that only about 10 per cent of households in the aged or disabled category have private transport at hand. Even when a household does own a car (or has one made available through employment agreements) there are still members of it who may be deemed in need of additional transport. A study of mobility by Hillman *et al.* (1973), for instance, found that 70 per cent of young married women in the outer metropolitan area of London had no car available for their everyday use – even 30 per cent of those qualified to drive were in this position. There are arguments, therefore, that these groups are in need of adequate and inexpensive public transport services (or special transport provision in the case of the disabled) and that the normal market mechanism is inadequate in this respect. Despite the comparatively limited availability of special transport services to cater for these forms of need, Bailey (1977) estimated that in 1977 some 35 million such trips were made in the UK.

If one accepts the notion that need is, in certain contexts, the relevant concept rather than effective demand, then, for practical purposes, this idea requires integration into more standard positive economic theory. (It should perhaps be noted that many people do not accept the idea of 'need' as an allocative device but advocate tackling problems of low income or disadvantage at their source through measures such as direct income transfers, but this is an issue outside our present discussion.) Perhaps the simplest method of reconciling the difficulty is to treat the monies paid out by government and other agencies in subsidies to social transport services, as the effective demand of *society* for the services. One can then perceive the situation as analogous to that of conventional consumer theory. Just as effective demand reflects the desire of an individual to purchase a particular service so government's response to need reflects society's desire to purchase particular transport services for certain of its members.

3.4 The valuation of travel time savings

The importance of travel time in transport economics should by now be apparent. While the action of travel involves some time costs, it is perhaps more useful to consider travel time in a chapter on demand and benefits rather than costs. This is because travel or transport time savings are normally considered to be a major component of any scheme designed to improve transport efficiency. As we see in Table 3.10 time savings form the major component of inter-urban road investment benefits – a situation also found in most fields of passenger transport. For reasons of comparability with other forms of benefit, a vast amount of energy has gone into devising methods of placing money values on such benefits.

Two quite distinct methodologies have been developed for time evaluation, the distinction being made between time saved in the course of employment and time saved during non-work travel (including commuter trips when fixed working hours are involved). The distinction is drawn because work time involves lorry drivers, seamen, pilots, etc. not simply in giving up leisure but also in incurring some actual disutility from the work undertaken. Hence, if they could do the same amount of work in less time these people would be able to enjoy more leisure and also suffer less disutility (or the employer must pay them more to encourage a

continuation of the same work hours with a higher output). Savings in non-work time do not, by definition, reduce the disutility associated with work and, consequently, although more leisure may be enjoyed, they are likely to be valued below work travel-time savings.

Table 3.10
Benefits from an average road improvement scheme

Benefit	*(%)*
Accident savings	20
Vehicle operating cost savings	0
Working time savings	
Car	26
Light goods vehicles	11
Heavy goods vehicles	11
Buses	3
Non-work time savings	
Car	23
Buses	6
Total	100

Source: UK Department of the Environment (1976, Vol. 2)

The valuation of work travel time (which embraces all journeys made when travellers are earning their living) is made simpler if we accept the traditional economic idea that workers are paid according to the value of their marginal revenue product. On this basis, the amount employers pay workers must be sufficient to compensate them for the marginal time and disutility associated with doing the job. Thus it becomes possible to equate the value of a marginal saving in work travel time with the marginal wage rate (plus related social payments and overheads). An alternative way of arriving at this cost savings approach is by reflecting upon the opportunity costs involved – as Benjamin Franklin once said, 'Remember that time is money.' Time savings at work permit a greater output to be produced within a given time period which, again drawing on the marginal productivity theory of wage determination, will be reflected in the marginal wages paid. Official UK policy is to value work travel time savings as the national average wage for the class of transport user concerned plus the associated costs of social insurance paid by the employer and a premium added to reflect overheads.

A major problem with the wage equivalence approach is that it assumes employees consider the disutility of travel during work to be the same as the disutility of other aspects of their work which they may be required to undertake if travel time is reduced. In many instances workers may consider the travel much less arduous than these alternative tasks. This implies that savings in work-time travel should, in such cases, be valued at less than the wage rate plus additions. Also some people may view travel time as highly productive – many rail and air travellers, for instance, certainly work on their journeys – suggesting that reduced travel time would not significantly alter output. Even time spent in car travel can be used to complete mental tasks – for example Fowkes *et al.* (1986) found that about 3 per cent of business travel time by car was spent working. The wage rate ceases to be a useful measure of work travel time savings in such cases.

While labour economics provides a useful foothold to obtain values of work travel time, rather more empiricism is required in the evaluation of non-work travel time. The behavioural approach involves using revealed preferences to consider trade-off situations which reflect the willingness of travellers to pay in order to save time. In other words, if a person chooses to pay X pence to save Y minutes then he is revealing an implicit value of time equal to at least X/Y pence per minute. Empirical studies attempting to value non-work travel time have looked at a number of different trade-off situations (Waters, 1992 offer a survey), notably when travellers have a choice among:

(1) route;
(2) mode of travel;
(3) speed of travel (by a given mode over a given route);
(4) location of home and work; and
(5) destination of travel.

The standard approach in these trade-off studies is to employ a simple equation of the general form:

$$P_1 = \frac{e^y}{(1+e^y)} \text{ where } y = \alpha_0 + \alpha_1 (t_1 - t_2) + \alpha_2 (c_1 - c_2) \tag{3.2}$$

where P_1 = probability of choosing mode (route, etc.) 1;
y = choice of mode (route, etc.); takes value of 1 for mode (route, etc.) 1 and 0 for mode (route, etc.) 2;
e = exponential constant
t_i = door-to-door travel time by the i^{th} mode (route, etc.); i = 1, 2;
c_i = door-to-door travel cost by the i^{th} mode (route, etc.); i = 1, 2;
α_1, α_2 and α_3 = constants to be estimated.

A value of time is then inferred by looking at changes in the dependent variable which result from a unit change in either the time or the cost difference. Strictly it may be found as the ratio α_1/α_2 in equation 3.2.

Many of the early studies of non-work travel time concentrated on urban commuter trips because there was pressure at the time to provide information for cost-benefit analysis of urban transport investment plans. In consequence, mode and route choice evaluation techniques were developed to a high level of mathematical sophistication. Early work by Beesley (1965) specifically employed discriminant analysis to examine the journey to work mode choices of employees at the UK Ministry of Transport during 1965/6. This technique essentially finds the trade-off value of time that minimises the number of misallocations of commuters to alternative modes. Beesley found that commuter trip time savings were valued at between 30 and 50 per cent of the gross personal income of the commuters. One of the main problems with this pioneering study is that it failed to isolate on-vehicle travel time from the other components of journey time (for example, waiting and walking time). The defect was subsequently remedied in a larger study of mode choice in Leeds undertaken by Quarmby (1967) which embraced seven variables including walking and waiting time as well as on-vehicle time. The findings indicate that savings in walking and waiting times are valued at between

two and three times savings in on-vehicle time. Table 3.11 provides details of the non-work time values which have been revealed in these and subsequent studies.

Table 3.11
Computation of estimated values of travel time savings

Study	*Country*	*Value of time as % of wage rate*	*Trip purpose*	*Mode*
Beesley (1965)	UK	33–50	Commuting	Auto
Quarmby (1967)	UK	20–25	Commuting	Auto, Transit
Stopher (1968)	UK	21–32	Commuting	Auto, Transit
Oort (1969)	USA	33	Commuting	Auto
Thomas & Thompson (1970)	USA	86	Interurban	Auto
Lee & Dalvi (1971)	UK	30	Commuting	Bus
		40	Commuting	Auto
Wabe (1971)	UK	43	Commuting	Auto, Subway
Talvitte (1972)	USA	12–14	Commuting	Auto, Transit
Hensher & Hotchkiss (1974)	Australia	2.70	Commuting	Hydrofoil, Ferry
Kraft & Kraft (1974)	USA	38	Interurban	Bus
McDonald (1975)	USA	45–78	Commuting	Auto, Transit
Ghosh et al (1975)	UK	73	Interurban	Auto
Guttman (1975)	USA	63	Leisure	Auto
		145	Commuting	Auto
Hensher (1977)	Australia	39	Commuting	Auto
		35	Leisure	Auto
Nelson (1977)	USA	33	Commuting	Auto
Hauer & Greenough (1982)	Canada	67–101	Commuting	Subway
Edmonds (1983)	Japan	42–49	Commuting	Auto, Bus, Rail
Deacon & Sonstelie (1985)	USA	52–254	Leisure	Auto
Hensher & Truong (1985)	Australia	105	Commuting	Auto, Transit
Guttman & Menashe (1986)	Israel	59	Commuting	Auto, Bus
Fowkes (1986)	UK	27–59	Commuting	Rail, Coach
Hau (1986)	USA	46	Commuting	Auto, Bus
Chui & McFarland (1987)	USA	82	Interurban	Auto
Mohring et al (1987)	Singapore	60–129	Commuting	Bus
Cole Sherman (1990)	Canada	93–170	Commuting	Auto
		116–165	Leisure	Auto

Source: Waters (1992) which contains full references to studies cited.

Stated preference techniques, whereby hypothetical questions are posed to travellers to gain information about trade-offs they would be willing to make have become more common in recent years. A pioneering example was that of Lee and Dalvi (1969) who used questionnaires, rather than looking at actual choices, to discover the level of fare increase required before passengers switched from one mode of public transport to an alternative. Interestingly, in Manchester it was found that on-vehicle time, walking time and waiting time were not separately important and travellers did not distinguish among them. Overall it was estimated that non-work travel time was being valued at 15–45 per cent of hourly income.

While most urban studies have tended to focus on mode choice decisions, the evaluation of non-work inter-urban travel time has tended to concentrate rather more on route and speed choice situations - although imperfections in travellers' knowledge of the latter make speed choice trade-offs suspect. Pioneering work on route choice by Claffey *et al.* (1961) looked at choices made between tolled and free roads in the USA and attempted to allow for differing accident rates and levels of driver discomfort when assessing the time/money cost trade-offs. Mathematical weakness limits the value of this specific model but subsequent reworking suggests time differences are unimportant in route choices of this type. Thomas (1967), again using USA data, conducted a study on a similar basis and here time differences did appear significant and he estimates that non-work travel time appeared to be valued at between 40 and 83 per cent of average income. Dawson and Everall (1972), using a further modification and looking at route choices of motorists travelling between Rome and Caserta and between Milan and Modena, where autostrada offered alternatives to ordinary trunk roads, found that observed trade-offs indicate that commuting and other non-work travel time was valued at about 75 per cent of the average wage rate.

It is clear from the selection of studies cited above that non-work time savings are, indeed, valued below the wage rate, but it is equally clear that the actual values obtained from the behavioural studies are extremely sensitive to the assumptions made and the estimation technique employed. Hensher (1979) goes further and, in particular, points to the rather strong assumptions that are implicit in the not uncommon practice of taking time values obtained from, say, a mode choice study and employing them in route or speed choice situations. He also questions whether enough consideration is given to the composition of time savings beyond the in-vehicle/waiting time split and, in particular, to preferences between constant journey speed (with a lower average) and faster, variable speeds (with a higher average). There is also the common practical problem that it is difficult to separate the influence of comfort and convenience factors from travel time savings.

In Britain the UK Department of Transport and its predecessors have since the 1960s recommended standard values of time for transport analysis purposes (see Table 3.12). The use of standard figures is to encourage uniformity in investment appraisal. While the work-travel time figures are open to only minor criticisms (and even quite major errors here would seem unlikely to distort decisions), the use of standard non-work travel time values has met with more serious criticism.

Empirically, non-work travel time values have generally been shown to be correlated with income level (Heggie, 1976) being one of the few exceptions), but on occasions an *average* value across all income levels has been used for policy formulation purposes. The argument supporting this 'equity' value is that if time values were directly varied with income this would tend to bias project selection towards projects favouring the higher income groups. In evaluation, the travel time savings of such groups would automatically be weighted more heavily than those of the less well-off. The Leitch Committee in the UK, however, rejected this line of argument because it is not consistent with the way other aspects of transport investment are evaluated. Since the overall distributional effects of transport investment may be treated more directly in the appraisal process (see Chapter 9), the notion of 'equity' values was rejected in favour of income-based time evaluations.

Even if generally acceptable values of travel time could be obtained there are still difficulties associated with using them. One of the major problems is that

some projects can result in a small number of large time savings while others produce a multitude of extremely small savings. The problem becomes one of deciding whether sixty one-minute savings are as valuable as (or more valuable than) one saving of an hour's duration. It could be argued that travellers, especially over longer routes, tend not to perceive small time savings or cannot utilise such time savings (see Tipping, 1968). If this is so it would tend to make urban transport schemes appear less attractive *vis-à-vis* inter-urban ones because the main benefits of urban improvements have been small time savings spread over thousands of commuters. One suggestion is that a zero value should be adopted for small travel time savings with a positive value only being employed once a threshold level of saving has been reached (say ten minutes). This ignores the fact that small time savings may, in some circumstances, be combined with existing periods of free or idle time to permit substantial increases in output or in leisure enjoyment. Further, if there are non-linearities in the value of travel time this would imply that widely used trade-off methods of time evaluation based upon *average* time savings must be giving biased estimates of the value of travel time. The debate over the handling of small travel time savings is unlikely to be resolved easily.

Table 3.12
Official UK values of time for transport investment appraisal purposes (pence per hour)

Time category	*1975*	*1976*	*1989*
Working time			
Car driver	331	379	849.7
Car passenger	287	332	705.3
Rail passenger	357	407	1006.1
Bus passenger	168	196	701.2
Underground passenger	313	360	1050.0
Heavy goods vehicle occupant	155	178	622.5
Light goods vehicle occupant	139	158	660.8
Bus driver	166	191	647.6
Bus conductor	158	182	n.a.
Leisure time			
In-vehicle time	35	36	207.5*
Walking and waiting time	70	72	

* Standard appraisal value for all non-working travel time
Source: UK Department of the Environment (1976), UK Department of Transport (1978) and *COBA 9 Manual*.

Transport studies in less developed countries tend to adopt the convention that while work travel time savings should be given a monetary value based upon the cost-savings approach (although the wage rate is generally modified to allow for imperfections in the local labour market), savings in non-work travel time – especially in rural areas – are given a zero value (Howe, 1976). The justification for this is that the prime objective of improving transport infrastructure in the third world is to assist in economic growth and thus the emphasis should be exclusively concentrated on economically productive schemes – leisure time is not seen as 'productive'. Thomas (1979) has pointed to a serious anomaly, however, when this argument is carried into practice. While non-work travel time savings in rural areas are ignored, savings in vehicle operating costs for such travel is not. Not only is this inconsistent but it also has important distributional implications because the main beneficiaries of low operating costs are almost invariably high income car owners.

3.5 The demand for car ownership

Car ownership in Great Britain has risen considerably since the First World War with only brief halts during periods of major military conflict and occasional decelerations in the trend during periods of macroeconomic depression (see Table 3.13). This upward trend is not unique to Britain but is also to be found in all other countries irrespective of their state of economic development or the nature of their political institutions. The upward trend in car ownership is the result of both the considerable benefits which accompany car availability (notably improved access and greater flexibility of travel) and the long-term increases in income enjoyed by virtually all countries since the Second World War. The 'demonstration effect' has tended to accelerate the process in less developed countries as attempts are made to emulate the consumption patterns of more affluent states.

Table 3.13
Car ownership growth in Great Britain

Year	*Cars and vans (thousands)*	*Cars and vans per capita*
1930	1056	0.023
1935	1477	0.032
1940	1423	0.030
1945	1487	0.031
1950	2258	0.045
1955	3526	0.071
1960	5526	0.108
1965	8917	0.169
1970	11515	0.213
1975	13747	0.252
1980*	14772	0.277
1985*	16454	0.320
1990*	19742	0.374

*Not strictly comparable because of changes in data collection method
Source: *Transport Statistics in Great Britain* (various years)

Considerable effort has been focused on exploring both the rate of increase in vehicle ownership and reasons why this should differ between countries and between areas within a single country. Information on the underlying demand functions is sought in Great Britain for a variety of reasons. Car manufacturers need to know the nature of changing demands for new vehicles, both within the country and within their export markets, and to be able to forecast likely changes in the type of vehicles which are wanted. While work in this area often sheds some useful light on the workings of the car market, it is only of limited use to transport

economists (see Button *et al.*, 1982). By contrast, central government is generally more interested in the aggregate number of vehicles in the country, mainly for road planning purposes, but also, to a lesser extent, to assist the Treasury in its fiscal duties. Regional variations, which can be quite pronounced (Table 3.14), are also of interest for strategic planning purposes.

Table 3.14
Regional variations in household car ownership patterns in the UK (1988)

Region	*Percentage of households with regular use of*		
	No car	*One car only*	*Two or more cars*
England	34	44	22
North	46	41	13
Yorkshire & Humberside	43	41	16
East Midlands	31	46	22
East Anglia	27	48	25
South East	30	44	26
Greater London	40	43	17
Rest of South East	24	45	31
South West	25	49	26
West Midlands	35	43	22
North West	39	42	20
Wales	32	50	17
Scotland	47	39	14
Northern Ireland	40	44	16

Source: *Transport Statistics Great Britain* (1992)

The theory underlying much of the early forecasting work in this area is closely akin to the management theory of a 'product life' cycle, where a product has a predetermined sales pattern almost independent of traditional economic forces, although taste and costs are not altogether absent from the model. The logistic curve fitting model developed by the Transport Research Laboratory (then the Road Research Laboratory and subsequently the Transport and Road Research Laboratory over the period), in its basic form, treats per capita vehicle ownership as a function of time (Figure 3.1) with the ownership level following a symmetric, sigmoid growth path through time until an eventual saturation level is approached (Tanner, 1978). Broadly, it is argued that long-term growth in ownership follows a predictable diffusion process. Initially, high production costs and unfamiliarity will keep sales low, but after a period, if the product is successful, economies of scale on the supply side coupled with bandwagon effects on the demand side would result in the take-off of a comparatively rapid diffusion process. Finally, there is a tailing-off as the market becomes saturated and everyone wishing to own a car does so.

The TRL extrapolative approach provided relatively good forecasts in the 1960s, but it has tended to be less reliable in more recent years (see Table 3.15) and to suffer from a tendency towards over-prediction. While some of the difficulties may be associated with problems of estimating key parameters such as the ultimate saturation level, or with the correct configuration of the growth curve – in later work a power function replaced the logistic – at least one school of thought rejects the underlying extrapolative philosophy as inadequate (Bates *et al.*, 1978). In particular, it is argued, car ownership forecasting should be based upon explicit economic variables such as income and vehicle prices rather than 'proxy' variables such as time. The TRL forecasting framework has attempted to meet this criticism by incorporating economic variables, but both a time trend is still retained and the income and vehicle operating cost elasticities are not estimated internally within the model but derived from 'external' sources. The demand model developed by Bates and others, as part of a larger Regional Highway Traffic Model (RHTM), in contrast is based entirely upon 'causal' variables and all the relevant elasticities are estimated directly within the forecasting model.

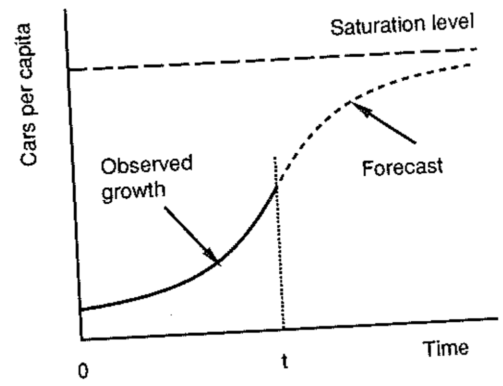

Figure 3.1
The logistic growth curve approach to car ownership forecasting

At the national level the RHTM relates car ownership per household (expressed mathematically in logit form) to household income. The data used is not the time series registration statistics employed by the TRL but rather a series of cross-sectional sets of statistics obtained from annual Family Expenditure Surveys and other sources. For forecasting purposes it is necessary to be able to predict reliably the level and distribution of future income. Additionally, it is recognised that changes in motoring costs will influence ownership levels, so rather than deflate changes in money income over time by changes in retail prices to obtain a real income prediction, money income is deflated by an index of anticipated motoring cost changes to give a projection of 'car purchasing income'. Simply, it is assumed that a £1 rise in income will have the same positive effect on car ownership as a £1 fall in car prices. The approach also concentrates on the probability of households having a certain level of vehicle ownership rather than, as with the TRL model, on forecasting the national average ownership level; this conforms more closely to other recent trends in transport demand forecasting (see Chapter 8). At present the TRL and RHTM approaches to forecasting car ownership have in a sense been combined; while economic variables are the main driving force along the lines of the RHTM, the addition of number of driving licences effectively acts as a time trend surrogate.

Table 3.15
Comparison of actual car ownership and TRL forecasts

Year of publication	*Base year for calculation*	*Forecast annual growth in cars per capita 1975 ÷ Actual annual growth in cars per capita 1975*	*Forecast car pool 1975 ÷ Actual car pool 1975*
1962	1960	1.14	1.13
1965	1964	1.57	1.57
1967	1966	1.67	1.68
1969	1968	1.84	1.84
1970	1969	1.66	1.66
1972	1971	1.62	1.58

Source: Button *et al.* (1980)

Differences in the geographical demand for car ownership interest transport planners both because they need to be able to forecast future demand for links in the local road network and because, where ownership is low, social commitments may require that alternative public transport is provided. At the national level there are quite marked differences in ownership levels, as we saw in Table 3.14. The nation can broadly be divided into three regions: the South-west, South-east and East Anglia have a high propensity for car ownership, the West Midlands, Wales and East Midlands form a middle grouping, while the North-west, Yorkshire and Humberside, the North and Scotland have the lowest incidence of car ownership. This general trend towards lower car ownership levels as one moves north has been observed in many studies of the car market but no really satisfactory explanation of the phenomenon exists. It has been observed, however, that if the regions are broken down by their constituent counties then those with low car ownership tend to incorporate substantial urban concentrations and many have a major industrial component in their economies. This association of urban concentration with low car ownership is also found at the local level and in Table 3.16, which looks at the situation in West Yorkshire, a clear trichotomy emerges among household car ownership levels in urban, suburban and rural areas even after allowing for variations in income levels.

It seems likely that these spatial variations at the local level may, once allowance has been made for differing income and demographic factors, be explained in terms of the quality of local transport services. Good, uncongested roads combined with poor public transport increases the demand, *ceteris paribus,* for private car ownership. Regional econometric studies of car ownership have attempted to reflect this cost of transport effect by incorporating variables such as residential density in their models (it being argued that a densely populated area is normally well served by public transport while motoring is adversely affected by the higher levels of traffic congestion). More sophisticated local models have shown the frequency of public transport services to influence car ownership rates (Fairhurst, 1975). In West Yorkshire it has been found that car ownership rises as the generalised cost of public transport trips increases (Button *et al.*, 1982). If these studies are correct then there is some evidence that the long-term growth in car ownership may be contained by improving public transport services although from a policy point of view the overall cost of such actions needs to be fully assessed.

Table 3.16
Household car ownership in West Yorkshire in 1975 (UK)

Area	*Household income*							
	Less than £1041	*£1041-£2080*	*£2081-£3120*	*£3121-£4160*	*£4161-£5200*	*£5201-£6240*	*£6241-£7800*	*More than £7800*
Urban	0.07	0.25	0.55	0.68	0.84	0.95	1.16	1.47
Dormitory	0.15	0.53	0.80	1.03	1.41	1.65	1.50	2.07
Small town and rural	0.07	0.34	0.69	0.91	1.03	1.38	1.48	1.83

Source: Button *et al.* (1982)

3.6 Further reading and references

Readers interested in the influence of different variables on transport demand, especially demand elasticities, see Goodwin (1992) and Oum *et al.* (1992). Discussion of 'need' is usually rather imprecise but Banister *et al* (1984) offer a useful and more detailed assessment of many of the analytical problems. Sharp (1981) provides a detailed examination of the economics of time, Bruzelius (1979) a review of the theoretical literature while Waters (1992) provides a comprehensive survey of the empirical literature. The problems of evaluating travel time savings in low-income couties is examined in Button and Pearman (1984). Hensher (1979) offers a much more rigorous critique, focusing specifically on the inappropriate use that is made of values obtained by empirical means. A detailed account of the development of national car ownership forecasts is provided by Tanner (1978) although the treatment of disaggregate modelling techniques is rather thin. Button *et al.* (1982) provides a more comprehensive overview and critique, with a specific emphasis on the economic content of car ownership forecasting. It also contains a considerable list of further, technical references.

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