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Transport Economics

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PREFACE

This book was conceived when the three authors jointly taught a course in transport economics at Manchester University. During its gestation other books on transport economics have appeared although none fulfils the role originally intended for this one. Our aim is to provide the student with the basis to appreciate the key issues that affect the economics of transport, and in this we assume no prior knowledge of transport.

In general we have tried to pitch the level of the book at second-year standard, assuming some acquaintance with statistical techniques such as regression analysis. However, in Chapter 3 on demand modelling and in Chapter 7 on spatial equilibrium we are consciously offering material at a higher level for the brighter or the third-year student. Thus, if transport economics is offered as a second-year course, these areas can be considered optional; but if it is offered at third-year level, we hope that these chapters plus more extensive reference to cited works will provide the student with something to bite on. In Chapters 9 and 10 we offer an introduction to international transport as this is all too often neglected in other texts; lack of space, however, precludes the treatment of investment in ports and airports.

We should like to thank numerous colleagues and an anonymous referee for their comments; we should also like to thank Margot Tyson, Helen Grindrod and Edith Gillet (together with members of her academy) for typing the manuscript and Marjorie Watt for assistance with the diagrams. The manuscript was substantially completed by mid-1977, but we have included a modest number of later additions and amendments.

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CONTENTS

CHAPTER 1

The Characteristics and Scope of Transport Economics

Transport is a keystone of civilisation. The spread of production, trade and ideas and the economic ascendancy of mankind all depend upon movement. Personal mobility is one of democracy's most valued freedoms, and a surprisingly high proportion of our income is devoted to our movement and to the movement of the goods that we buy. However, the systematic economic analysis of transport is relatively recent.

Transport economics is basically a branch of applied microeconomics. While it uses many standard techniques of economic analysis, it faces a number of special problems and characteristics that justify its consideration as a specific branch of the discipline. The demand for transport is a derived one, and each journey is unique in time and space; it cannot be stored or transferred – and from these seemingly simple statements follows a host of implications. The complexities of economic problems involving transport are illustrated by the controversies over supersonic aircraft, the Third London Airport and motorway construction and by the difficulties posed by road congestion, declining public transport, air traffic control and the vagaries of ocean freight rates. Technology, with all its expense and uncertainty, has played a critical role, and it will continue to do so as the depletion of oil necessitates a replacement for conventional motor cars.

The simple canons of market economics cannot be applied to transport for a variety of reasons. Since journeys are unique in space and time monopoly is likely to arise in varying degrees, especially when technological change offers an advantage to a particular mode or where economies of scale affect one mode more than another. The state has therefore intervened in transport; railways in Britain have been regulated since 1844 to prevent any repetition of the monopoly abuse evident among canal companies. Since then regulations and often state ownership have pervaded all sectors of transport (Gwilliam and Mackie, 1975, Chapter 3). The danger that a monopoly will restrict output and force up price is well known, although sometimes the only means to realise economies of scale is to accept monopoly but constrain its behaviour

by statute. In the short run the degree of monopoly may be intense as the user has no alternative; but as the time span lengthens so does choice, and the user may seek alternative modes, routes and sources of supply of the goods that he seeks or even other destinations that will satisfy the purpose of his trip.

The external effects of transport also warrant intervention. Pollution and congestion are both real costs imposed on the community by the users of transport, but they are not reflected in the private costs met by the individual user. Social decisions should, however, make allowance for these costs, and they should also recognise the need to preserve certain public goods (e.g. visual amenity) that are not priced in the market but are accepted as legitimate concerns for community planning and decision. Intervention may also be important where the individual fails to perceive the full economic implication of his own defective decisions. One example of this is compulsory safety tests for cars; another is the legal obligation to wear car safety belts that applies in Australia.

Another important source of difficulty in transport economics is indivisibility. This problem impinges on both pricing and investment. Many investments in transport are large and infrequently made, and there are problems over how their costs should be allocated. For example, if passenger and freight trains use the same track, how should track costs be allocated between them? At the time of writing British Rail charges its track costs to passenger trains, but this clearly represents a cross-subsidisation of freight services. Peak traffic also poses problems over the allocation of costs; and so does journey length, for often the cost of a journey is not simply proportional to distance but includes an element of cost for loading or boarding the vehicle, implying that cost per mile diminishes with the length of journey. Indivisibilities render marginal cost pricing difficult, however. Consider the cost of a train journey: should the first entrant of the carriage pay his full marginal cost? Clearly not; some form of averaging is necessary here although the ideal might be, as Dupuit (1844) put it over a century and a quarter ago, that 'the best tariff would be one which makes all users of communication pay a toll proportionate to the utility they derive from the passage'.

All the complications mentioned above make pricing and investment appraisal in transport a difficult and even subtle business. Investment appraisal has made great strides in the past half-century as economists have refined cost–benefit analysis to take close cognisance of non-market items; but transport economists remain a long way from infallibility in either pricing or investment, and the ultimate decisions are frequently political ones.

However, the difficulties of economic decisions should not distract from their importance for transport is vitally important. The figures in Table 1.1, published by the United Nations, show the percentage of gross domestic product derived from the transport and communications sector. The figure for Norway is enlarged by the importance of its maritime industry. Communication by post and telephone represents only a small proportion of these figures but the real significance of transport is underplayed by considering the service sector alone since many elements of the manufacturing sector (e.g. the motor industry) are key contributors to transport. Thus in Britain in 1975, 12.4 per cent of consumers' expenditure went on travel (if car purchase is included), while in the United States it has been claimed that 18 per cent of gross national product relates to highway transportation alone (Motor Vehicles Manufacturers' Association, 1975).

Table 1.1 *Proportion of gross domestic product derived from transport and communications*

Country	*Year*	*%*
Australia	1972	7
Canada	1974	6
West Germany	1974	6
Japan	1974	7
Norway	1974	15
UK	1973	8
USA	1973	6
USSR	1974	6

Source United Nations (1975, Table 188)

The pattern of transport has changed across recent years. Table 1.2 gives some figures for recent British trends in passenger and freight transport, which are fairly typical of those in advanced market economies.

However, the figures in Table 1.2 treat passenger-kilometres (and tonne-kilometres) as homogeneous although in practice they may differ widely. A faster journey, by saving time, may be valued differently. It may be more difficult and therefore more valuable to provide freight services for awkward goods or on difficult modes of transport for these reflect more closely the valuation that society puts upon them, although it is difficult to assess the changing nature of user valuation over time because taxes and subsidies on different modes have altered. Table 1.3 shows how British users distributed their expenditure on transport in the period 1965–75.

Table 1.2 *Trends in British transport, 1954–77*

	1954		*1964*		*1977*	
Passenger traffic ('000 million passenger km)						
Bus and coach	81	(38.0)	65	(20.0)	53	(11.4)
Car and motor cycle	76	(35.6)	213	(65.6)	370	(79.9)
Pedal cycle	17[a]	(8.0)	8	(2.5)	4	(0.9)
Road subtotal	174	(81.6)	286	(88.1)	427	(92.2)
Rail	39	(18.3)	37	(11.4)	34	(7.3)
Air	0.3	(0.1)	1.5	(0.5)	2.1	(0.5)
Total	213.3	(100.0)	324.5	(100.0)	463.1	(100.0)
			1964		*1976*	
Freight traffic ('000 million tonne-km)						
Road			65.7	(55.7)	95.6	(66.2)
Rail			26.2	(22.2)	23.1	(16.0)
Coastal ship			24.7	(20.9)	20.0	(13.8)
Waterway			0.2	(0.2)	0.1	(0.1)
Pipeline			1.1	(0.9)	5.7	(3.9)
Total			117.9	(99.9)	144.5	(100.0)

Source Department of Transport (1979)
Notes Figures in parenthesis are percentages of totals.
(a) Unofficial estimate.

It is evident from Table 1.3 that road traffic has made great inroads into rail traffic. By comparing the physical outputs in Table 1.2 it becomes apparent that consumers are willing to pay a premium for movement by road. The road system is much bigger than the rail network, and as well as this spatial flexibility the relatively modest loads required to fill a lorry give it greater temporal flexibility, just as the private car driver enjoys freedom to establish his own timetable. The hopes of some protagonists of public transport that such trends can be completely reversed are probably more pious than realistic, and the depletion of oil resources may be mitigated by developments in batteries and the increasing expenditure on fuel cell technology. Yet, it must be acknowledged that road traffic brings hazards as well as benefits. Road vehicles, by their numbers or weight, impose fumes, noise, congestion and accidents upon society, which make it necessary to consider adjustments where social costs outstrip social benefits. These issues are legitimate interests for the transport economist; and even if he cannot solve all the problems, he may shed light on issues where others are apt merely to generate heat. However, the economists must be aware of the conflicts that may arise between efficiency and equity. It is often possible

Table 1.3 *User expenditure on surface transport in Great Britain, 1965–75*
(£ millions)

	1965		*1975*		*% rise 1965–75*
Expenditure (£ millions)					
Total passenger of which	2,903	(99.9)	8,938	(100.0)	208
Bus and coach	381	(13.1)	865	(9.7)	127
Private vehicles	2,256	(77.7)	7,359	(82.3)	226
Taxis and hire cars	53	1.8)	190	(2.1)	258
Rail	213	(7.3)	524	(5.9)	146
Total freight of which·	2,929	(100.0)	9,161	(99.9)	213
Road	2,634	(89.9)	8,807	(96.1)	234
Rail	290	(9.9)	341	(3.7)	18
Inland waterway	5	(0.2)	13	(0.1)	160
Total passenger & freight of which:	5,832	(99.9)	18,099	(99.9)	210
Total road	5,324	(91.3)	17,221	(95.1)	223
Total rail	503	(8.6)	865	(4.8)	72
Consumer cost indexes (1970 = 100)					
Car purchase	85		176		
Car running costs	79		197		
Rail passenger	78		204		
Road public transport	71		193		
All goods and services	80		179		

Source Department of Transport (1977[a])
Note Figures in parenthesis are percentages of totals

to show that a total transport operation would be made more profitable by eliminating some of its less efficient parts or that there would be financial gain by eliminating cross-subsidisation. This last-named is the practice whereby high prices, relative to costs, are charged on one service and the surplus revenue thus generated is used to augment the revenues of another service where prices are low relative to costs. This practice restricts demand in the low cost area and promotes it in the high cost area, and it is clearly apt to produce inefficient results in the private, accounting, sense. However, there may be broader social reasons for sustaining apparent anomalies. Where the elimination of these practices could destroy or impoverish disadvantaged communities the economist must heed the politician. Perhaps his most valuable role is to clarify the issues, the costs and the benefits to both politicians and public alike, for such a role is no mean task as the following chapters will show.

CHAPTER 2

The Analysis of Demand

INTRODUCTION

In this chapter we shall examine the demand for transport and the factors that influence the traveller to choose one mode of transport rather than another. The importance of analysing demand hardly needs emphasising, for in such long-lived investments as motorways, airports, docks and railways the skilful and accurate analysis of demand is a vital element of efficient investment decisions. Overinvestment is clearly wasteful, but underinvestment can prove expensive to remedy; it is difficult to add an additional lane to an existing motorway, for example. At the moment the demand for motor cars and motor travel dominates the pattern of travel, and so we shall devote some attention to demand studies; but modelling the total demand for travel and the way in which it is split among different modes has grown in importance recently and is now a vital part of transport planning, and in Chapter 3 we shall discuss models of passenger traffic.

THE INFLUENCE OF INCOME ON THE DEMAND FOR TRANSPORT

Economic theory suggests that the demand for goods and services depends largely upon consumers' income and the price of the particular good or service relative to other prices. The demand for travel in general is clearly dependent on the income of the traveller, but income also affects the choice of mode. Thus the average citizen of the United States travels further each year than the average Australian or Briton, who travels further than the average Russian, who in turn travels further than the average Indian.

Table 2.1 shows some national differences. The aggregate figures are an indication of the size of respective national transport modes, while the percentage figures emphasise the American propensity to travel by car, such that air travel seems relatively low. About half of the American

Table 2.1 *Passenger transport by mode in selected countries.*

	Car	*Bus*	*Rail*	*Air*	*Total*	*Annual passenger-km per person*
Passenger-kilometres ('000 millions)						
UK (1975)	357	54	35	2	448	8,000
Oceania (1970)	127	16	9	11	163	8,425
USA (1969)	2,578	141	43	70	2,832	13,985
USSR (1970)	56	198	265	79	598	2,462
World (1970)	5,742	1,384	1,140	463	8,729	3,036
Percentages of total passenger-kilometres						
UK (1975)	79.7	12.0	7.8	0.4	99.9	
Oceania (1970)	77.9	9.8	5.5	6.7	99.9	
USA (1969)	91.0	5.0	1.5	2.5	100.0	
USSR (1970)	9.4	33.1	44.3	13.2	100.0	
World (1970)	65.7	15.9	13.1	5.3	100.0	

Sources Tulpule (1974); Motor Vehicle Manufacturers' Association (1975).

figures for bus traffic represents school children. The high percentage figure for air travel in the USSR reflects deliberate government encouragement for the state airline Aeroflot, against a background of general lack of support for personal movements.

It is also possible to examine the relationship between personal income and travel at the national level, as in Table 2.2. These British data show clearly how travel expenditure rises with income level. To avoid the problems caused by the tendency for household income to increase with persons per household the table shows expenditure by a standardised household of a man, woman and two children in 1975. Expenditure on buying and running cars obviously rises with income, as does expenditure on rail travel, but buses and coaches are evidently less attractive as income rises.

Figures are not generally available for the breakdown between urban and non-urban travel – this latter, ugly, expression is preferred to 'rural' because it includes interurban travel – but there are some estimates for the recent British pattern, shown in Table 2.3. These show the high dependence of non-urban areas, which are often ill-served by public transport, upon the private car.

The growth of motor car registrations and the decline in passenger-mileage on trains and buses illustrate the impact of the car on public transport usage. More specific analysis of the decline in bus usage in a variety of British urban areas has revealed that the decline in the number of bus journeys per head of population through the 1960s was closely correlated with the increase in the number of cars per head in each of the urban areas concerned. In seven cities in northwestern England a simple regression model relating bus journeys to the level of car ownership has 'explained' 87–98 per cent of the observed variation in bus journeys per head. Fare increases seemed to be only weakly associated with the decline in bus travel. Fairhurst (1975) has shown that the availability of public transport was a significant factor in explaining public patronage, so that declining services hastened the demise of public transport.

The underlying explanation of this phenomenon, as we have stressed, is the effect of rising real income per head. The British trends mentioned above accord with the established pattern in the United States, where Meyer, Kain and Wohl (1965) have observed that the income elasticity of demand was substantially positive for transport by private car but inconsequential or even negative for public transport. Moreover, the price elasticity of demand and cross-elasticity between modes appeared to be relatively less important.

The reasons for the preference for the private car that manifested

Table 2 2 *Weekly expenditure on transport in the United Kingdom, 1977*

	Weekly income of household[d]								
	30– 59 99	*60– 69 99*	*70– 79 99*	*80– 89 99*	*90– 99 99*	*100– 119 99*	*120– 149 99*	*Over 150*	*Average of all households*
Transport expenditure									
Purchase	1 82	2 30	3 59	3 50	3 85	3 52	4 91	6 68	4 00
Car running and maintenance	2 76	3 48	3 89	5 96	4 51	5 60	6 65	7 60	5 41
Purchase and maintenance of other vehicles and boats[a]	0 18[c]	0 35[c]	0 04[c]	0 07[c]	0 07[c]	0 47	0 24[c]	0 28[c]	0 23
Rail fares	0 21[c]	0 13[c]	0 25[c]	0 19[c]	0 25	0 31	0 42	1 14	0 40
Bus and coach fares	0 79	0 68	0 58	0 54	0 77	0 64	0 74	0 43	0 64
Other travel and transport[b]	0 25	0 30	0 20	0 61	0 30	0 16	1 03	0 49	0 44
Total transport expenditure	6 00	7.24	8.55	10 89	9 74	10 70	13 99	16 63	11 12
As % of total household expenditure	10 33	11 50	12 40	14 43	13 14	12 93	13 87	13 50	13 14
Percentage of total transport expenditure									
Purchases of vehicles, spares, etc	30 3	31 8	42 0	32 1	39 5	32 9	35 1	40 2	36 0
Car running and maintenance	46 0	48 1	45 5	54 7	46 3	52 3	47 5	45 7	48 6
Purchase and maintenance of other vehicles and boats[a]	3 0[c]	4 8[c]	0 5[c]	0 7[c]	0 7[c]	4 4	1 7[c]	1 7[c]	2 1
Rail fares	3 5[c]	1 8[c]	2 9[c]	1 8[c]	2 6	2 9	3 0	6 9	3 6
Bus and coach fares	13 1	9 4	6 8	5 0	7 9	6 0	5 3	2 6	5 8
Other travel and transport[b]	4 1	4 1	2 3	5 6	3 1	1 5	7 4	3 0	4 0
Total	100 0	100 0	100 0	99 9	100 1	100 0	100 0	100 1	100 1

Source Department of Employment (1978)

Notes Certain figures do not sum exactly to totals becuase of rounding (a) Includes bicycles and prams. (b) Includes taxis, hire cars, air and water travel (c) Subject to sampling difficulty (d) Household comprises two adults and two children

Table 2.3 *Surface passenger-mileage in Great Britain by area and mode, 1970.*

	Passenger-miles (millions)	*%*
Urban areas		
Rail	9,210	8.88
Bus	17,500	16.86
Total public transport	26,710	25.74
Car	77,047	74.26
Total	103,757	100.00
Other areas		
Rail	9,515	6.55
Bus	16,600	11.43
Total public transport	26,115	17.98
Car	119,153	82.02
Total	145,268	100.00
All areas		
Rail	18,725	7.52
Bus	34,100	13.69
Total public transport	52,825	21.21
Car	196,220	78.79
Total	249,045	100.00

Source Stubbs and Tyson (1972).

itself so strongly during the third quarter of this century are quite plain. In most cases the car possesses great advantages, especially in its flexibility. By offering literally door-to-door transport with a virtually infinite frequency of service and minimal perceived motoring costs, it has a qualitative superiority that no competing mode can match. Also, the competition from these other modes has weakened, most notably in the United States, as their service frequency has diminished and relative cost has increased.

DEMAND STUDIES

Economists and econometricians have analysed the demand for transport in a variety of ways, reflecting their different purposes. Since the rise of the motor car has been a predominant factor in determining the

pattern of transport services in advanced economies, it is appropriate that we consider some of the economic analyses of demand for cars that have been undertaken. In this case analysis dates back over several decades. An early study commissioned by General Motors Corporation in the late 1930s was concerned primarily with the relatively short run – the period over which the company was concerned with its marketing and investment decisions (Roos and von Szeliski, 1939). Other studies have taken a longer view, being less concerned with the annual sales of new cars and more directed towards estimating the total stock of cars when demand is said to be *saturated*. Saturation occurs when everybody who wants a car actually has one and the ratio of cars per person ceases to rise. The speed with which it is reached and the ultimate extent of car ownership are important factors when the investments associated with the private car are being considered – especially the construction of roads and motorways, which usually incorporate a significant excess capacity over present levels to cater for the growth expected in the future.

The sophistication of demand analysis varies. Some studies have considered the level of demand for a particular mode in isolation, but as we shall show in Chapter 3, techniques have been devised to model the demand for transport in systems as a whole where several transport modes are offered and there is an explicit measure of inter-relationship between the demand for different modes. We shall assume that the reader is acquainted with the statistical technique of regression analysis, which examines the extent and nature of systematic relationships between economic variables. Readers unfamiliar with the technique may refer to a wide variety of econometrics textbooks (e.g. Johnston, 1972; Stewart, 1976; Walters, 1970).

The prime purpose of demand analysis is to enable future patterns of demand to be predicted from the detailed analysis of past relationships. Regression analysis is basically a form of extrapolation, albeit a sophisticated and powerful one if it takes into account a wide variety of explanatory variables. Yet, it must always be borne in mind that extrapolation should be subject to constant scrutiny.

Few econometricians have been bold enough to attempt the analysis of the entire pattern of consumer demand. In the United States Houthakker and Taylor (1970) have examined the determinants of demand for a wide range of goods and services, including various items of transport. Laudable though their attempt was, the scope of the work, covering eighty-two categories of personal consumption expenditure across the period 1929–65, limited the elaboration of individual categories. Thus, expenditure on new cars and net purchases of used cars