THE ECONOMIC EVALUATION OF ROAD INVESTMENT IN THE REPUBLIC OF IRELAND*

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INTRODUCTION

The Statistical and Social Inquiry Society of Ireland has a long standing interest in the transport problems of the country. In the Society's Symposium on the Present and Future of Inland Transport in 1956 the Vice-President, Professor Charles Carter stated that "the Statistical Society is nearly 110 years old and it has discussed the problems of Irish transport on some 25 occasions" (35). In the interim, five further discussions of the problem of Irish transport have been held by the Society making this the thirty-first paper on the topic. I am indeed grateful to Professor Carter not only for counting the number of meetings on transport held by the Society during its first 110 years but also for many stimulating discussions on transport policy.

Road transport has received a relatively small amount of attention in the Society's discussions on transport. A reason for this was pointed out by Professor B. F. Shields in a paper to the Society in 1946 when he stated that "limited information on road transport" was a serious problem in transport research in this country (36). In recent years this information gap has been reduced through the papers read to this Society by Reynolds in 1962/3 and Sexton in 1966/7, the ESRI papers by Reynolds and Blackwell, and the publications of the Roads Division of An Foras Forbartha (37).

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This paper draws heavily on the last series of publications. Since 1968 there has been a systematic traffic counting programme recording the volumes of traffic on the major routes (40). In 1969 an estimate was made by Hearne (38) of the volume of road traffic on all routes. The estimate was derived from fuel consumption and has been updated annually in the Foras Forbartha Road Accident Statistics.

In 1971 a Road Inventory of the National Routes Primary and Secondary was published (39). The Inventory recorded all the physical characteristics of the routes affecting capacity, pavement, and safety. The Inventory, in conjunction with forecasts of vehicle numbers which are described below, was used in a Road Needs Study. The study, to be examined, estimated the cost of catering to a greater or lesser extent for future traffic on the national primary routes. The Road Needs Study and the related material provide the statistical base for this paper. They also reduce substantially the area of ignorance in road transport statistics reported to the Society by Professor Shields almost thirty years ago.

This paper addresses the question "How much money should be spent on road improvement over the next twenty years?". It examines the factors that influence the answers to the question as it applies to the national primary route network in the Republic of Ireland. The information on the cost of roads was obtained from Foras Forbartha Road Needs Study (33). The information on the benefits from road improvements was obtained from the COBA Manual of Economic Appraisal of Highway Schemes, published by the UK Department of the Environment (17).

The Road Needs Study examines the cost of catering for projected increases in traffic at various levels of service. The concept of level of service was introduced in the US Highway Capacity Manual (2). The levels are described as follows:

Level of service A: A free flow condition where traffic density is low and there is little or no restriction in manoeuvrability due to the pressure of other vehicles. Drivers can maintain their desired speed with little or no delay.

Level of service B: A stable flow condition where traffic speeds are beginning to be restricted somewhat by traffic conditions. Drivers have reasonable freedom to select their speeds.

Level of service C: A stable flow condition but speeds and manoeuvrability are more closely controlled. Drivers experience restriction in their freedom to select their speeds, change lanes or overtake.

Level of service D: A condition approaching unstable flow. Fluctuations in traffic volume and temporary restrictions may cause substantial drops in operating speeds. Drivers have little freedom to manoeuvre and comfort and convenience are low.

Level of service E: An unstable flow condition with traffic volumes at, or near, absolute capacity and complete stoppages occurring from time to time.

Level of service F: An unstable flow condition with queues of vehicles backing up from restrictions and with traffic flows below capacity.

The minimum operating speeds corresponding to each of these levels of service were calculated from the Highway Capacity Manual and the Foras Forbartha National Routes Inventory (3). The Inventory is an examination of the national primary routes system showing its characteristics in terms of gradients, roadside developments, bends as these affect capacity. Information on pavements and safety is also included in the Inventory. The operating speeds are shown in pcu's per hour in Table 1. The pcu or passenger car unit statistic measures the effect of a vehicle on traffic flow. Heavy vehicle acceleration braking, overall size, and manoeuverability are major sources of traffic interference and hence contributors to pcu values. A pcu value of 3 for trucks was assumed in the Road Needs Study although the Report admits that "the evidence favouring this value was largely speculative".

The capacity estimates assume a 40 percent passing sight distance and a loss of 7 percent of capacity due to roadside development. Passing sight distance exists on the portions of the network on which overtaking is possible. The Road Inventory is the source of the above estimates of both passing sight distance and loss due to roadside development.

Table 1: *Level of service, capacity and operating speeds*

	Capacity in pcu's per hour		
Level of Service	D	C	Mid. C
Single	1415(35)*	950(40)	670(45)
Wide	1800(35)	1500(40)	1060(45)
Dual	4250(35)	3300(45)	2333(50)
2 + 2 Motorway	5100(40)	4250(50)	3790(52.5)
3 + 3 Motorway	8160(40)	6800(50)	6067(52.5)

*Figures in brackets indicate corresponding operating speeds in mph.

Estimating Vehicle Numbers

The Road Needs Study used the population projections of Knaggs and Keane (1) for 1995 with 1985 as an intermediate year. It was observed that car ownership levels show a high correlation with population density. A set of projections were therefore made where the ownership rates at saturation were related to population denisty for each county. Present and target year ownership rates were seen as stages towards saturation. A range of high, median, and low ownership rates was combined with the high, median, and low population projections and the median values for both used to predict vehicle numbers.

Given the median saturation level of ownership for each county the car number projection by McCarthy (24) estimated the remaining parameters of the logistic function from a time series of car ownership data from 1951 to 1971. The car ownership rates were then projected to the target years and multiplied into the alternative populations for the various counties to yield car number projections. The projections are shown in Table 2.

The specification used by McCarthy was

$$V_i = a_o + a_1X_1 + a_2X_{2i} + U_i \qquad (1)$$

Where

V_i = ownership rate in county i,
X_{1i} = income or wealth in county i
X_{2i} = population density in county i
U_i = a random disturbance

and a_0, a_1, and a_2 = numerical coefficients.

Table 2· *"Mean" predictions for 1985 and 1995*

County	*Assumed saturation level (per 100)*	*1971 Population*	*1971 car ownership (per 100)*	*1968 car numbers*	*1985 car ownership (per 100)*	*1995 car ownership (per 100)*	*1985 Population (B)*	*1995 Population (B)*	*1985 car numbers*	*1995 car numbers*	*Cars 1985 / Cars 1968*	*Cars 1995 / Cars 1968*
Carlow	41	34.2	15.05	4394	26.87	33.66	39.0	48.9	10480	16460	2.39	3.75
Cavan	43	52.6	13.47	5985	30.00	37.68	53.3	57.7	15990	21740	2.67	3.63
Clare	41	75.0	12.86	7436	29.00	36.30	88.5	111.1	25670	40330	3.45	5.42
Cork	40	352.9	15.17	43123	28.08	34.46	403.5	463.9	113300	159860	2.63	3.71
Donegal	43	108.3	10.27	9421	25.12	33.52	108.2	112.3	27180	37640	2.89	4.00
Dublin	37	852.2	15.03	101266	24.53	30.20	974.1	1040.3	238950	314170	2.36	3.10
Galway	41	149.2	11.43	13741	25.30	33.51	169.3	213.9	42830	71680	3.12	5.22
Kerry	42	112.8	12.06	11135	28.40	36.32	121.2	136 5	34420	49580	3.09	4.45
Kildare	41	72.0	14.68	8930	27.33	30.99	92.4	119.3	25250	39830	2.83	4.46
Kilkenny	42	61.5	14.61	7270	27.14	34.21	68.7	79.4	18650	27160	2.56	3.74
Laois	42	45.3	14.40	5523	27.60	34.57	50.7	60.1	13990	20780	2.53	3.76
Leitrim	43	28.4	11.06	2545	25.44	34.11	24.2	22.4	5160	7640	2.42	3.60
Limerick	40	140.5	13.62	15642	26.90	33.74	164 9	200.5	44360	67650	2.84	4 32
Longford	42	28.3	14.26	3375	29.02	36.21	31.2	40.4	9050	14630	2.68	4.33
Louth	40	75.0	13.07	8091	25.58	32.47	90.1	106.0	23050	34420	2 85	4.25
Mayo	43	109.5	10.00	8863	25.15	34.66	106.0	114.5	26660	39690	3.01	4.48
Meath	42	71.7	15.70	9339	27.74	34.41	90.1	113.6	24990	39090	2 68	4.19
Monaghan	43	46.2	13.34	5156	26.97	35.03	47.9	51.0	12920	17870	2 51	3.46
Offaly	42	51.8	13.22	5752	26.11	33.66	57.6	68.4	15040	23020	2.61	4.00
Roscommon	43	53.5	12.20	5550	27.65	36.12	50.2	50.8	13880	18350	2.50	3.31
Sligo	42	50.3	12.15	4981	26.27	34.53	50.8	53.6	13350	18510	2 68	3.72
Tipperary	41	123.6	15.16	16011	27.93	34.41	140.9	176.7	39350	60800	2.46	3.80
Waterford	40	77.3	13.57	8325	24.75	31.56	87.3	98.3	21610	31020	2.60	3.73
Westmeath	41	53.6	13.61	6180	25.81	32.93	62.2	79.4	16050	26150	2 60	4.23
Wexford	41	86.4	14.30	10657	28.16	34.98	99.3	123.5	27960	43200	2.62	4.05
Wicklow	41	66.3	14.92	7924	27.92	34 73	79.1	89.1	22080	30940	2.79	3.90
National Total		2978.4	13.90	336615	26.36	33.22	3350.7	3831.6	883221	1272919	2.62	3 78

McCarthy found the three income equations had an a_2 value which was negative, significant at above 90 percent and not significantly different from one another at above 95 percent. The income equations were based on income studies by Ross for 1960, 1965 and 1969 (31). His values estimated for a_2 imply a difference in ownership rate between the most densely populated and least densely populated counties of between 3 and 4 points per hundred at present, as a result of density influences alone. At saturation the differences in population density will probably be greater so that the results of the cross section regressions are not inconsistent with a spread in rates of 5 or 6 points at saturation. The spread of counties according to urbanisation gave Dublin the highest degree of urbanisation and therefore the lowest level of saturation. Counties Cavan, Donegal, Leitrim, Mayo, Monaghan, and Roscommon, with less than 30 percent of urbanisation in 1996, have the highest saturation levels.

Past growth in traffic at a selection of counting stations on the network was then compared with the corresponding growth in car numbers within the same county. A factor of 1.01 was observed to represent the increase in traffic corresponding to a unit increase in car numbers when all sites were considered together. This factor was applied to the forecasted increase in car numbers to give growth coefficients for each county. The coefficients were in turn applied to the 1968 traffic flows to give corresponding flows for 1985 and 1995.

Table 3 shows the number of miles of road required in 1985 and 1995 at a range of levels of service. The unit costs are based on information provided by the Department of Local Government. We have now assembled information from studies forecasting traffic volumes on the national primary route network, relating traffic volumes to speeds and levels of service, and estimating time savings in travel hours per day on rural portions of the network. From these we have a range of costs for each level of service. In the following section we examine the application of cost-benefit analysis to the choice between higher levels of service and their higher costs and lower levels of service with their cost savings.

Cost-Benefit Analysis

Cost-benefit analysis is concerned with the effects of a project on the economy as a whole. It examines the effect on the welfare of society and not any smaller part of it.

The economist engaged in a cost-benefit analysis of a project is dealing with the same sort of question as the manager of a private firm. The cost-benefit analysis asks the question whether society will become better off as a result of an investment. A commercial appraisal asks only if the owners of the enterprise will be better off. It is important not to overlook the benefits that a commercial enterprise confers on people other than its shareholders. It also confers benefits on its consumers, its employees, and through its tax payments, on the general public.

The need for cost-benefit analysis arises precisely because commercial profitability may not be an indicator of social profitability or benefit. A higher profit in the lumber industry may be obtained at the cost of increased risk of increased soil erosion of nearby farming areas. A higher profit in pulp and paper may occur at the expense of fishermen and recreationalists using rivers close to pulp mills. The use of extra cars at peak times in crowded cities may impose costs on other road users. In a cost-benefit analysis costs im-

Table 3: *Mileages and costs of roads required 1985 and 1995 at 1970 prices (33)*

		Miles of road required								
		Year 1985				Year 1995				
Population:		*med*	*med.*	*med.*	*high*	*med.*	*med.*	*med*	*high*	*med*
Ownership:		*med.*	*med.*	*med.*	*high*	*med*	*med.*	*med.*	*high*	*med*
Service Level:		*D*	*C*	*Mid C*	*Mid. C*	*D*	*C*	*Mid C*	*Mid C*	*E*
	r	839	251	23	21	313	70	4	4	750
Existing	u	77	20	2	1	22	4	0	0	68
	r + u	916	271	25	22	335	74	4	4	818
	r	324	489	341	294	435	284	165	122	356
Single	u	36	40	22	18	39	18	9	7	41
	r + u	360	529	363	312	474	302	174	129	397
	r	60	417	500	458	309	455	224	226	63
Wide	u	9	51	48	42	36	43	17	16	9
	r + u	69	468	548	500	345	498	241	242	72
	r	189	213	436	516	299	484	773	759	187
Dual	u	51	41	60	69	49	67	86	82	32
	r + u	240	254	496	585	348	551	859	841	219
	r	11	42	100	86	25	63	159	176	59
2 + 2 M	u	2	22	30	25	13	14	27	26	28
	r + u	13	64	130	111	38	77	186	202	87
	r	5	16	29	54	47	72	103	141	14
3 + 3 M	u	8	9	20	27	24	37	44	52	11
	r + u	13	25	49	81	71	109	147	193	25
Total Miles		1611	1611	1611	1611	1611	1611	1611	1611	1618
Cost Total		£133m	£246 m	£362 m	£385 m	£264 m	£374 m	£492 m	£518 m	£175 m
Rural						£219 m	£316 m	£423 m		£139 m

Notes: r = rural
u = urban
r + u = rural and urban
costs are cumulative, i.e., 1995 cost includes 1985 cost.

Basis of Estimation. Single £0.10 m per mile
Wide £0.15 m .. ..
Dual £0 30 m .. .
2 + 2 M £0.50 m .
3 + 3 M £0 60 m .

Source Road Needs Study

posed on the third parties who are not directly involved in the market transaction are included. Social benefit replaces firm revenue as an indicator of return. Instead of the private cost of a firm we use the concept of opportunity cost. This measures the social value foregone when the resources in question are moved away from alternative economic activities into the specific project. Social or opportunity cost may be below market cost in the case of factors which would otherwise have been unemployed.

The correction of market prices to reflect social cost involves the use of shadow prices. These adjustments allow for considerations not reflected in the prices. The social element in cost-benefit analysis refers to society and not to social expenditure where the object is to redistribute income. Several economists would require, however, that in addition to having an excess of benefit over cost, a project should not have distributional effects which are regressive or inequitable.

The rationale of cost-benefit analysis is contained in the criterion of potential Pareto improvement. The latter, based on the work of an Italian economist who was Professor at Lausanne until 1923 is defined as an improvement which makes one or more people in society better off without making anyone worse off. A potential Pareto improvement can, assuming costless transfers of money and/or goods, make everyone better off. It is a change which produces an excess of benefit over cost so that the gainers could fully compensate the losers and remain better off than before the change.

Cost-benefit analysis is concerned with the opportunity costs of a choice. Transfer payments such as monopolistic markup in the price of goods produced under conditions which do not conform to the assumption of a perfectly competitive market, and taxes and subsidies which drive a wedge between cost and market price are netted out of the calculation.

A major problem in a cost-benefit analysis is the choice of interest rate. The market rate of interest is the price of money. The supply of funds from lenders reflects their willingless to forego present in favour of future expenditure i.e., their rate of time preference between present and future goods. The argument for a social rate of time preference is based on the belief that the future is more uncertain for individuals than for the community as a whole.

On the other hand, the usual expectation is that real income will increase through time while it is also assumed that income has a diminishing utility. There is no agreed solution to the choice of interest rate in a cost-benefit analysis. It has become customary to use the current rate of interest on government borrowing, as the opportunity cost of capital, since this is the amount necessary to bid the capital away from other uses.

The benefit of Road Improvement

The main benefits from raising the level of service on the National Primary Network are time savings, a reduction in accidents and vehicle cost savings. In the examination of time and accident costs below we review the theoretical issues involved, examine some empirical work and project current values to 1995.

Time Savings

Time savings allow further activities to be engaged in. If working time is saved then in general more goods and services can be produced with the labour released. If leisure is saved existing activities can be conducted at a more leisurely pace or new activities can be undertaken.

(a) Working Time

The most usual approach to the valuation of working time is the cost savings approach which is based on the marginal productivity theory of factor rewards. Employers hire labour until it is no longer worth their while to do so. The average wage paid therefore equals the marginal revenue product of the employee.

The wage rate as an indicator of the value of time (4) has been subject to objections as follows:-

(i) Imperfections in the labour market may mean that the value in other uses of labour using road transport is not adequately represented by the wage rate.

(ii) The release of resources assumed in theory may not take place because of labour restrictions.

(iii) The release of resources assumed in theory may not take place because of the inability of road using enterprises to convert time savings into resource savings.

(iv) The assumption that resources have other uses may not always hold.

(v) The approach values working time purely from the point of view of the employer and does not consider the value the employee might place on journey time and hence on the way his work time is spent.

(vi) The approach treats travel time as a disutility; in some cases travel time may be used productively.

The wage rate ceases to be a measure of opportunity cost where there is a monopolistic element in the wage rate. Friedman and Kutznet (5) estimated that the lifetime earnings of physicians in America exceeded that of other equally educated professionals owing to the restrictive practices of the American Medical Association.

In cases such as these the wage paid to a class of labour may overstate its opportunity cost. Monopolistic power of this kind is probably limited for the groups which account for the bulk of travel in working time such as professional drivers, salesmen, commercial travellers, travelling service engineers and mechanics, etc.

The extent to which resources are saved following a time saving may vary in the short and long run. Empirical tests would be required to establish whether rescheduling is possible to convert time savings into extra output or leisure.

Indivisibilities in the road haulage industry may prevent costs and output being adjusted with perfect flexibility to changed cost schedules. G. A. Fleischer's study of a Californian trucking firm's operations found that advantage could not be taken of some improvements until further improvements were made sufficient to overcome an indivisibility in the firm's operations (6).

Haning and McFarland (7) estimate that for common carriers of freight in the US a range of 40 - 60 percent of potential value should be regarded as actual value because this type of carrier is heavily restricted. Hauliers in the US are licensed on, and restricted to, individual routes. Specialised carriers, having more freedom, were given utilisation rates of 60 - 80 percent and private and contract carriers, 80 - 100 percent.

(b) Non-Working Time

The proposition that non-working time should be valued at the same rate as working time is based on the classical theory of the labour market. The marginal value of leisure to the consumer is equal to what he foregoes in extra earnings. Adjustment in the length of the working week maintain this equality. Winch states that " with the present state of organisation of the labour market it is surely not unreasonable to assume that if all empolyees in a firm would prefer a longer or shorter working week this would be achieved with a compensating increase or decrease in the numbers employed" (8).

The use of the wage rate as a value of leisure time also assumes that the traveller is indifferent at the margin between work and travel. This ignores disutility attached by the consumer to work. The inclusion of disutility from work changes the equilibrium condition from:-

$$\frac{Ui}{Uy} = P$$

where $\frac{Ui}{Uy}$ is the marginal rate of substitution between work and leisure

and P = money wage

to

$$\frac{Ui}{Uy} = P + \frac{Uw}{Uy}$$

where $\frac{Uw}{Uy}$ is the marginal rate of substitution between income and time spent at work.

The marginal utility of leisure time is thus equal to the marginal utility of money less marginal disutility of work. Where the disutility of work is positive the value of leisure time will be less than the wage rate.

The value of travel time will differ from the value of leisure time to the extent that the disutility attached to travel is different from that attached to work. Where the disutility of travel is negative then a time saving can have zero or negative value. If, on the other hand, travelling is half as unpleasant as work a correction factor of 0.5 would be used and the individual would be indifferent between two hours work and one hour's travel. The degree of disutility of travel time may also depend on whether the time saved is waiting, walking or 'in vehicle' time. Some empirical studies examining the disutility of travel and waiting time are examined below.

(c) Studies of the Value of Leisure Time

Dawson and Everall (9) studied traffic on the Rome-Caionello and Milan-Modena autostrada compared to alternative multipurpose routes between these towns. They found values for commuting and non-working time of 75 percent of the average wage rate. The routes were 147 km (92 miles) and 163 km (101 miles) respectively.

In the UK the Department of the Environment (DOE) use a figure for non-working time of 25 percent of average hourly wage rates. This is based on empirical studies carried out, *inter alia,* by Beesley, Quarmby, Lee and Dalvi and the Local Government Operational Research Unit (LGORU).

These studies have attempted to derive a value of time by analysis of situations in which people make choices between different packages of time, cost, and other travel characteristics. These choices may involve:

(i) choice of destination to travel to, or frequency of trip-making to a particular destination;
(ii) choice of mode of travel;
(iii) choice of route;
(iv) choice of speed at which to drive;
(v) choice of relative locations of home and work.

Harrison and Quarmby (4) note that (i) cannot be examined because "there are no published studies of attempts to establish values of time from this method applied to data on trip making from one origin to several destinations".

Beesley's study on The Value of Time Spent in Travelling: Some New Evidence, *(Economica 1965)* examines modal choice by employees at the Ministry of Transport. He derived values of time of 31 - 35 percent of income for public transport users and 31 - 49 percent for car users.

Quarmby (Journal of Transport Economics and Policy 1967) used a discriminant analysis model to explain the choices made between car and public transport by commuters in Leeds in 1966. He obtained a value of time of 20 - 25 percent of earnings. Lee and Dalvi (Manchester School 1969) analysed trade-offs in time between public transport modes. Respondents were asked what increase in travel cost would make them indifferent between modes. The average value of time derived was 30 percent of earnings.

The Local Government Operational Research Unit examined the modal choices of commuters in Liverpool, Leicester, central Manchester an an industrial suburb of Manchester. The study distinguished in-vehicle, walking and waiting times. The value of time obtained was about 20 - 25 percent of income. The Dawson study of autostrada travel is categorised under (3) above. Method (4) assumes that motorists are fully aware of the relationship between speed and operating cost. There are other factors which determine the choice of driving speed such as safety considerations. There is no evidence that cars with more passengers drive faster than those with fewer.

Method (5) faces the difficulty of disaggregating other factors which determine house prices such as accessibility to non-working activities such as shopping, and the general housing environment. Harrison and Quarmby state that "generally this is not likely to be a fruitful area until much more comprehensive general urban models exist, out of which sub-models for time-cost trade-off analysis might be carved".

The difficulties in placing price tags on the value of time are compounded by the absence of any applied research in Ireland on their value. We have examined some of the several studies of these costs in the British economy. The values of time, based on these studies, and used in road investment appraisal by the Department of the Environment are shown below. These values are taken from the COBA Manual, compiled by the Department's Highway Economics and Modelling Analysis Division (17). Leisure time savings are valued at 25 percent which the Department believes is the value indicated by the studies carried out in the UK.

The UK practice is to value the time of children at one third of the adult rate. This valuation must remain arbitrary according to Harrison and Quarmby (page 65). The value of children's time may be significant for the same reasons as an adult's time is valuable. It may also be of value to parents if the journey is made more tedious through the presence of the child.

There is no study of standard occupancy rates on the national primary routes in Ireland. The rate found in the Dublin Transportation Study was 1.4.

Time savings are valued as follows in 1970 prices:

Vehicle	Journey purpose	Standard occupancy rate	Value of Time per head per hour	Value of Time per vehicle hour
			p	p
Cars	Working (17%)	1.3	129	57
	Leisure (83%)	1.9	18	
Light Goods	Working	1.3	59	76
Heavy Goods	Working	1.2	57	69
PSV	Leisure and Working	18 + crew	-	450

Time savings values in 1985 and 1995 assuming an increase of 3.25 percent per year.

Journey purpose	Value of Time per vehicle hour (p)		
	1974	1985	1995
Car working (17%); Leisure (83%)	57	89	119
Light goods working	76	118	159
Heavy goods working	69	108	144
Public service vehicle	450	701	942

The real increase in incomes of 3.25 percent per year in the UK and its relevance to the Irish economy are discussed later. There is no published survey of journey purpose on the national primary routes in Ireland.

The proportion of trucks in traffic is expected to fall from 13.5 percent in 1968 to 10.5 percent in 1985 and 9 percent in 1995 according to the Needs Study. An Foras Forbartha surveys show that bus travel on the national primary routes accounts for less than 0.5 percent of total vehicle mileage. This is likely to show further relative decline by 1985 and 1995 and the benefit of time saving to it is not included below.

The Road Needs Study (Appendix F) estimates that there will be 48,000 heavy commercial vehicles and 21,000 light commercial vehicles in 1995 and 40,000 heavy commercial vehicles in 1985.

The weighting of commercial vehicle time savings according to the numbers in each category gives a value of commercial time savings of 154p in 1995 and 115p in 1985.

The weighting of these commercial time values and car time values in proportion to their share of total gives average time values of 91p in 1985 and 122p in 1995.

Table 2 showed the following travel times in 1995 on the rural portions of the network at each level of service.

Level of Service	Time in thousand vehicle hours per day
E	287
D	258
C	244
Mid C	233

Taking an estimate of 122p per hour the incremental value of time savings from each level of service are valued as follows:-

	Hours saved per day (thous)	Value (£m) per year
E to D	29	12.914
D to C	14	6.234
C to Mid C	9	4.008

The total cost is shown below:-

Level of Service	Cost (£m)
E	127.8
D	114.9
C	108.7
Mid C	103.8

The share of commercial time savings in the above calculations is 24.5 percent comprising 9 percent commercial vehicles and 15.5 percent cars on working trips.

Accident Costs

The most difficult problem in estimating accident costs is the valuation of human life. There are four methods at present used to value human life.

The most common way of calculating the economic worth of a life is that of discounting to the present the person's expected future earnings. This is the gross output approach.

The net output approach measures the economic loss to others of the death of an individual. This approach calculates the present discounted value of the person's expected future earnings *less* his consumption.

The 'shadow price' approach derives, from society's political judgements, an implicit value of human life in cases where deaths are increased or reduced by public policy.

The insurance method seeks to calculate the value a man sets on his life from the premium he is willing to pay and the probability of his being killed in a particular activity.

There are difficulties associated with each of the above approaches to the valuation of human life. The gross output method depends on Gross National Product being the sole criterion for economic performance. It does not take account of other goals, and of factors such as the suffering of the victim, the loss of utility from being alive, and the bereavement of relatives and friends.

The net output approach could lead to the death of a person whose productive life span had ended being treated as a benefit to society. It measures only the effects on the survivors of the death and does not include the loss to the victims.

The derivation of a value for human life from the political process faces many difficulties. Governments are elected in Western societies on a general mandate. It is not usual to have popular voting on particular items of expenditure. There may also be wide disparities in the values of human life derived from different public programmes.

The valuation of a life based on insurance premia only provides for compensation to others. The amount of insurance a person takes is an indication of his concern for his family and dependents rather than an index of the value he sets on his own life.

The important factor missing in all four approaches is the Pareto compensation principle. The value of a person's life is the minimum sum he is prepared to accept in exchange for it. The calculation of this figure would require conditions of certainty in the project evaluation. If the project in question required the death of a specific person, the value of life to that person could be ascertained and included as a cost of the project. Only after compensating this person fully would it be possible to make all members of the community better off by a redistribution of the net gains.

Under conditions of uncertainty only the risk of injury rather than its certainty can be included in the evaluation. The costs to be included are the sums required to compensate all persons in the community for the additional risk to which they are exposed.

The risks associated with a project may be grouped in four categories: direct voluntary risk, direct involuntary risk, indirect physical risk and indirect involuntary risk.

Direct voluntary risk is assumed by each person when availing himself of a service or facility. If a person purchases a car, knowing that this increases his risk of death then his consumer's surplus net of risk is positive. If purchases of cars by others increase the risk of death for an individual the extra risk can be avoided by his refusal to use his car. If he retains it he reveals that he believes he is better off with his car than without it.

Cost-benefit analysis does make provision for risks that are imposed on the community as a whole as a by-product of some activity. The direct involuntary risk of death arises from the exposure of third parties to risk from a project. For example, extra traffic in an area could increase the number of deaths among the frail and elderly. In cases where the victims of a direct involuntary risk of death could increase (for example, through infection) the risk to others a secondary involuntary risk occurs. There is also an indirect risk, arising from the general concern of each person with the physical risks to which any of the others are exposed. Where indirect risk is significant the community is made worse off by the death of others.

(d) Studies of the Cost of Accidents in the United Kingdom

The first estimate of the costs of deaths in road accidents in the United Kingdom was based on the net output approach.

In 1965 Dawson (14) estimated the discounted value of output during the expected lives of people killed in road accidents. He deducted from this, an estimate of consumption saved. His cost of the material value of human life was:

Males	+£4,360
Females	-£1,120

Dawson recognised that the value of human life is greater than its additon to net output. There is a loss to the victim and his family and friends. Society spends significantly on keeping alive those who no longer contribute to GNP. Dawson's response to these problems was to assess the subjective value of life at £5,000. The justification for this value was that it was sufficient to give a positive value of life to all age groups even when non-paid work such as housewife's services was not valued.

The net output approach was criticised on the grounds that, if benefits are measured after the fatal accident has been prevented, then the person saved is alive to enjoy his consumption. Consumption should not therefore, it is argued, be deducted from output and a gross output estimate of cost should be used.

Beesley and Evans (15) suggest that gross output is also subject to qualification as a measure of the value of life. No one would surrender the whole of his future income to escape a fatal road accident unless he preferred death by starvation. Income net of subsistence costs is suggested as the amount which people would pay in order to escape death.

Dawson's second report, on accident costs in 1968 (16) values life as the total discounted value of expected output plus the arbitrary sum of £5,000. Consumption is not deducted. The approach may involve double-counting through the addition of £5,000 for subjective value when consumption is not deducted from output.

Mishan (25) argues that estimates of accident costs such as those used by Dawson violate the Pareto criterion. They do not include the compensating variation of those killed. They do not include non-monetary factors such as the loss to friends. They do not include the exposure to involuntary risk of third parties.

Mishan emphasises the first point in particular. "If the project in question required the death of a specific person or more generally, a number of specific persons it is highly unlikely that any conceivable excess of benefit over cost, calculated in the absence of these externalities, would warrant its undertaking on the potential Pareto criterion".

The investments which are examined in this study would reduce accident costs as rates are lower the more expensive the road type. The greater the importance attached to the points raised by Mishan the more the values in the COBA Manual understate the benefits in the form of increased safety.

The COBA Manual assumes that the real cost of accidents increases at 3 percent per year because of the increase in the real value of earnings foregone through accidents. The estimated cost per accident in 1970, 1985 and 1995 are shown below:

Estimated Cost Per Personal Injury Accident

Road Type	1970	1985	1995
Urban	1400	2181	2931
Rural	2300	3583	4816
Motorway	3500	5452	7329
All	1600	2493	3350

These estimates are derived from Dawson's work on accident costs in 1968 at 1970 prices.

Table 4 shows the number of vehicle miles per day over each road type at each level of service. Table 5 combines the estimates of cost, volume, and accident rates in order to estimate accident costs on the rural portions of the National Primary routes in 1995.

Table 4: *Millions of vehicle miles per day in 1995 on rural portions of routes*

Road Type	D	Level of service C	Mid C
Exst	1.4	0.2	0.0
Sngl	2.4	1.0	0.4
Wide	2.2	3.0	1.3
Dual	4.1	4.7	5.5
2 Mtr.	0.6	1.2	2.3
3 Mtr.	1.3	1.9	2.5
Total	12.0	12.0	12.0

Table 5: *Daily accident costs on rural portions of the national primary routes in 1995 (in 1970 £)*

Accident cost £	Rate per 10^6vkm	Daily numbers of accidents D	C	Mid C	Daily cost (£000) D	C	Mid C
(a) Motorway 7329	0.4	1.22	2.06	3.08	8.94	15.10	22.57
(b) Dual Carriageway 4816	0.6	3.96	4.53	5.31	19.07	21.82	25.57
(c) All purpose rural routes 4816	1.2	11.52	8.11	3.27	55.48	39.06	15.75
Total per day		16.60	14.70	11.66	83.49	75.98	63.89
Number per year		6095	5366	4256			
Cost per year (£m)					30.47	27.73	23.31
Incremental accident costs prevented per year (£m)						2.74	4.42

Accident rates taken from COBA Manual.

Vehicle Costs

Higher levels of service through higher speeds lead to higher vehicle running costs. The COBA formula for vehicle costs is

$$C = a + \frac{b + d}{v} + cv^2$$

where C = operating and delay costs per km of travel (p)
a = a constant per km relating to vehicle operating costs
b and c = coefficients of vehicle operating costs varying with speed
d = value of time of vehicle occupants
v = operating speed in km per hour

The value of time savings has already been examined and estimated. A zero value for d is therefore used in this calculation.

The values for the other parameters are listed in the COBA Manual as follows:-

	Cars	Light Goods	Heavy Goods
a	0 67	1.37	3.23
b	12.13	18.33	29.33
C	.000022	.000028	.000064

Table 2 of the Road Needs Study shows the following average vehicle speeds at each level of service:-

Level of service	E	D	C	Mid C
Average Vehicle Speed km/h	58.6	68.8	78.4	86.4

Weighting cars as 91 percent of vehicle flow in 1991 and dividing the balance equally between light and heavy goods vehicles gives the following weighted average of vehicle operating costs.

Level of Service	Cost p per mile
E	1 7995
D	1 7916
C	1.8135
Mid C	1.8394

The difference between level of service D and Mid C is 2.67 percent of operating costs.

Total vehicle costs of 12.0 m vehicle miles per day are as follows:-

Level of Service	Cost (£m)	Incremental Cost
E	78.8	
D	78.4	-0.4*
C	79.4	+1.0
Mid C	80.6	+1.2

*Denotes saving through increased speed

Maintenance Costs

Maintenance cost also varies with the level of service. The annual maintenance costs in 1970 per km per year in the UK shown below are taken from the COBA Manual.

Road Type	Maintenance Cost/km/Year	
	Per km	Per mile
D3 Motorway	£ 1,800	2,880
D2 Motorway and D2 and D3 all purpose	£ 1,200	1,920
S2/S3	£ 400	640

The mileage of rural routes in each type in 1995 would be as follows:-

Level of Service Road Type	D	C	Mid. C	E
		Miles		
M3	47	72	103	14
M2	25	63	159	59
D2	299	484	773	187
Wide	309	455	224	63
Single	740	354	169	1106
Maintenance Cost £(m)	£1.429	£1.775	£2.338	£1.261
Incremental Maintenance Cost	0.168	0.346	0.563	

THE CHOICE OF RATE OF INTEREST

The choice of the rate of interest on capital employed in public investment has been the subject of dispute between two groups of opinion. The first group favours the opportunity cost rate of return on investment in the private sector. The second group holds that the Government should use a social rate of time preference in evaluating its investment projects.

The case for social time preference (STP) is that the private rate may be too high because individuals who control resources may possess a myopic or defective telescope faculty which causes them to save and invest less. The Government, on the other hand, can take a longer view and accepts an obligation to promote the welfare of unborn generations.

The optimum social rate of time preference is an assertion that the rate of capital formation is too low because the private rate of time preference is too high. The use of social time preference rates of interest in public sector projects alone would however produce a bias in favour of the public sector unless the cost of *all* investment was reduced proportionately through tax and subsidy devices etc. If the capital costs in the two sectors are not equalised then the policy of using a lower STP rate in the evaluation of public sector projects will be an inefficient way of attaining the growth objective. It will produce a bias within the public sector in favour of capital intensive projects.

The case for social time preference rates gives this generation responsibility for future generations and is concerned to pass on more capital stock to posterity. On the other hand, it is likely that future generations will be wealthier than the present. Policies designed to restrict current consumption are a transfer to groups which will be wealthier than those making the transfer. The income distribution effects of inter-generational transfers are likely to be regressive.

The opportunity cost rate of discount assumes that a public investment will involve the loss of some other project. The Government is thought of as competing in capital markets with other users of funds. If a rate of return of X percent could be earned on a marginal project in the private sector then X is the appropriate rate of discount for public projects. The opportunity cost argument underlies the initial choice of an 8 percent discount rate, subsequently raised to 10 percent for United Kingdom nationalised industry investments.

The Internal Rate of Return
The internal rate of return on a project is the discount rate which would give the project a zero net present value. On deciding whether or not to sanction a project this rate would then be compared with a predetermined reference rate such as that set by the Treasury in the United Kingdom.

CONCLUSION

Table 6 estimates the annual value of the incremental costs and benefits on the rural network for each level of service up to 2010. This date is chosen as the terminal date of the investments because of uncertainty about petroleum supplies after that date. The Economist Intelligence Unit Report on the Future Prospects for Oil in the Transport Sector (30) states that "although crude petroleum reserves will certainly last for another 30 or 40 years, crude prices and therefore those of transport fuels will rise around the year 1990 onwards as exploration for and production of oil moves into deeper waters offshore".

The items listed in Table 6 are in 1970 £m. Over the lifetime of the road investments it is assumed as in the COBA Manual that the value of time savings will increase by 3.25 percent per year, that accident costs will rise by 3.0 percent per year, and that all other costs remain constant in real terms.

Table 6 shows the net present values of each set of road investments over a range of discount rates. Interpolation of the relevant net present values and discount rates gives the following summary table:-

Cost and Returns for Rural Primary Network

	Level of Service		
	D	C	Mid. C
Total cost (1970 £m)	219	316	423
Rate of Return (1)	21%	14%	11%
Incremental Rate (2)	21%	7%	6%

(1) With respect to base condition, i.e. Level of Service E.
(2) With respect to the next highest Level of Service.

There is no standard reference rate of discount for public sector projects in the Republic of Ireland. In the analysis of a recent public works project, the Maigue Arterial Drainage Scheme, a rate of 3.5 percent was used (34).

ASSUMPTIONS AND LIMITATIONS OF RESULTS

The rates of return in Table 6 are subject to many assumptions which should be borne in mind when interpreting the results. The assumptions are listed below and sensitivity tests of the significance of the assumptions are made in Table 7.

The assumption that the *growth in road traffic will continue* is a central part of the Road Needs Study. Petrol prices at the beginning of 1975 are over 130 percent higher than those charged in the summer of 1973. There appears to be no immediate threat of a shortage of petrol but a highly effective producers' cartel has increased prices.

Table 6: *Discounted net benefits 1995/2010 from each level of service (1970 £ million)*

Level of Service D with respect to E:

	Costs				Benefits				Net Benefits						
										Discounted to 1995					
Year	Capital	Mtce.	Vehicle running	Total costs	Time	Accidents	Vehicle running	Total benefits	Before discounting	r = 6%	r = 8%	r = 10%	r = 12%	r = 20%	r = 22%
1995	80	0.2	-	80.2	12.9	n.a.	0.4	13.3	-66.9	-66.9	-66.9	-66.9	-66.9	-66.9	-66.9
1996	-	0.2	-	0.2	13.3	..	0.4	13.7	13.5	12.7	12.5	12.3	12.1	11.2	11.1
1997	-	0.2	-	0.2	13.8	..	0.4	14.2	14.0	12.5	12.0	11.6	11.2	9.7	8.4
1998	-	0.2	-	0.2	14.2	..	0.4	14.6	14.4	12.1	11.4	10.8	10.3	8.3	7.9
1999	-	0.2	-	0.2	14.7	..	0.4	15.1	14.9	11.8	11.0	10.2	9.5	7.2	6.7
2000	-	0.2	-	0.2	15.2	..	0.4	15.6	15.4	11.5	10.5	9.6	8.7	6.2	5.7
2001	-	0.2	-	0.2	15.7	..	0.4	16.1	15.9	11.2	10.0	9.0	8.1	5.3	4.8
2002	-	0.2	-	0.2	16.2	..	0.4	16.6	16.4	10.9	9.6	8.4	7.4	4.6	4.0
2003	-	0.2	-	0.2	16.7	..	0.4	17.1	16.9	10.6	9.1	7.9	6.8	3.9	3.4
2004	-	0.2	-	0.2	17.2	..	0.4	17.6	17.4	10.3	8.7	7.4	6.3	3.4	2.9
2005	-	0.2	-	0.2	17.8	..	0.4	18.2	18.0	10.0	8.3	6.9	5.8	2.9	2.5
2006	-	0.2	-	0.2	18.4	..	0.4	18.6	18.6	9.8	8.0	6.5	5.3	2.5	2.1
2007	-	0.2	-	0.2	19.0	..	0.4	19.4	19.2	9.5	7.6	6.1	4.9	2.1	1.8
2008	-	0.2	-	0.2	19.6	..	0.4	20.0	19.8	9.3	7.3	5.7	4.5	1.8	1.5
2009	-	0.2	-	0.2	20.2	..	0.4	20.6	20.4	9.0	6.9	5.4	4.2	1.6	1.3
2010	-	0.2	-	0.2	20.9	..	0.4	21.3	21.1	8.8	6.6	5.0	3.9	1.4	1.1
Total										93.1	72.6	55.9	42.1	5.2	-2.8

Table 6 contd.

Level of Service C with respect to D:

	Costs				Benefits				Net Benefits					
										Discounted to 1995				
Year	Capital	Mtce.	Vehicle running	Total costs	Time	Accidents	Vehicle running	Total benefits	Before discounting	r = 6%	r = 8%	r = 10%	r = 12%	r = 20%
1995	97	0.3	1.0	98.3	6.2	2.7	-	8.9	-89.4	-89.4	-89.4	- 89.4	-89.4	-89.4
1996	-	0.3	1.0	1.3	6.4	2.8	-	9.2	7.9	7.4	7.3	7.2	7.1	6.6
1997	-	0.3	1.0	1.3	6.6	2.9	-	9.5	8.2	7.3	7.0	6.8	6.5	5.7
1998	-	0.3	1.0	1.3	6.9	3.0	-	9.9	8.6	7.2	6.8	6.5	6.1	5.0
1999	-	0.3	1.0	1.3	7.1	3.1	-	10.2	8.9	7.0	6.5	6.1	5.7	4.3
2000	-	0.3	1.0	1.3	7.3	3.2	-	10.5	9.2	6.9	6.3	5.7	5.2	3.7
2001	-	0.3	1.0	1.3	7.6	3.3	-	10.9	9.6	6.8	6.0	5.4	4.9	3.2
2002	-	0.3	1.0	1.3	7.8	3.4	-	11.2	9.9	6.6	5.8	5.1	4.5	2.8
2003	-	0.3	1.0	1.3	8.1	3.5	-	11.6	10.3	6.5	5.6	4.8	4.2	2.4
2004	-	0.3	1.0	1.3	8.3	3.6	-	11.9	10.6	6.3	5.3	4.5	3.8	2.1
2005	-	0.3	1.0	1.3	8.6	3.7	-	12.3	11.0	6.1	5.1	4.2	3.5	1.8
2006	-	0.3	1.0	1.3	8.9	3.8	-	12.7	11.4	6.0	4.9	4.0	3.3	1.5
2007	-	0.3	1.0	1.3	9.1	3.9	-	13.0	11.7	5.8	4.6	3.7	3.0	1.3
2008	-	0.3	1.0	1.3	9.4	4.0	-	13.4	12.1	5.7	4.5	3.5	2.8	1.1
2009	-	0.3	1.0	1.3	9.8	4.1	-	13.9	12.6	5.6	4.3	3.3	2.6	1.0
2010	-	0.3	1.0	1.3	10.1	4.3	-	14.4	13.1	5.5	4.1	3.1	2.4	0.9
Total										7.3	-5.3	-15.5	-23.8	-46.0

Level of Service Mid C with respect to C:

Year	Costs				Benefits				Net Benefits				
									Before	Discounted to 1995			
	Capital	Mtce.	Vehicle running	Total costs	Time	Accidents	Vehicle running	Total benefits	discounting	r = 6%	r = 8%	r = 10%	r = 12%
1995	107	0.6	1.2	108.8	4.0	4.4	-	8.4	-100.4	-100.4	-100.4	-100.4	-100.4
1996	-	0.6	1.2	1.8	4.1	4.6	-	8.7	7.5	7.1	6.9	6.8	6.7
1997	-	0.6	1.2	1.8	4.3	4.7	-	9.0	7.8	6.9	6.7	6.4	6.2
1998	-	0.6	1.2	1.8	4.4	4.8	-	9.2	8.0	6.7	6.4	6.0	5.7
1999	-	0.6	1.2	1.8	4.6	5.0	-	9.6	8.4	6.7	6.2	5.7	5.3
2000	-	0.6	1.2	1.8	4.7	5.1	-	9.8	8.6	6.4	5.9	5.3	4.9
2001	-	0.6	1.2	1.8	4.9	5.2	-	10.1	8.9	6.3	5.6	5.0	4.5
2002	-	0.6	1.2	1.8	5.0	5.4	-	10.4	9.2	6.1	5.4	4.7	4.2
2003	-	0.6	1.2	1.8	5.2	5.6	-	10.8	9.6	6.0	5.2	4.5	3.9
2004	-	0.6	1.2	1.8	5.4	5.8	-	11.2	10.0	5.9	5.0	4.2	3.6
2005	-	0.6	1.2	1.8	5.5	5.9	-	11.4	10.2	5.7	4.7	3.9	3.3
2006	-	0.6	1.2	1.8	5.7	6.1	-	11.8	10.6	5.6	4.5	3.7	3.0
2007	-	0.6	1.2	1.8	5.9	6.3	-	12.2	11.0	5.5	4.4	3.5	2.8
2008	-	0.6	1.2	1.8	6.1	6.5	-	12.6	11.4	5.3	4.2	3.3	2.6
2009	-	0.6	1.2	1.8	6.3	6.7	-	13.0	11.8	5.2	4.0	3.1	2.4
2010	-	0.6	1.2	1.8	6.5	6.9	-	13.4	12.2	5.1	3.8	2.9	2.2
Total										9.9	-21.5	-31.4	-39.1

Table 7: *Sensitivity of incremental rate of return to changes in assumptions*

D	C	Mid C	Notes on Basis for Rate
	Rates of Return %		
21.3	7.1	6.4	Assumptions as per COBA Manual
11.8	4.0	5.0	Assumes zero value for lesiure time savings Time as % of all benefits D : 97.5% C : 69.9% Mid C : 48.1%
28.6	8.8	7.5	Assumes leisure time savings are 40% of wage rate. This raises leisure time value to 52p per hour per head and 98p per car. Average car time value would increase to 103p per hour or 81%
23.4	7.6	6.7	Assumes time savings worth 10% more than in COBA. X% change in time savings value changes rates of return for D by .975X%, C by .69X%, Mid C by .48X%
19.2	6.6	6.1	Assumes time savings worth 10% less than in COBA
21.3	7.3	6.7	Assumes accident costs 10% more than in COBA. Accident costs : 30.1% of benefits from C and 51.9% from Mid C. Accident benefits not included for D. X% change in accident costs changes rates of return for D by 0%, C by .31X%, Mid C by .52X%
21.3	6.9	6.1	Assumes accident costs 10% less than in COBA

In discussion with officials at the UK Department of the Environment the prevailing view was that while the 50 percent increase in prices of petrol had caused an initial drop in road traffic, there was no reduction in summer traffic volumes in 1974 compared to 1973. The census of the number of vehicles registered in September 1974 in Ireland shows a 2.5 percent increase over the number registered in 1973.

In examining the effect of energy costs on vehicle mileage and road requirements it should be borne in mind that petrol is less than one-third of motoring costs, that taxation is the main cause of increased motoring costs since 1971 and that over that period public transport costs have increased faster than motoring costs over the period (27). In the UK it is estimated that the elasticity of car traffic to changes in petrol prices is -0.23 at current ownership levels declining as saturation approaches to -0.1 (28). The UK projections are that vehicle mileage will now increase to 2.75 (central forecast), 2.92 (upper forecast) or 2.52 (lower forecast) times the 1968 level. The pre energy crisis estimate was 2.77 times.

The *population projections* of Knaggs and Keane, used in the Needs Study, are now recognised to have been conservative. Their assumed net emigration of 12,000 per year compares with net immigration in recent years. The population projection of Knaggs and Keane was 3.302m - 3.514m in 1986. The projection by Walsh (22) is for a population of 3.509m - 3.778m in 1986. Table 1 shows that at level of service Mid C a high population projection increases the total programme cost by only 5 percent. The choice of level of service remains the main determinant of cost.

No account is taken of *regional development benefits* in the Road Needs Study. The evidence for these benefits is not convincing at present. The EEC Transport Advisory Committee Report on The Contribution of the Transport Sector to Regional Development within the Community (32) states that "in addition to the many beneficial effects of the opening in the UK of the Severn Motorway Bridge between S. Wales and the eastern side of the Severn estuary, one of the results may have been to encourage some firms to close down distribution centres in S. Wales because they were no longer requred".

There is at present no published *origin and destination survey of travel* on the National Primary routes. In the estimation of benefits in the form of *time savings* the results of such a survey would be of value. In the review of time savings studies it was seen that a school of thought exists which places a low value on small time savings. If the majority of journeys on the National Primary Route Network were short then the units of time savings from higher levels of service would be small.

It is currently the practice in the UK to value *leisure time* savings at 25 percent of the value of working time. American studies produce consistently higher values and a higher proportion would seem appropriate there. As European countries approach the American level of income per head it may become appropriate to value leisure at a higher proportion of income.

There is no published comparison of *drivers' incomes* in the United Kingdom and the Republic of Ireland. The National Prices Commission (29) surveys show that vehicle prices here are 25 percent to 32 percent more expensive than in the UK. Thus while incomes are lower in the Republic the incomes of drivers may be similar in both countries or even higher in the Republic.

The projections of the EEC Inventory of the Community's Economic and Financial Situation (October 1974) of 5 percent annual average growth in GNP in the Republic and 3 percent annual growth in the United Kingdom would result in similar GNP per head in both countries in 1995. The time and accident cost estimates are derived from GNP per head estimates.

Definition of Capacity

In the definition of capacity the Inventory Report on the National Primary Routes (RT.74, An Foras Forbartha), it was assumed that 40 percent passing sight distance will be obtainable and that roadside development will cause a loss of 7 percent of capacity. The latter figure may now be conservative because of changes in the application of planning laws to roadside development.

Truck Equivalencies

The Report assumed a passenger car unit (pcu) value for trucks of 3 in 1968 "although the evidence favouring this was largely speculative". The pcu values for 1985 and 1995 were estimated at 4.2 and 4.6 on the assumption of direct proportionality between average pcu and average unladen weight.

Sharp and Jennings (23) estimate that the benefits from imposing on commercial vehicles a minimum power to weight ratio of 6 B.H.P. per ton would exceed the costs. The costs and benefits would be approximately equal at a ratio of 8 B.H.P. per ton for vehicles of less than 30 tons gross weight. Over this weight the benefits would exceed the costs.

Under EEC transport policy compulsory testing for heavy vehicles will be introduced in 1978. This is expected to lead to better standards of these vehicles and thus lower their pcu values.

Cost

The Needs Study points out that "the inclusion of cost data is made solely to assist the choice between level of service options and is not intended to give a reliable guide to construction cost". In practice cost estimates for each section taking into account terrain conditions on the section would have to be made. Construction of the same road type would require a higher level of benefit in hilly terrain than on flat terrain in order to be sanctioned.

CONSTRAINTS ON THE SUPPLY OF PUBLIC FUNDS AND THE ALTERATION OF PRIORITIES

In the event of a shortage of public funds the opportunity cost of their use in the road building programme would increase. Should this lead to a reduction in the supply of funds available it would be important to ensure that the reductions in expenditure resulted in the smallest possible social cost. The Road Needs Study is prepared in a way which makes this possible. It indicates the year in which each road type on each route is expected to become obsolete. Table 8 shows the backlog of obsolete road types since before 1968. On the first ranked section, Dublin to Dublin Airport the basic road types, single and wide carriageway, have been inadequate since the base year 1968. A dual carriageway would be obsolete by 1977.

Table 8: *Priority ranking of backlog of road improvements (Level of Service D)*

Route	Link Description	Year of road type becoming inadequate				Miles
		Existing	Single	Wide	Dual	
(a) Road links inadequate before 1968						
N1	Airport/Dublin	-1968	-1968	-1968	1977	1.38
N11	Bray/Kilmacanogue	-1968	-1968	1969	1983	2.56
N11	Dublin/Bray	-1968	-1968	1969	1987	5.16
N4	Lucan/Dublin	-1968	1968	1970	1990	2.28
N11	Newtown/Kilmacanogue	-1968	1969	1972	1989	5.76
N11	Rathnew/Newtown	-1968	1969	1972	1990	7.16
N4	Leixlip/Lucan	-1968	1968	1971	1994	1.15
N4	Kilcock/Maynooth	-1968	1975	1978	1996	3.17
N2	Emyvale/Monaghan	-1968	1973	1978	+2000	0.29
N20	Patrickswell/Jn. Tralee N21	-1968	1975	1979	1999	0.12
N3	Clonee/Dublin	-1968	1976	1982	+2000	5.90
N13	Letterkenny/Pluck X	-1968	1981	1987	+2000	3.18
N22	Ballincollig/Cork	-1968	1985	1992	+2000	1.52
N2	Ballybay Jn./Castleblaney	-1968	1988	1996	+2000	0.43
N11	Wexford/Ferrycarrig	-1968	1992	1998	+2000	1.95
N4	Ballinfad/Boyle	-1968	+2000	+2000	+2000	4 26
(b) Road links which become inadequate 1968/73 incl.						
N1	Dundalk/Jn. Greenore	1968	1970	1974	1990	0.58
N20	Cork/Mallow	1969	1989	1998	+2000	18.61
N4	Maynooth/Leixlip	1969	1973	1977	1993	4.13
N1	Balbriggan/Swords	1970	1970	1973	1999	10.13
N4	Sligo/Ballisodare	1970	1979	1984	+2000	3.37
N7	Kildare/Newbridge	1970	1971	1975	1990	3.17
N7	Newbridge/Naas	1970	1969	1972	1987	5 08
N13	Letterkenny/Ballybofey Jcn.	1970	1979	1984	+2000	1.17
N18	Ballycasey/Limerick	1970	1971	1974	1988	8.93
N25	New Ross Jcn./Waterford	1970	1997	+2000	+2000	13.17
N3	Butlersbridge/Cavan	1971	+2000	+2000	+2000	3.42
N13	Pluck X/Newtowncunningham	1971	1995	+2000	+2000	6.64
N15	Ballintra/Ballyshannon	1971	1995	+2000	+2000	6.21
N1	Swords/Dublin Airport	1972	-1968	1969	1986	1.35
N6	Galway/Oranmore	1972	1974	1977	1993	3 21
N13	Newtowncunningham/Derry Jcn.	1971	1995	+2000	+2000	0.68
N25	Murintown Jnc./Wexford	1973	1973	1977	1995	0.52
N1	Dundalk/Castelbellingham	1973	1972	1975	1993	5.96
N1	Dunleer/Drogheda	1973	1974	1978	1999	7 74
N4	Enfield/Kilcock	1973	1977	1982	+2000	6.69
N7	Monasterevin/Kildare	1973	1975	1978	1996	5.99
N9	Kilcullen/Naas	1973	1979	1983	+2000	5.97
N19	Ballycasey X/Shannon	1973	1982	1987	+2000	1.57

Tolls

It is also possible to finance the construction of roads by direct charges to users, thus by-passing a shortage of funds at government level. The scope for financing the programmes examined in the Road Needs Study by tolls is limited. For example at level of service D, only 72 miles of motorway, costing 18.5 percent of the total programme, would be required by 1995.

The marginal costs above refer to marginal improvements in road types and not to marginal vehicles on existing roads. A toll covering the difference between the motorway cost per vehicle mile and the dual carriageway cost would be .28p per mile at level of service D assuming a 10 percent interest charge. The incremental maintenance cost of motorways over dual carriageways is zero according to the COBA Manual.

Two further adjustments in the toll may not radically alter the costs listed above. An apportionment of the costs of motorways according to their share of benefit would require that vehicles remaining on old roads pay some portion of the cost of motorways. Collection costs would also be incurred.

Table 10 shows the total cost of motorways.

The toll required at level of service D, using a 10 percent discount rate, would be .6p per vehicle mile. The adjustment of the above figures to cover marginal cost only reduces the capital cost per mile to £0.2m for two lane and £0.3m for three lane motorways compared to dual carriageways. The incremental maintenance cost of motorways compared to similar dual carriageways is zero, according to the COBA Manual.

Table 9: *Incremental cost of motorways in 1995*

Type	Marginal cost per mile of motorways over dual carriageway	Miles Required			Cost (£m)		
		D	C	Mid C	D	C	Mid C
2 + 2	£0.2m	25	63	159	5.0	12.6	31.8
3 + 3	£0.3m	47	72	103	14.1	21.6	30.9
Total incremental cost (£m)					19.1	34.2	62.7
Annual cost (£m)							
	r = 5%				1.0	1.7	3.1
	r = 10%				2.0	3.4	6.3
	r = 15%				3.0	5.1	9.4
Annual cost per vehicle mile (p)							
	r = 5%				0.14	0.14	0.17
	r = 10%				0.28	0.29	0.35
	r = 15%				0.42	0.44	0.53

Table 10: *Total cost of motorways in 1995*

Type	Construction cost per mile	Miles Required D	Miles Required C	Miles Required Mid C	Cost (£m) D	Cost (£m) C	Cost (£m) Mid C
2 + 2	£0.5m	25	63	159	12.5	31.5	79.5
3 + 3	£0.6m	47	72	103	28.2	43.2	61.8
Total construction cost (£m)					40.7	74.7	141.3
	Annual cost (£m)	r = 5%			2.0	3.7	7.1
		r = 10%			4.1	7.5	14.1
		r = 15%			6.1	11.2	21.2
	Maintenance cost per mile per annum						
2 + 2	£1932				0.048	0.121	0.307
3 + 3	£2898				0.136	0.209	0.298
Total annual maintenance cost (£m)					0.184	0.330	0.605
	Total annual cost (£m)						
		r = 5%			2.18	4.03	7.71
		r = 10%			4.28	7.83	14.71
		r = 15%			6.28	11.53	21.81
Vehicle miles per day (millions)					1.9	3.1	4.8
Total annual cost per vehicle mile (p)							
		r = 5%			0.32	0.36	0.44
		r = 10%			0.61	0.69	0.83
		r = 15%			0.90	1.01	1.24

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DISCUSSION

Mr. John Blackwell: I am glad to propose this vote of thanks to Dr. Barrett. We have heard one of the most comprehensive evaluations which has been made of a particular public investment decision in this country. It is good to see the excellent work, which has been done by the Roads Division of An Foras Forbartha, being used.

With regard to the measure of benefits from a higher level of service, the estimation of time savings cites an occupancy rate based on the Dublin Transport Survey. Occupancy on the whole network may differ from occupancy got from an urban study, and occupancy may, on average, have increased since the increase in the relative price of petrol. With regard to the value of time savings of goods vehicles : these may be under-estimated. One can envisage a situation where relatively valuable loads are being carried, and where the payment which would be prepared to be made for a saving in time would exceed that which is based on average earnings. There are futher possible savings which are not included in the paper : the savings due to a possible reduction in goods vehicle fleets, at a higher level of service. Finally there is the possibility that there could be a significant amount of generated traffic, due to the reduction in relative transport costs at a higher level of service. For well known reasons the benefits per vehicle-mile would be lower for this traffic than for the existing traffic. This leads one to ask what the implicit assumption is regarding the annual average vehicle-mileage per year. It is striking that vehicle-mileage per private car has been relatively high in Ireland, and has seemingly increased over time. It will be of interest to see whether the increase in the relative cost of motoring affects car ownership or car usage. Recent forecasts by the Road Research Laboratory assume that car usage, in the medium to long term, will not be influenced by cost, but this is questionable.

On the costs side, the parameter b/v in the formula for vehicle cost is a bit puzzling; one would expect, say, a quadratic function relating vehicle costs to speed. Throughout this paper, Dr. Barrett was handicapped by the lack of previous Irish research. But there are some cases where Irish values could possibly have been used : for example, Irish earnings data to provide values for working and non-working time savings, data on Irish accident rates and on maintenance costs. The proposition about the similarity of the incomes of drivers in Ireland and in the United Kingdom might prove amenable to testing, using Household Budget Inquiry and Family Expenditure Survey data.

It might be worth considering whether a shadow wage should be used, on the costs side. This would be relevant in a country with unemployed resources. One would like to compare the incremental rates of return which Dr. Barrett obtains, with rates of return from other public investment projects - especially those in the area of transport. An obvious comparison would be with urban road investment where, it has been argued, a very high social rate of return can be obtained. It is clear from Dr. Barrett's paper that the marginal rate of return from certain stretches of the inter-urban road network must be very high : this is evident from Table 8. These rates of return would be much higher than the rates obtained from choosing going to a higher level of service for the network as a whole. This suggests that there is a need to study specific links in the road system.

There is an old problem here concerning the inter-dependencies in the road network if one improves one segment, this can lead to congestion in an urban area. Furthermore, the methodology of cost-benefit analysis is strictly applicable only to marginal changes. A change to a different level of service is not a marginal change, but has effects on the road system as a whole and results in changes in derived demands and in costs in the whole economy. But this is not really a criticism of Dr. Barrett's paper, since a 'systems' approach is not feasible without a large investment in data-collection and evaluation of data.

Table 7 is surely crucial, and one would like to see more variables chosen for the sensitivity tests. The sensitivity tests are needed both to take care of uncertainty, and to allow for the inevitable arbitrariness in measurements of time and accident savings. For example, recent work in the United States based on wage differentials which attend jobs of different degrees of risk, would suggest much greater higher implicit values for accident costs. One of the variants in Table 7 uses a higher value for leisure time, and it is certainly puzzling that some work based on the Dublin Transport Study suggests a much higher value for leisure time than that found in a number of British studies. One would like to see the sensitivity of the rate of return to a higher value for accident costs, to different rates of growth in car numbers and in traffic volumes, and to a lower growth rate in the value of time savings over time. To sum up, though, this paper is a significant advance on the level of discussion of the economics of transport in this country, and shows that in many areas there is need for measures, based on Irish data, to help the evaluation of transport investments.

Mr. A. Metcalf: In thanking Dr. Barrett for his paper on the evaluation of Road Investment proposals, I would like to say that it is gratifying to see modern transportation planning cost benefit technology being used in an assessment of Ireland's transport needs. It is my long held view that the more familiar we become with this complex technology the more useful it will become to us in determining the different investments, strategies and policies we wish to follow.

However, my overall enjoyment of this paper was marred by the number of difficulties that the speaker faced in carrying out this research work. Of course, a number of these difficulties are recognised and described by the speaker in his 'Assumptions and Limitations of results' section; however, because of their importance I would like to restate them adding my own interpretation. I have classified these problems as threefold:

(1) terms of reference and data;
(2) methodology; and
(3) implications.

1. Terms of Reference and Data

The economic evaluation procedures of the COBA manual require the assessment of trip generation, distribution, modal split and assignment before it can carry out its economic evaluation of the costs and benefits of any investment proposals. The programme can, and has frequently, in some of the uses that British Local Authorities have made of the programme, operate on guesses and inspiration. Obviously, however, as with any computer process rubbish in gives rubbish out. Although of course in the case of the COBA programme this will be handsomely presented rubbish.

Certainly the speaker's own concern with the inadequacies of the Road Needs Study as a data base are in my opinion well founded. However, it is not merely that the Road Needs Study lacks origin and destination information - which is a serious enough problem - but the whole basis of this study as a forecasting procedure is in question.

The lack of information, on which this study is based, prevents first, a proper understanding of influential factors which are basic to the disaggregate transportation planning process (i.e. we don't know what has caused current trends and therefore we do not know how changing circumstances may alter them in the future), and secondly, for the same reason we do not know what the impact of various investments will be on future traffic levels, distributions and modal splits. As a result, it is no wonder that in picking his way through the list of assumptions that the Road Needs Study makes that the speaker is forced to disregard the impact which rail, bus and air investments might make on the traffic flows. This I regard as a particularly serious omission in a country which has only limited capital for investment in transport and in which therefore the consideration of the trade-offs between alternative mode of travel is very important.

2. Methodology

In terms of the methodology of COBA two very important problems exist. The first is concerned with how well COBA carries out its function in terms of the things it claims to assess, and the second is how relevant it is to use COBA in the Irish context.

With regard to the first, I think that the speaker has covered himself with suitable disclaimers about how inadequately each item he considered carried out its function. However, some aspects such as the generation of traffic were not fully considered and the author has not followed the implication of the limitations far enough by testing the likely error ranges associated with each element in a sensitivity analysis. Apart from making this general statement I have little to say except that I cannot resist from complaining at the misconceived way in which the DOE uses Quarmby and my own (noted but unreferenced) time valuations. In particular the assumption that average overall invehicle travel time values measured for work journey to the CBD somehow reflect all types of personal *leisure* travel is very sweeping and is based on only the most limited evidence. Also, I am deeply concerned by the use of the average invehicle travel time value for inter-urban travel. This estimate is an aggregate estimate reflecting the time values for both public and private transport invehicle times. In this study we are concerned with inter-urban car trips and as such a disaggregation of the value of time into modal types is the correct procedure. A disaggregation of values of time into modal values shows that car invehicle time is valued at considerably less than public transport invehicle time. Removing the advantage gained by this averaging reveals that car invehicle time should be valued at a rate of 14 percent of income. Further, recent research by myself, Quarmby and Markham has shown that the techniques used by all of us in our original research may have under-valued money and that as a result even the value of 14 percent of income for car invehicle time may be an over-estimate. The new procedures puts the estimate of car invehicle time at the very low value of 8 percent of income. The implication of this research is quite clear, the benefits derived in this study from car invehicle time savings are probably excessively large by a factor of 2 to 3, and time saving benefits should be scaled down accordingly. Further, it should be remembered that value of time estimates have error ranges of 50 to 100 percent on either side of the estimate.

Finally, with regard to the Discount Rate it should be noted first that, it is far easier for a transport investment to show a high rate of return than any other public sector investment. The reason for this is that the quantification of time savings has produced a very large social benefit, which other investment areas may have but which are currently unquantified. As such it is important to bear in mind that there is a very real imbalance in comparing a transport investment with investments in other public sectors. Secondly, and largely, because it is so easy to justify transport investments, any country must impose some form of capital rationing system on transport investments so that a net present value return of say 10 percent should be considered as a minimum rate of return rather than a satisfactory rate of return. Personally I prefer and would advise on a Cost-Benefit Ratio assessment of investment projects as it contains a form of capital rationing.

Turning to the second problem associated with COBA we are concerned with how realistic it is to use COBA in the Irish situation. The main point at issue here is how relevant do we regard a cost benefit technique designed to cope with inter-urban traffic of an industrialised society in the Irish context. In my view the technique fails to include a significant element of social costs and benefits. I am not assured by the DOE's view of the Bristol-Cardiff experience. In my opinion in the *developing*, rather than the *developed*, economy of Ireland, transport infrastructure can be the leading sector of the Rostow 'take off' theory. I believe there are high regional, industrial and welfare benefits associated with transport infrastructure and of course particularly public transport infrastructures, which in the Irish context have been given a role of providing regional, social and welfare services in the west of Ireland. If the speaker is to comprehensively address the question "How much money should be spent on road improvements over the next twenty year?" he can not ignore the investments trade-offs required between private and public transport and thus the level of social benefit and cost each achieves. The fact that this technique is probably only measuring a small percentage of total benefits in rural areas is a cause of great concern. I believe that the application of urban technology to national level studies without a serious revision of the evaluation procedures, particularly in developing countries, will result in a series of misallocation of resources.

3. Implications

As a consequence of all that I have said about the Terms of Reference, the data, the methodology and the validity of the application of this methodology, I believe it is vital that we consider the conclusions of this work with at least a degree of scepticism. Without questioning the availability of capital for the investments proposed, without questioning the costs of building roads, which are unhappily ill-defined in the paper, we are sure that the range of sensitivity testing needs to be dramatically expanded.

The speaker has in my view been set a Herculeun task; for which no amount of computer technology could compensate. A single application of the COBA technology is in itself a difficult task; but when the difficulties are compounded by inadequate data, and a lack of support research in redefining the evaluation process for Irish circumstances, the task requires at least an integrated team and government support and direction. As such these circumstance prevent us regarding the studies conclusions with the seriousness that the results from such an important contribution to Irish transportation planning deserves.

I hope that we will learn the lessons of this study; which are, first, to regard this contribution as an important initial step in the development of proper evaluation procedures for Ireland, and secondly, through an appreciation of studies limitations, to see the need for the greater integration of public and private transport planning programmes, the setting up of a national programme of research work; the establishment by the respective Government Departments of Irish transport planning criteria standards, and the development of co-ordinated national, regional and urban traffic plans.

Mr. McIlraith (Summary of remarks): added his thanks, to those of previous speakers, to Dr. Barrett for his paper.

He opened his contribution by voicing his disagreement not with anything in Dr. Barrett's paper but with one aspect of the basic 'Needs Study'. This was the matter of forecasting of future vehicle ownership. The method used in the Needs Study was a Mathematical Growth Curve which based on past trends in ownership and a postulated saturation level of ownership estimated the level of ownership in a specific future year as 1991. This method required an assumption of a level of ownership at a very distant future date - saturation - in order to estimate the level at an intermediate point in future time. Mr. McIlraith believes that such a method is logically absurd and meaningless.

In respect of Dr. Barrett's paper there are a number of points where Mr. McIlraith felt that care must be taken in interpretation of results - not least due to the (necessary) use of the British COBA system of evaluation. This was developed for evaluating specific schemes - like a proposed by-pass to a town - and not for a total national network - to which the same criteria would probably not be applicable. Similarly the inherent assumption that all elements of the network were similar - and requiring similar levels of service - might not be true. For instance is it possible to assume that the same level of service is required on a main road in Donegal as on one approaching Dublin?

One of the major problems in calculating benefits in Transportation is the value of time and the value of accident costs. It is not possible to arrive at definite answers to the query 'what are these true values' so care must be taken that reasonable figures are used.

Dr. R. C. Geary (Communicated after meeting): I have been associated continuously with statistical practice and theory for fifty-two years so, for the following comments, I arrogate to myself the role of Keeper of the Statistical Conscience. Indeed I would have taken my line here in relation to most generalised cost-benefit studies I am aware of.

Costs are all right; the trouble usually is valuation of benefits. The benefits tonight are mainly (i) increased speed as saving in working time and (ii) reduction of accidents. While the author marshals his arguments with skill, in my opinion he has not justified his numeration process.

He states that "cost-benefit analysis is concerned with the effects of a project on the economy as a whole". In my view this is going too far but let us accept it for the moment. Clearly a main object of this exercise of estimation must be to assist decision-makers confronted with the problem of priorities in capital investment, the total sum available being limited. It would indeed be wonderfully convenient if, in regard to every possible project the net benefit per £1 invested, taking into account every cost and every benefit social and economic, could be stated as a single figure. As decision makers in the public zone so well know, this is rarely, if ever, the case. It is not, in my view, the case with investment in roads. Despite the lecturer's obvious knowledge and able economic pleading, he has not convinced me that average values can be put on human lives or on the value of an hour saved by lowering of travel time, especially passenger travel. Decisions must be made taking account of non-measurable elements. I recall the late Sean Lemass's bringing down a statistical house (in fact in this Society) by concluding "the best things in life are not measurable by statistics and we fervently pray that they will remain so".

And, whether numerable or not, I do not think he has taken "the economy as a whole," his own words, fully into account, which means that he has not considered all relevant elements of costs and benefits. For instance, what about the deleterious effect on railway usage of improvement in roads at vast cost. I think that a better case for major investment in roads than his could be made by regard to "the economy as a whole."

His estimates cover such a wide numerical range (and this textual criticisms of details so many) that I suspect the author has some doubts about them. For my own part, my criticism may be unfair for I have not read even his main sources; indeed I know little about the problem of investment in roads. But in my ignorance, I may be like people who have to make decisions. For instance, I do not know what "Mid C" is, the meaning of the last column of Table 3, how the very vague standards of "level of service" could be made operational, the meaning of Table 8. I do not always know how the textual development was used to produce the numerical estimates. Perhaps the lecturer would help tyros like me in these matters in the definitive version of his paper.

The sentence after citation of the form of the McCarthy regression should be changed to read "The three negative a_2 values were significantly different at 0.05 null-hypothesis probability level, but not at .10", if this is what is meant.

I shall be glad not to be around when, as Table 2 promises, cars in Dublin will be three times as many as now. You, who may survive, should start praying that small personal planes will be in common use in 1995 or, better still, that people will have reverted to bicycles. In almost every aspect transport is now ridiculous.

Reply by Dr. S. Barrett: A point in all three comments is whether it is appropriate to use the COBA data in Irish conditions. There are obviously areas such as wage rates, occupancy rates, etc. where Irish data could have been included. On the other hand there has been no work on accident, time, or vehicle costs here. COBA is a binary system in the United Kingdom and local authorities are not permitted to insert local values for either costs or benefits in the programme. I therefore applied COBA without modification.

I share Mr. Blackwell's opinion on the COBA vehicle cost formula but note that benefits under this heading are relatively unimportant. I did not include a shadow price for labour to reflect the difference between market and opportunity cost because of the time period in the paper. I trust that current investment planning does not have to assume the current high unemployment between 1995 and 2010.

Mr. Metcalf's plea that transport does stimulate regional development has an intuitive appeal but recent literature does show that this is very much a two-sided coin.

I disagree with Dr. Geary's pessimism about the value of techniques such as cost-benefit analysis to government expenditure. I would also have disagreed with the naive optimism which surrounded the techniques in the early 1970s. Cost-benefit analysis can be used to compare broadly similar projects and to make explicit the values in public choices. The most difficult problem tackled in this paper was the valuation of human life. Society places neither a zero nor an infinite value on life. Dawson attempts to plot the chasm between the two.

In the absence of any information on the scheduling of the road investment programme before 1995 I assumed that there would be zero net benefits before then. While Table 8 indicates a high rate of return on eliminating the backlog of routes now inadequate there would be a counterbalancing effect in the dislocation caused by the construction programme.