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THE DIRECT BENEFITS OF ROAD IMPROVEMENTS TO COMMERCIAL VEHICLE OPERATORS - A REVIEW

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ABSTRACT

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This paper reviews the existing theoretical and empirical literature on the direct benefits to commercial vehicle operators of road improvements. The exercise resulted from a need to estimate operating cost and time savings generated by the Humber Bridge. Although there is significant inter- and intrasectional variation, transport and distribution costs average 10-12% of total costs. In assessing the value of time savings, it is argued that several normally serious problems in business travel time analyses are irrelevant for lorry dirvers, whose work is travel. The crucial issues are the usability (and additivity) of time savings and nature of constraints on utilization of time savings, while a set of firms' operating characteristics determines the extent of such utilization.

This paper forms part of a series reporting the results of an ESRC-sponsored research project, "The Economic Impact of the Humber Bridge on the Carriage of Goods". The material is being published in this preliminary format so as to encourage discussion and obtain feedback. Our focus here is on the conceptual and theoretical underpinnings of the study, namely the nature and extent of direct benefits accruing to commercial vehicle operators from road improvements such as the Humber Bridge.

I. INTRODUCTION

The principal direct effect of the Humber Bridge has been a reduction of road distance and hence journey time between a range of origins and destinations on either side of the Humber estuary. Determination of the resultant operating cost and time savings therefore forms a key problem in evaluating the bridge's benefits.

The production of road goods transport requires inputs of labour, capital and running expenses. The cost of such production depends primarily on three variables - travel time, distance and speed, though some costs may be pure overheads, related to none of these. Labour costs are primarily time related, though distance and productivity may play a role through bonus systems. Capital costs of vehicles are both distance-related and time-related, while operating costs are related to distance and speed. Clearly, accurate evaluation of road schemes requires us to unravel the time, distance and speed effects on costs.

Transport costs enter firms' decision-making processes at two distinct levels. At the higher, strategic, level their overall magnitude is crucial to decisions governing the location or number of plants, their respective output levels and market areas. A trade-off thus exists between location costs, output and transport costs. Alternative transport modes are also evaluated on cost and other criteria. At the lower, operational, level concern is primarily with the cost structure of road freight transport. The relative magnitude of the respective cost components determines the extent of own account versus hire and reward transport employed, optimal vehicle and fleet size, vehicle replacement policy, scheduling possibilities within the market area, and even decisions on direct multidrop delivery ex factory or depot versus trunking with subdepot distribution.

It is instructive to examine briefly the available empirical evidence on the structure of road transport costs. Apart from the literature being scant, comparisons are hindered by definitional and methodological differences.

A recent survey of 66 firms showed that total distribution costs accounted for 12.3% of total sales revenue overall for the 1981/2 financial year (CPDM, 1983). Table 1 gives the sectoral breakdown, from which it can be seen that overall distribution costs ranged from 27.5% of sales in bricks/pottery to a mere 4.7% in "other manufacturing". Some caution is necessary, however, since there was also wide variation within sectors (e.g. from 3.2% to 31.8% in food, drink and tobacco), and sectoral coverage was uneven, with several, including "other manufacturing", represented by a single firm. These data are also not strictly comparable with those of Edwards (1970) because he used net output rather than total sales as his measure and because of the inclusion of distributive trades in the CPDM survey. However, the 'transport' category in Table 1 most nearly approximates Edwards' definition, and the average figures are surprisingly close (3.7% and 3.5% respectively). Allowing for the difference between total sales and net output, the sectoral rankings in the two studies also correspond reasonably well. However, Edwards' (1969) wholesale industry data give transport costs in that sector as an average of 21.6% of gross margins (= net output), compared to the CPDM figures of only 1.85% of total sales for

Table 1 Total Distribution Costs (% of Sales) 1981/2

Industrial Classification	Storage		Stock Interest		Transport		Admin./ Others		Totals	
Food, Drink and Tobacco	2.50	(20%)	1.39	(11%)	4.83	(39%)	3.77	(30%)	12.49	(100%)
Coal and Petrol Products	1.56	(11%)	4.05	(27%)	4.85	(33%)	4.34	(29%)	14.80	(100%)
Chemicals and Allied Products	2.74	(26%)	2.38	(23%)	3.14	(30%)	2.18	(21%)	10.45	(100%)
Metals and Metal Goods Manufacture	-	-	-	-	-	-	-	-	-	-
Mechanical Engineering	2.83	(25%)	1.64	(14%)	2.82	(25%)	4.07	(36%)	11.36	(100%)
Electrical Engineering	1.64	(19%)	1.81	(21%)	3.17	(36%)	2.10	(24%)	8.72	(100%)
Other Metal Goods	2.65	(35%)	1.65	(22%)	2.12	(28%)	1.10	(15%)	7.52	(100%)
Textiles	2.59	(23%)	5.37	(48%)	1.56	(14%)	1.67	(15%)	11.18	(100%)
Bricks, Pottery, Etc.	10.50	(38%)	2.86	(10%)	7.74	(28%)	6.44	(24%)	27.54	(100%)
Timber, Furniture, Etc.	1.47	(12%)	0.25	(2%)	9.57	(75%)	1.40	(11%)	12.69	(100%)
Paper, Printing and Publishing	3.55	(20%)	5.62	(32%)	4.01	(23%)	4.31	(25%)	17.49	(100%)
Other Manufacturing Industries	1.13	(24%)	1.06	(23%)	1.41	(30%)	1.07	(23%)	4.67	(100%)
Distributive Trades	5.44	(50%)	2.37	(22%)	1.85	(17%)	1.31	(11%)	10.95	(100%)
Miscellaneous Services	4.12	(27%)	3.96	(26%)	1.21	(8%)	5.82	(39%)	15.11	(100%)
Overall	3.34	(27%)	2.37	(19%)	3.74	(30%)	2.88	(24%)	12.33	(100%)

Source: CPDM (1983): Survey of Distribution Costs, p. 22.

'transport' or 10.95% for 'total distribution' in the distributive trades (Table 1).

Table 1 also gives a breakdown of the transport cost structure for the CPDM sample as a whole, and for the respective sectors. Overall, thirty percent of total distribution costs were incurred by transport, 27% by storage, 24% by administration and 'other' costs, and 19% by inventory holdings. As with total costs, the intersectoral variation for each component is significant.

Edwards and Bayliss (1971) provide a very detailed analysis of transport cost structures for both own account and haulage firms. Unfortunately the own account category is not broken down into sectors or industries, while transport costs are given only in money terms and not as a percentage of sales or net output. Total operating costs rise with vehicle size, but the unit costs fall. Wages form the single largest cost component, although inversely related in magnitude to vehicle size e.g. 70% of van operating costs, but only 30% of those for the largest HGVs. Fuel costs, which increase sharply relative to greater vehicle size, form the second largest category. While provision for depreciation is significant, maintenance costs prove more important for vehicles over 2 tons u.w. There also appears to be little difference between own account firms and hauliers in their provision for vehicle replacement.

These data provide some, admittedly dated, insights into the likey cost structures facing road transport using the Humber Bridge. The relative importance of particular cost components may well have changed in consequence of the two fuel crises of the 1970's and trends in real wages, but this need not have affected the ranking of trades and industries in the respective sectors unless particular cost components are especialy important to individual industries. Unfortunately these categories are incompatible with those in the CPDM survey, thus again precluding comparison with the more recent figures.

What the available data do show is that there is significant variation both between and within sectors as regards the magnitude of total transport costs and its respective components. Further generalization would appear premature at this stage. With this in mind, we now move on to discuss the principles and practice of evaluating benefits of road improvements to commercial vehicle operators.

II. VALUE OF TIME SAVINGS - PRINCIPLES

The basic approach used to evaluate travel time savings during the course of work is the so-called 'cost saving' approach. This has its roots in the marginal productivity theory of factor rewards. Producers are assumed to expand their employment of labour to the point at which the value of the marginal product of labour equals the wage rate. Then, when travel time is saved, permitting an increase in work done in a given time (or a reduction in time for a given amount of work), the wage rate indicates the social value of the increased production.

There are numerous problems with this approach:-

i) This version of marginal productivity theory assumes perfect factor and product markets.

ii) The marginal productivity theory may not hold in any case.

iii) The gross marginal cost of labour to the firm (including wages, national insurance and employment-related overheads) is relevant, rather than the wage alone.

iv) The individual saving travel time is assumed to be indifferent between travelling and working.

v) The individual is assumed to be unproductive while travelling, but fully productive while working.

vi) The time savings are assumed to be fully convertible into additional work effort at a uniform rate, irrespective of their duration.

vii) By implication, the cost savings are assumed to accrue to firms (and their consumers), rather than to labour. They are to be valued gross of direct taxation.

The first of these points will be relevant in many markets where the assumptions are violated. With a competitive labour market, but imperfect competition in the goods market, the profit maximising firm employs the volume of labour for which the marginal revenue product is equal to the wage rate; with imperfect competition for labour, the firm will set the marginal cost of labour equal to the marginal revenue product. In both cases, the wage paid will be less than the value of the marginal product of labour under competition. However, this is arguably less of a problem in the freight transport market than elsewhere in the economy. The market for road transport is generally considered to be competitive (e.g. Duffy, 1984; Foster, 1978) while the market for drivers may be characterised by elastic supply at the going wage rate, or set of wage rates, made by trade union/company bargaining.

The second argument, that firms simply do not behave in this way, has force in highly organised or monopolised sectors, where firms may be induced to hire "off the relevant labour demand curve". Again, in the haulage context, we would expect competitive conditions to compel a fairly close adjustment of the vehicle fleet and labour demand to market conditions. A number of institutional features, including a significant amount of overtime working and sub-contracting, assist the adjustment process.

The third argument is obviously relevant and poses the problem of estimating the unobservable marginal wage increment. In practice the optimal approach may well be to use values derived from regularly published cost tables or Department of Transport estimates from COBA or other packages.

The forth and fifth arguments are germane to the problem of valuing travel time savings for business executives, for whom travel is the means to a productive end. In the case of goods vehicle drivers, who are acting as couriers, travel <u>is</u> work, and these problems largely disappear. However, if the Bridge permits four loads per day to be hauled between X and Y rather than two, then if the driver prefers driving to loading and unloading, the content of his day has changed for the worse.

The important problems in the goods vehicle driving context are numbers six and seven. According to the cost savings approach, all travel time savings have one of two possible effects. They may generate additional business for the firm, the value or marginal revenue, of which is approximately equal to the marginal wage and other costs of serving those affects (otherwise the firm should have had that business before the transport improvement). Alternatively they may reduce the costs of serving the existing set of customers, there being no possibility of business expansion. In that case, resources are released into the rest of the economy, where, assuming wages reflect the marginal opportunity cost of the class of labour involved, its value elsewhere is given by the wage cost savings. Alternatively, labour works shorter hours in its existing employment. In that case, providing labour is in a classical equilibrium, with wages compensating labour for the value of leisure time foregone plus the disutility of work effort, the cost saving properly represents the social gain from the travel time saving. The way in which this cost saving is distributed between operator, labour and customers then depends upon the relevant market conditions.

However, there are several potential problems:

i) Constraints may prevent the time savings from being usable so that the assumed release of resources cannot take place, or takes place only after a long time lag.

ii) Resources may be released, but may go into unemployment.

iii) The assumed neo-classical wage equilibrium may not hold.

iv) Some or all of the gains may accrue to labour rather than firms, and this may affect the social value of travel time savings.

The constraints which can prevent time savings from being used have been reviewed in a recent study by Thomas (1983). They include the need to collect and/or deliver at specific times, lack of advance knowledge of loads reducing the possibilities for efficient scheduling and utilisation, and long distance movements creating indivisibilities making it impossible to exploit time savings of a given size unless or until new activities are found to absorb the slack time. Note that this type of constraint is a necessary precondition for problems to arise with the wage rate assumption but is not in itself sufficient.

For example, if indivisibilities prevent a travel saving from being exploited, and paid working time falls as a result, then provided that the wage represents proper compensation for the leisure time foregone plus the disutility of work effort, the wage rate assumption remains valid. These constraints therefore need to be considered in conjunction with various forms of labour market disequilibrium.

The first possibility is that resources are released into unemployment rather than into other lines of production. Clearly in such a case, the private cost saving to the firm from releasing the resources exceeds the social benefit of the saving. A shadow price of labour is required in order to reflect the social opportunity cost of the resources released. Though largely irrelevant in the early days of UK road project evaluation, this argument has now taken an increased significance as unemployment has risen.

The second possibility is that resources are not released because of the constraints outlined above, and the assumed neo-classical wage equilibrium does not hold. In practice, wage contracts take an all-or-nothing character, so that there is no reason to suppose that the marginal wage rate precisely compensates for leisure and work effort in the way described above. Some employees may work more hours than they would desire in a freely adjustable equilibrium, others less. For the former, the value of a travel time saving, providing it is usable, will exceed the loss of wages for the latter, the wage rate will overstate the value of time (VOT) saving. It might be argued that in an industry with a history of overtime working, good adjustment by individuals is more likely than under a 40 hour week regime. On the other hand, the existence of laws limiting drivers' hours, which are frequently the practical constraint on work done, suggests that drivers might prefer longer hours of work still. In that case, overtime rates would exceed the value of time saved to the individual.

A related argument becomes relevant in the presence of income taxation. Now firms employ labour to the point at which the value of their marginal product equals the gross of tax wage rate. But individuals supply labour to the point at which their net of tax wage equals the value of leisure plus the disutility of work. So, in the case where the time savings release additional leisure time, the net of tax wage other than the gross of tax wage would be the appropriate basis of valuation. A mathematical exposition of this appears in the Value of Time Working Paper 3, pp. 7-8.

The final possibility is that some or all of the gains accrue to labour rather than being passed on to operators and customers. The assumption behind the cost saving approach is that labour is paid by time, so that a time saving automatically feeds through in lower unit costs. At the other extreme is the piecework system, exemplified by the "job and finish" arrangements sometimes found in the road haulage industry. In this case, unless the job is re-evaluated when travel conditions change, the travel saving accrues to labour. The benefit is the value of time savings to the employee, which, subject to the arguments outlined above, is approximated by the wage rate. But since the unit costs do not fall, no traffic generation occurs. This can be thought of as the developed country equivalent of the 'middleman' argument in relation to feeder roads, where road improvements are sometimes asserted to assist distributors' margins rather than producers or final consumers.

Obviously in reality, intermediate positions are possible. Sometimes, labour is paid an hourly rate plus a percentage of the vehicle turnover. In this case, unless the benefits of the Bridge are fully passed on to final customers, labour and operators will share the benefits. There is, incidentally, a difficulty with these systems of determining whether the turnover should be computed gross or net of bridge tolls, and we shall return to this in a subsequent paper.

Some recent work by Lowe (1983) formalises these arguments. He distinguishes the output which the employee is required to produce from the time for which he is required to be present in employment. Then two possibilities arise: the employee is employed to produe a given level of output, or he is employed for a given amount of time. In general, the output and time constraints will not bind simultaneously.

From Lowe's work, the following table can be constructed:

Value of a reduction in time required for a given amount of work

	Employee	Employer
Time constraint active		
(a) time rates of pay	-	value of extra output (= wage rate)
(b) piece rates of pay	wage rate	-
Output constraint active		
(a) time rates of pay	MV leisure time + MV working time - wage rate	wage rate
(b) piece rates of pay	MV leisure time + MV working time (? = wage rate)	-

In the first case, the employer uses the extra time released to produce more output; the social value of the time saving is the value of that extra output (which is approxmated by the wage rate). In the second case, labour gets the benefit of an extra job in the hours worked, so that wages rise. In the third case, the employer gains the cost saving from getting the job done cheaper; labour loses wages, but this is counterbalanced by the release of leisure tme and the shorter hours of work. In the fourth case labour gains the value of the released time. In each case, under certain assumptions, the value of the resources released is approximated by the wage rate. However, its distribution, and the significance for generated traffic depends upon the nature of payment systems and wage contracts.

Three CONCLUSIONS emerge from the foregoing analysis:

1. Some of the questions which are posed about the value of savings in business travel time, for example, whether travel is preferred to work, and whether work can take place during travel time, are irrelevant to the case of lorry drivers, for whom travel is work.

2. The most important single question is whether the travel time savings are usable, or whether constraints and indivisibilities prevent their use, and if so whether they accrue as unusable leisure time to drivers.

3. The nature of the wage payment system determines who gets the benefits, and whether they are passed on. There are implications for the usual assumptions concerning generated traffic benefits. But the wage rate assumption is generally reasonable.

III. VALUE OF TIME - EMPIRICAL WORK

A complementary approach is to attempt empirical validation of the wage rate theory. Do firms behave in the way suggested in the previous section? Are their decisions on routeing, scheduling etc. consistent with the wage rate hypothesis? How do they respond to relevant changes in their environment e.g. faster roads, relaxation of maximum speed limits for HGVs, changes in drivers' hours regulations? As will emerge from the following review, the existing literature contains surpisingly few behavioural studies.

(i) Harrison (1963) surveyed a sample of operators using the M1 to establish whether or not the time savings generated had economic value to them. Quoting a subsequent paper by Harrison (1969: paras 3 and 4), "it proved difficult to obtain information, but the general impression gained from those that did reply was that time savings were rarely of value and that there were obstacles of various kinds to their utilisation. Some firms however did comment on the benefits they had received ... To some extent, the empirical work ... indicated that there were indivisibilities in the operation of road haulage vehicles ... The unit of output might be a journey of some hours, and the unit of cost a shift's work, neither of which might be affected by the gain of a few minutes."

(ii) Fleischer (1962) conducted a longitudinal study of the impact of road improvements on one major road-using firm over a 25 year period. He suggests that there are 3 principal objections to the "additivity of increments" argument that time savings of all magnitudes are equally valuable and immediately realizable: a time lapse may occur before time savings are utilised, operating rigidities may prevent their use, and labour union rigidities may also prevent their use. He finds that adjustments clearly take place in discrete jumps - in one example, it becomes possible at a particular stage of highway development to make a return trip in one shift. He notes that if wages are paid on a shift basis rather than a time basis, then the benefits will only accrue to firms at the discrete intervals at which rescheduling can take place. There will thus be lags, the duration of which depend upon the operational characteristics of the individual company. He suggests that the effect is to reduce the net present value (NPV) of road schemes, but this presumably depends on the lag structure and the distribution of previously under-utilised time in the system. The fundamental drawback of such single-firm studies is that the results, while interesting in themselves, may well not be generally representative. For example, Fleischer hints that his subject firm operates within a highly structured, unionised framework. This might not be universally valid.

(iii) Adkins, Ward and McFarland (1967) review various methods of computing values of time savings for commercial vehicles. These include (1) estimating the net operating profit from having a driver and truck available for an extra hour, (2) the cost savings made from reducing travel time by an hour, (3) the cost of producing an hour's time savings in terms of the capital outlays required on new roads, and (4) the willingness to pay approach. The first two methods correspond closely with the approaches discussed in the previous section, the third method is clearly irrelevant since the social value of a time saving is given by the benefit it yields, not the cost of producing it. The fourth method is relevant here, but most of the studies quoted refer to passenger time savings. The authors conclude (1967:17) "For commercial carriage operating under the principle of profit maximisation, such a measurement [the willingness to pay method] appears to be ideal. The method was not developed further in this report because (a) data generation for the model is quite difficult due to the relative infrequency of toll facilities and other situations where opportunity costs can be observed and isolated, and (b) the model is incomplete in that the higher values of time in a distribution are seldom demonstrated in the real world and usually must be estimated. The mean of values thus must be extrapolated by methods not yet fully developed." These comments remain relevant 20 years on.

(iv) R. Travers Morgan (1977) conducted a study which involved interviewing, inter alia, 60 commercial vehicle drivers, with the aim of establishing values of travel time savings including both the conventional effect on firms and the effect on drivers' utility of a travel time saving. All the 60 interviewees were being paid for driving, so that, on the assumption that a time saving could be used productively (overtime did not fall), the wage rate assumption was validated.

If overtime does fall, then it is assumed that x% of the time saving goes into working time and (1 - x) % into leisure time, where x% = % of the total working week taken up in working time. The value of leisure time savings being less than the value of working time savings, this then reduces the overall value below the wage rate.

This procedure is open to criticism on two grounds. There appears to be no reason why an hour's reduction in overtime should not result in an hour's increase in leisure. What is presented as a limiting case is not, in fact, one. In any case, the value of a time saving to the individual is given by the value of increased leisure time plus the value of the disutility of work effort. In the neoclassical model considered above these together equal the wage rate, though we have presented arguments concerning disequilibria and taxation systems why the equality might in practice not hold. No clear conclusions therefore emerge from this study.

(v) Thomas (1983) reports a major empirical study of the value of time savings to commercial users in West Malaysia. The study focuses on the usability of time savings, and the factors which may prevent their full convertibility into increased vehicle utilisation. The major constraints are identified as follows:-

(a) The relative importance of transport in the company - in hire and reward operations, high productivity is essential; in own account, where transport is the servant of the main company function, the pressures may be less strong.

(b) Control over loading and unloading times - whether additional activities can take place within the "time window" during which customers are available to receive or consign loads.

(c) The length of loading and unloading time - the size of the time saving relative not just to journey time but to total trip time including loading and unloading time.

(d) The scheduling of vehicles - the amount of advance notice required to enable efficient journey planning to take place.

(e) The degree of specialisation - in type of load, routes operated and journey distance.

(f) The ability and opportunity to carry return loads.

(g) Night driving, which greatly increases the mileage flexibility of the road transport industry.

(h) Other constraints, which proved less important than expected included drivers' hours restrictions, licence restrictions, and entry restrictions into Kuala Lumpur.

Thomas's main conclusions are as follows (1983:32-33):

"... for most types of commercial vehicle, the relationship between time savings and increased vehicle utilisation is weak and limited ... The impact of journey time savings is likely to be substantial only if journeys are short and there is little difference between journey and total trip time ... or there is a spectrum of journey lengths ... The value of time for commercial vehicles is generally composed of a limited increase in utilisation probably with a significant time lag before increased utilisation is possible, and an increase in driver non-working time. ... it is clear that benefits from journey time savings will be significantly overestimated if based on the simple assumption that a 1% increase in speed leads to a 1% increase in trip utilisation ... time savings may, however, lead to a change in the trip structure ... in more developed countries the main effect of time savings may be on the distribution system .. vehicle utilisation increases not because vehicles are making more trips of the same length, but because they are making the same number of longer trips, the result of a changing distribution pattern. There is some evidence to suggest that the introduction of the motorway system in the U.K. has had precisely this effect."

Thomas's work is the richest and most relevant of the empirical studies which we have found. His approach and findings thus provide a benchmark against which to compare our own study in the different environment of Humberside.

IV. VALUE OF TIME - PRACTICE

U.K. project appraisal practice in using values of time savings for commercial vehicles can be briefly stated. "The relevant cost of working time to the employer is taken to be the gross wage rate increased by National Insurance and pension contributions and those overheads which vary directly with the labour employed. An addition of 31.3% is made to the gross wage rate to cover these indirect costs. Wage rate data are based on Department of Employment statistics and are related to various classes of traveller through the National Travel Survey" (Leitch, 1977: para 4.19).

The relevant values quoted in the HEN 2 paper which forms a part of the COBA 9 Manual are

	pence/hour (1979 prices)
Other Goods Vehicle (OGV) occupant	300.0
Light Goods Vehicle (LGV) occupant	258.3
Vehicle occupancies - OGV	1.20
LGV	1.30

V. VALUE OF OPERATING COST SAVINGS

The non-labour elements of vehicle operating costs comprise fuel, lubricants, tyres, maintenance and repairs, depreciation and interest. The crucial problem is to determine the relevant causal relationships between travel speed, time and distance and these cost elements.

The assumptions currently used for appraisal purposes are as follows. Costs relate to the passage of time, to distance travelled, and to speed. The fuel equation is derived from studies by Everall (1968) and gives the familiar U-shaped relationship between cost and speed. Oil and tyre consumption is assumed to be related purely to distance travelled. Two-thirds of maintenance costs are assumed to be distance-related; the remainder is assumed to behave in the same way as fuel. The precise justification for this assumption appears to be lost in the mists of time.

The cost categories most pertinent here are interest and depreciation. Since 1973, the procedure has been to take account of three separate elements of capital consumption:-

(a) the change in the total depreciation cost which arises from use of vehicles on the new and old road networks (i.e. mileage-related depreciation).

(b) the once and for all change in the necessary total vehicle stock, resulting from changes in the total travel time on the new compared with the old network. This is calculated as the flow of interest savings from the vehicle stock change.

(c) the change in the total non-use related depreciation which results from the vehicle stock change indicated in (b) above.

From discussions with commercial vehicle operators it emerged that depreciation is strongly use-related. Therefore, for commercial vehicles (though not for cars), term (c) drops out. Current practice therefore has it that depreciation is use related, while interest is time-related.

Both of these propositions are questionable. Is the evidence that depreciation is solely mileage related actually robust? Is it valid to assume that vehicles travel for given annual hours of use, so that travel time savings generate a vehicle stock change?

On the first of these questions, the main counter-evidence comes from Nash (1974). His empirical work suggests firstly that vehicle age plays an important role in determining the timing of replacement, and secondly, that obsolesence plays a substantial role in the commercial vehicle market since vehicle life would otherwise be very long. "Rises in annual vehicle mileages (at any rate when not accompanied by other major changes in operating conditions) have little effect on vehicle life" (1974:233). This, if true, would suggest that depreciation should be regarded as a standing charge, related purely to the passage of time, and unrelated to distance travelled. In that case, road improvements would only affect depreciation via their effect on the equilibrium capital stock (argument (c) above), so that the assumption of constancy of hours in service becomes critical. This is the vehicle equivalent of the utilisation of time savings argument for drivers. Here, Nash notes Harrison's (1963) study of the M1, which had been unable to unearth a single example of an operator "saving" a whole vehicle.

Nash concludes that "inadequate justification for the existing assumption of constant hours in service has been given, and - on balance - that this is inclined to understate vehicle operating costs after a road improvement" (Nash 1974:236). In other words, if utilisation falls somewhat, then a part of depreciation and interest is truly overhead, i.e. related to neither journey time nor distance travelled. The effect of the Humber Bridge on fleet size and vehicle utilisation rates is clearly relevant if it can be isolated from other influences, such as general movements in the local and national economies.

CONCLUDING REMARKS

This review has shown the available literature to be inadequate in terms of coverage, and varied in terms of research findings. Many aspects of neoclassical theory appear to be contradicted by at least some empirical evidence. We have undertaken a series of detailed structured interviews with commercial operators using the Humber Bridge in an attempt to throw light on the issues discussed here, among others. The results will be presented in subsequent ITS Working Papers.

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