MODAL SPLIT AND THE VALUE OF TIME

A Note on "Idle-Time"

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Recent studies in modal choice have concentrated on the use of a model with two modes in which a linear combination of factors expressing the relative characteristics of one mode with respect to the other, and perceived by the traveller as important in his choice of mode, are used to construct a relative disutility function.[1]

Such models of binary choice have subsequently been used to derive measures of the relative disutility of the various factors entering into the relative cost function and, in particular, to derive the value of time by comparing the parameters relating to time with those relating to money outlays.

The success of this approach depends upon correct specification in the function of those relative costs perceived by the traveller. It is largely for this reason that studies in binary choice have concentrated on commuter journeys, where the perceived cost structure is both comparatively simple and frequently considered and what are thought to be the important variables can be easily identified. Typically, we have seen the introduction of money outlays (fares, parking charges, vehicle operating costs), on-vehicle time, excess travel time (walking and waiting time), overall travel time and car demand ratio. Discussion has then centred upon how travellers actually perceive these relative costs, and various functional forms of the differences, such as ratios and logarithms, have found expression. Time is categorised on the basis that the different ways in which it is expended will affect its importance and consequently its valuation. Expenditure of time on travel can be regarded as involving a disutility, with some types of travel involving a greater disutility (less comfort, more frustration) than others. For example, more weight is attached to waiting time than to on-vehicle time. In some studies [1][2], [2] this distinction has not been made and all components of travel time have been given an equal weighting. It is important, nevertheless, for a correct appreciation of relative disutilities that all components perceived differently are distinguished; failure to do so will lead to biased estimates of their value.

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[1]This usually takes the form:

$$Z = \alpha + \beta_1 U_1 + \beta_2 U_2 \ldots \beta_n U_n,$$

where Z is the relative disutility of travel by a particular mode;

U_1, U_2, U_n are the comparative aspects of one mode with respect to the other;

$\beta_1 \ldots \beta_n$ are the parameters expressing the relative importance of each.

This function is then transformed into the probability of one particular mode being chosen in a given circumstance, using an expression of the general form:

$$P(Z) = \exp[K(Z)](1+\exp[K(Z)])$$

[2]Beesley's study was not a study of modal split as such but of the value of time. The emphasis therefore differs, but the point made is still applicable.

No study appears to have treated explicitly, or even to have mentioned (except occasionally in passing), reliability, a factor which will be termed here *idle-time.*[3] As defined here it comprises two elements. One is essentially schedule delay, that is, the difference between the desired time of arrival at one's journey destination and the actual time forced upon the traveller by the "timetable". It is a function of service frequency and is more commonly associated with inter-urban travel. The second element arises from the lack of predictability of journey times, commonly found expression in such phrases as "unreliability and unpunctuality". Whereas schedule delay is really a matter concerning public transport, unpredictability affects both private and public modes alike. A traveller may know that on average a certain journey will take him x minutes, but he will also know that on any particular occasion it may take him $x+y$ minutes. He therefore allows a margin of time, the amount depending partly on the importance of his reaching his destination by a given time and partly on his assessment of the probability distribution of y. On a majority of occasions he will arrive before his desired time of arrival and a *travel-associated* cost will arise.

In the binary choice model context it might be argued that idle-time affects only a very small percentage of the travelling population and that, in those journeys affected, idle-time is only a small proportion of total journey time, or that as a travel-associated disutility it has a very low value attached, or that it affects all modes to an equal extent and will continue to do so in the future. Let us consider these points briefly.

Both Thomson [4] and Smeed [5] have provided information on the predictability of journey times. Thomson's analysis of journey lengths of 2½ to 3 miles in Central London shows that in 1960, if a person was prepared to arrive after a desired time of arrival on 15 per cent of occasions only, he would have to allow a margin of 20 per cent over the average time taken. To arrive late on only 5 per cent of occasions, he would have to allow a margin of 40 per cent. By 1966 the position had worsened slightly, so that he would have to allow a margin of nearly 50 per cent if prepared to arrive late on only 5 per cent of occasions. Similar information provided by Smeed, based on several towns and for different average journey speeds, shows that at 20 m.p.h. to arrive late on only 5 per cent of occasions the traveller would have to allow a margin of up to 33 per cent longer than the average time. At an average speed of 10 m.p.h. he would have to allow up to 70 per cent longer than average.[4]

The existence of schedule delay, on the other hand, is a direct function of service frequency and it will naturally vary considerably according to circumstances. Where the desired times of arrival are evenly distributed over time, the average schedule delay time will equal half the service frequency. In practice there is probably some bunching of desired times of arrival, which may be reflected not only in the frequency

[3]The one exception would appear to be [3]. Lave refers to the "sensitivity to arriving at a particular time" being "obviously most important for work trips". Nevertheless, there is no explicit account of this factor in Lave's model.

[4]These calculations possibly over-estimate the margins, relating as they do to specific sections on the road network. A person can be expected to vary his route according to circumstances and thus reduce the effects of a variation in congestion on any particular route.

of service but also in the precise timings. In this case, desired times of arrival and actual times of arrival will accord more closely.

In those instances where the choice of mode lies between private transport and public transport sharing the same track system, we can argue that idle-time will be greater for public mode users. Bus journeys, for example, can be expected to be subjected to the same conditions of uncertainty as car journeys (if not more so because of the need to keep fixed routes), with the additional element, specific to the bus users, of idle-time caused by schedule delay. Where the car competes with public transport running on exclusive track, each mode is subjected to different conditions of uncertainty and the idle-time of one mode *relative* to the other is *a priori* indeterminate.

The extent to which a desired time of arrival exists in people's journey plans can be expected to vary considerably between different types of journeys. We might expect journeys *to* work to be subject to such considerations, as well as many forms of business journeys. Other types of journeys, such as shopping trips and holiday trips, can be expected on the whole to be free of such constraints; but there are exceptions – for example, trips to sporting events and to the theatre.[5]

Evans [6] and Phillips [7] have shown, in their reformulation of the general theory of time valuation as applied to travel, that the benefits derived from time savings have two elements, the utility of leisure and the utility of travel itself. The utility of travel may be, and is most likely to be, negative – that is, a dis-utility is incurred – and in that case the benefit of a reduction in time will be greater than the utility of leisure time. It seems reasonable to assume that idle-time has marginal utilities of leisure time rather similar to those of the various forms of travel time, such as on-vehicle and excess time. Any comparison of the value of idle-time with that of on-vehicle time, etc., must therefore hinge upon the respective utilities. In most cases, as pointed out above, the various travel time components are considered to have a negative utility. This need not be, and probably is not, the case with idle-time. Neverthelelss, in so far as a desired time of arrival exists in people's journey plans the saving of idle-time will have a value, but probably less than that of travel time itself.

The accuracy of any calibrated modal split model, and the extent of any distortion introduced into the value of time by ignoring idle-time, are likely to be much affected by the circumstances in which the data was collected and the manner in which it was collected. Because a number of advantages are thus gained, empirical work has concentrated on the work journey and particularly on the journey *to* work, which unfortunately, as pointed out above, is normally subject to a desired time of arrival and, therefore, idle-time considerations ([1], [2], [9]).

This still leaves the possibility that the effects of idle-time on modal choice have been "picked up" in the various models. There is a possibility, again depending very much on the precise circumstances examined, that the waiting time factor could have included idle-time. It is clear that schedule delay is a function of service frequency. To a certain extent this is also true of waiting time [8]. It is possible,

[5]The modal choice of the return half of those journeys subject to timing constraints, although not itself necessarily similarly subject, is probably preconditioned by the constrained leg of the journey. This joint-demand aspect is a further factor in the modal choice of any particular type of journey.

therefore, that in those cases where waiting time has been separately specified the appropriate parameters reflect in part the effects of idle-time on modal choice.[6] The more they do so, the more will the value of waiting time (excess time) have been overestimated.

A further possibility is that persons reporting their journey times have consciously or unconsciously allowed, at least to some extent, for idle-time. This possibility only arises, of course, where perceived travel costs have been used in the model and have remained uncorrected.[7]

It is therefore rather difficult to judge the effect that ignoring idle-time may have had on the models calibrated so far. To some extent it depends how far idle-time co-varies with other factors already included in the model. Where the co-variance is considerable the parameters of the relative cost factors may lack stability. If, on the other hand, the co-variance is slight, any influence that idle-time has on modal choice will probably be reflected within the constant term. The point remains that the overall predictive power of the model will be suspect, although the parameters relating to any relative cost factor may be reasonably correct. It is interesting that, as Phillips [7] has pointed out, when time cost differences match the money cost and other differences (i.e. when the variables on the right-hand side of the discriminant function cancel each other out so that the "dependent" variable sums to zero) the probability of choosing either mode should be one half. But in Quarmby's case [9] there is 0·7 probability of choosing a car. As idle-time is more likely to favour private transport, such a bias could be explained in this way, and this would also indicate that waiting time has failed to pick up at least the whole of the bias. Phillips [7] has shown that a probability of one-half is obtained if Z, the measure of disutility of the bus mode with respect to the car, equals $-0{\cdot}354$, which is a bias in favour of the car equivalent to 3·6 minutes of excess time and 6·5 minutes of overall time, on the basis of Quarmby's parameters.

We must conclude, therefore, that there is a suspicion that the failure to incorporate idle-time as a separate perceived cost of travel may have produced parameters for the binary choice model which lack stability, and may have produced biased estimates of travel time which overestimate its value.

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[6] This would not be true in [1] and [2]. Quarmby [9] took waiting time into account but combined it with walking time and termed it "excess" time.

[7] There is a tendency for model builders to "correct" for reported travel costs which diverge widely from some objective measure (for example, [9], page 285).

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