Conditions for Successful Measurement in Time Valuation Studies

M. E. Beesley, London Graduate School of Business Studies

This paper arose out of the feeling that in the last few years progress in getting usable values of time has not matched progress in theoretical understanding. Time values are most useful, one supposes, in project evaluation. For this, estimates of the opportunity cost of time—its value to the consumer in alternative activities—and estimates of the values of specific disutilities associated with the activity of traveling are both useful. It seems perfectly legitimate now to distinguish the "valuation of time in general" and its "valuation in a particular use," to quote Evans (1). For example, until 1969, in British and European work at least, there seemed a growing and useful consensus from empirical studies that one could value the opportunity cost of leisure time at about 25 percent of the relevant wages and salary and that transport time elements such as walking and waiting could be assigned twice these values. More recent British work has seemed to upset this growing consensus.

I shall argue in effect that better theoretical insight has coincided with less attention to the conditions predisposing to successful measurement; the quality of data and the experimental situations have been relatively neglected. In any case, it is certain that better estimates will require a good deal of attention to the selection or creation of study opportunities, and I wish to explore the conditions here. The points are developed first with regard to binary choice situations for convenience in exposition and because most studies have taken this form.

In transport sector evaluation we are obliged to adopt an account of the value of time in general—the rate at which it is substituted at the margin of transport and nontransport activities. We can also hope to go further: to specify the value (or cost) of within-mode travel. But the latter may not always be possible. If so, we can fall back on the generalized opportunity cost measure. The assertion that, for evaluation purposes, this would be better than omission would be hard to prove, but it is intuitively appealing. The focus here will be on evaluation of investments. As we shall see, the requirements of evaluation on the one hand and prediction of modal choice on the other may conflict; what is efficient procedure for one may not be so for the other. Also, in what follows, I concentrate on nonworking time as the most debatable of items in evaluation.

My argument is that there has, in varying degrees, been insufficient attention to the following elements necessary for a satisfactory outcome of a binary choice study:

1. The separate populations for which values of time are fitted should be homogeneous;
2. The choices observed should refer to a situation in which the demand for travel approaches zero;
3. There should be no ambiguity in the measured (cash) outlays;

4. The more "traders" (i.e., those sacrificing time for cash, or vice versa) the better; and

5. The trader should be well distributed with respect to revealed minima, and maxima, observations.

The paper shows why these points are important and presents other statistical requirements that have been noted elsewhere for good studies (2). Harrison and Quarmby (2) summarize these as follows: Each variable that may be important in an explanatory equation should exhibit sufficient variance in the data; and variables expressing time and cost should not be collinear. In terms of binary choice, as we shall see, this requirement appears in a particular guise. Also, they remark, "The analysis technique must show a sufficiently high level of explanation of behaviour"—i.e., be subjected, if possible, to formal tests of significance. And they added, "The sample analysed must show non-trivial proportions making different choices"—which again has a particular significance for binary choice.

Most binary choice studies have been of different modes. A subtheme of the present paper is that to be efficient in predicting modal choice is not necessarily to be efficient in deriving values of time. I also consider the bearing of the argument on alternatives to binary choice studies. Having established the importance, in principle, of observing the conditions for a "good" study opportunity, the paper then considers how far recent British studies have fulfilled these conditions. Because they appear to have considerable shortcomings, I draw the conclusion that there are as yet insufficient grounds to reject earlier notions about values of time.

EXPERIMENTAL CONDITIONS

My starting point is that of a study consisting of binary choices by consumers. I assume that the best evidence derives from observations of actual choices. I ground this on the assertion, not to be further considered, that evidence of what consumers do, or have done, as part of their experience is better than what they might do or seem to do in hypothetical conditions set up by the observer (laboratory tests). Also I assert that, as a matter of practice, consumers can give far better evidence when choice is confined to 2 options than when choice is multiple; i.e., consumers tend to think in terms of, and more accurately report, single alternatives. Having said this, one immediately encounters the difficulty that a special weight is then thrown on the assumptions about, and evidence for, the homogeneity of the classes of people to whom the measurements are held to apply.

One needs to classify consumers first because one has to identify, operationally and as economically as possible, who is to be affected by an investment or policy change and second because one hopes thereby to ease the problem of estimating within acceptable error limits. Thus, one also chooses to group consumers together to obviate or lower the cost of explanation. One may be more or less successful in bringing these requirements together. For example, if we can regard consumers within defined income brackets as homogeneous, it is a great computational convenience. But this may, on the one hand, not serve to illumine behavior and, on the other, not distinguish among policy options in a useful way (e.g., if choice of policy does not involve greatly varying mixes of income groups). The test of a successful system of categorization is thus not only its robustness in maintaining explanatory power but also its relevance to decisions.

In the case of binary choice, particular emphasis is laid on selection of population classes because any definite outcome depends on a grouping of individual observations. The information from a single observation is at best one minimum or one maximum estimate; to fix specific values of time, one must observe examples of each and assume them to be drawn from the "same" population.

Our first requirement of a good study opportunity is therefore a clear justification of homogeneity assumptions and their relevance, when selected, to decisions. There must be good a priori reasons for supposing the samples to contain "like" people.

There is a good case for using experiments not directly involving prices—for exam-

ple, administered in laboratory conditions—to test whether the conventional definitions of traveling (for example, into income classes) do distinguish sets of people having like values of time. One example would be to apply nonmetrical scaling devices to samples of people confronted with hypothetical choices among several modes, such as conventional bus, taxi, dial-a-bus, and jitney, for their journey to work. The interest in this would be to see whether those who were revealed as regarding alternatives as close substitutes conform to conventional classifications of consumers, or whether they must be recognized differently. Once satisfactory classifications are established in this way, one can proceed more confidently to the observed, real-world choices involving trade-offs between cash and time.

The second requirement concerns demand for travel. One can distinguish several levels at which binary observations may be attempted. Basically one regards transport activities as inputs to commodities or services that must be consumed at specific locations. One could observe choices between commodities or services at the top level of the hierarchy; choices among places at which these commodities are consumed at the second level; (conventional) mode choices to each given place at the third level; and choices of routes within a mode at the fourth level. In transport, those below the first level have been attempted; they represent respectively distributional, modal, and route choice studies. Clearly it is possible to envisage successful observations at any level. Recent theoretical insights have taught us also to look at these levels in another way: as bundles of attributes to be thought of as attaching to alternative commodities, alternative places of consumption, and the like. At any level above the lowest choices, features of a lower level will combine. (Thus a mode choice necessarily involves a route and a particular selection from a set of attributes.) As the level rises so, one would expect, would the complications—the complexity and number of attributes. Other things being equal, one expects a simpler, more manageable exercise in the lower the level observed. But the opportunities to make such observations, or to save their cost, may not occur in the same way. Decreasing complexity may have to be bought at the price of fewer relevant observations.

Clearly also, the binary choice observation does not permit a direct link with conventional estimates of demand for services or commodities. A given observation can be defined either as an acceptance or a rejection of one of a pair of alternatives. Estimation of demand requires distinguishing between acceptance and rejection to get a quality-price relation, whether that price be reckoned in cash, as is usual, or in time, as is occasionally encountered in demand studies. To put the matter another way: In estimating from binary choice one always assumes the rejected alternative to be one that would have been selected had the first not been available. This is plausible, for example, in considering the journey to work, where one can assume, for the relevant range of observations, that the elasticity of demand for getting to work at all is near zero. For other situations of (derived) demand for travel, this is not so plausible; thus, the selection of the binary choice approach implies that the underlying demand conditions are favorable. Estimating demand, on the other hand, essentially involves testing for rejection of the goods or service.

With binary choice, the connection with conventional demand estimates, if it is to be achieved, must be done by combining populations with different measured values of similar attributes to yield a total volume-price relation measured in terms of time or cash. Standardization of attributes across the combined sets is also required to be recognizable as normally labeled commodities or service in a given market. Where one chooses to declare a relevant market (in terms of the above discussion, at the commodity or place or modal level) depends on the purpose or policy in hand. A fully articulated connection between binary choice and market observations is thus likely to be difficult. But because a connection with normal demand estimates is often desirable both for policy formation involving actions by operators in real markets and for cross-checking, the choice of opportunities to make measurements to value time should be influenced by the existence of conventional demand measurements or their potential derivation from independent data. If, then, a study of valuation can be clearly linked with conventional demand estimates, so much the better.

The third requirement for a good study opportunity concerns measuring the costs

involved. Unless it can eliminate the differences plausibly, a successful study must distinguish at least 2 components of time and should choose situations in which ambiguity in the cost variable is minimized. Where cash outlays are clearly related to sacrifices of income, no problem arises. Difficulties will arise where costs themselves may represent opportunity costs or advantages not necessarily reflected in cash outlays. Then it becomes a matter of judgment whether to make time or cost the variable to be explained. This problem is at its most acute where choice involves car costs. The conventions usually adopted in studies that involve car costs are clearly extremely unsatisfactory. Normally, studies involving car costs have sought to impute a reasonable account of outlays on car trips—the resource costs involved, e.g., gasoline and parking.

Occasionally, when reported car costs are observed to vary by users, an attempt is made to use perceived car costs. These are essentially the costs that, from trial runs with alternative possible imputed costs, appear to give best fits in models of modal split that include time and cost elements. The resultant costs may diverge from resource costs and hence give rise to a series of problems about the appropriate valuations to take in cost-benefit studies. But, in fact, the relevant concept is the opportunity cost of the car, and that may vary widely according to factors such as whether its use on a trip deprives anyone else of use or whether it is to be used for further trips during the day. There is no a priori reason to suppose that an imputed average cost per mile is representative of the total true opportunity cost or, indeed, that car users' opportunity costs are distributed in any particular way with regard to alternative imputed average costs. The fact that respondents, when asked to define their car costs in terms of cash outlays, vary in their responses enormously may be due as much to genuine variance in opportunity costs as to a failure to perceive costs correctly. Moreover, there is an obvious difficulty for respondents to translate their experiences into what may seem rather irrelevant terms, namely, cash. Thus, choices involving cars must be expected, other things being equal, to yield rather unfavorable potential measurement conditions unless consistently large specific cash outlays are involved (e.g., high parking fees or tolls). Again, this depends on the level at which choice is to be observed. For example, a study at the route level of speed and cost trade-offs in which drivers are observed to choose to travel faster or slower may (if one can believe that differences are substantial enough to be perceived) escape the criticism. Studies of commuters not facing high parking charges will not, because there the ambiguities about car costs are at their most acute.

The fourth requirement concerns traders. This is a question of the factors that influence the number of effective observations among a data set. We may proceed from a simple example. Essentially, the explanation of the value of time spent traveling is derived from what I have called traders, i.e., those respondents showing a choice of the following type:

$$\begin{array}{ll} 50 \text{ minutes} & \left\{\begin{array}{l}\text{is preferred to}\\ \text{is not preferred to}\end{array}\right\} \begin{array}{l}30 \text{ minutes}\\ \$1.25\end{array} \\ \$0.75 & \end{array}$$

The value of time should be understood as the amount that compensates the person in question for his or her sacrifice of time. It is not the price that a person has to pay in a given situation to save time; that would be, and often is, less than the amount that he or she would be prepared to pay. The traders are important because they can be used to demonstrate the limiting values attached to time, i.e., what is or is not sufficient cash compensation for gains or losses in time.

In an earlier article (3), I made the rather heroic assumption of indifference to walk-wait and specific public transport proportions in choices. So it is clear, contrary to the implications of some critics since, that I was attacking the problem of what one would now call the opportunity cost of time and recognized the problem of what one would now call the "intramodal" utility. These traders represented 27.5 percent of all responses, whereas apparently illogical choices, e.g., those that preferred 50 minutes and $1.25 to 30 minutes and $0.75 (or up to 50 minutes or $1.25 in the latter option), accounted for 6.3 percent. Dominant choices, i.e., where both time and cost

were inferior and rejected, accounted for the remaining 66 percent.

With a simple choice situation, i.e., no ambiguity about cost or time, clearly the more traders the better. The greater then is the possibility of stratifying the data successfully to test issues such as variance with income. That is, one can concentrate on the issue, which is crucial to using such choices, whether the sets used really are homogeneous, and, if not, in what respects are they not, so that separate estimates can be made. Notice, however, that statistical success also requires a reasonable balance between what are called above minimum and maximum observations from traders. In fact, as shown by the diagram in my article (3), my data were relatively short on maximum observations. Had one attempted more than a simple explanation (as reported there, others were contemplated but rejected because the data were not sufficiently good, I thought, to stand up to such sophistication), this might well have appeared as a formal difficulty with error terms. (The maxima and minima observations were weighted for their frequency in my estimates, again contrary to the assumption of at least one critic since!)

The general conditions for observing traders were probably rather favorable in the case of my study. London is possibly one of the richest of all cities in alternative transport routes and modes. Yet only just more than a fourth of the observations appeared as traders. Since I also started from quite a large sample overall (1,109), it is natural to inquire what is involved in attempting to split the simple observations into components. Clearly, sample size requirements may rise drastically if inferences have to be confined to traders. But do they?

In what follows, I assume there are really at least 2 components in the observed time, say, opportunity cost and comfort. Our example of a trader becomes $50x + 50y + \$0.75 - 30x + 30y + \$1.25$, where x = opportunity cost and y = comfort. This adds little to our information. We need something further to distinguish proportions of comfort on each alternative. Suppose we observe 30 minutes of walking on the first, and 20 minutes on the other. (This is relatively easily observed: The consumer can report it, and it is a category we all intuitively think is so distinct from other parts of the journey as to require labeling only. Such an instinct may be correct for walking, but for other dimensions of comfort, such as crowding, one has to rely on actual observations to distinguish the choices. This raises, quite substantially, the research cost.) Now we can say the observation is $50x + 30w + 20z + \$0.75 - 30x + 10w + 20z + \$1.25$, where w = walking and z = other modal time. To use this information, we have a choice of procedures. We can combine traders in such a way as to match similarities (for example 20z on each side above) and isolate values. This again puts up the sample size requirements. However, we can see whether we can add to the traders observations by bringing in the other categories, dominants or illogicals.

Consider a dominant, e.g., $30x + \$0.75$ is preferred to $50x + \$1.25$. If, with further evidence, this can be converted into a trader, e.g., $30w + 20x + \$0.75$ is preferred to $50w + 10x + 40y + \$1.25$, where the notation is as before, this becomes an observation from which information can be extracted. A necessary condition is that a sacrifice on the noncash side is revealed since the cash gain remains unchanged. Not all dominants will show this on disaggregation. And the nature of the value thus revealed is always a maximum because cash is preferred to time. Unless, therefore, observations can be found with cash sacrifices also, these extra observations will have limited value for estimation purposes.

So, to get a balance, can one bring in (apparent) illogicals? Clearly, yes; there are possible sets of revealed weights that will transform them into either dominants or traders, of which the traders are useful for estimating purposes. Hence, the illogicals and the dominants could yield a possible set of ratios of values for the disaggregated items that, given that the observed set of people are really rational, enable some test values to be accepted. Depending on whether the people concerned sacrifice costs or not, these will be minima or maxima. Thus, information can be increased from these sources. But disaggregation will not always reveal traders, and revealed traders must be balanced between maxima and minima. On the other hand, if original traders are subjected to disaggregation, they always provide information, for there is no selection of possible values for the constituents that will change them into illogicals or dom-

inants. (Of course, the values to be fitted to them may not coincide with the corresponding values for the rest of the disaggregated observations; i.e., adding all observations may not increase explanatory power. But that merely would throw doubt on the homogeneity of the sample population.)

So, in the consideration of the relatively small numbers of illogicals—or potential maxima—seemingly typically observed and the potential for disaggregating traders, an important indication for the success of studies seems to emerge: The more traders the better still seems to be a useful rule of thumb, meaning those in which a simple time and cost trade-off is observed. An important corollary seems to follow from these arguments about what can be observed in binary choice situations. Whatever the sophistication of the statistical estimation technique used, the underlying limitations—that information must be capable of transformation into the trader form—apply and so do the requirements of a good potential distribution of traders between maximum and minimum values.

Much of the recent work has formulated the problem in terms of statistical methods designed to contrast the characteristics of 2 populations, e.g., by discriminant analysis. Often this has also taken the form of discriminating modal choice, e.g., between public transport and cars. The technique is more powerful than the graphical approach in my earlier article (3). But whether an observation happens to be a choice in favor of bus or rail is irrelevant. Which way a choice goes in terms of modes depends on the objective opportunities open to the population. So to formulate the problem instead as one of modal choice, where the modes are recognizable everyday modes, is to constrain the estimation unnecessarily. The right choice of attributes is all that is required. So all attempts to improve on the (supposed?) simplicity of the trade-off approach involving reformulation as a modal-choice problem have involved some loss in explanatory power from the point of view of estimating values of time.

That is, of course, one aspect of the fact that what is efficient procedure for time valuation may not be so for modal-split prediction. Each has different objectives. The conditions for success in observations for modal-split problems may well be considerably different. For example, for many modal-split purposes a high incidence of dominant choices is not necessarily limiting. If modes are clearly identified as superior or inferior for most of the sample population, so much the better; one can, and should, dispense with complicated explanations.

But what of alternatives to binary choice observations? Many of the points made above about homogeneity, costs, and statistical requirements apply to these also. The distinguishing characteristic is the use of more aggregate data; and they often involve, explicitly or implicitly, choice among ends to which travel time and cost are devoted. The principal source of data is urban transportation studies. One can, for example, seek to explain the modal choice between zones in terms of the time and cost characteristics of the modes. If one standardizes to trip purpose (eliminating irrelevant activities) and if one standardizes to trip length (eliminating the possibility of rejection of this purpose), one might observe the changing proportions of people by mode from a given zone to others. This then becomes formally equivalent to a binary choice problem. Thus, if we observe that between zone a and zones b and c respectively the modal characteristics are

Zone Movement	Mode 1		Mode 2	
	Time	Cost	Time	Cost
a to b	50	30	30	50
a to c	30	20	20	10

and 50 percent take mode 1 in the first and 80 percent in the second, one has information that can be redrawn; for example, 5 trading such that 50t and 30c is preferred to 30t and 50c and 5 vice versa. One can describe the second as having 8 dominants and 2 illogicals. Supposing, then, indifference between the a-b and a-c options as objectives for travel, one can estimate over the combined set. It does not matter, of course, how many people there are in the zones; the information essentially comes

from the different modal time-cost proportions and the distribution over traders and the rest. Apart from difficulties of defining homogeneous sets, one supposes the potential useful observations to be quite limited. A recent application of this approach is commented on later.

A second approach takes one activity, say, work, and compares the relation between the distribution of interzonal trips and the time-cost characteristics of one or more modes constituting paths between zones. This necessarily introduces the notion of acceptance and rejection of attributes of the activity, for a willingness to make given zone-to-zone movement depends not only on the characteristics of the zone population and cost of time of the paths but also on the trade-off with utilities in the activity, which itself must be equally attractive apart from travel costs. Again, the data requirement rises.

An opportunity to standardize the activity arises where, for example, an important leisure-time target can be distinguished. An example by Mansfield (4) is the Lake District. If one assumes that, in respect to the Lake District's attributes, all populations are similarly distributed (they regard it for example as offering pleasures in equal measure), one can then seek to explain a differing incidence of trips made to it among populations according to the latter's differential expenditure of time and cost to reach it. Clearly, it helps if modes can be standardized across populations at the same time. (Mansfield necessarily considered car journeys only.) In terms of the levels of observations referred to earlier, one selects a given location for an activity and the same mode, but different routes.

If there are then differing proportions of times and costs in the trips made, one can infer time values from the relation between these and the propensity among the population to make trips. Reduced to its simplest form, the following gives the percentage of those making a trip from the zone to the objective, the time and cost, and the differences from each to the next nearest:

Zone	Percentage	Time	Cost	Differences		
				Percentage	Time	Cost
e	1	50	30	-50	+10	+ 5
d	2	40	25	-60	+ 5	- 5
c	5	35	30	-50	+15	+10
b	10	20	20	-16	+10	+ 5
a	12	10	15			
Avg				176	+40	+15

It is hypothesized that the average percentage difference, 176/4, is explained by the average time difference, 40/4, and the average cost difference, 15/4. Thus, the ratios of time and cost differences—here 40 and 15—are weighted by their contribution to the differences in trip-making to give an estimate of time value. This approach has the merit of providing potentially an estimate both of time values and of demand. It is close, indeed, to the Clawson method of estimating demand of a leisure activity (5). Given the value of time, it becomes possible to relate increasing use with decreasing total cost. From the point of view of time values, however, there are obvious difficulties. Opportunities for observation depend heavily on car journeys, with attendant cost difficulties. The number of observations, dependent on zones, are typically few. On the other hand, large zonal populations perhaps are more persuasive in terms of homogeneity. But the leisure objective must be conspicuous and plausibly unique. This limits observations useful for decomposing to find time values.

In summary, alternatives to direct observations of consumer choices pose very similar problems to those found with the traditional binary choice models. And they seem to encounter quite severe limitations of observations from the point of view of time valuation. Viewing the field, one cannot help regretting that authors have not sought to build more on work of their predecessors. Product differentiation seems to have been a main objective: Each new study seeks to innovate either in technique or

observations. Trying to replicate results with new data and to improve methods of estimation is thoroughly helpful, of course. What is not helpful emerges when one attempts to set up criteria for likely success. For example, if the division among traders, dominants, and illogicals is as important as the earlier arguments suggest, it would have been most useful to have known, in each study, their incidence and characteristics. If, through attention to the underlying limitations of inference from data, it were possible to improve comparability among studies, then it might become possible to recognize more clearly, by juxtaposition of studies, what value of time in the sense of opportunity cost is. This should be a common characteristic, and some tendency to approximate to a common value over all studies should emerge.

SOME RECENT VALUATIONS

Although we expect to find generally better or worse conditions for discovering time values, we must conclude that adopting any one partial approach involves trade-offs between requirements. Let us now review the findings of recent studies in the light of the discussion. An excellent start is given by Harrison and Quarmby (2). Further, there are the papers and proceedings of a 1970 value of time conference (6).

Let us first consider an alternative to binary choice models. Blackburn (6), in a nonlinear model of the demand for travel, developed a model to account for decisions to travel and choose mode in 20 California city-pair markets. There were 4 modes—air, car, bus, and rail—and 2 principal attributes of modes, time and cost, were estimated. A most sophisticated estimation procedure and heroic assumptions (e.g., about car costs) produced an estimated standard error of estimate of approximately the same size as the average and twice that of the median, estimated, values of time.

The disparity between average and median values is explained by Blackburn as due to the fact that the means (from $4.55 per hour for $2,000 income per capita, 1960 dollars, to $5.55 for $3,500) reflect the population as a whole, not merely those who travel. As he says, "Those individuals who would pay $20 to avoid an hour in transit do not travel." The implication is, of course, that attributes should be extended to include disutilities in travel: What was measured was not the "pure opportunity cost of time."

It is likely that this kind of study will always encounter great data difficulties. Quandt (6), in discussing the development of such models, says, "The most important improvement needed in data would be the creation of a reliable and highly disaggregated data base, preferably with information on a household level." If these were available, of course, other approaches become more feasible too. For urban areas, de Donnea (6, p. 176) fixes the difficulty with models proposing to use, for example, aggregate city-zone data when he remarks, "The most fundamental weakness of aggregate models is that only rough and average measures of transport system characteristics in each city zone can be included among the explicatory variables." Within-zone variance may easily swamp useful between-zone variations.

The objective of binary choice studies has been not necessarily to derive time values but often to predict more efficiently modal split, particularly between cars and public transport. As indicated earlier this can conflict. One wishes to distinguish values for components of time and not necessarily to constrain one's explanations to modes that are themselves unspecified aggregates of attributes. One essential problem with car-public transport choice is the overwhelming general superiority of the car. For many practical purposes, one probably would get useful and simple predictions of modal split by using time measures alone. Improvement in prediction in urban areas is probably as much a matter of securing more detailed measures of actual point-to-point times as complicating the explanations of reported alternatives by respondents. This is particularly true in planning entirely new modes, e.g., "travellators" to assist pedestrians. There, one needs only a simple behavioral notion—that people save time—but also a great deal of attention to the opportunities to save it. Cost and other variables are secondary.

However, as we saw earlier, there are great difficulties with using car data in any

case because of defining costs. Recent work has indeed stressed the great variation of time value results that are possible with different accounts of car costs (6, p. 204). No one has yet succeeded in stratifying for conditions to recognize varying opportunity costs; that respondents themselves vary greatly in car cost assessments is confirmed (7, 8). Because of car cost difficulties and the basic need to sample for situations in which traders can be found and balance between maxima and minima can be achieved, it is natural to look to urban studies depending chiefly on public transport alternatives or walking choices.

In such studies (2), a distinction emerges between values of time (meaning, though the authors' intentions are not always explicit, an opportunity cost of time) in studies of public transport and those of car-public transport choices. My own study and those of the Institute d'Amenagement d'Urbanisme de la Région Pariesienne (LAURP) and of Lee and Dalvi report estimates varying from 30 to 43 percent of the income of travelers. Studies by Quarmby and Stopher that report bus-car or public transport-car choices estimate a value of 20 to 25 percent. Studies that average overall modes by Local Government Operations Research Unit (LGORU) and by Barnett and Salman estimate a value of 20 to 25 percent for in-vehicle time and 14 to 33 percent varying with income respectively.

Since each of the studies involving cars chose an average car cost rather arbitrarily (best fit tests between different imputed values fail to discriminate cost very sharply, unsurprisingly), one might be inclined to opt for the higher values as more representative of opportunity cost of time because they avoided the difficulties.

But the studies obviously did not succeed in eliminating other mode-related utilities entirely. How serious is this? The LAURP study specifically measured for walking and waiting, finding that these factors had twice the effect on choice as did in-vehicle time. This effect has been confirmed elsewhere by Quarmby and by the LGORU studies. But the mere presence of walking and waiting in the public transport choice studies would not be sufficient to invalidate the estimates; there would have to be significantly measurable differences in proportions as between choices. And present work suggests this important element might well be waiting, not walking. Thus Veal's preliminary study (9) of leisure journeys (to libraries) involving, among other things, bus-walk choices indicates little difference between walking and in-vehicle values of time; on the other hand, it showed the familiar doubling of values of waiting. Waiting itself is, of course, normally a much smaller part of total commuter travel than walking and probably would not show up strongly. Veal's results (between 20 and 30 cents an hour, but the sample likely contains many low-income users of libraries) also seem to indicate a lower value of (in-vehicle) time than earlier public transport studies. So we are left, still, in doubt. But there is, a priori, reason to suppose that studies involving car choices cloud rather than clarify the issue.

A similar comment may be made in respect to another main issue: whether and to what extent "pure" values rise with income. We would expect some absolute rise, and perhaps the most plausible expectation is a value more than proportional to income (corrected for factors such as household dependents) of the respondent. Again there is a tendency for the answer to become less clear if car choices are involved, though public transport choice studies are certainly not unequivocal, and Quarmby's public transport-car study reported proportionality. Recent work by LGORU, refining earlier commuter studies (10), makes a very pertinent comment here, however. After arguing in general to confine valuations to what we call traders, the authors found that, when so confined, comparatively few observations in higher income groups remain: "In this situation, it would perhaps be surprising if any strong relationship (of values with income) were found" (10, p. 6). Since traders are necessary, we argue, to any successful estimation, judgment must again be suspended until more appropriate data are found and worked on.

A recent study, started in 1969 and still proceeding, has dealt with multiple mode choices facing travelers crossing the Solent (between Hampshire and the Isle of Wight in England); the choices are ferry, hovercraft, and hydrofoil, with or without cars. Data on alternative journeys were secured from a large sample of 3,342 passengers. From our earlier arguments, one can set up the circumstances in which one would ex-

pect reliable estimates of values of time. These would include a large incidence of regular users (so relying on those in a position to form realistic views of alternatives); responses such that passengers would not reject an alternative if faced in fact with the nonavailability of the preferred alternatives; respondents not involved in a car option; a large incidence of trading among alternatives; and among the latter a balance of acceptance and rejection of time savings. Unfortunately, the interim report so far available does not allow one to construct these numbers (11). But we learn from the report that only between 5 and 11 percent of respondents travel once a week or more, that between 2 and 7 percent of the total reporting alternatives are commuting, and that another 1 to 3 percent travel for education. Well over half the sample uses the modes once a year or less frequently. In these circumstances, it is perhaps not surprising that time values (calculated from models set up to explain modal choice) indicate "a range of between 15 and 858 p an hour." The authors remark, "Discriminate analysis should refine these values considerably." One may confidently predict that unless the underlying data turn out to be favorable in the sense we have described it will do nothing of the sort!

Perhaps the most significant recent study, from the point of view of promising to upset received ideas of the value of time, has been that by the Transport and Road Research Laboratory on choices made by motorists in Italy (12). This report states, "Only limited data were collected on income, but the indications are that in non-working time the overall average value of time per head is slightly above the average family income and that in working hours it is over double the average income." The relation between values in work and out of it is not unexpected, but the nonworking value of time derived from journey-to-work choices and other (leisure time) journeys, at double instead of 25 percent of wages or salaries, is no doubt a challenge to the accepted official practice and the more serious because it emanates from an official source. On inspection, however, it aptly illustrates many of the points we have made.

The study concerns autostrada and alternative route choices on trips to Rome and Milan. The number of answered questionnaires was high—more than 5,000. The study, though concerned with cars, was not confined to them; and the difficulties of car costs were avoided at least in part by the presence of an important cash outlay on the autostrada alternative—the toll. A sophisticated statistical approach to route choice (logit analysis) was run alongside a simpler approach derived from my own study. Let us appraise the study in the light of our implied "checklist" for studies.

First, homogeneity of the population for whom estimates were made was ensured chiefly by confining observation to Italian cars, carefully keeping controls on sampling proportions of interviewed to total traffic, and avoiding main holiday periods. These, combined with the closely paralleled choices (autostrada and ordinary roads often run close together), arguably provided the best yet reported means of deriving generalizations for populations.

Second, the choice of level of observation fulfilled the binary condition of plausibility in eliminating or controlling for demand elasticity much more for journeys to work than for others, which could range significantly up to journeys of 2 hours or more on which differences between alternatives could rise above 1 hour in time.

Third, cost problems were not entirely avoided. Costs were assumed only to vary between the toll on the autostrada and the free road. We are not given an estimate of total car costs with which to compare this; but these in any case would be highly suspect. Opportunity cost is more likely to be a problem in commuter studies. Gasoline and other outlays, insofar as they were wrongly omitted (and this is probably a very small blemish), would probably be higher on free roads and more certainly where these were urban. If included, they would tend to lower measured values, for time differences were unaffected.

Fourth, whether there were sufficient traders and whether they were distributed well between minima and maxima is difficult to tell because the study did not address these problems directly. One real difficulty is that it was assumed implicitly that there was no need to study possibly different attributes among the choices. This omission is conspicuous for the autostrada choices, which internal evidence confirms. Thus, for example, there were apparent illogicals. More important perhaps, a sample of mo-

torists were asked their reasons for choosing between the alternatives.

The most important difference with respect to the autostrada and the ordinary road seemed to be that the former was "more comfortable." Surprisingly large numbers claimed the ordinary road to be quicker than the autostrada. This perhaps throws some doubt on the identification of route choices and also indicates that an unknown, and perhaps large, item accounting for the high time values is the lessened disutility of travel by autostrada. It would, presumably, have been possible to test the hypothesis that values of time were lower by autostrada than by ordinary roads. However, even ignoring the question of the value of autostrada comfort, there is some evidence in the study of difficulty with the numbers of effective trader observations and their distribution between minima and maxima.

This study cannot, therefore, be said to conform to the requirements for a successful time valuation study. The last study to be noted here throws some light on the issue of the difference made to results by using simple or more sophisticated methods. This study (13) brought together data from several commuting studies and, among other things, compared in some detail the differences made to values of time estimates by using on the same data a discriminant or "limiting time value" approach. The latter is essentially the procedure in my earlier paper. It turns out that limiting the data set to traders makes a considerable difference to results and that, as one might expect from the points made earlier, formulating the problem as a choice between modes or estimating time values directly (via limiting time values or LTV) also shows great differences. Thus, according to the report (13, p. 15), "The inclusion or exclusion of non-trade-off individuals can have a considerable effect on the time values obtained from discriminant analysis and that by following the correct procedure of formulating a hypothesis about time values and examining the consistency of observed data with the hypothesis, not only is the best value of time less than that obtained by discriminant analysis, but also, perhaps surprisingly, the explanation of observed mode choice is improved."

For the authors "time value" means what was called earlier "opportunity cost of time." Values of time were very much higher for the discriminant form. This result, and that of improved mode-choice prediction, is derived from a model in which it is hypothesized that value of time is the same for all individuals; the model selects the value of time that best explains modal choice. One should perhaps not take the "better modal prediction" result too seriously, both because the difference in performance is very small and because it may in any case have been due to the particular form of LTV criterion to get the best values. (The criterion was the proportion of persons misclassified. This weights everyone equally: There is no a priori reason not to pay some attention to the degree to which persons are misclassified.) On the time value issue, however, there is little doubt of the difference. The authors summarize their evidence as showing that the best estimate of the value of total commuting time (from the LTV technique) is 0.63 an hour; they found little to support or refute the hypothesis that income is systematically related to time values. It is worth noting that the 0.63 is much closer to former ideas of values than was the TRRL study (12) emphasized above. [The authors also ran models of modal split from which the coefficients of walking and waiting compared with in-vehicle time were about 2:1, much as expected (13, p. 37).]

However, one cannot deny that the LGORU study still exhibits some of the typical difficulties we noted earlier. Thus, there are strong grounds for rejecting the notion that a very wide value of time is consistent with the reported results (13, Figs. 1, 2, and 3, p. 38). There was a marked imbalance in maxima and minima in the most used commuter data (13, Tables 9 and 11). Most of the estimates were performed on choices involving a car; doubtless car cost (not discussed) imported much noise. It is perhaps significant that the results that most clearly show considerable evidence of a limited range of time values are those for a subsample of 96 traders in London whose reported choice was bus-tube. Earlier arguments would strongly point to this choice being the best to observe in London because difficulties stemming from car costs are absent; the modes reported are the most widely used alternatives for commuting; and even modal differences, when considered in terms of total door-to-door journeys, might well be least for that pair of modes. [Six choices were reported: (a) bus-tube, (b) bus-rail,

(c) bus-car, (d) tube-rail, (e) tube-car, and (f) rail-car. No determinate value of time is discernible in b through f in the sense that, within the range of time values considered from 0.5 to 1.0, no one value gave fewest misclassifications (13, Table 7, p. 22). Those familiar with London will know that the most likely pair to eliminate relative disutility, tube-rail, is unfortunately not so widespread as bus-tube, and the sample, drawn at random, duly turned up with only half as many observations.]

CONCLUSIONS

A review of recent British studies on the value of time indicates that the established figures should not be abandoned without much more attention to the circumstances of the observations on which the studies were based. The apparent increase in variance of measured values has coincided with a shift toward much less favorable conditions for making useful observations and estimates. One cannot finally arbitrate the issue of whether to rely on the higher or the lower of the measured values now available until, among other things, the detailed incidence of actual and potential traders and their distribution between maxima and minima, any bias imported by car costs, and the implications of disaggregation of time savings or losses in binary choice have been investigated. There is a need to reduce the studies in common terms. Issues of estimation of values of time should be separated from those of modal choice. The authors of the LGORU study also stress the importance of using traders to estimate values of time. They point to 4 areas in which their use could now be directed: to measure values of component times, to develop measures of sensitivity, to apply the technique to existing data sets, and to observe individuals who make 2 choices involving respectively gains and losses of money against time (13, p. 16). These are indeed worthwhile pointers; but the argument of this paper is that the greatest payoff will be in intensive sampling where measurement conditions and opportunities are most favorable, and it is to the determination of these that we should devote our ingenuity.

REFERENCES

1. Evans, A. W. On the Theory of the Valuation and Allocation of Time. Scottish Journal of Political Economy, Feb. 1972.
2. Harrison, A. J., and Quarmby, D. A. The Value of Time in Transport Planning: A Review. Sixth Round Table, Economic Research Centre of the European Conference of Ministers of Transport, Paris, Oct. 1969.
3. Beesley, M. E. The Value of Time Spent Travelling: Some New Evidence. Economica, Vol. 32, May 1965; reprinted in Urban Transport: Studies in Economic Policy, Butterworth, London, 1973.
4. Mansfield, N. W. Recreational Trip Generation. Journal of Transport Economics and Policy, Vol. 3, No. 2, May 1969, pp. 152-164.
5. Clawson, J. M., and Knetsch, J. L. The Economics of Outdoor Recreation. 1966.
6. Time Research. Gt. Brit. Department of the Environment, Note 16, May 1970.
7. Lee, N., and Dalvi, Q. Variations in the Value of Travel Time: Further Analysis. Manchester Schools, pp. 192-193.
8. Planning the Journey to Work. Local Government Operations Research Unit, No. 73, Aug. 1970.
9. Veal, A. J. The Value of Time on Short Urban Leisure Trips: A Pilot Survey. Time Research, Gt. Brit. Department of the Environment, Note 27, April 1971.
10. Interim Report on Research Study on Value of Time. Gt. Brit. Department of the Environment, Oct. 1971.
11. Interim Report on Solent Travel Study. Time Research, Gt. Brit. Department of the Environment, Note 26, Sept. 1971.
12. Dawson, R. F. F., and Everall, P. E. The Value of Motorists Time: A Study in Italy. Gt. Brit. Transport and Road Research Laboratory, Rept. LR 420, 1972.
13. Modal Choice and the Value of Time. Local Government Operational Research Unit, March 1973.