Time in Transport: A Perverted Problem? Arguments for a Fresh Look at Time Utility Research and Its Application

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The way in which time is converted into money is becoming increasingly important in transportation planning. In particular, the pricing of time is becoming more and more decisive for the calculated profitability and realization of road projects. The general trend is toward more and more traffic but smaller and smaller individual time savings, although, as always, such savings are discrete in time and space. These and other circumstances create very real problems of pricing, especially in view of the aggregation problem. It is argued that the problems of aggregation are ignored in the application of, and maybe in, economic theory itself. Whether this assertion is wrong or right, it raises the all-important question of how robust a theory is with respect to deviations from the underlying constraints before the application of that theory collapses in terms of validity of the results. The impression is that in the application of the time utilization theory the effects of such deviations have been ignored, which makes much of the present use of time in transport both meaningless and misleading. Pertinent questions about research problems and bottlenecks for a credible practical application of time utilization theories are raised.

How important is the issue of time in transport? It has been well documented that for the average road project, 70 to 80 percent or more of the total benefits are attributed to the time savings of the project—that is, benefits are defined and delimited in standard cost-benefit analyses. In other words, the issue is all important. By the same token, it is all important how we treat time in transport.

The point of departure was curiosity about the behavioral justifications (guidelines for how to aggregate and price accordingly) for time savings in time and space. What started as curiosity became skepticism, not because of what was said, but mainly because of what was not said: the discussion of these problems was found to be practically nonexistent. Rather, the process of obtaining the kind of time values we really want should be regarded as a three-stage rocket that can function only if the stages are released in the correct order:

1. Measurement of time and time savings;
2. Aggregation, that is, adding together time and time savings; and
3. Valuation of time in monetary terms.

It is imperative to approach Problems 1 and 2 critically because the answers to these determine how Problem 3 can be confronted.

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The important question in relation to Problem 1, the measurement of time savings, is as follows: How large must a single savings be to be judged as significantly larger than 0 so that a person will make alternative use of it? In other words, should all savings below a certain limit (1 sec, 1 min, 10 min, 30 min, and 1 hr) be considered equal to 0 in practice, or should they be retained; what is the threshold value in different situations? (The problem of errors of measurement, which is important in itself, is disregarded, particularly when small time savings are concerned.)

Problem 2 comprises yet another dimension:

- What can be aggregated? Which assumptions are necessary to allow time savings, or rather their effects, to be aggregated in time and space under what rules of aggregation?
- Which threshold values are appropriate when the individual savings are to be aggregated into hours and days of work and person-labor hours, days, and years?

The perception is that Problems 1 and especially 2 generally are treated as nonproblems in economic theory and practice. It should not be necessary to separate the different phases as rigidly as is suggested here. On the contrary, problems relating to the functional measurement of aggregation of time cannot be seen independently of the problem of valuation in monetary terms. That is because ideally we would like to be able to put a shadow price on every individual, nonaggregated time savings, depending on such factors as the person involved, the amount of time saved, and the circumstances under which the time was saved. But again, the crucial question is the relevance of the willingness to pay that is possible to measure or that we are able to measure. Therefore, this three-stage rocket should be seen as just as much an educational and practical aid as a fundamentally new way of looking at things.

THE EYE OPENER

Geographers—even though they have a subject called time geography—have always stayed in the background and left the problem of time and time valuations to economists, planners, and engineers.

To me, as a geographer, the case of the Sollihøgda Road changed all this. There I happened to discover that the realization of a major transportation project was being decided by the arguments related to time and savings of time. This fact in itself was hardly a shock, but the discovery of the

reasons behind the conclusions certainly was a shock, professionally speaking.

In fairness to the consultants and the decision makers involved, it should be stressed that the road project in question is not unique; it just happened to be the one that caught my attention. Such projects are becoming more and more typical, both in character and in analytical approach. In addition the project is not especially negative in the sense that the consultant did a poor job. Moreover, the road project is not necessarily economically unprofitable.

Until 1991, about NOK 150 million (approximately U.S. $20 million) will have been invested in various improvements to the existing Sollihøgda-Vik road some 30 mi from Oslo, Norway. Operated as a toll road, the length of the highway will be reduced by 2.4 km.

The consultant prepared an impact analysis that took into consideration costs related to construction and maintenance; vehicles; time; and accidents and noise. Only the time component shall be discussed here. In any case there is no conceptual confusion involved in the calculations of the others.

The three subprojects represent a total shortening of about 2.4 km. As a result of the improved standard, the average speed may be increased from about 50 km/hr to about 60 km/hr. This results in a total time savings per automobile trip of some 5 min, including a stipulated loss of time of 20 sec for toll collection. The following quote from the consultant's report may serve as an example of how mechanistic assessments of the sensitivity of people's behavior to changes are (*3*, p.48, translated): "Estimations for the section Sønsterud-Rørvik have been made which show that income-maximizing toll money rated will be close to . . . , on the assumption that the old road is subject to restrictions corresponding to 2 minutes addition in traveling time."

As an example, one car (containing one person) commuting between Hønefoss and Oslo 250 days a year will represent an aggregate annual time savings of about 40 hr. For such journeys, the conversion rate for time is conventionally NOK 25.20/hr. On this road, the car would then, equally conventionally, represent an economic savings of about NOK 4/day and NOK 1,000/year. If this were a car at work, the price per hour would be NOK 95.50. In this case the savings would be about NOK 3,900/year.

In this project, the actual volume and structure of the traffic forecast gave an aggregated savings of about NOK 18.4 million/year, in which the aggregation process in essence was nothing, as usual, but a series of straightforward additions.

The main point of the impact analysis is that the time savings constitutes the major and decisive factor. Without the monetary value of time savings, the project would be defined as unprofitable. With the time savings, the project suddenly becomes very profitable, since the ratio between benefits and costs jumps from being less than the necessary value to indicate profitability to twice that value:

Item	Value
Construction costs (NOK, millions)	138.0
Net benefit per annum with time valuation (NOK, millions)	29.2
Net benefit per annum without time valuation (NOK, millions)	10.7
Benefit/costs ratio with time	0.21
Benefit/cost ratio without time	0.08
Minimum benefit/cost ratio for profitability	0.10

What kind of time savings are we in fact talking about in this case, and what rationale permits the aggregation procedure? Despite considerable uncertainty and variability, the answer may be on the order of 5 min per vehicle per trip, assuming that the trip is long enough to take advantage of the entire savings provided by the system. The monetary valuation of these savings follows the specifications of the *Norwegian Driving Cost Manual*. It is assumed that all individual savings can be added to hours and person-labor years and then converted into money using time-price criteria. These aggregates become large because there are many cars (assumed to be "cooperating" with a view to obtaining something productive from the "unproductive" individual savings). And the aggregates become so big that they change the projects from nonprofitable to profitable and therefore allow their implementation—a particularly important point in a situation involving planning and decision making.

Should this be considered an acceptable procedure, representing public interest? In other words, does the benefit side of the calculation represent money that is as "real" as that on the cost side undoubtedly is? Are we comparing comparable units?

MANUALS: THE NEWEST TESTAMENT?

All Norwegian discussions on road investments refer to the *Driving Cost Manual*, as is presumably the case in other countries (*4*). Earlier editions of this manual dating back to 1959 also seem to have held an important position, although perhaps not to the same extent as now. The reason for that is that time was not as crucial to investment decisions as it has become in later years. The influence of the manual today appears to be so great that a reference made to the driving cost manual in itself legitimates without further discussion the use of time in transport in one very specific manner. This makes it clear that it, and presumably equivalent manuals, has a very strong influence on cost/benefit analysis and subsequent decisions on road investment and "competing" transport investments. What is written there should therefore be assessed equally seriously.

If we consider the manual in relation to the three-stage rocket, that is, measurement, aggregation, and valuation in monetary terms, we find nothing about Problems 1 and 2. These problems are implicitly "solved" by not defining them as problems.

The Swedish "Effect Catalogue" (*5*) may be considered equivalent to the Norwegian manual. We find no discussion of Problems 1 and 2 in this book, but we find the same arguments and standards with respect to the pricing of time.

A Manual of User Benefit Analysis of Highways and Bus-Transit Improvements (*6*) is less absolute in its presentation. Although the aggregation problem is not explicitly discussed here either, small and large savings are at least evaluated against each other in fixing prices. Because a savings of 0 to 5 min is considered to be small, 5 to 15 min average, and over 15 min large, and the curves climb steeply after only 5 min, leveling off again at 15 min, we also run into Problem 1—the problem of errors of measurement—although unfortunately only implicitly. This handbook was critically evaluated a few years after it was published (*7*). This evaluation was

studied with one question in mind: Do the critics see as a problem the way the manual deals with time and time costs? The answer is a definite no.

If biblical texts are used axiomatically, it is the users who must be held accountable. But who should be blamed here? The users, the authors, or both? Both, of course. On the other hand, it is hard to blame a user, usually a consultant, too hard for misuse. An author must take the main responsibility for misuse by users of the manual. Misuse by the users should be considered as mainly de facto rather than intentional. An important reason for this point of view lies in the structure of the manual, which provides answers but virtually no assumptions or interpretative reservations concerning the application of these answers. However, in all fairness one must also presume that use is based on professional acceptance of the manuals, not on blind faith. Therefore, any blame should be shared, the more so as the years go by, without anyone challenging the underlying assumptions of the procedures and thus the procedures themselves.

VALIDITY OF CORE ARGUMENTS

How time in transport is applied in cost-benefit analyses is based on the economic welfare theory, that is, on the individual's maximization of benefits: the marginal value of time is the one the consumer is willing to pay for a marginal reduction in travel time (8–11).

On the basis of this theory there is a vast amount of literature on the subject of pricing time. This literature will not be discussed, except for the observation that there seems to be little willingness to consider alternatives to the classic assumptions about marginal utility, momentary consumption, free individual adjustment of working hours, and others. Beyond this, examples relating only to the initial point on the validity of the core of a theory, its central adjustment, in view of deviations from the assumptions that underpin this theory, will be referred to.

Fridstrøm (12, p.3) illustrates very well one of the behavioral inconsistencies of the economic time utilization theory, as he describes its dependence on growth for the theory to hold and the relationship between time, goods, and welfare in economic theory. Referring to this theory, he states that the individual's welfare consists of two components: (material) goods and time. Only the first component can grow in volume, the number of hours in a day of course being constant. Thus, the only way to increase welfare is to increase the consumption of goods, implying for instance that the only way to increase the welfare by x percent is by increasing the consumption by x percent. This obviously perverts the concept of welfare if we want welfare to imply well being or even happiness. And still, this is one of the fundamental prerequisites of the economic time utilization theory.

Heggie (13) supports in this example the view that there is an imbalance between theoretical refining and empirical calibration, that is, a disagreement between planning models and research models:

> The reasons for these disagreements are various. Important amongst them are that much recent research has concentrated on theoretical and statistical issues. Little substantive work has been done on the empirical ones. Indeed, theoretical developments have tended to outstrip the practitioner's ability to esti-

mate empirical coefficients. The main dispute over the appropriate value of travel time savings may thus be an empirical, rather than theoretical one.

The particular issue of different valuation of small versus greater time savings—without explicitly coupling it to any aggregation problem—has attracted considerable attention.

Gårder (14) has made an in-depth study of the valuation of short time periods. In that study he also conducted an interesting inquiry among several outstanding people in transportation research to determine whether a small savings involved a different valuation.

Expert	Yes	No
D. Solomon	X	
F. A. Haight		(X)
W. F. McFarland		X
T. Miller		X
M. Luger	X	
E. Hauer	X	
A. Timar	X	
J. Lawson	X	X
S. R. Jara-Diaz	X	
L. Needleman	X	

The results speak for themselves: confusion; this is in a context in which implications of the one choice or the other are staggering, considering the size of time savings that we most often must speak of nowadays.

The pioneers among time economists were aware of the aggregation problem, as the following quote from Harrison and Quarmby (15) shows. One can argue whether their suggestion for tackling the problem is the right one and whether, for instance, the behavioral link to their "marginal consumer" is solid enough. This is not in itself a problem, but a natural, necessary, and continual challenge. It is, however, a real problem that the discussion of aggregation and behavior never, as far as can be seen, came to fruition, but was in reality rejected. This is even more regrettable in view of the fact that Harrison and Quarmby (15, pp.183–185) acknowledged as much as 25 years ago that

> this problem (of size of time saving) is put in two basic forms: first, is one saving of ten minutes worth ten savings of one minute; and second, do savings under some given amount have any value at all. Before these questions can be tackled, some theory must be developed as to the way in which time savings are of value to people . . . It is not difficult to construct simple arithmetic examples which show the equivalence of the numerous small savings with the single large saving, but it is apparent that any argument for equivalence must depend heavily on the validity of the probability distribution assumed.

And it will soon be as long since Burenstam Linder (16, pp.115–116) wrote:

> It must not be overlooked that what we have stated here as to savings and time allocation are criteria of efficient behaviour and not necessarily propositions about actual behaviour. It may be advantageous to combine consumption goods and enjoyment time in certain proportions over the years. But from our discussion of decision-making by households, it should be clear that such an efficiency criterion is built on an assumption of perfect knowledge and zero information costs. In reality the situation is different. We must expect that people will not systematically try to estimate their future earnings. There is quite a widespread use of current earnings as an index of the future situation. In such a case, actual behaviour will differ from what would be efficient behaviour under perfect knowledge.

Carlstein et al. (*17*, p.4) put it like this in their well-known treatise on time geography: ". . . shows how the rope of continuity can become a hangman's noose if basic facts of life such as indivisibility are not taken note of."

Although the following quotation appears only to deal with the Level 3 problem, monetary valuation, it is equally related to Level 2 (*18*, p.250, translated)

> As a measure of the value of the time spent on a specific activity, it is reasonable to use the value of time used in the best alternative application. Here it is reasonable to use the person's salary as a measure. Economically, this will also be the correct measure of the value of time, under normal conditions.

When it comes to the rationale of adding together time savings, small or great, which are also discrete in time and space, I have yet to find a discussion that reflects that behaviorally defined marginals are not or do not need to be the same as mathematical marginals. It is definitely pertinent that discussions of the conditions for identity between such marginals should be on the agenda. After all, we are talking about "normal conditions" such as the following:

• Individuals act independently of one another, taking their environment for granted;
• Individual preferences are rational (mutually compatible) and constant; and
• The employee is free to decide his own working hours.

These conditions are nothing less than conditions that must be fulfilled for the theory to be applicable in the sense we are talking about here. Therefore we should not avoid a discussion of the behavioral realism of such assumptions and to which of these, and to what extent, the models are sensitive. For instance, how important is the quoted condition of freedom with regard to the conversion of time to money?

The behavioral content represents the bottleneck criterion in a situation in which money valuation and profitability are what the theory must justify. Therefore, how far has the theory of time utility been calibrated against empirical observation?

Why then is it so hard to find such discussions? One can only speculate that positive causes would be those that assume that problems of aggregation are being solved indirectly through proper measurements of the individual's willingness to pay. A negative cause would be, for instance, whether the analysis technique required linear aggregation, and this was contrary to one's own conviction of how they should be added together, and whether this conviction was allowed to yield to the formal demands of the technique in question.

The following quotation from Bates (*19*, p.15) is probably a very plausible explanation, unfortunately, for why methods and techniques should not become straightjackets for thought, but tools for thought: "The problem is that their application would lead to distortions of the CBA calculus . . .".

In today's standard procedures for aggregating time savings and transforming them into real money—to be weighted against the real money costs of the project in question—it is assumed that these two products are equivalent: 1 year × 1 person and ⅟₃₆₀ year × 360 persons.

My point of departure would be that in general they may be equal from the point of view of individuals, but not from the point of view of society. In other words the individual is selfish, and may not, will not, or cannot act in the same way as a private person as he does as a citizen. Thus, the aggregation of individual willingness to pay may not—maybe it usually does not—add up to what society as a whole should be willing or should prefer to pay for a given time savings, in view of the alternative use of that same money. Surely, this sort of schizophrenia is a well-recognized phenomenon. But it is also as surely not dealt with accordingly in practical application. And that is what matters here.

CONCLUDING REMARKS

This paper has been an attempt to point out some methodological problems regarding measurement, aggregation, and pricing of time savings, without regard to whether we are in a situation of strong traffic growth. Until now, the present and, it is argued, sometimes sloppy way of applying economic theory has with the greatest of ease made feasible almost any road project calculation. Because growth has been what it has been, there has been little need to check out the forecasts as such. But this situation is changing. Because of higher mobility levels in the before situation and because marginal traffic generated from the same project will be less than it used to be, the marginal willingness to pay must be expected to decrease (Figure 1). This is definitely adding to the pressure on the relevance of CBA procedures in general and on the relevance of time valuation procedures in particular.

Finally, the question is not whether time is important, but where, when, and how time in transport is important. It is not the critical use of time that is criticized, but its uncritical use. What is attempted is to bring back to the agenda a problem that has been defined as a nonproblem for too long. In terms of the three-stage structuring of the problem of time in transport, the neglect of Stages 1 and 2—the problems of measuring and aggregating—is particularly stressed.

Still, one has heard and will continue to hear that all the problems touched on here are well known. That may be so.
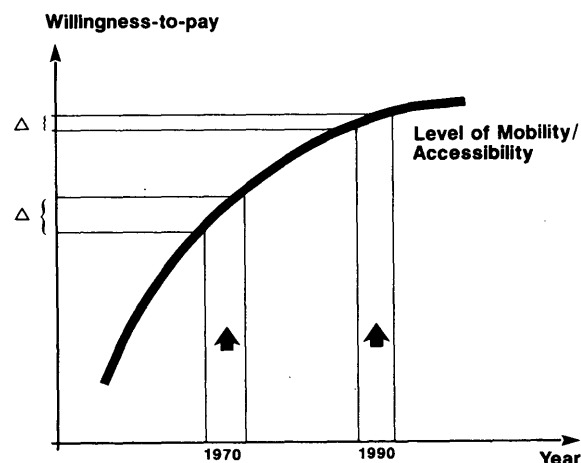

FIGURE 1 Variations over time in view of different preimpulse levels of mobility/accessibility: identical impulse–nonidentical effects.

However, this is not a very productive argument in the present situation, one characterized by an increasing lack of credibility: the feeling is that neither the individual user, as reflected in the failure of traffic forecasts, nor governmental decision makers, as reflected in their rejection of the recommendations of the cost-benefit analyses, believe any longer in what we are doing. Neither the individual nor the government behaves according to our findings on the value of time. In other words, we are not very good at unearthing the behavioral content of time savings. This general lack of credibility may be the best indication that something is wrong and that something must be done. In many ways, the utilization theory and the possibilities of applying it are found to be valuable but unused. The fact that there are no ready recipes for how to use this theory would be a matter to worry about only if one could not agree on the credibility diagnosis. Because if one could agree, it would be possible to find that receipe in only a matter of time and of that a very short time.

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