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The Value of Time In Economic Evaluation of Transport Projects

Lessons from Recent Research

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There are currently no general guidelines on the valuation of time, which is consequently often omitted in the economic evaluation of Bank transport projects. On the basis of a review of recent research this note suggests an appropriate approach where standard values are not available from government sources.

INTRODUCTION

Most OECD countries routinely impute value to travel time savings of transport projects using standard national conventions. In the UK, the Netherlands, and Finland, time savings account for 80% of the measured benefits of road projects. The national research studies on which the conventions are based show much similarity in level and structure of time values.

In contrast, Bank practice varies greatly, with time savings often omitted in the calculation of cost benefit rates of return.Click here to access a table of time values used in some recent Bank transport projects. Though HDM allows value to be attributed to time savings of car occupants and bus passengers, no default values are recommended. However, among non-OECD countries only Chile has

undertaken extensive studies of the value of time. This lack of local information has contributed to the reluctance to attribute value to time savings. This poses a problem for Bank evaluation of projects, particularly as the Chilean studies suggest that there may be substantial differences in travel time values between cultures (for example, the recommended value of time for the non-work journeys in Chile, particularly for inter-urban trips, is considerably higher as a proportion of household income than in the OECD studies). This note suggests an appropriate approach where local values are not available

THE CONCEPTUAL BASIS OF TIME VALUATION

The conceptual model underlying the valuation of travel time savings is one of consumer welfare maximization. It postulates that each individual maximizes the satisfaction or utility he gets by consuming and by engaging in leisure activities. Consumption of goods and leisure activities is constrained in two important ways.

- First, expenditure is limited by income which must be earned by devoting time to working.
- Second, work, leisure activities and travel compete for an amount of time available strictly limited by the number of hours in the day.

In allocating time between activities the individual must trade off the extra consumption that work earns against the foregone leisure which it requires. But he also has possibilities of extending the amount of working or leisure time available by spending extra money to save travel time. This may arise in the narrow context of choice between fast and expensive modes or routes and cheaper, slower alternatives or in the broader context of choices of activity or residential location. By analyzing the relative sensitivity of such choices to variations in money and time cost, the implicit value of time of decision makers can be identified.

This conceptual framework yields important insights into the nature of the value of travel time savings.

- Because working time produces goods which are a direct source of welfare it has a social value which is independent of the workers preference values.
- Since individual preferences vary so does the value of time; practical application will require some simplifying categorization.
- Since the value of non-work time would only equal the wage rate if individuals could freely choose how many hours to work and did not find work onerous, non-work time can only be valued empirically.
- Because activities and time are jointly consumed the value of a time saving will be related to the value of the activity with which it is associated.
- Because the value of time savings is a ratio between the marginal utilities of time and money it depends on the tightness of the budget constraint (and hence incomes) and the time constraint (and hence person type).

These preference structures can be identified in two main ways. *Revealed preference (RP)* analysis

estimates values of time which best explain actual observed choice behavior (for example choice between a fast expensive mode and a slow cheap mode). Conceptually this would appear to be the most realistic basis for study. In practice it tends to be expensive because many people really have little effective choice of travel alternative; at best only one decision can be analysed per respondent. It is also surprisingly uncertain because, even where there is a choice, direct evidence only exists on the alternative chosen and not on the alternative rejected.

Stated preference (SP) analysis overcomes the expense and clarity problems of RP by presenting hypothetical alternatives closely related to an activity currently being undertaken (for example, by interviewing people in the course of a journey). This can be done in a wide range of contexts offering alternatives designed to give numerous credible trade-off possibilities at little cost in a single experiment. This overcomes the limitation of RP analysis to situations where the number of "traders" is great and the nature of the trade obvious (mostly choice of mode for the journey to work and some choice between tolled and untolled routes). The British study of 1981-85 (ref. 1) was the first to make extensive use of SP methods in value of time studies. Most studies now use SP, though large programs often contain some RP work as a check and recent studies have shown RP to give slightly, but consistently, higher estimates of time values.

MAIN RESEARCH CONCLUSIONS

Relationship to income

The conceptual model of time valuation suggests that individuals' values of time will vary with the amount of both free time and the amount of money at their disposal. It has been customary to state all time values as proportions of either personal or household incomes. Recent studies showed values increasing with household income, but not proportionately. For example, the most recent Dutch studies implicitly showed the value of time for non-work travel varying from 39 percent of the earnings rate for the lowest group to 22 percent for the highest group (assuming 160 working hours per month). This exhibits an arc elasticity of 0.47, which is similar to the average elasticities found in the UK and slightly higher than that found in Sweden. Few countries have an equivalent research basis. In the absence of local evidence it is therefore recommended that the value of time saved should be expressed as a proportion of total household income (gross of tax).

Categories of journey

Work trips have usually been valued on the assumption that the value to an employer of the working time of employees must, at the margin, be equal to the wage rate, plus any extra costs directly associated with employment of labor (social security taxes, costs of uniform, etc). In the UK an "overhead" of just over a third of the wage rate is added. While high levels of unemployment might justify the use of shadow prices below the wage rate, it is recommended that working time saved should normally be valued at this "augmented" wage rate.

Business travel poses special problems. Many business travellers do not have fixed working hours so that it is difficult to know whether the time savings will be devoted to extra work or to more leisure. Furthermore, it is not always clear who makes the travel choice decisions and who incurs any increased money cost in choosing superior modes. A formula which includes the value of working time, corrected for the possibility that some work will be done during travel and the amount of time saving which accrues as extra leisure, suggested by Hensher, has proved somewhat difficult to calibrate. It is therefore recommended that business travel time should be treated in the same way as other working time savings.

Non-work trips have always been treated differently. If the wage rate recompenses people for giving up leisure, for the effort of the task, and for the special skills which they bring to the work task, then the value of leisure time differs from the wage rate by the sum of the last two elements (and will usually be less than the wage rate). In principle, the value may differ by journey purpose or timing. In practice, recent behavioral studies have not discerned significantly different values for different non-work journey purposes. It is therefore recommended that a common value of time be used for non-work journeys unless there is strong local evidence to the contrary with a default value of 30% of household income per hour being used for the valuation of non-work time.

Journey length, small time savings, gains and losses

Recent European studies have consistently shown unit values of time per minute to vary both between small and large savings and between gains and losses. For example, the unit value for car trips over 50 kms in Sweden was more than twice that for shorter journeys and that for other modes about 20 percent higher for long than short trips. UK and Dutch studies showed similar effects, particularly for business travellers. The unit value was also higher when the time saving was a large proportion of the base trip time.

The most troubling results are in the UK and Dutch studies which showed very small or zero unit values for very small time savings (<5 minutes), and greater unit values for time losses than time savings. As small time savings and losses comprise a large proportion of the effects in many projects, this would make the ERR dependent on the size of the project and would discourage sensible examination of projects on an incremental basis. However, these results may be an artifact of the research procedure as it is more difficult for respondents in SP experiments to imagine adjustment of activity patterns which would allow a small time saving to be put to beneficial use by activity rescheduling, than to see the immediate problems caused by a time loss on an existing tightly scheduled activity pattern. In the long run such savings are likely to be used (otherwise we should expect all individuals to be carrying increasing buffers of valueless unutilized "slack" in their schedules). Given also the practical difficulty of using any different convention it is recommended that the same unit values be attributed to time differences irrespective of the size or sign of the difference.

Walking and waiting time

Walk, wait and transfer times have usually been assigned higher values both in forecasting and

evaluation applications. The recent European studies still show transfer times and waiting times with values between one and a third and two times those of in-vehicle times. Chilean studies show an even higher ratio. Waiting in inclement conditions in Sweden predictably had a particularly high value. Although the most recent UK study did not show any difference between walking and in-vehicle time savings for commuters this was for car travellers for whom walking times were generally low. It is recommended that, where local evidence is not available, all "excess travel time" should be valued at a premium of 50 percent above the in-vehicle rate.

Time trends in the value of time

In most countries it is assumed that the value of time is directly proportional to income and hence that the attributed values of time should change over time in direct proportion to the change in income (in the UK the adjustment is made in proportion to real GDP per capita).

The value of non-working time is, in economic terms, a ratio of the marginal utility of time to the marginal utility of money, and hence is dependent on changes in income, changes in the opportunities for spending that income, changes in the amount of time disposable for leisure and changes in available leisure opportunities. *A priori* theorizing has yielded no conclusion on size or sign of the net effect on the value of time. Recent studies in the UK and The Netherlands suggest elasticities of VoT with respect to income of approximately 0.5. A study of the value of time in the UK in 1995 attempting to replicate an earlier study precisely also showed a result consistent with this value. However, given the limited evidence available, it is recommended that the value of time continue to be treated as increasing over time in proportion to GDP per capita unless there is local evidence to the contrary.

Distribution of time values and modally specific values

Recent studies show a wide distribution of individual time values for given income levels. Slower modes might thus be expected to attract those with lower values of time and faster modes to attract those with higher values. Empirical evidence confirms this hypothesis. For example, in-vehicle travel times (corrected for income, etc) were highest for high speed rail followed by air, car, inter-city train, regular train, long distance bus and local bus in that order. The highest value was double the lowest. Time savings for individuals attracted to an improved mode should be valued at the rate appropriate to the mode from which they are transferring.

Freight traffic time savings

Recent studies of value of time savings for freight vehicles in the US, UK, Denmark, Sweden, Norway, Netherlands, France and Germany have been of two broad types. The *factor cost method* involves identifying the components of vehicle costs which vary with the amount of elapsed time (mostly wages, interest on capital employed or tied up in inventory on wheels, and licensing fees). The *stated preference method* involves carefully customized studies of shippers choice, and might be expected to pick up additional, more subtle, sources of value such as the possibility of restructuring logistic systems as

transport performance improves.

Empirical results tend to confirm that expectation. For non-bulk road transport in the Netherlands, factor cost methods valued time savings at about $22-24 per truckload shipment per hour at 1995 prices compared with SP studies values of about $40 per shipment per hour. SP values for road haulage in Sweden and for rail freight in both the US and UK, all of which related mainly to long distance bulk transport, gave much lower values. In most Bank client countries there is inadequate evidence to substantiate the adoption of the higher values. It is therefore recommended that, in the absence of local evidence, the value of freight vehicle travel times should by calculated on the factor cost basis.

Bus and coach traffic

Bus and coach time savings can also be valued in the same two basic ways as freight traffic. As for freight, it is recommended that values of time savings per vehicle be compiled by summing savings of time variable operating costs, including the drivers time, and the value of passengers travel time savings.

Regional disparities and "equity values of time"

Values of time vary between regions within a country as a result of differences in wages and incomes. If these income related differences are reflected in the evaluation of investments, for which users do not pay directly, a vicious circle is created. High income areas yield high project returns, which attracts investment, which further increases income. This can be avoided by using national average wage rates for major categories of labor and applying national average income in valuing leisure time savings. It is recommended that such an "equity value of time" be used, especially where poverty alleviation or regional redistribution of income is a national objective.

Other relevant characteristics

A number of other personal, trip and ambient circumstances appear to affect personal time variations. Those with higher amounts of free time have lower values of time (retired people generally have lower values). Travel conditions have significant effects, with values of time savings in congested car driving situations having higher values than those in uncongested situations in both the UK and the Netherlands (this may reflect the value of reducing the variability of travel time as well as the unpleasantness of driving in congested conditions).

RECOMMENDATIONS FOR BANK PRACTICE

1. It is recommended that values of time savings, both for leisure and work, should always be considered in economic evaluation of projects.

2. For major projects demand analyses should be constructed in such a way as to make explicit the values of time implicit in forecasts. Stated preference experimentation is an economical way of doing

this, which clients consultants should be encouraged to employ. Special attention should be given to:

- modally specific values
- variation of values by journey length
- the relationship with income
- excess travel time (walking, waiting, transfer).

3. Where it is not possible to derive values locally the following bases should be used (note W = wage rate per hour; H = household income per hour):

Purpose	Rule	Value
Work trip	Cost to employer	1.33 w
Business	Cost to employer	1.33 w
Commuting and other non-work	Empirically observed value	0.3 H (adult) 0.15 H(child)
Walking/waiting	Empirically observed value	1.5 x value for trip purpose
Freight/public transport	Resource cost approach	Vehicle time cost + driver wage cost + occupants time

4. Where such "foreign" values are imported their general plausibility should be checked by reference to local expertise and experience.

TO LEARN MORE

1. MVA Consultancy et al. "The Value of Travel Time Savings." Policy Journals. Newbury, England. 1987.

2. Hensher, D.A. "The Value of Business Travel Time" Pergaman. Oxford. 1977

3. FONDECYT "Valor de tiempo para evuacion de proyectos" Pontificia Universidad Catolica de Chile, Departemento de Ingeneria de Transporte. Santiago, Octubre de 1994

4. Proceedings of an international conference on value of time estimation are to be published in 1997. Prior to publication, Bank staff can obtain copies of papers from Ken Gwilliam,, TWUTD

Transport Infrastructure Note OT-5: Value of Time Table

Year	Country	Motorcycle	Car	Pick-up	Bus	Truck	Rail	Project	Source
92	Venezuela		2.72	2.14	1.66			Urban Transport (Caracas only)	SAR
96	Uruguay	0.00	1.10	1.10	0.29	0.00		National Road Network Analysis (1996-99 Plan)	Govt Road Directorate Study
96	Ukraine				0.15			Urban Transport	SAR
93	Tunisia		1.07		0.48		0.48	Urban Transport II	PCR
83	Tunisia	0.33	0.33	0.33	0.33	0.33		Urban Transport II	SAR
75	Thailand	1.00	1.50		0.50			Bangkok Traffic Management	SAR
90	Sri Lanka	0.41	0.82		0.16	0.16		Colombo Urban Transport	SAR
91	Sierra Leone	0.00	0.00	0.00	0.00	0.00		Road Rehabilitation and Maintenance	SAR
93	St. Lucia		1.14	1.49	0.91	1.10			West Coast Road Study
94	Russia				0.35			Urban Transport	SAR
93	Perú	0.69	0.69	0.69	0.69	0.69	0.69	Transport Rehabilitation (Road Component)	SAR
95	Lebanon		1.72	2.59	1.24	0.00		National Roads	SAR
95	Latvia				1.80			Municipal Services Development (Riga UT component)	SAR
94	Korea (S)		2.57		1.70			Pusan Urban Transport Management	SAR
87	Korea (S)	$0.50 to $1.5 per passenger/hour for work-related trips						Kyonggi Regional Transport	SAR
84	Korea (S)		1.65		0.45	0.90		Seoul Urban Transportation	SAR
95	Kenya		1.24	0.24	0.24	0.00		Urban Infrastructure	SAR
93	Jordan		0.00					Transport III	SAR/Consultant Study
92	Jordan		0.00					Swaileh-Queen Alia International Airport Road	Consultant Feasibility Study
								Amman Transport and	

83	Jordan	1.26	1.26	1.26	1.26			Municipal Development	SAR
85	Indonesia		2.06	2.06	0.42			Regional Cities Urban Transport	SAR
96	India		1.00	0.00	0.75			Andra Pradesh State Highway	Project File Economic Evaluation
94	India	0.58	0.62		0.56 / 0.24	0.00		National Highway III	Consultant Study (N.D. Lea)
95	Hungary		**2.80**			**6.63**		Transport II (Highway component)	Borrower's evaluation summary
91	Honduras		0.60	0.60	0.14			Roads Rehabilitation & Maintenance	Government/Consultant Study
92	Guatemala		0.80	1.00	0.28			Roads Maintenance Program	Consultant Feasibility Study
95	Ghana		0.05	0.05	0.05	0.05		Highway Sector Investment Program	
96	Dominican Rep.		0.73	0.00	0.16	0.00		National Highway	SAR
81	Côte d'Ivoire	0.67	0.67	0.67	0.67	0.67		Urban II	SAR
95	Colombia		1.72		0.32	0.32		Bogota Urban Transport	SAR
96	China	0.12	0.12	0.12	0.12	0.12		Tianjin Urban Development and Environment	Consultant Feasibility Study
93	China	0.33	0.33	0.33	0.33	0.33		Shanghai Metropolitan Transport II	SAR
91	China	**bicycle=0.05**	**0.26**		**4.02**	**0.00**		Liaoning Urban Infrastructure	SAR
90	China	working time at $0.20/hr and non-paid time at $0.05/hr						Medium-Sized Cities Development	SAR
89	China	0.20	0.20	0.20	0.20	0.20		Shanghai Metropolitan Transport I	SAR
93	Chile		**5.97**	**8.31**	**30.89**	**4.48**		Road Sector III	SAR
93	Chile		**4.81**	**5.04**	**26.93**	**3.86**		Road Sector III	SAR (Draft?)
89	Chile		**2.17**	**2.55**	**14.40**	**2.40**		Road Sector II	SAR
85	Chile		**2.07**	**3.60**	**19.50**	**3.35**		Road Sector I	SAR
87	Cameroon		1.47		1.47			Urban II (Douala Infrastructure Component)	SAR
89	Burkina		0.63		0.63			Urban II	SAR
95	Brazil		4.46		1.28		0.78	Recife Metropolitan Transport Decentralization	SAR
79	Brazil		0.71		0.15		0.22	Urban Transport II (Porto Alegre)	SAR

93	Bangladesh		0.91	0.91	0.35	0.00		Jamuna Bridge	SAR
90	Bangladesh		0.57	0.43	0.23	0.23		Road Rehabilitation & Maintenance II	SAR
Note: where bold figures refer to $/vehicle/hour									

Crew Time Cost ($/hour/vehicle)

Year	Country	Car	Pick-up	Minibus	Bus	2-axle Truck	3-axle Truck	>3-axle Truck	Project	Source
92	Venezuela	1.39	1.39	1.39	1.39	1.39	1.39	1.39	Urban Transport (Caracas only)	SAR
93	Spain	0.00	42.29		21.14		25.36	22.86	Catalunya Highway Maintenance & Rehabilitation	Preliminary Study
91	Sierra Leone	0.00	0.00		0.47	0.47	0.47	0.47	Road Rehabilitation and Maintenance	SAR
93	St. Lucia	0.00	2.49	2.49		2.99	3.46	3.94		West Coast Road Study
93	Nigeria	0.00	0.25	0.25	1.41	0.47	0.47	0.98	Multi-State Roads II	SAR
87	Niger	0.00	1.05	1.05		1.73	1.73	2.79	National Transport investment Program	Government Report
94	Nepal	0.00	0.40		0.84	0.54			Road Maintenance and Rehabilitation	SAR
92	Mexico	1.33			3.87	1.67	3.33	3.33	Trunk Roads Network Maintenance Strategy	Government/Consultant Study
95	Lebanon	0.00	0.00		2.79	2.67	2.67	2.67	National Roads	SAR
95	Kenya	0.51	0.65		0.98	1.31	1.93		Urban Infrastructure	SAR
93	Jordan	0.00			1.02	1.81	1.81	1.81	Transport III	SAR/Consultant Study
92	Jordan	1.02	1.02	1.02	1.02	1.81	1.81	1.81	Swaileh-Queen Alia International Airport Road	Consultant Feasibility Study
96	India	0.40	0.00		1.80	1.80	1.80	0.00	Andra Pradesh State Highway	Project File Economic Evaluation
94	India	0.00	0.44		1.02	0.87	1.04	1.04	National Highway III	Consultant Study (N.D. Lea)
91	Honduras	0.00	0.39		0.96		0.96	1.35	Roads Rehabilitation & Maintenance	Government/Consultant Study

92	Guatemala	0.00	1.00	1.50	1.90	1.25	1.25	1.25	Roads Maintenance Program	Consultant Feasibility Study
95	Ghana	0.28	0.28		0.56	0.56	0.56	0.56	Highway Sector Investment Program	
96	Dominican Rep.	0.00	0.00		1.09	0.93	1.09	1.09	National Highway	SAR
93	Chile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Road Sector III	SAR
93	Chile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Road Sector III	SAR (Draft?)
89	Chile	0.00	1.00		3.00	1.20	1.80		Road Sector II	SAR
85	Chile	0.00	1.00		3.00	1.20	1.80		Road Sector I	SAR
87	Cameroon	5.52							Urban II (Douala Infrastructure Component)	SAR
94	Brazil	0.00	0.00		3.29	2.32	2.32	2.81	State Highway Management II	SAR
93	Bangladesh	0.00	0.00		0.84	0.70			Jamuna Bridge	SAR
90	Bangladesh	0.46	0.46	1.03	1.03	0.83	0.83	0.83	Road Rehabilitation & Maintenance II	SAR
94	Algeria	0.00	0.00		2.96	2.76	3.57	3.37	Highway VI	SAR

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