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THE VALUE OF TRAVEL TIME SAVINGS AND THE LINK WITH INCOME: IMPLICATIONS FOR PUBLIC PROJECT EVALUATION

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ABSTRACT: This paper summarises the link between the value of travel time savings (VTTS) and income levels found in various empirical studies. Most studies find that VTTS increases with income but less than proportionately. A square root relationship with household income relative to mean incomes is suggested as a useful approximation, although no theoretical support is offered. Actual project evaluations generally ignore changes in VTTS with income, i.e., government agencies follow an equity principle and value time the same for all users. But this results in an asymmetric treatment of benefits and costs. Benefit-cost studies normally do not make an income adjustment for monetary benefits and costs, but ignoring the link between incomes and VTTS means agencies *do* implicitly make an income adjustment for time savings. This could distort project ranking depending on the relative importance of time versus monetary benefits and costs, and/or the mix of income- and time-constrained travellers affected by the project.

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1. The Value of Time Savings in Relation to Income

The link between values of travel time savings (VTTS) and income levels is a recurrent question in the transport economics and project evaluation literature. There are three basic questions:

(1) does the value of time vary with levels of income?

(2) by how much?

(3) does this make any difference for project evaluation?

The first two are empirical questions. Different authors find different empirical links between VTTS and income. The third is partly a policy question: *should* differences in VTTS and income be taken into account in public project evaluation? Although theoretical and empirical evidence generally conclude that there is some link between VTTS and income levels, many government agencies are reluctant to recognise this and some explicitly reject such an adjustment on equity grounds. This results in an inconsistent treatment of time- and non-time-benefits (and/or costs) in public projects, hence could distort choices among government investments. This potential distortion is discussed following a brief review of the empirical links between VTTS and income levels.

VTTS and the Level of Income

There are some theoretical reasons for expecting the value of time savings to differ with income levels. Since time is fixed at 24 hours per day, rising wages imply increased opportunity cost of time, although more complex tradeoffs can be involved, e.g. greater use

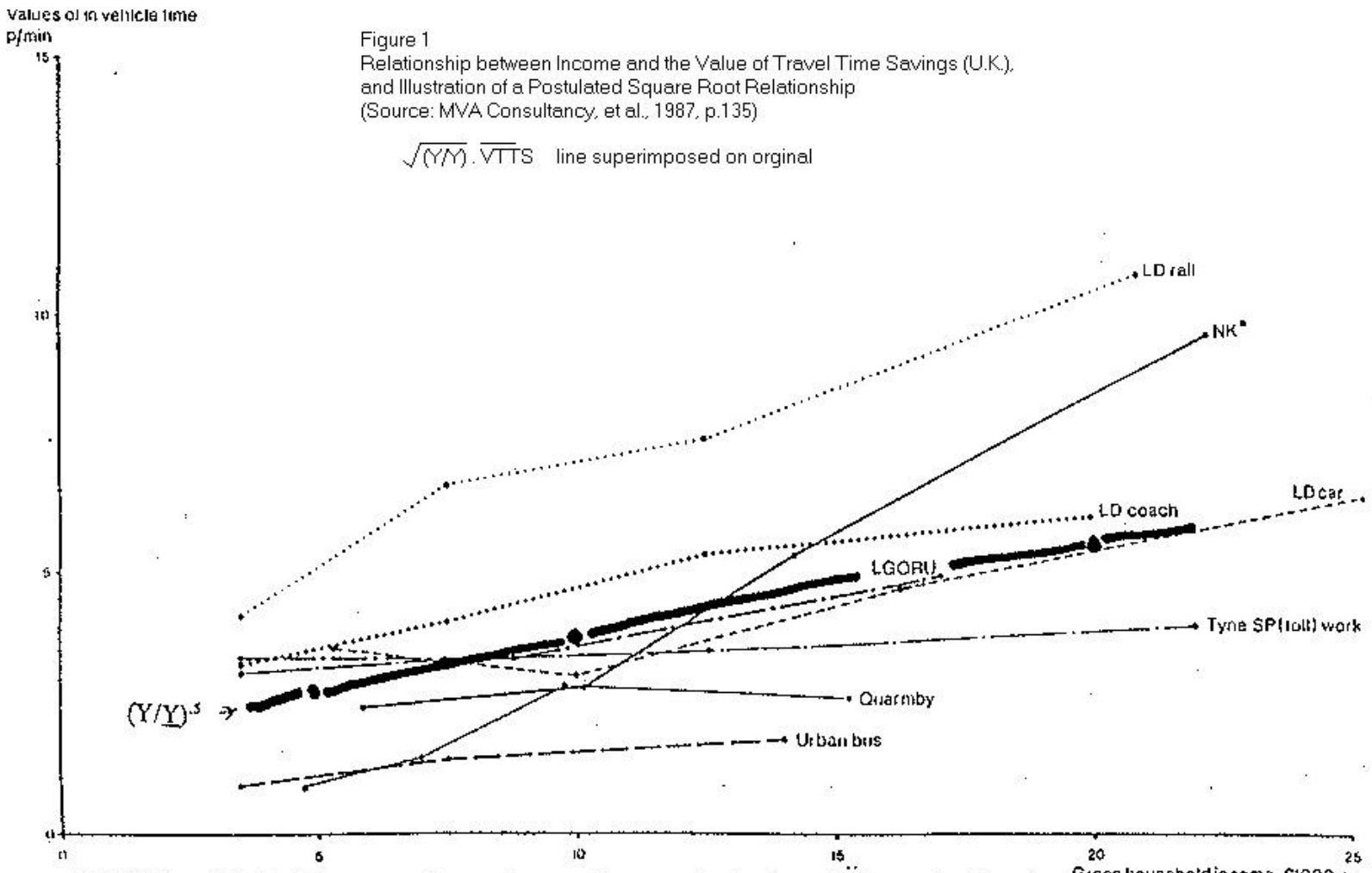
of time-saving devices are possible, the number of working hours can be reduced. Therefore theoretical guidance is not definitive, although one would expect a positive relationship particularly over large differences in income.

In comparing major income differences across countries or income groups, it is likely that their respective values of time will differ. But it is less obvious when comparing time values for people with similar cultural backgrounds and relatively modest differences in incomes. These are the relevant conditions facing most project evaluations in developed countries. Other variables affecting VTTS and/or trip or person characteristics could offset income differences. Nonetheless, most empirical studies which have investigated the value of time with income have concluded that there is a connection, although it is not necessarily a simple proportion.

Probably the most convincing recent major studies of the link between incomes and values of time are those done in the UK (MVA Consultancy et al. 1987).[1] The UK results are shown graphically in Figure 1. The UK results involved several studies which produced different results. Some studies showed sharper responses to income differences than in other studies, but there is a positive relationship in all the studies in Figure 1. All but one of these results show VTTS rising less than proportionately with income.[2]

Other studies over the years find differing links between VTTS and income levels. Stopher (1968) found VTTS increasing less than proportionately with income. Lisco (1967) found a more complex relationship: at first VTTS increases more rapidly than income but then less than proportionately thereafter. McDonald (1975) shows VTTS increasing with income in one of two models investigated; the increase appears less than proportional with income increases. Deacon and Sonstelie (1985) found VTTS to first fall and then rise as average income increased; the rise with income is less than proportionate. McFadden's (1974) results show low but positive correlation between VTTS and income. Thomas and Thompson (1970) found a more complex relationship: VTTS was approximately proportional to income but could be in greater or lesser proportions to income depending on the income class and size of time saving. Beesley (1965) and Mohring et al. (1987) show VTTS rising more than proportionately with income. Hau (1986) also shows VTTS increasing more than proportionately with income; however, he has only three income categories and he noted that higher income groups tended to travel greater distances, which could affect the imputed value of time savings. In contrast, Quarmby (1967) and Heggie (1976) did not find a link between incomes and values of time.

Figure 1
Relationship between Income and the Value of Travel Time Savings (U.K.),
and Illustration of a Postulated Square Root Relationship
(Source: MVA Consultancy, et al., 1987, p.135)



* abbreviations: NK is North Kent survey; *income is personal income rather than household income for NK study
LGORU is Local Government Operational Research Unit; LD is long distance; SP is stated preference.

A Square Root Relationship?

The evidence for a link between income levels and values of time is compelling, but the exact relationship is not so clear. Some judgement must be involved in recommending how to vary VTTS with income for particular situations. On balance, the evidence suggests that the VTTS increases but less than proportionately with income. One suggestion is advanced here and is illustrated by the dark line in Figure 1. It is an arbitrary choice of a formula, but it is relatively easy to work with and has a conservative rate of increase in the VTTS with income (Waters 1992). A $VTTS_Y$ which varies with income Y of the traveller can be written:

$$VTTS_Y = (Y/\overline{Y})^{0.5} \cdot \overline{VTTS} \quad \text{or} \quad \sqrt{(Y/\overline{Y})} \cdot \overline{VTTS}$$

where $\overline{Y}$ is the mean income level and $\overline{VTTS}$ is the VTTS for average income. This formula has the property that as income increases four-fold, the VTTS increases only twice. Similarly, for incomes which are only half of the average, the VTTS is 0.71 of that for average incomes, rather than 0.5. Figure 1 shows that this formula fits reasonably well, although note that it is an imposed formula and not fitted statistically.[3] There is no obvious theoretical reason for this relationship. Household characteristics probably change as income increases, e.g. differences in family size, stages in the life cycle, social class, etc. Ideally, these influences on VTTS would be modelled separately from income effects. But as an approximation of the link between household incomes and VTTS, this square root relationship looks promising.

Another issue in linking VTTS with income levels is the definition of income. The UK studies generally relate VTTS to household income rather than personal wage levels. The rationale is that household income may be the more relevant influence on time tradeoffs of an individual. Low income earners in a high income household will not be constrained by their personal income in making time-money tradeoffs; conversely, individual wage earners in large households do not necessarily have high discretionary income.[4] Unfortunately, many studies of VTTS are not clear on the definition of income used. Absolute estimates of VTTS might be compared to statistical average wages rather than incomes of those actually sampled. Studies which do include income in the data set often use personal incomes rather than household incomes. In brief, not only is there uncertainty about the links between VTTS and income, it is compounded by different concepts of income referred to in different

studies. The meaning of income must be scrutinised carefully to ensure comparability across studies.

2. Should the VTTS for Project Evaluation be Allowed to Vary with Income?

Despite evidence that values of time vary with income, this is often ignored in valuing time for urban and highway project evaluation. (It is common to use very different values of time for aviation projects than for land transport modes; more on this shortly). There are practical reasons for ignoring the relationship between income and values of time, as well as questions of principle. There are significant practical difficulties in working with time values which vary with income. It requires a level of detail for traffic flow data which almost never exists, i.e. it is rare to know income levels of travellers with accuracy, even if we agree on exactly how time values vary with income.

Another practical reason for ignoring variations in VTTS with income is that, in many cases, differences in income are not likely to matter much. Although the very lowest income groups might not have access to a car, most income groups in North America do. Thus the traffic on any given road is likely to include a wide cross-section of income levels. If so, use of uniform values of time might be reasonable.

However, there are situations where the differences can be substantial. Lawson (1989) notes the dilemma of comparing highway investments with aviation investments, where the differences in income and values of time can be substantial. There are both efficiency and equity issues involved. In terms of economic efficiency, there is greater willingness to pay (value of benefits to be gained) from aviation users. Not recognising this in public investment decisions is a move away from the efficient allocation of resources.

Ultimately, the choice of whether or not to incorporate an adjustment in the VTTS for income levels requires a public policy decision. There is accumulating evidence that the VTTS does differ with income levels. Because benefit-cost principles focus on the net benefits to society regardless of who gains and who loses, deviating from projects with highest net benefits because of who receives them reduces the overall level of wealth in the economy. The traditional textbook argument is that since there are separate policies to deal with income distributions, one does not need to constrain every project decision to adjust for all income distribution effects. The opposing concern is the possibility that government projects could, cumulatively, aggravate income distributions over time and not be corrected

by other government policies.[5] This is a possible but not necessary outcome; it is influenced by how projects are financed and what mix of projects are carried out over time.

Governments may be subject to popular political pressures to adopt evaluation criteria which are seen to be more egalitarian in nature. As a matter of principle, governments may elect to use a common value of time for project evaluation to avoid charges of favouring groups according to their wealth position. The UK government has maintained this policy for many years, and it was reaffirmed following the results of their review of valuation of travel time (Sharp 1988). New Zealand has followed the same policy.[6] Transport Canada (1990) has recommended this approach; they recommend a uniform value for non-work time for all transport projects including aviation. (They do recommend a higher value for work travel on airlines).

There is no definitive guideline for governments here, but this is an important issue with some troublesome implications. There is a pure economic efficiency case for incorporating different values of time with income. The marketplace responds to different willingness to pay, and efficiency principles call for a similar response by governments. But public investment decisions are also subject to political will which could conflict with efficiency considerations in this instance.

This leaves a troublesome issue in project evaluation as it has been practised. If we accept that VTTS does vary with income, then using a uniform VTTS in project evaluation is implicitly applying an income adjustment to this category of benefits (or costs). Consistent treatment requires that a similar income adjustment be applied to non-time benefits and costs.[7] Otherwise, this equity or income adjustment is being applied to only part of the benefits and costs of a project. This could distort project ranking depending on the relative importance of time versus direct monetary benefits and costs, and/or the mix of income- and time-constrained travellers affected by the project. Since the vast majority of transport benefit cost studies use uniform values of time and no income adjustment for other benefit and cost categories, this suggests that there is a potential inconsistency in valuation in practically every benefit-cost study which has been carried out. For projects with a random sample of different income groups, this probably will not matter (a uniform average value of time will give about the same results as one weighted by income groups). But in comparing projects across income groups, this inconsistent treatment of time and other benefit/cost categories could be important.

3. Conclusion

There is accumulating evidence that the VTTS varies by income level, although not necessarily in strict proportion. A relatively simple square root formula for an income adjustment is introduced. But it appears that government agencies tend to avoid such adjustments, presumably because of potential controversy over perceived equity issues. But strictly speaking, this means that standard practice in transport project appraisal is deviating from the economic efficiency criteria that provide the foundation of social benefit cost analysis. Of course, it is appropriate to incorporate non-efficiency objectives into project evaluation, but this appears to be an implicit rather than explicit decision. Further, it raises resource allocation questions across sectors of the economy where time benefits are compared with different types of benefits.

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Endnotes

1. MVA Consultancy et al. (1987); with some caveats, they conclude that they had: "clearly demonstrated the existence of an income relationship, ... [and] the value of time as a proportion of income is a decreasing function of income, rather than as a constant as has hitherto been assumed." (p. 134).

   Another important recent study which included analysis of the link between VTTS and income is the HFC Hague Consulting Group (1990), respectively. The Netherlands study found a slight increase in VTTS with income for business, commuting and "other" travel, with a significant jump in the VTTS for high income business travel (summarised in Bates and Glaister 1990).

2. In Exhibit 1, the Quarmby results (1967) show a flat relationship between VTTS and income, while the North Kent study (labelled NK in Exhibit 1) is expressed in relation to personal income rather than household income as used in all the other studies.

3. The square root relationship plotted in Figure 1 is calibrated for an assumed mean income level of £10,000. This was chosen so the line would lie apart from the empirical relationships plotted in Figure 1.

4. Heggie (1976) noted this possible explanation of the lack of correlation of values of time and income levels found in his sample of university employees.

5. Benefit cost analysis calculates benefits on the basis of *potential* compensation, i.e. those who gain can, in principle, compensate those who suffer so all parties can be better off. But compensation normally is not paid. Therefore, governments following benefit cost criteria could carry out a sequence of projects which benefited upper income groups at the expense of lower income groups, but because compensation was never paid, the net results would be to aggravate the distribution of income.

6. "In December 1990, ... the question of an equity value was put directly to the Transit New Zealand Authority. It was proposed that any variation in the VTTS arising from differences in income should be averaged out for evaluation purposes... This proposition was accepted by the Authority" (Travers Morgan et al. 1992, p. 41).

7. Adjusting benefits and costs for income levels has been proposed and applied. Foster (1968) proposed weighting benefits and costs by $Y/\underline{Y}$ where $\underline{Y}$ is the mean income; Nash, Pearce and Stanley (1975) proposed a weighting procedure of $(Y/\underline{Y})^b$ where b is the income elasticity of demand. For further discussion, see Nash and Pearce (1981), pp 31-33 and Pearce (1983).