VTT or VTTS: a note on terminology for value of travel time work

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Abstract

The value of travel time (VTT) can be said to be the most important number in transport economics, and its estimation has been the topic of extensive academic and applied work. Numerous papers use the term "value of travel time savings", or VTTS. The addition of the word "savings" has not arisen suddenly but goes back to the 1970s, and has also been used in the titles of national studies. The addition of 'savings' is in our view incorrect, misleading and unhelpful. Unlike money, time cannot be stored or borrowed – there is no piggy bank for spare minutes. In addition, the modelling approaches used for many of the more advanced VTT studies in fact produce valuations that are bracketed between gains and losses in time. It is then clear that the value obtained from this averaging cannot be described as the value of time savings, as it includes the higher value of losses as well. To add empirical weight to our theoretical points, we show how for the 2015 UK VTT study, using the bracketed value for commuters and labelling it as a VTTS implies an overestimation by a factor of more than 2.

Introduction

The value of travel time (VTT) can be said to be the most important number in transport economics, and its estimation has been the topic of extensive academic and applied work. An indication of the large number of studies is given by the fact that for their meta-analysis, Wardman et al. (2016) found 389 studies for Europe alone. A Scopus search in November 2017 finds 1,805 papers mentioning "value of travel time", or VTT, going back to 1971[i]. Of these, 936 use the term "value of travel time savings", or VTTS. The addition of the word "savings" has not arisen suddenly but again goes back to the 1970s, and has also been used in the titles of national studies, for example the recent UK (2015) and Swiss (2006) studies.

In general parlance, it is common to speak of 'spending' or 'saving' time, but this is not accurate. Unlike money, time cannot be stored or borrowed – there is no piggy bank for spare minutes. The most we can do is to transfer time from one activity to another, as has been pointed out in several studies (e.g. Truong and Hensher, 1985). In making such transfers, the value of time can be seen as having two components: one relating to the impact of a change in the amount of time on the total amount available to the individual, subject to the 24 hours/day constraint we all face – this has been called the resource value of time; the other component relates to the specific utility of the activity – this has been called the direct utility of time (cf. Jara-Díaz, 2007).

While the above points are well known to transport economists, the addition of 'savings' to the label is remains common practice[1]. It is in our view incorrect, misleading and unhelpful, as we shall try to demonstrate.

Applications of VTT

The primary application of VTT is in the appraisal of transport policy, including infrastructure investment. Here, the issue is not to study what time savings might be made (or time losses incurred, given increasing competition for network space), but to evaluate the time *differences* between alternative futures, which can be described as do-minimum, do-something, do-something-else etc.. In the period between the base year and the forecast years, individuals will lose and save time in multiple ways; they will also move house, change jobs, retire, start or leave school, set up new households etc., all of which will cause changes in their travel patterns and the time spent travelling. But these losses and savings are not relevant to the appraisal, which needs to focus on the differences between the scenarios, not on the path that is followed to get to them, and many of the losses and savings may be unrelated to the changes to the transport system.

The secondary application of VTT is in composing generalised cost for use in forecasting travel demand, in contexts where model estimation using local data is impractical or undesirable (e.g.

[1] Some studies have replaced the term "savings" by "reductions" and while this addresses the issue that time cannot be stored, the further objections raised in this note still apply.

WebTAG Unit M2, DfT 2017, see Section 5). Here there is even less argument that time savings can be identified and what is required is a marginal VTT that applies to each time component and all amounts of travel time.

In both of these applications it is necessary (for a number of reasons, well rehearsed elsewhere) and it is the practice of most governments to maintain a standard VTT (Daly et al., 2014) which applies to all amounts of time, even if these could clearly be labelled as savings or losses. Labelling the values as savings might even appear naïve, suggesting that the policy adopted will always yield a Pareto-optimal solution where nobody is worse off than in alternative scenarios.

In application, therefore, the notion of VTT savings does not arise. Moreover, the use of the term VTTS is misleading, giving the reader the impression that it is being applied to situations in which individuals gain time as a result of transport policy. While of course it is to be hoped that do-something will lead to better time outcomes for most travellers than do-minimum, these differences are not experienced by travellers and so time savings or losses are not relevant.

Behaviour of travellers and interpretation of model results

It has long been known (cf. Kahnemann and Tversky, 1979) that people attach more value to losses than to gains, the difference being known as the loss ratio. This effect may be entirely or partially short-term. Moreover, surveys conducted to investigate valuations may well enhance the loss ratio. Empirical evidence strongly supports the existence of such asymmetries. In a value of travel time context, the difference applies to gains and losses in both time and money, so that models need to account for these possibilities. Indeed, a model not allowing for these differences between gains and losses would produce a single value of travel time measure which could be interpreted as either the value of savings or losses.

Recent national studies in Denmark (Fosgerau et al., 2007) and the UK (Hess et al., 2017) have investigated travellers' valuations of time and money savings and losses relative to a *status quo* and find consistent significant impacts on the 'sign' of both time and cost differences, i.e. gains are less valuable than losses. Consistent with Hicksian appraisal, the monetary VTT is defined as the amount of money the traveller would pay or need to receive (e.g. in price reduction) to maintain indifference after a time saving or loss (respectively). Thus the monetary VTT of a saving, which compares a time gain with a cost loss, i.e. willingness to pay, is always lower than the VTT of a loss, i.e. willingness to accept, which compares a time loss with a cost saving[ii].

A key issue then arises in the use of results from such models. While earlier work such as Hess et al. (2008) reports both the willingness to pay for travel time reductions and the willingness to accept travel time increases in return for reduced cost, in practice, appraisal needs a single value, as discussed above. It is then necessary to calculate average VTT taking account of time and cost savings and losses .In practice, the geometric average of the gain value and the loss value is used; in recent national studies, the use of the de Borger & Fosgerau (2008) approach has become popular. This approach allows for asymmetry in the sensitivities to gains and losses for an attribute but can give a value function that is bracketed between these gains and losses. It is then clear that the value obtained from this averaging cannot be described as the value of time *savings*, as it includes the higher value of losses as well.

As an example of the potential for misrepresentation and misinterpretation, we re-calculated[iii] the results for the key valuations reported in the guidance for the 2015 UK value of time study (Arup et al., 2015). These official values are segmented by mode for employees' business trips, while mode free values are used for commute and other non-work trips. We used the results from the behavioural models reported by Hess et al. (2017) in terms of the asymmetry and non-linearity parameters, and contrast the resulting values for savings and losses to the bracketed values, where these averages are referred to as VTTS in the official government guidance. The results shown in Table 1 show very substantial differences between the value of savings and losses for some of the calculations (in the absence of asymmetry in the models, no difference arises for employees' business trips on other public transport modes). As an example, using the bracketed value for commuters and labelling it as a VTTS implies an overestimation by a factor of more than 2. Labelling the average as the value of either savings or losses can thus be very misleading.

Table 1: comparison between bracketed values and values for gains and losses for 2015 UK study (all in £/hr)

	bracketed value	value of savings	value of losses	bias if referring to VTT as VTTS
commuting (all modes)	11.21	5.32	24.75	110.70%
Employees' business (car)	16.74	12.02	23.31	39.27%
Employees' business (other PT)	8.33	8.33	8.33	0.00%
Employees' business (rail)	27.61	24.71	30.85	11.73%
Employees' business (all modes)	18.23	13.82	24.27	31.96%
other non-work (all modes)	5.12	3.25	8.13	57.16%

Summary

Monetary valuations of travel time are a key input to transport planning and appraisal and substantial academic and consultancy work has led to major improvements in the techniques used to derive these values. To maintain that vital interchange between transport research and practice, it is important that the insights from experts are taken on board and that the results are used and interpreted correctly. In this context, it is our strong view that the use of the term VTTS instead of VTT is incorrect. First, the value that is required is for time differences, and time cannot be "saved". Second, the label is misleading because state-of-the art estimations give an average value of time savings and time losses. Third, the term is unhelpful because it provokes a discussion which is not productive, introducing a number of difficult issues of appraisal methods, behaviour and survey responses which cannot easily be resolved. The term VTT is more accurate, less misleading and avoids opening unproductive discussions.

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Authors' contributions

A Daly: literature review and manuscript writing

S Hess: additional empirical work and manuscript writing

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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[i] The numbers would be higher if we also included studies using the term "value of time" as opposed to "value of travel time".

[ii] In the simplest terms, we have that $|\beta_{time\ increase}| \geq |\beta_{time\ reduction}|$ and $|\beta_{cost\ increase}| \geq |\beta_{cost\ reduction}|$, so that with $WTA = |\beta_{time\ increase}|/|\beta_{cost\ reduction}|$ and $WTP = |\beta_{time\ reduction}|/|\beta_{cost\ increase}|$, we see that $WTA \geq WTP$.

[iii] For the interested reader, these values are obtained as follows, based on Hess et al. (2016). We have that the value of a change in attribute x relative to a base value x_0 is given by $v(\Delta x) = S(\Delta x).\exp(\eta\, S(\Delta x)).|\Delta x|^{\alpha}$, where $\Delta x = x - x_0$, $\alpha = 1 - \beta - \gamma S(\Delta x)$, $S(\Delta x)$ is the sign of Δx, η gives the difference of gain value and loss value (with $\eta > 0$ showing that losses are valued more strongly than gains), β allows the impact of gains and losses to be non-linear and γ allows the non-linearity of value to be different for gains and losses. With θ giving the underlying VTT, we then have from Hess et al. (2016) that when taking the geometric mean of gains and losses, $VTT = \theta^{\kappa}|\Delta t|^{\kappa-1}$, where $\kappa = (1-\beta_t)/(1-\beta_c)$. On the other hand, if we look separately at gains and losses, then we have that VTTS=$\frac{\left(\exp(-\eta_T-\eta_C)|\theta\Delta T^-|^{\alpha_T^-}\right)^{\frac{1}{\alpha_C^+}}}{|\Delta t^-|}$ and VTTL=$\frac{\left(\exp(\eta_T+\eta_C)|\theta\Delta T^+|^{\alpha_T^+}\right)^{\frac{1}{\alpha_C^-}}}{|\Delta t^+|}$, where the + and – superscripts on ΔT and α_T and α_C reflect the different signs of changes.