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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, and an average between these gains and losses, typically the geometric mean, is then used as the VTT. It is then clear that the value obtained from this averaging cannot be described as the value of time savings (or reductions), as it includes the higher value of losses (i.e. increases) as well. To exemplify the magnitude of 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

Given current practice, 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[1]. 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[2]. 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 remains common practice. It is in our view incorrect, misleading and unhelpful, as we shall try to demonstrate. Some studies have replaced the term "savings" by "reductions" and while this addresses the issue that time cannot be stored (and we will generally use the latter term henceforth), the further objections raised in this note still apply.

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 reductions (gains for the traveller) might be made (or time increases incurred, i.e. losses for the traveller, 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,

[1] We acknowledge that the widespread use by governments of monetary valuations of time is not uncontroversial but this is not the topic of the present work, which takes its use as given and seeks to improve terminology and interpretation. Similarly, we do not discuss how VTT is used.

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

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

As discussed for example by Daly et al. (2014), in both of these applications it is necessary, and indeed the practice of most governments, to maintain a standard VTT, which applies to all amounts of time, even if these could clearly be labelled as gains or losses. Labelling the values as savings or reductions 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 or reductions 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 gains 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. If an analyst specifies a model that does not allow for these differences between gains and losses, the model would produce a single value of travel time measure, and it would then clearly be incorrect to interpret this as either the value of gains 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 gains 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[3].

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 an average VTT value taking account of time and cost gains 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, and the term "bracketed" has been used to refer to this value between gains and losses. 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 (or reductions or gains), as it includes the higher value of losses as well.

[3] 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 $WTA \geq WTP$.

As an example of the potential for misrepresentation and misinterpretation, we re-calculated[4] 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 produce values for gains (i.e. reductions in time) and losses (i.e. increases in time), as shown in the first two columns of Table 1. In line with many other studies, we see differences between the gains and losses, with losses in time having a higher monetary value than gains, with the exception of employees' business trips on other public transport modes. The interest for the present note lies in the geometric means[5] between these two valuations, where these averages are referred to as VTTS in the official government guidance (cf. Arup et al., 2015). It is clear that this interpretation implies a substantial bias for all cases where asymmetry exists between the gains and loss valuations, where, using the important case of commuters, using the bracketed value and referring to it as VTTS implies an overestimation by a factor of more than 2. Labelling the average as the value of either savings/reductions 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)

	value of gains	value of losses	bracketed value	bias if referring to VTT as VTTS
commuting (all modes)	5.32	24.75	11.21	110.7%
Employees' business (car)	12.02	23.31	16.74	39.3%
Employees' business (other PT)	8.33	8.33	8.33	0.0%
Employees' business (rail)	24.71	30.85	27.61	11.7%
Employees' business (all modes)	13.82	24.27	18.23	32.0%
other non-work (all modes)	3.25	8.13	5.12	57.2%

We are aware of discussions in which reference is made to the lower value of savings (compared with losses, and in particular the still lower apparent values of small time savings) to argue that lower values than the standard averages should be used for appraising new roads, for example. Since these discussions are conducted in a political arena, rather than in academic discussions, there is plenty of scope for misleading arguments to be made without space for proper refutation. It is better if the values that are used are not mislabelled, removing at least one support for such argumentation.

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

[4] For the interested reader, these values are obtained as follows, based on Hess et al. (2017). 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. (2017) 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 VTTG=$\frac{\left(\exp(-\eta_T-\eta_C)|\theta\Delta t^{-}|^{\alpha_t^{-}}\right)^{\frac{1}{\alpha_C^{+}}}}{|\Delta t^{-}|}$ 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.

[5] It should be noted that for the three valuations in Table 1 that are for "all modes", the presented bracketed value does not correspond to the geometric mean of the presented values of gains and losses. This is a result of the results being obtained as weighted averages across models for different modes. The bracketed value is in each case the weighted average of bracketed values from models for individual modes. The values for gains and losses we present are the weighted averages across models that would be used if using only the gains or losses value.

values. The work by these experts on improving the toolkit has the potential to lead to more reliable values used in practice. However, to do justice to this work and encourage further developments, it is important that the "users" of the methods describe, interpret and use the results in a way that is consistent with the underlying theory. In this context, it is our strong view that the use of the term VTTS instead of VTT is incorrect. We appreciate that the term VTTS is commonly used and understood by both academics and practitioners, as well as maybe the travelling population, but feel that this alone should not justify its continued use. We base this on three key arguments. First, the value that is required is for time differences, and time cannot be "saved", meaning that analysts should not talk about gains or reductions. Second, the label is misleading because state-of-the art estimations give an average value of time gains and time losses. Third, the term is unhelpful because it provokes a discussion which is not productive, introducing into the political arena a number of difficult technical 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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