Valuing travel time savings
A case of short-term or long term choices?

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Author(s):
Beck, Matthew J.; Hess, Stephane; Ojeda Cabral, Manuel; Dubernet, Ilka

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VALUING TRAVEL TIME SAVINGS: A CASE OF SHORT-TERM OR LONG TERM CHOICES?

Matthew J. Beck (corresponding author)
Institute for Transport and Logistics Studies, University of Sydney
378 Abercrombie Street, Darlington, Sydney, NSW 2008
Tel: +61 (02) 9114 1834; Email: matthew.beck@sydney.edu.au

Manuel Ojeda Cabral
Institute for Transport Studies, University of Leeds
30-40 University Rd, Leeds LS2 9JT
Tel: +44 (0) 783 473 8505; Email: m.a.ojedacabral@leeds.ac.uk

Ilka Ehreke
Institute for Transport Planning and Systems (IVT), ETH Zurich
Stefano-Franscini-Platz 5, CH-8093 Zurich
Tel: +41 (44) 633 3092; Email: ilka.ehreke@ivt.baug.ethz.ch

Stephane Hess
Institute for Transport Studies, University of Leeds
30-40 University Rd, Leeds LS2 9JT
Tel: +44 (0) 113 343 6611; Email: s.hess@its.leeds.ac.uk

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ABSTRACT

Most value of time studies make use of stated preference data framed around short term decisions such as route choice. However, except in the presence of toll roads, most travellers only have the ability to really trade time and money in a longer term setting, such as when changing residential or employment location. In this paper, we make use of a unique dataset which presented respondents with both short term and long term decisions. The former involved trading between travel time and travel cost, while the latter looked at changes in employment. We find substantial differences in the valuations coming out of these two types of experiments. In common with many other studies, we also see differences depending on whether willingness to accept or willingness to pay scenarios are presented in the short term settings, but we additionally note that the type of scenario shown in the short term choices has an impact on the valuations in the long term settings, which are always framed as a willingness to accept setting.

Keywords: value of travel time changes, commute, WTA-WTP, long-term choices, framing effects.
1. INTRODUCTION

Understanding commuting preferences and value of time for commuting is important as for many people, the commute trip is the most common trip that is made. For example, in Sydney, almost a quarter of all trips are made for commuting or work related purposes and on average represent the longest trip made (1). It is important to understand commuting behaviour, not least because commuting can have significant impacts on levels of happiness and anxiety (2) as well as physical health measures such as blood pressure (3) and heart disease (4). That said, there are also claims by some authors that commuting can be a source of positive utility, and that those with short commutes may desire one that is slightly longer (5).

The commuting patterns of males and females have also been compared and contrasted. It has been found that women tend to exhibit shorter commutes than men (6) and are more likely to use public transport (7). How dissonant people are with respect to their residential location has been shown to significantly influence commute mode choice behaviour, in particular those who are experience dissonance over living in an urban environment more likely to use the car compared to those whom are consonant (8). Attitudes also affect the choice of commute, for example (9) demonstrate the importance of a ‘personality measure’ on the commute mode choices of staff at the National University of Columbia. Despite these extant differences in the way in which individuals choose to commute, at an aggregate level the phenomenon of Marchetti’s Constant is worth noting; that is the seemingly innate “desire” of humans to travel at least some distance each day, with that distance being approximately one hour. This constant has held for many years, leading some to speculate that any improvements in travel time are “lost”, and the savings are simply spent by people so that they can travel longer distances (10).

Consequently, commute behaviour is a significant part of daily activity wherein people behave in many different ways. Thus, it is important to understand the values that people place on their commuting time given the role they play both with respect to health and economic activity. Better understanding how trips of this nature are valued will allow transport planners to better manage these trips. It is not surprising, then, that the value of time has been a subject of analysis for the past five decades, beginning with the work of 11) and built on by others (12) and (13). Value of time can be inferred from either revealed preference data where estimates are derived from the actual choices made by travellers (see for example 14, 15, 16 17), or from stated preference experiments where travellers are typically required to make choices between hypothetical choices that vary by both time and cost (see for example 18, 19, 20).

While each method has positives and negatives¹, many jurisdictions now use stated preference methods (see the reviews in 21, 22)

Most, if not all, value of time studies consider variations in short term decisions framing experiments around a situation where respondents are presented with variations to the travel

¹ Stated preference require respondents to make hypothetical choices which may not be the same as the corresponding real choices, while revealed preference data has f such as unknown choice alternatives, multi-collinearity and difficulty in isolating the effects of key attributes.
time and cost of a single trip. This in many instances is very different from real world situations where outside of toll roads there are few ways in which a commuter can readily vary the characteristics of their commute. On the other hand, it is perhaps more reasonable to assume that changes in commutes occur because of longer term decisions that people make such as where to work or where to live, thus experiments which vary trip characteristics in this context may reveal better insights into how people truly value the time spent commuting. In this paper, we examine for the first time the value of time measures in order to compare and contrast the values calculated on short term changes versus long term workplace and salary choices.

This paper makes use of stated preference experiment conducted in Sweden where commuters were asked to make trade-offs between commuting travel time and costs for either public transport (bus) or car use, but in particular all respondents were also given a choice experiment where they considered additional travel time for higher salary. This last choice set represents a novel approach to valuing travel time. A typical travel time experiment will require consumers to make choices which are more short term in nature; what route to take or what mode to use. Trading workplace location, however, represents a long term choice; it is a decision that is not made easily and cannot be changed quickly. This presents us with the unique opportunity of contrasting valuations in a short term and long term context, for the same respondent. We also gain insights into how valuations differ depending on whether people are presented scenarios involving an increase in time in return for a reduction in travel cost, or a reduction in time in return for an increase in cost.

The remainder of this paper is structured as follows; the next section outlines the survey used to collect the requisite data for analysis; this is followed by a discussion of the methods used to examine the short-term and long-term commute choices made by respondents; Section 4 outlines the results of the modelling before presenting final discussions and conclusions.

2. SURVEY DESCRIPTION

The case study used in this paper is an examination of salary and travel time trade-offs in the Stockholm region of Sweden (cf. 25). The sample consisted of dyadic households, wherein each member of the household provided information about their travel behaviour, in particular commuting.

Important for this paper is that the survey included a number of stated choice experiments, where respondents made choices between different trips which typically varied by travel time and travel costs, of which we will be using three.

The first of the three games we use was given to public transport users and presented choices via an unlabelled choice experiment where respondents were asked to choose between current commute conditions via public transport (current time via bus with an assumed cost of 600KR per for a monthly bus pass) and an alternative trip that varied in time, cost and frequency. Respondents could also indicate that they were indifferent between the two travel alternatives. An example of this choice task is shown in Figure 1. A respondent received four
choice tasks that either all involved a situation where the hypothetical trip was longer but cheaper (i.e. aimed at a willingness to accept increases in time) or where the hypothetical trip was shorter but more expensive (i.e. aimed at willingness to pay for reductions in time). In both settings, frequency of service was also varied against the current conditions; either “double” or half”. This was translated into headway for the analysis.

FIGURE 1  Example of public transport short term choice task

The second choice game was similar to the first, but was given to car users, with changes to the travel time and cost of car based trips and the inclusion of the number of speed cameras (instead of frequency of service). Again, half the respondents were presented with scenarios involving an increase in time while the other half were presented with reductions. In both formats, the speed camera attribute varied in addition (either 0 or 2 speed cameras) and respondents could again select an indifferent opt-out. An example of this choice task is shown in Figure 2.

FIGURE 2  Example of car short term choice task

The third and final choice task used in this paper involves choices which represent a longer term decision; variations in commute time and salary because of a change of workplace location. Like the two preceding games a status quo option was contrasted against an alternative that was always presented in a willingness to accept style; a commute that was longer by 10 or 25 minutes for a monthly salary that was higher by either 500KR or 1000KR.
Once again, an indifferent opt-out was also presented as a third alternative. An example of this choice task is shown in Figure 3, where the same format was used for car travellers and public transport users.

![Figure 3 Example of long term choice task](image)

Each of the three choice experiments presented respondents with four choice tasks per experiment. In our analysis only respondents who commute via car or bus only are used. Those who commute via public transport receive choice experiments one (public transport) and three (workplace location), whereas those who use the car receive choice experiments two (car) and three (workplace locations).

3. METHODOLOGY

We first look at the specification of $U_{1nt}$ and $U_{2nt}$, i.e. the utilities for alternatives 1 and 2, as faced by respondent $n$ in choice situation $t$, where the specification differs across games and across modes. For the short term game for public transport, we write

$$U_{jnt} = \mu \left( tc_{jnt} + \left( \frac{inc_n}{30} \right)^{\lambda_{inc}} \left( e^{a_{ln(WTP_t)}} + b_{ln(WTP_t)} \xi_{1nt} \cdot tt_{jnt} \cdot \left( \frac{tt_n}{35} \right)^{\lambda_{tt}} + e^{a_{ln(WTP_h)}} + b_{ln(WTP_h)} \xi_{2nt} \cdot hw_{jnt} \right) \right),$$

where $tc_{jnt}$ is the travel cost for alternative $j$ in choice task $t$ for respondent $n$, and $tt_{jnt}$ and $hw_{jnt}$ are the corresponding values for the travel time and headway attributes, respectively. The attributes $inc_n$ and $tt_n$ refer to the income and reference trip travel time for respondent $n$, respectively. We allow the willingness to pay (WTP) for travel time and headway changes to vary randomly across respondents, where we use a log-uniform distribution. In this context, $\xi_{1nt}$ and $\xi_{2nt}$ are random variates that follow a uniform distribution between 0 and 1 across respondents, and $a_{ln(WTP_t)}$ and $b_{ln(WTP_t)}$ are the bound and range parameters for the uniformly distributed logarithm of the VTT, with a corresponding definition for $a_{ln(WTP_h)}$ and $b_{ln(WTP_h)}$ in the context of headway. We did not find additional scale heterogeneity, such that the parameter $\mu$ is a simple scalar, while $\lambda_{inc}$ gives the income elasticity on the WTP measures and $\lambda_{tt}$ the elasticity of the VTT in relation to current travel time. The two
denominators simply ensure that the base valuations are for a respondent earning SEK30,000 per year, with a reference commute trip of 35 minutes.

For the short term game for car, the specification only changes for one attribute, with

\[ U_{jn} = \mu \left( tc_{jn} + \left( \frac{inc_{jn}}{30} \right)^{\lambda_{tc}} e^{\alpha_{inc}(\text{WTP}_t + \beta_{inc}(\text{WTP}_t))t_{n}} + e^{\alpha_{inc}(\text{spcam}) + \beta_{inc}(\text{spcam})s_{n}} \right), \]

where we replace headway with speed cameras (spcam).

Finally, for the long term game, we have:

\[ U_{jn} = \mu \left( inc_{jn} - e^{\alpha_{inc}(\text{WTP}_t \cdot t_{jn})} + e^{\alpha_{inc}(\text{WTP}_t \cdot t_{jn})} \right), \]

where \( inc_{jn} \) is now the income presented for alternative \( j \) in choice task \( t \) for respondent \( n \).

The sign reversal on the distribution for the VTT is simply a result of the fact that income (a positive attribute) has replaced travel cost (a negative attribute).

Given the inclusion of an indifference alternative, the use of a standard random utility model such as MNL is not appropriate (23). With an interest in monetary valuations, the use of a random regret specification as advocated by . (23) is however also not appropriate. We instead rely on an ordered logit specification, where the indifference option is chosen when the difference in utilities between the two hypothetical options is small.

We then define \( dU_{nt} = U_{1nt} - U_{2nt} \) to be the difference in utility between the two alternatives. In an ordered logit framework, alternative 1 would be chosen if \( dU_{nt} \) is greater than \( \tau_2 \), alternative 2 would be chosen if \( dU_{nt} \) is less than \( \tau_1 \), and the indifference option is chosen if \( dU_{nt} \) is in between \( \tau_1 \) and \( \tau_2 \). The two threshold parameters are to be estimated alongside the other model parameters. In particular, with \( \delta_{jn} \) being 1 if alternative \( j \) is chosen by respondent \( n \) in choice task \( t \), and with the indifference option being coded as alternative 3, the likelihood of the observed choices for respondent \( n \) is given by:

\[ L_n = \delta_{jn} \prod_{t=1}^{4} \left( (1 - e^{\frac{\alpha_1 \cdot dU_{nt}}{1 + e^{\alpha_2 \cdot dU_{nt}}}} + \delta_{2nt} \left( e^{\frac{\alpha_2 \cdot dU_{nt}}{1 + e^{\alpha_1 \cdot dU_{nt}}}} - e^{\frac{\alpha_1 \cdot dU_{nt}}{1 + e^{\alpha_2 \cdot dU_{nt}}}} \right) \right) f(\xi_1, \xi_2) d\xi_1 d\xi_2. \]

where \( f(\xi_1, \xi_2) \) is a bivariate standard uniform distribution. We approximate this integral using numerical simulation, with 200 Halton draws used per random parameter and per individual (24).
4. RESULTS

The final sample included 1,285 respondents who use only public transport and 1,241 respondents who use only car. The characteristics of each sample are described in Table 1. Car commuters have longer commutes, are older, more likely to be male, earn higher incomes and are less likely to have a university education.

<table>
<thead>
<tr>
<th>TABLE 1 Characteristics of Public Transport and Car Commuters</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Gender</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Income/Mth (pre-tax)</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Education - No University</strong></td>
</tr>
<tr>
<td><strong>Education - University</strong></td>
</tr>
<tr>
<td><strong>Commute - Less than 20min</strong></td>
</tr>
<tr>
<td><strong>Commute - 20 to 40 min</strong></td>
</tr>
<tr>
<td><strong>Commute - More than 40 min</strong></td>
</tr>
</tbody>
</table>

As described earlier, different groups of respondents saw different types of choice tasks. For public transport, 643 respondents completed willingness to accept style choice experiments where they traded increased travel times for public transport in exchange for short term monetary gains, 642 respondents completed willingness to pay style experiments where they traded reduced times for increases in short term costs. For car commuters, 619 respondents completed willingness to accept experiments (increased commute times) and 622 completed willingness to pay tasks (reduced travel times). The characteristics of each of these sub-samples are displayed in Table 2. Outside of gender, differences between the samples are marginal. In the estimation of the value of time models, we tested for gender effects but none were significant, meaning that any differences uncovered later in the calculated values of time are more likely a result of the way in which respondents perceive the experiments.
All of the models produce good fits suggesting that the modelling of the choice as an ordered logit better captures the choice behaviour where respondents are indifferent. Examining the short-term games, in the willingness to accept style questions for both public transport and car, the threshold parameters ($\tau$) are significant and positive indicating that all else being equal, respondents have a preference for moving away from the status quo alternative. On the other hand, in the willingness to pay style questions, these parameters are significant and negative indicating that the status quo would be preferred. This result suggests that there may be some effect on choices depending on the way they are framed. Albeit to a lesser extent, the same pattern emerges in the long term choices based on whether they saw a WTP or WTA question in the short term games; suggesting that this potential effect carries over to subsequent games, even though these games were all willingness to accept experiments.

The parameters which indicate the range of the underlying uniform distributions ($b$) are all significant (with the exception of speed cameras in the WTP game) indicating that there is significant heterogeneity in preferences of respondents. The elasticity parameters ($\lambda$) for income are significant and positive in all instances, indicating that as income increases the respondents value of time also increases, i.e. their marginal utility of money decreases. For the travel time elasticity, however, there is a mix of results. For the public transport WTA games this parameter is not significant (but negative) indicating that values of time do not differ based on the length of the commute for these respondents. On the other hand the parameter is significant and positive, among respondents who were presented with a WTP series of choice tasks. Among car commuters the elasticity is significant and negative in the case of the WTA choices indicating that as the base travel time increases among these respondents the sensitivity to further time increases diminishes. Though marginally significant, the parameter is positive in the context of WTP choices indicating the opposite; as base travel time rises, the sensitivity to reductions increases.
TABLE 3 Results from the Value of Time Experiments

<table>
<thead>
<tr>
<th>Public Transport Commuters</th>
<th>Car Commuters</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Increased commute time in short term game</strong></td>
<td><strong>Reduced commute time in short term game</strong></td>
</tr>
<tr>
<td><strong>Respondents</strong></td>
<td><strong>Respondents</strong></td>
</tr>
<tr>
<td>643</td>
<td>619</td>
</tr>
<tr>
<td><strong>Choice Obs</strong></td>
<td><strong>Choice Obs</strong></td>
</tr>
<tr>
<td>2,572</td>
<td>2,476</td>
</tr>
<tr>
<td><strong>Short term game results</strong></td>
<td><strong>Short term game results</strong></td>
</tr>
<tr>
<td><strong>Log-likelihood</strong></td>
<td>-1,541.86</td>
</tr>
<tr>
<td><strong>Adjusted $\rho$</strong></td>
<td>0.45</td>
</tr>
<tr>
<td><strong>$\beta_1$</strong></td>
<td>-3.3653</td>
</tr>
<tr>
<td><strong>$\beta_2$</strong></td>
<td>2.3418</td>
</tr>
<tr>
<td><strong>$\mu$</strong></td>
<td>-3.9958</td>
</tr>
<tr>
<td><strong>$\lambda_{inc}$</strong></td>
<td>-0.6401</td>
</tr>
<tr>
<td><strong>$\lambda_{tt}$</strong></td>
<td>-0.0635</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>208.03</td>
</tr>
<tr>
<td><strong>Sdev</strong></td>
<td>134.83</td>
</tr>
<tr>
<td><strong>VTH (kr/hr), assuming 20 return trips per month</strong></td>
<td><strong>VTH (kr/hr), assuming 20 return trips per month</strong></td>
</tr>
<tr>
<td><strong>Long term game results</strong></td>
<td><strong>Long term game results</strong></td>
</tr>
<tr>
<td><strong>Log-likelihood</strong></td>
<td>-1,425.76</td>
</tr>
<tr>
<td><strong>Adjusted $\rho$</strong></td>
<td>0.49</td>
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<tr>
<td><strong>$\beta_1$</strong></td>
<td>-3.0799</td>
</tr>
<tr>
<td><strong>$\beta_2$</strong></td>
<td>1.4822</td>
</tr>
<tr>
<td><strong>$\mu$</strong></td>
<td>4.3401</td>
</tr>
<tr>
<td><strong>$\tau_1$</strong></td>
<td>1.0265</td>
</tr>
<tr>
<td><strong>$\tau_2$</strong></td>
<td>1.6024</td>
</tr>
<tr>
<td><strong>$\lambda_{inc}$</strong></td>
<td>0.3303</td>
</tr>
<tr>
<td><strong>$\lambda_{tt}$</strong></td>
<td>-0.0381</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>158.28</td>
</tr>
<tr>
<td><strong>Sdev</strong></td>
<td>66.53</td>
</tr>
<tr>
<td><strong>VTH (kr/hr), assuming 20 return trips per month</strong></td>
<td><strong>VTH (kr/hr), assuming 20 return trips per month</strong></td>
</tr>
<tr>
<td><strong>VTH (kr/hr), assuming 20 return trips per month</strong></td>
<td><strong>VTH (kr/hr), assuming 20 return trips per month</strong></td>
</tr>
<tr>
<td>157.79</td>
<td>2,476</td>
</tr>
<tr>
<td>91.13</td>
<td>2,488</td>
</tr>
<tr>
<td>150.06</td>
<td>2,488</td>
</tr>
<tr>
<td><strong>VTH (kr/hr), assuming 20 return trips per month</strong></td>
<td><strong>VTH (kr/hr), assuming 20 return trips per month</strong></td>
</tr>
</tbody>
</table>
Looking at the value of travel time, we first observe major differences between the valuations obtained in games presenting an increase in time from the reference trip to those presenting a reduction. Indeed, the former always lead to a higher VTT measure than the latter. This is the result of respondent having a lower marginal utility for reductions in cost (which would accompany time increases) than their disutility for increases (which would accompany time reductions), along with possible asymmetries in time sensitivities. These differences are especially large for public transport (a factor of around 7:1, compared to less than 2:1 for car). These effects are also reflected in the differences for the headway and speed camera valuations between the two samples, supporting the notion that cost sensitivity asymmetries are the prime source for the differences.

Looking at the contrasts between short term and long term, it is instructive to compare the values from the short term games involving an increase in time from the reference trip with the long term ones, which also presented an increase. In the context of the public transport games when comparing the implied monetary valuation of travel time increases respondents require a greater financial compensation in the short-term games than in the long-term games (208.03Kr versus 158.28Kr and 135.65Kr) while for car the opposite applies (110.51Kr versus 141.91Kr and 131.57Kr).

Finally, it is interesting to note also that for those respondents who received scenarios involving a time increase (in return for a cost reduction) in the short term game show a higher VTT measure in the long term game (i.e. a higher willingness to accept time increases), across both modes. While these differences are relatively small, it nevertheless suggests some carry-over across experiments.

5. DISCUSSION AND CONCLUDING REMARKS

In this paper, the objective was to estimate the value of travel time across a range of different elicitation approaches. We examined choices derived from willingness to pay style questions where trade-offs were between time reductions versus cost increases and those from willingness to accept style choices where travel time increases were traded against reductions in the cost of travel. We also compared these choices (which are more short-term, such as different routes for a single trip) to value of time experiments framed more in the long term by asking respondents to consider a change in workplace location that necessitated longer travel times for an increased salary. Our analysis revealed a number of interesting, and often starkly contrasting results.

Firstly, it is interesting to note that the threshold parameters derived in the short-term games are seemingly dependent on the type of experiment that each respondent experienced, specifically that in willingness to pay choice experiments there is a ceteris paribus preference for the status quo alternative, whereas in the willingness to accept experiments the thresholds indicate that the alternative travel option is preferred over the current trip. This behaviour generally holds among the respondent sub-samples in the long-term game as well, even though the long-term game is a strictly a willingness to accept experiment. This result provides some evidence that the way in which value of time experiments are framed simply
as a function of increases or decreases in cost can have a significant impact on choice behaviour at an alternative level.

Secondly, looking at the values of travel time themselves, there is the obvious asymmetry in willingness to pay versus willingness to accept; respondents require far more compensation to increase their travel time than what they would be prepared to pay to reduce it by an equivalent amount. Finally and perhaps most importantly, we find significant differences in the value of travel time derived from the short-term style games versus the long-term style questions. Interestingly there is no uniformity in how these differences present themselves; sometimes the long-term values are higher than the short-term estimates and sometimes they are lower. Indeed, looking only at games which are presented as willingness to accept longer commutes for reduced costs, the WTA from the short-term game for public transport users is lower (i.e. needing a bigger financial incentive) than the WTA from the same set of respondents in the long-term game, whereas the WTA for car commuters in the short-term is lower than the value in the long-term again among the same sub-sample of respondents. Finally, there is some evidence of carry-over, where depending on the type of short term experiment presented to a respondent, the preferences in the long term experiments are different.

The preliminary evidence from this study into values of time in the short and long term clearly indicates that the values differ. Given that it could be argued that the long-term style choice is a more realistic way to value travel time, particularly for commuting, we argue strongly that more research is needed to determine the best way to frame and present travel time experiments, which will ideally lead to more reliable valuations of time.

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