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Consistency and fungibility of monetary valuations in transport: An empirical analysis of framing and mental accounting effects

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ABSTRACT

Governments around the world use monetised values of transport externalities to undertake project appraisal and cost–benefit analysis. However, because different types of benefits are monetised (e.g., travel time savings, preventing statistical fatalities, reliability, etc.) the question naturally arises as to whether they are consistent. That is, whether a "dollar is a dollar" as welfare economics requires, or whether spending money in one area carries a different disutility from spending money in another area. This would equate to a violation of fungibility, which is the property of a good or a commodity whose individual units are capable of mutual substitution. The view that money is not fungible is explained in behavioural economics through theories of framing and mental accounting. This paper describes the results of a stated choice experiment designed to test the fungibility and consistency of monetary valuations in transport. From a nationally representative sample, we elicit direct values for the three pairwise trade-offs between travel time, travel cost, and safety. We then show that in the context of our analysis, any trade-offs inferred on the basis of other trade-offs, as is common practice (e.g. inferring a safety vs time trade-off on the basis of monetary valuations for time and safety), produces biased results, suggesting that the assumption of fungibility does not hold. Specifically, we find that time is valued more highly when valued directly by cost than when traded with safety, and the reverse is true for safety.

1. Introduction and statement of the research question

Preference elicitation methods are used throughout the world to produce monetary valuations which in turn are used to underpin policy application. In the United Kingdom (UK), for example, the Department for Transport (DfT) currently uses a number of such valuations for appraising projects. The same is the case for national transport authorities in numerous other countries, and extensive use of such measures is also made by regional or metropolitan transport planning authorities, or indeed by transport operators. While the present paper focuses on two specific such measures, it should be stressed that these have been chosen to illustrate the hypothesis put forward in this paper which is felt by the authors to be more generally applicable.

The first valuation tool utilised in this paper is the monetised valuation of travel time (VTT). The second is the monetised value of preventing a statistical fatality (VPF). When undertaking project appraisal or constructing a business case which might have beneficial impacts on travel time or safety, these values are utilised to construct economic impact assessment.

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In the UK, these figures are currently reflected in the DfT Transport Analysis Guidance (also known as webtag), with DfT (2009a) for the VTT, and DfT (2009b) for the VPF.

Both the VTT and VPF measures currently used are based on studies employing willingness-to-pay survey methodology to derive the economic valuation, and were published in reports for the DfT (and the then Department of Environment, Transport and the Regions). The VTT figure is derived from Mackie et al. (2003), and the VPF figure is derived from Chilton et al. (1998) and supporting research by the same research team for the health and safety executive (Chilton et al., 2000), where the figure is also discussed and uprated to current prices in DfT (2007).

The existence of two economic values for cost–benefit analysis which have been separately determined through preference elicitation approaches begs an immediate question: are the monetary valuations consistent? This question is both of methodological interest and of enormous policy relevance. Methodologically, the idea that there might be different types of "mental accounts" or processes of "choice bracketing" would be an interesting explanation for having potentially inconsistent valuations of safety and time (see Thaler, 1990, 1999; Heath and Soll, 1996; Read et al., 1999; Sloman, 2004). The policy relevance is obvious: if safety and time are valued differently, it could mean that decisions made by the DfT are *relatively* either under- or over-valuing time or safety.

The issue of the possible lack of fungibility also has broader implications. Indeed, while the majority of studies will aim to directly produce estimates of the trade-offs at interest from the data at hand, this is not always the case (or possible). As an example, studies looking at reliability may focus their data collection solely on trade-offs between mean travel time and travel time variability, and then, on the basis of the estimated reliability ratio, infer a monetary valuation of travel time variability by means of an *existing* value of time measure.

To test whether the valuations of the two goods are consistent entails a simple test of consistency. This involves first eliciting the willingness-to-pay estimates for safety £(S) and time £(T) from which a ratio of £(S)/£(T) can be constructed. An experiment is then developed to directly value safety with respect to time through a series of trading opportunities designed to construct a marginal rate of substitution (MRS) between safety and time, i.e. S/T. The test then involves establishing whether the ratio £(S)/£(T) is equal to S/T.

This exploration can then lead to a second area of methodological interest. If the valuations are not consistent, what is the "direction" and "size" of the inconsistency? That is, is safety valued more highly with money than when traded against time, or vice versa? And, if so, by what margin?

The remainder of this paper is organised as follows. The following section talks about the general issue of fungibility of money and mental accounting. This is followed by a discussion about survey design and data collection and the methodological framework used for testing the fungibility assumption. Section 4 presents the findings of the empirical results, with the conclusions of the research being discussed in Section 5.

2. The fungibility of money and mental accounting

The assumption of fungibility is crucial to the valuation of any good through the use of money. Money is the ultimate fungible resource, which is a feature of any economic textbook. To address the underpinning of any potential problem of consistency, we employ the idea of "mental accounting" (Thaler, 1985, 1990, 1999; Shafir and Thaler, 2006). In this theory, the use of money can be viewed as a fungible resource which is used consistently to purchase goods *within* a single category, but not necessarily *between* categories. The theory of mental accounting is similar to related ideas in behavioural economics such as framing and is also known as choice bracketing Loewenstein et al. (1999).

To take the case of mental accounting, consider an early example from Thaler (1985):

> *"Mr. X is up $50 in a monthly poker game. He has a queen high flush and calls a $10 bet. Mr. Y owns 100 (worth $100 – ed.) shares of IBM which went up ½ today and is even in the poker game. He has a king high flush but he folds. When X wins, Y thinks to himself, 'If I had been up $50 I would have called too.'"* (1985, p. 199).

In this example, Y has (at least) two mental accounts. One is his accounting within the poker game, the other is, say, all other income. Even though Y is ahead in the "overall income" account because of his shares in IBM going up, he does not take this into account in his decision to take a risk in the poker game. This is because in his "poker game" mental account, he is only breaking even and cannot afford to take the risk to call, even though he has an excellent hand and is up $50 for the day, just as is X.

This theory obviously draws on the general phenomenon of framing of choices. Our hypothesis is that subjects will potentially have different mental accounts for money spent on different transport externalities, say in our case safety and on time. For example, one possibility would be that, when trading money against safety, subjects may isolate their choice such that they see safety as something which should be purchased with a great deal of thought and may not compare the costs of their safety costs with all other relevant opportunity costs. Trading money with time however is far more frequent and is less likely to be subject to "mental accounting" effects. So trading money against safety is relatively unfamiliar, while trading money against time is highly familiar, however trading safety against time is highly *un*familiar. This could arguably lead respondents to frame their valuations differently when trading time against safety and create different and unfamiliar mental accounts, and could hence lead to different valuations. More specifically, the results of choice vs valuation types of task lead to a standard preference reversal. And indeed, the presence of the price attribute or of valuing vs choosing is known to