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Measuring risk aversion to guide transportation policy: Contexts, incentives, and respondents ☆,☆☆

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ABSTRACT

Road pricing may provide a solution to increasing traffic congestion in metropolitan areas. Route, departure time and travel mode choices depend on risk attitudes as commuters perceive the options as having uncertain effects on travel times. We propose that Experimental Economics methods can deliver data that uses real consequences and where the context can be varied by the researcher. The approach relies on the controlled manipulation of contexts, similar to what is done in the Stated Choice approach, but builds in actual consequences, similar to the Revealed Preference approach. This paper investigates some of the trade-offs between the cost of conducting Experimental Economics studies and the behavioral responses elicited. In particular, we compare responses to traditional lottery choice tasks to the route choice tasks in simulated driving environments. We also compare students (a low cost convenient participant pool) to field participants recruited from the driving population. While we see initial differences across our treatment groups, we find that their risk taking behavior converge with minimal repetition.

1. Introduction

In the area of transportation policy an important issue is how congestion pricing may provide a solution to the increasing degree of traffic congestion in most metropolitan areas. To address this question it is important to understand behavioral responses to congestion pricing when travel times are unreliable. Such behavioral responses depend on the distribution of risk attitudes in the driving population. The majority of studies on the willingness to pay for travel time savings rely on assuming risk neutrality, although since the mid-1990s we have seen an emergence of academic research with a focus

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on the role of risk aversion in transportation choices (see Senna, 1994; Bates et al., 2001; Brownstone and Small, 2005; Small et al., 2005; Bhat and Sardesai, 2006; Hensher et al., 2011; Devarasetty et al., 2012). Despite the two decades that have passed, Rasouli and Timmermans (2014, p. 79) express the concern that "[t]he overwhelming majority of models in travel behavior research assume implicitly or explicitly that individuals choose between alternatives under conditions of certainty." Li et al. (2010) also found that in project appraisals the value of travel time reliability have been ignored, but De Jong and Bliemer (2015) report that several countries have begun to adopt some measures of travel time reliability, although using relatively simple methods. Ignoring or using only poorly measured values of travel time reliability could lead to significantly biased assessments. Fosgerau and Karlstrom (2010) report that about 15% of the travel time cost would be unaccounted for if not including the value of travel time unreliability. Therefore, more attention to risk attitudes is warranted.

The evidence of risk aversion in travel choices comes predominantly from studies using the Stated Choice (SC) approach. In this approach researchers present a large number of hypothetical driving scenarios to respondents, and ask them to make route or departure time choices in each scenario. The scenarios usually differ in travel time and road pricing. The SC approach is low cost since it involves only surveys of intentions, and can identify a large set of decision model parameters. Although the SC methodology can be informative, its main limitation derives from the absence of real consequences to the choices expressed in the surveys. This lack of consequences can lead to not just a great deal of noise in the responses, but also, more seriously, to response biases (Holt and Laury, 2002; Cummings et al., 1995; Li et al., 2010). A common way in recent SC studies to decrease such biases is to relate the hypothetical scenarios presented to scenarios that participants reveal as being familiar, such as usual commuting routes and their attributes (Hensher, 2010), or to use cheap talk to nudge respondents to be aware of response biases or to use certainty scales (Fifer et al., 2014).

The Revealed Preference (RP) approach provides an alternative to the SC approach with real consequences. The RP approach involves directly observing the choices of drivers in the field, with naturally occurring consequences such as variations in travel time and road pricing. The limitation of the RP approach is that it cannot implement a large set of contexts since it relies on existing field contexts (Louviere et al., 2000). Further, when the interest is in characterizing risk attitudes RP data may be confounded by unobserved variations in the perceptions of travel times and other consequences.

We propose that the Experimental Economics (EE) approach can deliver data that uses real consequences and where the context can be varied by the researcher. The EE approach relies on the controlled manipulation of contexts, similar to what is done in the SC approach, but builds in actual consequences (Harrison and Rutström, 2008). The majority of this literature is based on non-contextual choice situations, such as choices over various lotteries that differ in probabilities and prizes, but examples with field contexts can also be found (List and Lucking-Reiley, 2000; Fiore et al., 2009; Dixit et al., 2014). The drawback of the EE approach is that it can become expensive if a large set of responses is needed, since the cost of the consequences built into the tasks will add up. This paper investigates some of the trade-offs between the cost of conducting EE studies and the behavioral responses elicited.

The value to transportation planning of estimating risk attitudes is to generate better predictions of behavioral responses. Jackson and Jucker (1982) appear to be the first empirical application of risk attitudes in transport, using a mean–variance utility approach. Senna (1994), further investigated this by adding a separable travel cost variable to the model, and found both risk averse and risk preferring responses using SC data. Li et al. (2010) compared estimates of value of travel time and value of travel time reliability across several empirical papers using SC or RP data. Generally, their review revealed that participants are willing to pay both for reduced mean travel time, and for reduced travel time variation, or for the likelihood of arriving late or early (as in scheduling models), consistent with risk aversion. They found that the ratio of the value of travel time reliability to the value of travel time savings vary greatly. Small et al. (1999) report values for mean travel time at $3.90 and values for travel time variability at $12.60 using a mean–variance utility approach, and the SC data implying that the latter is over three times that of the former. Asensio and Matas (2008) also report values with similar patterns. However, Small et al. (2005) find the opposite relationship when using both SC and RP data. They report values for mean travel time at $12 and $21.50 for the SC and the RP data, respectively, and values for travel time variability at $5.40 and $19.70 for the SC and the RP data, respectively. Hensher et al. (2011), further, find some risk loving behavior based on SC data from Australian participants. They conclude that 66% of their participants are risk loving and 34% are risk averse, thus providing evidence of heterogeneity in risk attitudes. Carrion and Levinson (2012) while reviewing evidence literature also find great variation in the ratio of the value of reliability to value of time. They report that the ratio range from 0.10 to 2.51, with Ghosh (2001) and Yan (2002) reporting RP estimates to be higher than the SP estimates. Li et al. (2010) attribute much of the variation in inferences about risk attitudes to the variations in how information is presented to participants.

Most of this evidence relies on Expected Utility Theory (EUT). In this paper we estimate both EUT models and Rank Dependent Utility (RDU) models, but do not include loss aversion as in Prospect Theory (PT). According to Li and Hensher (2011), very little evidence has been collected in the transport literature that is suitable to testing Prospect Theory. According to the PT literature and its applications on SC data (Chateauneuf and Cohen, 1994; Attema et al., 2013) loss aversion and risk loving preferences in the loss domain are important behavioral considerations. However, Li and Hensher (2011) give an overview of the requirements necessary to implement PT, and find very few studies in transport that fulfill these. The most important difficulty in applying PT is the specification of a credible reference point. Avineri (2006) demonstrate how PT valuations are sensitive to the choice of reference point. Individual drivers' reference points are bound to vary with their experiences and expectations, and are difficult to measure jointly with their preferences. Stott (2006) evaluated the various functional forms for the utility function and probability weighting. Note that loss aversion is not required for changes in