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Is car drivers' response to congestion charging schemes based on the correct perception of price signals?

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ABSTRACT

This paper deals with the question of whether the capability of car drivers to estimate the cost of a new hypothetical, highly differentiated congestion charge influences their decision to change travel behaviour. The analysis makes use of an integrated choice and latent variable model (ICLV) which merges classic choice models with the structural equation approach (SEM) for latent variables. This hybrid model improves the explanatory power considerably compared with a conventional discrete choice model. The results suggest that charge complexity decreases the resistance in considering behavioural changes. Car drivers tend to avoid a travel option where the price is not known beforehand, a phenomenon known as ambiguity avoidance.

1. Introduction

Over the last decade research has made considerable progress in developing, testing and applying methods to estimate the social marginal costs of road use (see for example Nash et al., 2010 and INFRAS et al., 2007 for an overview on estimation methods). At the same time, both technically and practically feasible electronic road pricing systems have become available which are capable to charge road users by taking into account several dimensions of pricing such as time of day, type of road, road section, type of vehicle, etc. Meanwhile there are also practical examples for dynamic road pricing schemes which involve a considerable amount of complexity in charging structures such as the I-15 and SR91 HOT lane projects as well as the Singapore ERP scheme. However, while first-best pricing appears to move from a theoretical concept towards a both technically and practically feasible concept, the question remains whether a theoretically optimal, fully dynamic and highly differentiated charging regime will be too complex for car drivers to understand and to generate the desired rational changes in travel behaviour. Against this background it becomes increasingly important to analyse whether and to what extent car drives are able to predict such highly differentiated charges correctly, and to respond rationally to these price signals.

While various studies have analysed the factors influencing the acceptability of pricing measures such as the type of charging, the use of revenues, compensation measures as well as the role of attitudes, psychological factors, etc. (see for example Odeck and Bråthen, 1997; Rienstra et al., 1999; Schade and Schlag, 2003; Link and Polak, 2003; Jaensirisak et al., 2005; Souche, 2012; Eliasson, 2014), only few research is dealing with the question how highly differentiated pricing schemes are perceived and how individuals respond to such complex price signals. There is some empirical evidence on the response of users to tariff complexity from sectors such as telecommunication, internet services, etc. (see for example OFGEM, 2001; FDS, 2001; Altmann et al., 2001). The response of travellers to highly differentiated prices has only recently

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gained research interest. Bonsall and Lythgoe (2009) and Franke and Kaniok (2013) provide results from laboratory experiments where individuals' understanding, perception and intended behavioural responses to spatially and time differentiated road pricing schemes were examined. However, these studies are restricted either to descriptive statistical analysis or use rather simple regression models. Bonsall et al. (2007a) model stated responses on hypothetical urban road pricing schemes of different degree of complexity by means of conventional binary logit models and feed the model coefficients into a transport assignment model to analyse the effects of road pricing on traffic flows and congestion levels.

The research presented in this paper is an extension of research carried out in Bonsall et al. (2007b) and deals with the question of whether the capability of car drivers to estimate travel distance, travel time, fuel costs and other motoring costs as well as the cost of a new hypothetical congestion charge influences their decisions to change their travel behaviour. With this research focus the paper contributes to existing research on user responses to congestion charging by an analysis of car drivers' perception of and response to complex congestion pricing schemes. Specifically, it attempts to answer the following research questions: (1) Are car drivers able to predict highly differentiated charges and to adjust their travel behaviour accordingly? (2) How can this prediction capability of drivers be incorporated into discrete choice models for explaining behavioural response to complex road user charges? (3) What are the consequences for charging policies if road users' responses do not fully reflect the expected rational response to complex charges, either due to a lack of capability to predict charges correctly, or because car drivers disengage from the process of attempting to do so? The analysis is based on surveys with regular car drivers in two German cities and makes use of an integrated choice and latent variable model (ICLV) which merges classic choice models with the structural equation approach (SEM) for latent variables.

The rest of this paper is organised as follows: Section 2 discusses the phenomenon of complex decisions in general, derives propositions to guide the modelling work and sets out the modelling framework. Section 3 describes the data used. Section 4 presents the estimation results and Section 5 concludes.

2. Methodology

2.1. Definition of complexity

The analysis presented in this paper starts from the following definition of charge complexity based on Bonsall et al. (2007):

A road user charge can be regarded as complex if (1) a large number of charging dimensions does exist (e.g. time, location, type of road, level of congestion, type of vehicle), (2) the number of charge levels in each dimension is high, (3) the calculations required for estimating the charge to be paid for a specific journey are difficult and time-consuming (e.g. is the charge fixed or is it a function of one or more variables, is the function linear or more complicated, etc.) (4) the amount of information needed to be collected for calculating the charge is high, (5) the number of discounts and exemptions is high.

Apparently, there exists an *objective* complexity which can be defined through the factors described above, and a *perceived* complexity which finally influences peoples' behavioural responses and which is the subject of interest in this paper. Perceived complexity refers to the degree of difficulty which an individual faces when estimating the charge to be paid for a specific journey. Apart from the objective factors listed in the definition above, it is influenced by a number of not directly observable factors such as

- Individuals' general attitudes to travel cost and cost saving strategies,
- Individuals' capability to deal with incomplete information and to supplement missing information by own search and collection on the one hand, and their capability to deal with various and complex information on the other hand,
- Individuals' capability to perform the necessary calculations if many charge dimensions and charge levels have to be considered,
- Individuals' capability to deal with uncertainty over prices and their attitudes towards risk,
- Individuals' coping strategies used when a full evaluation of available travel options is not possible or considered to be not justified,
- The degree of individuals' familiarity and experience with making complex decisions in general and in dealing with complex prices in particular.

This paper seeks to identify how the prediction ability of individuals in combination with their attitudes to travel costs influences their behavioural response on a complex road charge. Bonsall et al. (2005) provide an excellent overview on case study evidence from different branches and on the relevant literature from psychology and human decision making. Out of this review the following major issues have guided the design of the study presented in this paper.

A first issue refers to the fact that people face problems in estimating travel distance correctly (see Bonsall, 2004). Travel distance is often estimated via travel time whereby there is evidence that journey times tend to be over-estimated for inter-urban journeys and under-estimated for urban journeys (see Kang et al., 2003). A second issue is the capability of humans to process information and to perform (complicated) calculations. Psychology has established the seven-items rule according to which people can deal with no more than seven (plus/minus two) items of numeric or abstract data at a time (see Miller, 1956). Furthermore, the capability to process complex information is apparently influenced by socio-demographic factors