Transportation Research Part A 116 (2018) 361–388

Contents lists available at ScienceDirect

Transportation Research Part A

journal homepage: www.elsevier.com/locate/tra

Hypothetical bias and decision-rule effect in modelling discrete directional choices

Milad Haghani*, Majid Sarvi

Department of Infrastructure Engineering, The University of Melbourne, Parkville, VIC 3010, Australia

ARTICLE INFO

Keywords:
Contextual bias
Random regret minimization
Random regret logit
Regret theory
Choice rule
Choice axiom
Axiomatic decision theories
Choice experiments

ABSTRACT

Introduction: This empirical study investigates, in parallel, two key questions in relation with modelling discrete choices. (i) To what extent econometric modelling estimates and predictions derived from responses to hypothetical choice scenarios differ from those of an equivalent realistic choice context (i.e. hypothetical bias)? (ii) To what extent econometric modelling estimates and predictions differ as a result of postulating "regret minimisation" as the decision rule as opposed to the "utility maximisation" assumption (i.e. decision-rule effect)? The magnitude of these two effects are also compared relatively.

Methods: We explore the two aforementioned problems in the context of discrete directional choices. Disaggregate experimental observations are collected from both stated-choice (SC) and realistic (or experimentally revealed) choice (RC) settings. We perform our analyses on the basis of four distinct criteria: parameter estimates, parameter ratios, predictions and prediction errors (in terms of disaggregate (i.e. individual-level) choice probabilities)).

Results: (i) Our results displayed a great degree of resemblance between the parameter estimate patterns emerged from both data sources including a perfect match between the sign and significance of the SC and RC estimates. Major observed discrepancies, however, were related to the scale of the estimates as well as certain coefficient ratios. In terms of the predictions (i.e. simulated probabilities) and prediction errors (i.e. based on a hold-out part of the sample), SC-based models performed surprisingly similar to those of their RC-based counterparts. (ii) The assumption of the decision rule made even a much less noticeable modelling difference (compared to the hypothetical bias) in both parameter estimates and predictions. The shift from utility to regret model led to only marginal differences in estimates, simulated probabilities and prediction errors. Compared to the hypothetical bias in particular, decision-rule specification was a much less impactful modelling component.

Applications: These findings contribute to the accumulation of the empirical evidence that can determine how and when one can make best use of the SC methods which, in essence, demands the creation of links between hypothetical and real data in various contexts of choice. Our results suggested that, at least in certain contexts and applications, choice elicitation outcomes are reasonably consistent between the hypothetical and realistic settings. The findings also add to the existing evidence that point at the virtual neutrality of the discrete-choice modelling outcomes to the use of utility versus regret optimisation assumption as the choice rule.

Future directions: The study also leaves us with the further question of how the observed similarity/dissimilarity patterns (SC versus RC; and regret versus utility) would materialise if aggregate prediction measures are of main concern (as opposed to the use of disaggregate measures). The question has particular bearings on applications in which discrete-choice models are applied to simulate or predict a whole system (i.e. when discrete choice models perform as part of

* Corresponding author.
E-mail addresses: milad.haghani@unimelb.edu.au (M. Haghani), majid.sarvi@unimelb.edu.au (M. Sarvi).

https://doi.org/10.1016/j.tra.2018.06.012
Received 12 October 2016; Received in revised form 7 March 2018; Accepted 20 June 2018

a broader model) as a common practice in transport studies. This question will be investigated in a subsequent work.

1. Introduction

Humans' choices in real life are binding commitments to a course of action with actual consequences. In studying choices, however, researchers and planners have often resorted to what people state *would* choose as opposed to observing what they actually decide in real life. Hypothetical choice surveys have increasingly permeated into in many decision domains and within the recent years have gained increasing acceptance as a practical method of measuring humans' preferences. Hypothetical choices are also particularly crucial in many domains where implementing real or consequential choices are basically unethical or impractical. Examples of such decision contexts are studies of distressing moral decisions (Kühberger et al., 2002) or establishing the value of nontraded goods (notably that of the human's life) (Krüger and Svensson, 2009; Svensson, 2009) or non-existent products, or assessing the willingness to accept for policies prior to implementation (Vossler and Evans, 2009; Vossler and Watson, 2013).

In reliance on hypothetical choice data it is implicitly assumed that such evidence are legitimately good proxies for people's actual behaviour and can be used for forecast purposes or that they can be adjusted using certain relationships between the two data types (e.g. the certainty adjustments) in order for the hypothetical data to become an adequate representation of the reality. Nonetheless, the literature offers a great body of evidence suggesting that humans are biased in their hypothetical valuations (Murphy et al., 2005). It has been particularly shown in many studies that contingent valuations of goods based on stated choices systematically and substantially exceed their actual realisations in the real-world (List and Gallet, 2001; Mjelde et al., 2012). The systematic deviation of the survey-based evaluation of preferences from their true values due to the hypothetical nature of the elicitation method is referred to as *hypothetical bias* (Hensher, 2010).

Relative to the great (and often mixed) wealth of the evidence as to the hypothetical bias effect in the conjoint analysis method for valuation of preferences (Johnston, 2006; Schläpfer, 2008), the phenomenon is particularly poorly understood in the domain of discrete choice experiments (that is currently the favoured approach over the conjoint analysis in many substantive applications (Louviere et al., 2010)). Having reached certain levels of maturity in terms of the developments of theoretical methods with desirable statistical features for survey generation and model estimation, the discrete choice domain demands particular attention and recognition towards investigating, quantifying and possibly mitigating the hypothetical bias (Beck et al., 2016; Fifer et al., 2014; Loomis, 2014). The scarcity of robust evidence as to the extent, prevalence and the direction of hypothetical bias in discrete choice experiments has been largely attributed to the paucity (and in certain contexts, unavailability) of observations obtained from real choice settings to serve as the basis of comparison (Hensher, 2010, 2015).

As opposed to hypothetical bias that is an empirical aspect of modelling discrete choices, a theoretical question also pertains to this class of econometric models as to how the decision rule should be axiomatised. Choice makers, in the domain of econometric choice modelling, are conventionally assumed to be utility maximisers, whereas an alternative approach would be to assume them as regret minimisers (Chorus et al., 2008). Whether or not the latter could provide a better explanation or more accurate representation of the choice-making behaviour has been debated in the literature. Here, we investigate the magnitude of the impact that shifting from the more traditional utility approach to regret model would make in terms of the modelling outcomes. We refer to this as the *decision-rule effect* (Hess et al., 2012b; Hess and Stathopoulos, 2013).

We also contrast the magnitude of the decision-rule effect with that of the hypothetical bias which has practical applications as to which one is a more impactful modelling component. To achieve modelling accuracy, should the attention be deployed on gathering more realistic data or should the modeller prioritise identification of the most suitable decision rule?

Here, we investigate the hypothetical bias problem along with the effect of decision rule specification in particular context of discrete directional choice. Stated choice (SC) experiments were conducted to investigate the emergency escape behaviour of pedestrians evacuating crowded confined spaces. The hypothetical scenarios were then mimicked (using an independent sample of individuals) in a series of field-type experiments in which escape choices were made more naturally while subjects making realistic interactions with one another. Revealed choice (RC) data were extracted by individual analysis of their movement and behaviour. The RC data is split into two separate subsets in our analysis, for the estimation and for the prediction error calculations. The SC and RC-based parameter estimates as well as model predictions are contrasted numerically using both random-regret logit and random-utility logit models.

2. Background[1]

2.1. Contextual bias: a broader perspective

Experimental methods have gained an increasing popularity within the last few decades in different domains of social sciences as

[1] This section is meant to provide a broad and hopefully comprehensive overview of the notion of contextual bias from an interdisciplinary perspective (along with a more limited and narrower overview of the decision-rule effect in discrete-choice literature). It gathers references and evidence from various domains of social science including experimental economics, empirical econometrics, cognitive sciences and behavioural neuroscience. A reader interested purely in the findings of our case