Transportation Research Part B 101 (2017) 72–88

Contents lists available at ScienceDirect

Transportation Research Part B

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

Goal-based models for discrete choice analysis

A.A.J. Marley[a,b,*], J. Swait[b]

[a] Department of Psychology, University of Victoria, PO Box 1700 STN CSC, Victoria, BC V8W 2Y2, Canada
[b] Institute for Choice, UniSA Business School, Level 13, 140 Arthur Street, North Sydney, NSW 2060, Australia

ARTICLE INFO

Article history:
Received 12 September 2016
Revised 13 March 2017
Accepted 14 March 2017

Keywords:
Choice model
Hybrid model
Goals
Heterogeneity
Multi-stage choice
Probabilistic choice
Strategy

ABSTRACT

Goals direct decision making, from the most abstract levels of motivation to the multitudinous details of evaluation of options available for choice. However, the pervasive influence of goals in decision processes is generally not explicitly recognized at the level of demand model formulation and specification. In applied economics generally, and transportation specifically, demand models relate product/service attributes directly to behavior, using utility (or value) as a shorthand representation for the impact of goals. In this paper we argue that this is a limiting view that restricts our thinking about decision making and, hence, our representation and inference-making about that behavior. We support this argument by reinterpreting and/or extending various applications of hybrid models in transportation to a goal-based framework and formulating goal-based choice models which recognize that goals (1) are drivers of choice, (2) explain the choice of strategy, (3) are part of the constraint set and (4) contribute to explaining impacts of the decision context on the allocation of cognitive resources by the decision maker.

Statement of contribution/potential impact

The particular focus and contribution of this work is to relate the influences of goals on choice processes to observable outcomes via the vehicle of goal hierarchies and consequent multi-stage choice processes. We support our arguments by reinterpreting and/or extending various applications of hybrid models in transportation to a goal-based framework. In particular, we reinterpret and extend standard maximization (e.g., utility) and minimization (e.g., regret) models to multiple and simultaneous goal pursuit, which is likely to be a cause of and, in turn, be influenced by, multiple stages in a choice process. We explore multiple choice model forms that reflect such stages and hierarchies, some within the Random Utility domain and others without. Many of these choice forms are present in the literature, but are here reframed as goal pursuit models that lead to familiar forms but substantively different interpretations; other choice forms (and/or their components) are new to the literature, and are presented in the spirit of stimulating further thinking on the incorporation of goals in choice models and subsequent empirical testing in transportation and other applied economics disciplines.

1. Introduction

Goals direct decision making, from the most abstract levels of motivation to the multitudinous details of evaluation of options available for choice (e.g., Austin and Vancouver, 1996; Weber and Johnson, 2009). Between these two roles in choice

* Corresponding author.
E-mail address: ajmarley@uvic.ca (A.A.J. Marley).

http://dx.doi.org/10.1016/j.trb.2017.03.005
0191-2615/

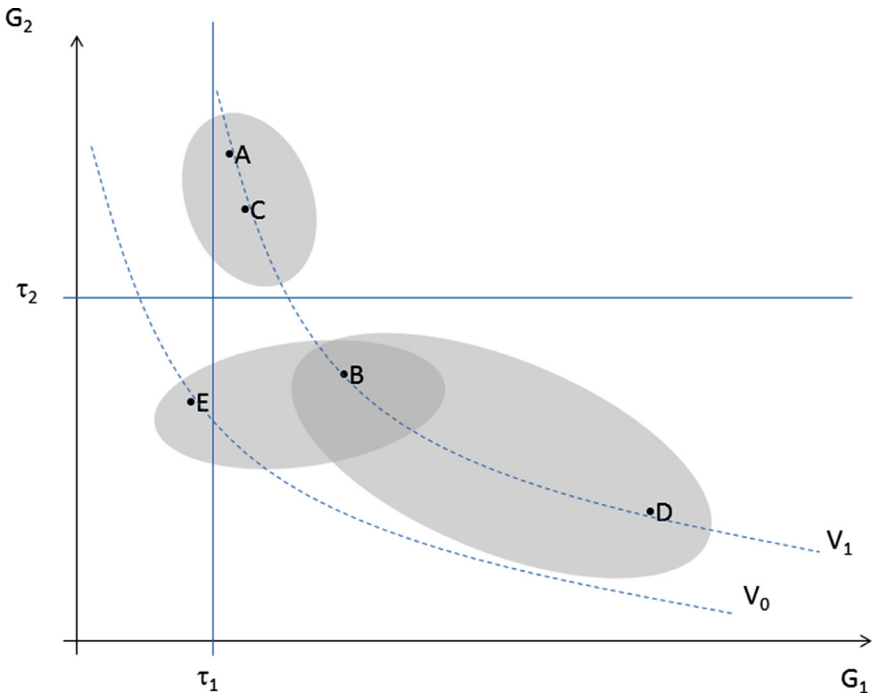

Fig. 1. A set of choice options with each option represented in terms of (i) level of achievement of each of two goals; (ii) value.

processes, goals are also used to determine the allocation of scarce decision making resources to arrive at good, or even optimal, choices (Weber and Johnson, 2009). In particular, the difficulty of making a decision due to personal restrictions (say, cognitive or budgetary limits), exogenous constraints (e.g., time limits) and contextual complexities (e.g., large numbers of alternatives or many aspects), can be addressed through the introduction of multi-stage decision strategies, which may be realigned with goal hierarchies and/or goal priorities. Thus, multiple and simultaneous goal pursuit is likely to be a cause of and, in turn, be influenced by, multiple stages in a choice process.

We illustrate these observations through an example (Fig. 1). Assume a retailing firm is designing its distribution system, partly by contracting outside package delivery to one or more outside suppliers (*A, B, C, D* and *E*). The selection of suppliers will be made in terms of two goals: operational flexibility (G_1) and cost effectiveness (G_2); the level of attainment of each goal represented by the axes in the figure will, in general, be a function of multiple attributes of the competing shipping firms – for example, operational flexibility a function of number of trucks and hours of service, and cost effectiveness a function of unit pricing and volume discount.

Using a traditional, though now goal-based value (utility) function, the curves in the figure show a possible nonlinear value function of the two goal attainments. If value maximization is the firm's highest priority goal, then under the conditions of the figure shippers *A, B, C*, and *D* each have the same maximal value and are equally attractive to the retailer. This provides an example of goal-based *choice set formation* (*CSF*); such value assignment is the traditional method for talking about CSF (Swait, 2001). Such CSF, which might also be called *screening*, is a major component of all the models in this paper. However, the retailer might apply a different goal-based screening rule to discriminate between the options in the set {*A, B, C, D, E*}. For example, the retailer might set a threshold on the attainment of each goal, and only consider shippers that exceed the threshold on both goals; this combination of two (sub)goals then becomes the *goal-strategy* in this situation. If these decisions are made deterministically, then with the thresholds τ_1 and τ_2 shown in the figure the (conjunctive) selection would be shipper set[1] {*A, C*}; note that the retailing firm did not assign a single (goal-based) value to any option, or to any set, with this screening rule. Also, the decisions about whether or not an option exceeds both thresholds might be probabilistic, so rather than one shipper or shipper set being chosen deterministically, each of several sets are possible outcomes.

It remains for the retailer to choose between *A* and *C*. If that choice is based on minimizing goal-based regret (defined in detail later), then *A* is chosen because the (negative) difference (vis., regret) between *A* and *C* on goal G_2 is greater than the (negative) difference (vis., regret) between *C* and *A* on goal G_1. Interestingly, this latter goal (minimizing goal-based regret) might lead to strategic interactions with the original task of screening a set of bidders for supplying the logistics services.

[1] Note that in this particular example, the set {*A, C*} is also selected if the retailer first screens on the basis of goal-based value, followed by screening with the conjunctive threshold goal.