Journal of Choice Modelling xxx (2017) 1–14

Contents lists available at ScienceDirect

Journal of Choice Modelling

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

The Stochastic Satisficing model: A bounded rationality discrete choice model

Felipe González-Valdés [*], Juan de Dios Ortúzar

[a] Department of Transport Engineering and Logistics and Centre for Sustainable Urban Development (CEDEUS), Pontificia Universidad Católica de Chile, Chile

ARTICLE INFO

Keywords:
Satisficing
Discrete choice
Non-compensatory
Bounded rationality

ABSTRACT

The interest in individuals' non-strictly rational behaviour has permeated into discrete choice models pushed by several psychological theories. We analysed Satisficing Theory, which is particularly useful when decision makers have to face the cognitive burden of complex decisions. Three principles of the theory are discussed noting that the third, partial pay-off functions, has not been addressed in the literature. We implement the three principles mathematically obtaining a discrete choice model in which the decision maker chooses the first satisfactory alternative. The model formulation is analytically derived, as well as its properties. The Stochastic Satisficing model allows variable or constant marginal rates of substitution and enables the explicit characterization of non-compensatory behaviours. The model can also explain attribute saturation and non-attendance of high order needs when basic needs are not fulfilled. We analysed the model performance on synthetic data, showing that it is likely to be unbiased and consistent for relatively common samples sizes. When tested on real data, the model proves its flexibility to also adapt to constant marginal rates of substitution. We conclude that the model is a good characterization of Satisficing behaviour for simple datasets.

1. Introduction

Since psychologist first pointed the potential impact of bounded rationality on decision making (Simon, 1955), there has been a growing consensus that people's limited processing faculties may affect the way they make decisions (Conlisk, 2014). This way, the concept of bounded rationality has permeated several disciplines, such as behavioural economics (McCain, 2015) and choice modelling (Araña et al., 2008; Stüttgen et al., 2012).

Simon's work on Satisficing Theory (Simon, 1955, 1956), henceforth ST, provides the basis for the Satisficing choice heuristic. Even though Simon's work does not give a precise definition for this heuristic (Manski, 2017), it highlights what elements of 'rational' choice are highly implausible and what reasons could trigger a simpler behaviour by decision makers (DMs). Simon analysed three simplifying principles. First, he argues that any choice model requiring the inspection of all attributes and a comparison (or consideration) of all the alternatives, would be highly implausible in many practical applications; thus simple pay-off functions are expected.[1] Then, Simon argues that information gathering is costly due to cognitive and processing effort, suggesting a reservation value or acceptance threshold. Finally, the third principle explicitly recognizes that DMs may have trouble combining attributes of a different nature (e.g.

* Corresponding author. Pontificia Universidad Católica de Chile (PUC), Chile, Av. Vicuna Mackenna 4860, Macul, Santiago, Chile.
E-mail address: fagonzalezv@uc.cl (F. González-Valdés).

[1] Simple pay-off function are for example, distinguishing between acceptable and unacceptable alternatives. Even though Simon (1955) does not restrict the pay-off functions to be binary, to our best knowledge, only binary pay-off functions have been implemented when modelling Satisficing behaviour.

https://doi.org/10.1016/j.jocm.2017.11.002
Received 17 April 2017; Received in revised form 31 October 2017; Accepted 7 November 2017
Available online xxxx
1755-5345/

quality and cost) into a single figure of merit (e.g. utility). Thus, DMs actually consider only partial ordering pay-off functions.

Several of Simon's ideas have been applied into decision and search theory. For example, some studies implemented directly the cost of information (Gabaix et al., 2006). Other researchers have implemented indirectly the cost of information through sequential inspection of the choice set (Caplin et al., 2011; Manzini and Mariotti, 2014; Aguiar et al., 2016) or by analysing sequential menus (Papi, 2012). Several models considered a reservation utility in accordance to ST (Gabaix et al., 2006; Caplin and Dean, 2011; Papi, 2012). However, to the best of our knowledge, none of the referenced studies have applied the third principle of ST (i.e. partial ordering pay-off functions), probably because it implies dismissing the concept of utility.

Following these theoretical considerations, discrete choice models have attempted to implement the principles in different ways; however, most models have not incorporated important cornerstones of the theory.[2] While some applications of ST completely inspects all available alternatives –violating the second principle– (Recker and Golob, 1979; Young et al., 1983; Durbach, 2009), other applications mix attributes of a different nature into a single figure of merit, violating the third principle (e.g. Radner, 1975; Richardson, 1982; Araña et al., 2008). Only recently, ST has been thoroughly applied using eye-tracking technology (Stüttgen et al., 2012), yet, this is not possible in most choice settings. Therefore, despite several attempts to implement ST in practice, a Satisficing choice model that can be used broadly with simple data[3] does not exist.

The main contribution of our paper is the proposal of an econometric model, the Stochastic Satisficing model, that applies ST as rigorously as possible for a simple dataset.[4] To create this model, we start by describing a general Satisficing behaviour, which incorporates the three ST principles that could lead to several ST models. Then, simplifications are stated to adapt to the data structure and the econometric model is solved. As a result, the model considers that DMs choose the first alternative which is stochastically satisfactory on all dimensions of the pay-off vector. Thus, DMs are assumed to explore the choice set sequentially, in a process based on alternatives rather than on attributes (Williams and Ortuzar, 1982).

One of the key features of the Stochastic Satisficing model is the consideration of a multidimensional pay-off acceptability function. This approach, which is explicitly suggested by Simon (1955) and identified by us as the third principle, differentiates our model from previous work. By using this approach, we imprint further realism to the choice heuristic and do not restrict the model structure, which has scalar utility functions as a particular case. As the multiple dimensions of the pay-off function interacts into a single stochastic acceptability, different substitution patterns are analytically obtained.

We test the proposed model's properties on synthetic and real data. The analysis on synthetic data suggests that the model could be unbiased and that consistency is reached with common sample sizes. The real data case provides an example where the model is able to adapt its behaviour when the evidence in the data suggests that constant compensation among attributes does actually exist.

The rest of the paper is organised as follows. In section 2 we describe the ST principles and the reported evidence in the literature that motivates people using a Satisficing choice heuristic. In section 3, we propose a general Satisficing behaviour theory which is later simplified into the Stochastic Satisficing model. We end section 3 by analysing the analytical properties of the model. Then, section 4 analyses the model in two contexts: synthetic and real data. Finally, conclusions are presented in section 5.

2. On Simon's theory: principles and motivation

We first address the behavioural theory of rational choice proposed by Simon (1955, 1956) and discuss its main principles. Then, we analyse how context can induce a Satisficing choice heuristic.

2.1. Simon's theory principles

Most discrete choice models, such as Random Utility Maximization –RUM– (McFadden, 1973), Elimination By Aspects –EBA– (Tversky, 1972a, 1972b), and Random Regret Minimization –RRM– (Chorus, 2010) among others, require the evaluation of all alternatives, involving a large cognitive load for DMs. Furthermore, this burden is increased in RUM and RRM due to the consideration of all alternative attributes in compensatory trade-off terms of either utility or regret.

ST suggests several simplifications, or principles, that make the behavioural process more plausible for the human mind. We have categorized such simplifications into three main principles.

The first, states that DMs may assume only a few evaluation outcomes per alternative (e.g. acceptable or not; desirable, neutral, or undesirable) instead of a continuous outcome (e.g. utility). In the Stochastic Satisficing model, we postulate that an alternative can be either acceptable or non-acceptable.

The second principle is based on the fact that information gathering is not costless. People may use information sequentially while they acquire it and use only a subset of the available information. For example, neither the need to visit an apartment before deciding if it is acceptable, looking at a shelf of a supermarket before settling for a bottle of wine, nor examining the attributes of alternatives presented in a stated choice survey are free of cost or burden. The higher the information cost is –probably relative to the importance of the choice decision– the simpler the cognitive process may become (e.g. not inspecting all alternatives or attributes). Simplifications can be attained by inspecting a subset of attributes of each alternative, as in the EBA model, or by inspecting a subset of alternatives as in the Satisficing heuristic. Therefore, in the Stochastic Satisficing model we assume that people truly choose the first “good enough” alternative.

[2] This is probably because Satisficing has been interpreted in different ways among researchers, without reaching a consensus (Manski, 2017).

[3] By simple data, we understand only alternative profiles and the chosen alternative.