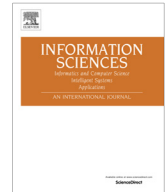




ELSEVIER

Contents lists available at ScienceDirect

Information Sciences

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

A bilateral exchange model: The paradox of quantifying the linguistic values of qualitative characteristics



Madjid Tavana ^{a,b,*}, Debora Di Caprio ^{c,d}, Francisco J. Santos-Arteaga ^e

^a Business Systems and Analytics Department, Lindback Distinguished Chair of Information Systems and Decision Sciences, La Salle University, Philadelphia, PA 19141, USA

^b Business Information Systems Department, Faculty of Business Administration and Economics, University of Paderborn, D-33098 Paderborn, Germany

^c Department of Mathematics and Statistics, York University, Toronto M3J 1P3, Canada

^d Polo Tecnologico IISS G. Galilei, Via Cadorna 14, 39100 Bolzano, Italy

^e Departamento de Economía Aplicada II, Facultad de Económicas, Universidad Complutense de Madrid, Campus de Somosaguas, 28223 Pozuelo, Spain

ARTICLE INFO

Article history:

Received 4 June 2014

Received in revised form 21 October 2014

Accepted 31 October 2014

Available online 10 November 2014

Keywords:

Decision analysis

Subjective perception

Shared language

Linguistic variable

Triangular fuzzy number

Information transmission

ABSTRACT

You can't always get what you want but (with a bit of luck) you may get what you expect. We study a bilateral exchange model where decision makers (DMs) perceive subjectively the characteristics of the products they initially own. They use a common language to communicate with each other while four requirements are imposed to prevent them from purposely trying to manipulate the exchange process. We illustrate how, even if these requirements are satisfied, the product that each DM receives from the exchange is possibly quite different from the one (or ones) that each had envisioned based on the reports provided by the other DM. In particular, the products received may deliver a utility higher or lower than that of the product originally owned by each DM which may be a direct consequence of the DMs using linguistic values to describe the qualitative characteristics of their products. However, we show that DMs may agree to exchange and turn out to be worse off even when they are asked to express their qualitative evaluations using real values belonging to a normalized interval. Paradoxically enough, we will argue that quantifying the linguistic values of qualitative characteristics creates more misunderstanding than using the corresponding linguistic values.

© 2014 Elsevier Inc. All rights reserved.

1. Introduction

The formal modelization of the imprecision and incompleteness inherent in the preferences and beliefs of decision makers (DMs) has constituted one of the main research interests among economists for quite some time [6,19,26,34]. At the same time, fuzzy set theorists [29,42,43] and intuitionist philosophers [4,5,20] have tackled and shed light on the imprecision inherent in the behavior of DMs through their respective disciplines. The current paper studies the modelization of the behavior of rational DMs within a bilateral exchange setting in such a way that can be useful to any of these disciplines.

* Corresponding author at: Business Systems and Analytics Department, Lindback Distinguished Chair of Information Systems and Decision Sciences, La Salle University, Philadelphia, PA 19141, USA. Tel.: +1 215 951 1129; fax: +1 267 295 2854.

E-mail addresses: tavana@lasalle.edu (M. Tavana), dicaper@mathstat.yorku.ca, debora.dicaprio@istruzione.it (D. Di Caprio), fransant@ucm.es (F.J. Santos-Arteaga).

URL: <http://tavana.us/> (M. Tavana).

We study the bilateral exchange of products between rational DMs. Products are defined through characteristics distributed among different categories. At the same time, DMs perceive subjectively the characteristics of the products while sharing a common language to communicate with each other. We will illustrate how *absent strategic considerations* based on the capacity of DMs to report falsely for their own benefit, commonly assumed in the economic literature [1,11], DMs may agree to exchange products and end up with a less preferred product than the one they were initially endowed with. This provides novel insights into the suboptimality inherent to the DMs interacting within a given exchange system.

The strategic approach to fuzziness from the economics literature concentrates on the topological properties and the selection process determining the existence of an equilibrium through a fixed point (see [24,33]), as well as analyzing the properties of the core in the determination of the equilibrium [22]. While we have previously dealt with the properties of fuzzy preferences under uncertainty (see [14,15]), in the current paper we focus on the effects that the subjective perceptions of DMs have when evaluating product alternatives and reporting the information *as they perceive it*.

Consider a system composed of two DMs, each endowed with a particular product that allows them to potentially engage in bilateral trade. Each DM must decide whether or not to exchange his product with the one of the other DM and will only do so if he expects to attain a higher utility level through the exchange. In order to be able to evaluate the expected utility derived from the exchange, each DM must communicate, that is, each DM must describe his own product through a report.

Four requirements are imposed to prevent the DMs from purposely trying to manipulate the exchange process (for their own benefit). After the DMs communicate their reports in a way that the manipulation-free requirements are satisfied, each DM calculates his exchange expected utility on the basis of his subjective beliefs regarding the product expected to be received. Each DM will agree to trade only if the value obtained from the exchange expected utility is higher than the utility value of the product that he owns. Hence, exchange will occur only if both DMs perceive this to be the case.

Suppose that the DMs agree to exchange under the manipulation-free requirements. Even if all the requirements are satisfied, the product that each DM receives from the exchange is quite possibly completely different from the one (or ones) that he had envisioned on the basis of the reports provided by the other DM. This difference is due to the subjective perceptions that DMs have of the products. Nevertheless, the newly acquired product may still deliver a utility higher than the one originally owned. Thus, even if the DM does not get exactly what he was thinking of, he may still get what he was expecting in terms of utility, i.e. an acceptable product.

However, it is also conceivable that one or both DMs get an unacceptable product delivering a lower utility than the one they were initially endowed with. This result may be considered a direct consequence of the fact that DMs use linguistic values to describe the qualitative characteristics of their products. Thus, one may intuitively conjecture that this suboptimal situation would not arise if the DMs were allowed to express themselves using a real scale $[0, 10]$ instead of through linguistic evaluations – a quite common assumption in the standard microeconomic literature [12,27,30].

The main contribution of our paper is a formal proof of the fact that the above conjecture is false and the DMs can agree to exchange and turn out to be worse off even when they are asked to express their qualitative evaluations via real values belonging to a normalized interval. Paradoxically enough, we will actually argue that quantifying the linguistic values of qualitative characteristics may create more misunderstanding than using the corresponding linguistic values.

Fuzzy methods are commonly used to evaluate the assessments made by DMs when describing linguistically the behavior or value of variables relating to the risk inherent in the decisions they must make, see [8,25]. In particular, the use of equally distributed (symmetric) triangular fuzzy numbers (TFNs) is quite prevalent in the literature on expert and knowledge based systems, see [37–40]. Our approach will consider asymmetric TFNs and it is in this sense more general. At the same time, it allows for a more natural formalization of subjective fuzzy descriptions whose ranges of variations are not imposed on the DMs but are autonomously constructed by them. Asymmetric fuzzy numbers constructed in this way are generally used in control, expert and knowledge-based systems [7], particularly when dealing with genetic and neural fuzzy systems (see [10,16,28]), but remain foreign to the economic literature. The subjective construction of asymmetric fuzzy numbers by DMs within a bilateral exchange setting does not only provide a novel approach to the corresponding economic analysis but also opens the way for the creation of multiple links and potential complementarities between the systems and economic literatures.

The paper proceeds as follows. In Section 2, we introduce the basic notations. Section 3 defines the shared language used by DMs, introduces the manipulation-free requirements and the exchange expected utilities, and discusses the distinction among expected, acceptable and unacceptable products. We use fuzzy numbers to objectify linguistic variables in Section 4. The main results are presented in Section 5. Section 6 provides managerial implications and highlights potential extensions. Section 7 concludes.

2. Basic concepts and initial assumptions

Let \wp be the set of all products. Let $\{C_j: j \in J\}$ be the partition of \wp whose elements are subsets of \wp formed by products of the same type or category. That is, $\wp = \bigcup_{j \in J} C_j$, where $C_j \cap C_{j'} = \emptyset$ for every $j \neq j'$. For instance, one may think of C_1 as the set of all cars, C_2 as the set of all wine bottles, C_3 as the set of all shoes, and so on. Following the standard set-theoretical notations, the symbol J will be used to denote both the cardinality of the set of all categories to which products may belong and the cardinal number indexing this very set.

Download English Version:

<https://daneshyari.com/en/article/392132>

Download Persian Version:

<https://daneshyari.com/article/392132>

[Daneshyari.com](https://daneshyari.com)