Omega 38 (2010) 84 – 94

Contents lists available at ScienceDirect

Omega

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

Planning a TV advertising campaign: A crisp multiobjective programming model from fuzzy basic data☆

B. Pérez-Gladish[a,*], I. Gonzalez[b], A. Bilbao-Terol[a], M. Arenas-Parra[a]

[a]Departamento de Economía Cuantitativa, Facultad de Ciencias Económicas de la Universidad de Oviedo, Avda. del Cristo s/n, 33006, Oviedo (Asturias), Spain
[b]Technical University of Valencia (Alcoy School), Spain

ARTICLE INFO

Article history:
Received 12 January 2007
Accepted 30 April 2009
Available online 8 May 2009

Keywords:
Ad impact
Weber and Fechner's logarithmic law
Audience expectation
Budgeting
Multiobjective programming
Fuzzy techniques

ABSTRACT

This paper proposes a crisp two-objective logarithmic programming model to help companies decide their advertising campaigns on TV networks for mature products. Both objectives are: (a) to achieve the highest audience impact and (b) to reduce advertising costs as much as possible. Information input is fuzzily elaborated from statistical data, the fuzzy variables being defuzzified to introduce them into the crisp model. This fuzzy information is elicited by TV experts (often independent consultants). Although these experts know statistical information on audience in the past, they do not fully trust its predictive ability. The approach leads to the strategic advertisement (ad) placement among different broadcasts. Users (often managers of big companies) should inform the analyst about their advertising campaign budget. From Weber and Fechner-based psychological research, the ad impact during the advertising campaign is measured depending on the logarithm of ad repetitions. The crisp two-objective problem is solved by a tradeoff method subject to TV technical constraints. A case study with real world data is developed.

1. Introduction

Decision making supported by mathematical tools can be achieved either using an existing approach or building a specific model tailored to the problem to be solved. This last option is appropriate when no existing approach can be directly applied or accommodated to our environment. Constructing a specific model does not mean overlooking previous methods, theories and results, but articulating them in a coherent structure with new elements and perspectives. In short, such a task is worth it under two conditions, relevance of the environment and serious difficulties to use an existing model adequately. In the TV advertising case addressed in this paper, both conditions hold. Indeed, advertising is a relevant ongoing issue concerning both new and mature products (see [1,2]). In particular, mature products need advertising to keep fit for a long time. Advertising is today a significant policy within the marketing structure of the five "Ps" (product, price, place, positioning and promotion), even adding new "P" strategies, e.g., "purple" (innovation) as suggested by Godin [3]. As to the second condition to justify research on specific models for advertising decision making, our literature search shows that TV commercial advertising is not treated from the Weber and Fechner's law of perception (see Section 2 below), whose articulation requires a new model of logarithmic structure.

This paper pursues the following aims. (i) To estimate an index of audience expectation based on experts' predictions. Although experts know statistical data, they prefer to handle them by fuzzy techniques because the future is not expected to resemble the past mechanically. (ii) To propose a crisp multiobjective logarithmic programming model to allocate companies' advertising budgets among an opportunity set of TV broadcasts. This model is established from the audience expectation fuzzy index above estimated, which will be defuzzified to use it in the crisp multiobjective approach. (iii) To develop a case study in which our theoretical contribution is applied to a real world problem with genuine information on broadcast audience and advertising fees for the three main TV networks currently operating in Spain.

To gain insight into our proposal, let us cite Paurcar-Caceres [4], who maps the management science discourse over the last 35 years in four paradigms: (1) optimisation/normative; (2) interpretative/learning; (3) critical and (4) a post-modern management science approach. Our proposal could be encompassed between the two first paradigms in the middle of the so called "hard" and "soft" OR/MS methods.

☆This article was processed by Associate Editor Stewart.

* Corresponding author. Tel.: +34 985106292.
E-mail addresses: bperez@uniovi.es (B. Pérez-Gladish), eballe@esp.upv.es (I. Gonzalez), ameliab@uniovi.es (A. Bilbao-Terol), mariamar@uniovi.es (M. Arenas-Parra).

0305-0483/$ - see front matter © 2009 Elsevier Ltd. All rights reserved.
doi:10.1016/j.omega.2009.04.004

Any industrial company faced with a TV advertising campaign for mature products is a potential user of the paper, i.e., the decision maker (DM). The proposed model looks appealing to big companies, which systematically choose TV to advertise products such as automobiles, appliances and home chemicals.

As to aim (i), the fuzzy forecasts should be made by TV experts/independent consultants who express their opinions on future audience in vague terms. They consider statistical data on audience as valuable complementary information but not as decisive information for their predictions.

As to aim (ii), the proposed model is new. We build a two-objective logarithmic programming model, namely:

(a) To maximize the advertising campaign impact. This statement relies on psychological research showing that the advertisement (ad) impact on viewers is not proportional to repetitions but proportional to the logarithm of repetitions, due to Weber and Fechner's law of perception and viewers' fatigue [5]. Using fuzzy logic techniques to handle estimations about each broadcast's future audience is here essential to formulate this objective.
(b) To minimize the cost of the campaign. This statement assumes that the cost of advertising on a given broadcast is proportional to the ad repetition on this broadcast.

Moreover, the model includes TV technical constraints. A solution is found by searching for an optimal tradeoff between both objectives, the optimum being approximated on an efficient possibility frontier. It is worth noting that few data are required from the user. One of them is the company's advertising budget.

Concerning aim (iii), the case study on Spanish TV networks uses public documents giving the audience share over the period from October 10th 2002 to February 7th 2003. Available advertising fees of the TV networks are also collected. This case illustrates how independent consultants familiar with TV advertising planning can potentially assist in the promotion management of industrial companies. However, no independent consultant has actually gotten involved in our case study, the fuzzy predictions being here authors' predictions.

The paper is organized as follows. Section 2 is a background that refers to previous concepts and literature. In Section 3, the multiobjective programming model is stated with a detailed analysis of the required information. Section 4 is devoted to the case study, where the proposed method is numerically applied to Spanish TV networks. Results and conclusions put an end to the paper.

2. Background

Previous methodological concepts needed to understand the scope and purpose of the proposed TV advertising programming model are briefly reviewed hereafter. They are: (a) basic psychological experiments concerning ad impacts and (b) some fuzzy notions.

2.1. Psychological experiments

Modeling the TV ad impacts is based on experience. From Weber and Fechner's classical experiments on stimulus and perception, we know that perception (ad impact in our model) increases with the stimulus (company's ad duration, in our model), the increment being governed by the following law:

$$dp = Kds/s \tag{1}$$

where p and s are perception level and stimulus level, while dp and ds are the respective differential increments. Parameter K is a positive constant. Eq. (1) yields:

$$p = K\log(s/s_0) \tag{2}$$

where log means natural logarithm while s_0 is the threshold of stimulus below which there is no perception.

Therefore, ad impacts are governed by a logarithmic law but not by a linear law. Further explanation on these classical results can be found in handbooks and encyclopedias (see for example, http://en.wikipedia.org/wiki/Weber-Fechner_law).

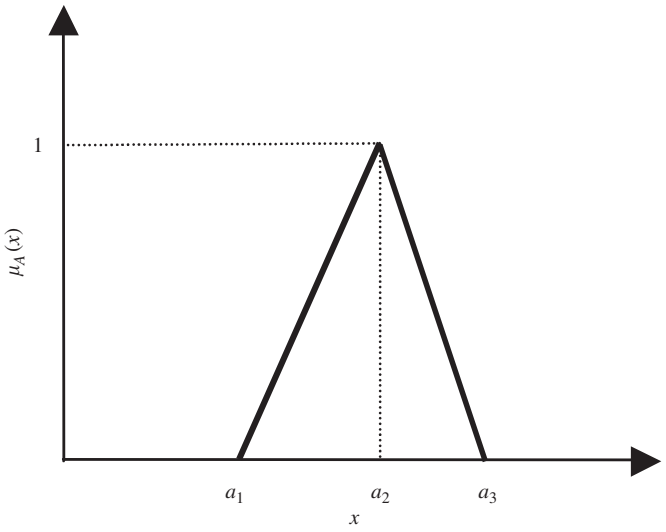

Fig. 1. Triangular fuzzy number membership.

2.2. Some fuzzy notions

As most of these notions are known by readers, we will only recall some concepts to pave the way for the development of the fuzzy treatment in Section 3.

Predicting TV audience ratings is a complex problem. Human capability to understand and analyze imprecise events such as future audience is troublesome indeed. Therefore, experts' subjective judgments are vital elements in evaluating TV advertising strategies. An appropriate method to deal with these imprecise judgments is fuzzy logic. Using statistical data from historical series might help the fuzzy analyst, but statistics is not sufficient to predict in our context. Many experts in the field would argue that several quantitative models might not be reliable due to their assumptions. In our prediction context, using historical data requires an unrealistic assumption that audience will behave in the future as in the past. Fuzzy set theory provides a standard tool to make decisions from imprecise (vague) data and incomplete information.

In this paper, we only use fuzzy numbers, which are a special kind of fuzzy set—a normal fuzzy subset of the real line with upper semi-continuous membership function. There are different classes of fuzzy numbers, but triangular and trapezoidal fuzzy numbers are the most commonly applied to decision making problems. In this paper, we need triangular fuzzy numbers. A triangular fuzzy number is defined by three real numbers, namely, the triplet (a^1, a^2, a^3), where $a^1 < a^2 < a^3$. Central real number a^2 will represent the event with the highest possibility of occurrence. Events lower than a^1 or higher than a^3 have no possibility of occurrence. Events between a^1 and a^3 have a possibility degree of occurrence between zero and one (see Fig. 1). This possibility degree is measured by the membership function $\mu(x)$, where the x argument refers to events. In the triangular fuzzy number, we have $\mu(a^1) = \mu(a^3) = 0$ while $\mu(a^2) = 1$.