KANTTEKENINGEN

AN EMPIRICAL INVESTIGATION OF SOME VARIANTS OF THE ADDITIVE INFORMATION-INTEGRATION MODEL IN A REAL-LIFE CHOICE SITUATION

by

Geert THIERS
and
Bert DE BRABANDER

Leerstoel Bedrijfsbeheer, Rijksuniversitair Centrum Antwerpen

SAMENVATTING — *Een empirisch onderzoek van enkele varianten van het additieve informatie-integratiemodel in een reële keuzesituatie* — Aan het Rijksuniversitair Centrum Antwerpen werd aan een groot aantal studenten de mogelijkheid geboden om deel te nemen aan één van acht verschillende groepsreizen. Het kiezen tussen deze reizen leek ons een goede gelegenheid om bepaalde theoretische beslissingsmodellen te toetsen in een realistische beslissingssituatie. Meer bepaald werden enkele varianten van het additieve informatie-integratiemodel onderzocht. Dit model tracht te beschrijven hoe een individu de verschillende aspecten (dimensies) van een multidimensioneel alternatief (b.v. een reis) combineert tot één globale waarde, waarop hij zijn keuze baseert. Het onderzoek toont aan dat de bestudeerde modelvarianten gemiddeld (over alle ondervraagde individuen) vrij goed voorspellen. Nochtans is het zo dat er belangrijke interindividuele verschillen bestaan wat betreft de predictieve waarde van de modelvarianten.

I. INTRODUCTION

This paper describes an empirical test of some single-stage individual decision models in a situation of choosing between multidimensional alternatives. An opportunity for this investigation was provided when the Belgian government decided to encourage university students to make international professional contacts, by placing at their disposal substantial funds for international study tours. At the university of Antwerp many students were given the opportunity to make a choice between eight different group journeys, which made it possible for us to study individual decision behavior in a real-choice context.

A choice had to be made between eight tours, all of which differed as to their itinerary, tour leading professors, participants, price, time of the year, etc. All tours extended over about two weeks. At the time the students had to decide, they were well informed about some aspects (dimensions) of each alternative, e.g. who was going to lead the tour, but they were less well informed about other aspects, e.g. price, participants and degree of professional interest. The objective values (or their probability distribution) of the alternatives on some dimensions were not or only partially known to the decision makers. As a consequence there was no point in trying to test pro-

babilistic models of any kind. On the other hand the situation was very well suited to test some additive algebraic models of the general form :

$$V_j = f\left(\sum_{k=1}^{n} W_k S_{jk}\right) \qquad [1]$$

where W_k is the relative „weight" value of dimension k, S_{jk} is the „scale" value of alternative j on dimension k and summation is over all n dimensions. V_j is the theoretical value of alternative j, which is assumed to be on a numerical scale. In the simplest case the function f is equal to one.

In fact the additive algebraic model claims to offer a simple explanation of how a decisionmaker integrates the S_{jk}'s into one V_j per alternative i.a. by equalizing V_j to the weighted average of the S_{jk}'s. Therefore it may also be called an integration model, of partial judgments when the S_{jk}'s are subjective values, or of stimulus-information when the S_{jk}'s are objective values. In this article we are only concerned with the integration of partial judgments. A test of the model can never be conclusive with respect to the directions of causality when judgments are at stake. Even when the partial judgments are obtained from the subjects before the global judgment, there is still a possibility that the subjects may first have mentally formulated the global value of the alternatives and then have derived their verbal partial judgments from this. This would be a straightforward instance of the „halo-effect" which would result in a high degree of covariance between the S_{jk}'s over the different alternatives. By a high degree of covariance we mean that the covariance between the verbal judgments is actually greater than the covariance between the perceived values of the alternatives on the different dimensions. This is extremely hard to test. It will be left to the reader to judge whether the intercorrelations between the partial judgments reported are higher than the intercorrelations he would expect between the partial values on the different dimensions studied, as he perceives it, in the set of alternative tours studied. The underlying psychological theory of the additive algebraic model is a well-established concept about the manner in which a conscious and motivated adult chooses among behavioral alternatives. The choice of a suitable behavioral alternative in a given situation is a problem which can best be represented as a means-ends-chain. An adequate formalization of this concept was elaborated by GALBRAITH and CUMMINGS (GALBRAITH & CUMMINGS, 1969, pp. 199-200). They rely heavily on VROOM's earlier work on workmotivation (VROOM 1964). A motivated individual in a choice situation perceives that a number of behavioral alternatives are open to him. These alternatives are-first-level outcomes of his choice. These first-level outcomes entail a number of perceived consequences : the second-level outcomes. Each second-level outcome k has a valence V_k. The first-level outcomes may be considered as more or less effective means to obtain the second-level outcomes. The degree of effectivity with which second-level outcome k is obtained by means of alternative j is called : the instrumentality of j for k i.e. I_{jk}.

The valence of alternative j is then equal to

$$V_j = f\left(\sum_{k=1}^{n} V_k . I_{jk}\right)$$

which is of course equivalent to the general algebraic form [1] when W_k stands for V_k and S_{kj} stands for I_{kj}. This amounts to a translation of the psychological concepts into the more general language of scaling-terminology (a terminology better suited to algebraic operations). The essential feature of the additive algebraic model and consequently of the underlying psychological model is the additivity of the partical expected satisfactions $W_k.S_{jk}$ or $V_kI^j{}_k$ for $k = 1 \ldots n$. The additivity-assumption implies that the decision-maker considers one by one the dimensions of satisfaction he expects to obtain by means of a given behavioral alternative and that he will not attribute any extra-value to combinations of expected satisfaction of different dimensions. Decision-makers who compare alternatives by means of simply added partial expected satisfactions can perhaps be considered partial optimizers. The behavioral decision-theorists have shown that this may be a valid assumption when one is concerned with decision-makers trying to avoid conflicts in a complex multi-person decision-situation (managers of business firms). The question arises whether this simplified model of choice may also be an adequate description of an individual's choices in a rather simple decision-situation.

In our experiment we tested three variants of the additive algebraic model. In the first variant the scale value S_{jk} is simply considered to be equal to the scale value given by the subject : S'_{jk}. In the second model variant S_{jk} is considered to be equal to the difference between S'_{jk} and the subject's „aspiration level" with regard to dimension k. While these models assume that subjects are maximizing „pay-off", they may instead be minimizing „regret". So in the third model variant S_{jk} is considered to be the difference between S'_{jk} and the scale value of the best alternative with regard to dimension k. It is obvious that variants 2 and 3 only differ from variant 1 by a linear transformation of S'_{jk}.

Another factor we wanted to test was the linearity of the scale of S_{jk}, in other words, whether the exponent E of S_{jk} is equal to one. To do this we tested each of the three model variants mentioned above with four different values of E, namely .5, 1. (linear scale), 1.5 and 2.

II. Experiment

Sample

All subjects were students for a master's degree in economics. One hundred usable answers were obtained.

Choice alternatives

The subjects were allowed to choose between eight different tours : Argentina, Mexico A, Mexico B, U.S.A., Chile A, Chile B, Iran, Poland.

Questionnaire

All subjects were confronted with the following list of tour aspects which were of possible relevance to them in choosing between the tours : the climate of the country to be visited, the tour leader and participants, the natural beauty (cenery, flora, fauna, etc...), the cultural and cultural-historical interest of the country, the interest of the tour from a professional point of view, the adventurousness of the tour from a professional point of view, the adventurousness of the tour, the possibility of making acquaintance with the people of another country, the accomodation and conveniences, the expenses. Because these nine dimensions may not be exhaustive, a tenth dimension was called „other aspects".

In order to determine the „weight" value W_k of aspect (dimension) k the subject was asked to indicate for that dimension „how important it was to him" in choosing between tours. The importance (weight) had to be expressed on a 0-100-scale, non relevant dimensions getting zero, maximally important dimensions getting 100. The „scale" value S_{jk} of alternative j on dimension k was obteined by asking the subject how well he expected this alternative (tour j) to satisfy his wishes respect he expected this alternative (tour j) to satisfy his wishes with respect to this dimension (aspect k) regardless of the weight value W_k. The subject was asked to respond on a 0-100-scale, putting zero when he expected the alternative not to satisfy these wishes at all, putting 100 when he expected the tour to satisfy them completely. Moreover, for each dimension the subject was asked to indicate which tours did not satisfy his „minimum wishes", with respect to this dimension, in order to determine his „aspiration level" A_k.

After answering all these questions the subject finally had to decide which of the eight tour he would join. He was also asked to rank all eight tours and to indicate the global „attractiveness" (subjective value) V'_j of each tour on a 0-100-scale.

Model

For each subject the theoretical value of each alternative has been calculated according to the following additive model :

$$V_j = \sum_{k=1}^{10} (W_k S^E_{jk})$$

where V_j = the theoretical value of alternative j.

W_k = the subject's response on a 0-100-scale about the importance to him of dimension k.

S_{jk} = the „scale" value of alternative j with regard to dimension k.

E = the exponent of S_{jk}.

Three variants of this model were tested :

one with :

$$S_{jk} = S'_{jk}$$

where S'_{jk} is the subject's response on a 0-100-scale.

a second with :

$$S_{jk} = S'_{jk} - A_k$$

where A_k is the „aspiration level" of the subject with respect to dimension k. It was considered to be equal to the lowest of all S'_{jk}'s ($j = 1,2,\ldots 8$) that still satisfied the subject's minimum whishes as to dimension k.

a third with :

$$S_{jk} = B_k - S'_{jk}$$

where B_k is the „best" (highest) of all S'_{jk}'s ($j = 1,2 \ldots 8$). In this case S_{jk} can be considered as a measure of „regret" and the best alternative will have the lowest V_j value.

Each model variant was tested for the linearity of the scale of S_{jk} by using four different values of E (.5,1,1.5 and 2). Whatever the value of E, the sign of each term in the summation has been that of S_{jk}, meaning that a negative value of S_{jk} has led to the subtraction of the corresponding $W_i S^E_{jk}$-term, while a positive value of S_{jk} has led to the addition of its corresponding term.

Model variants 2 and 3 are somewhat related to TVERSKY's additive difference model of choice (TVERSKY, 1969), which states that alternative x will be preferred to alternative y if, and only if

$$\sum_{k=1}^{n} f_k \left[U_k(x_k) - U_k(y_k)\right] \geqslant 0$$

where $f_k(-d) = -f_k(d)$ for all k, d being the difference between the two alternatives on dimension k. The difference function f_k determines the contribution of the k'th difference to the overall evaluation. Our model variants 3 and 2, however, suggest that alternative x is compared to the best, respectively worst but still acceptable, alternative on each dimension. This latter alternative can differ for each dimension. More information about additive and additive difference models, as well as about most other individual decision models, can be found in excellent review articles by J. W. PAYNE (1973) as well as by P. SLOVIC and Sarah LICHTENSTEIN (1971).

Results and discussion

A comparison of the tour actually selected by the subject with the tour having the best value V_j according to the model, did not yield a significant difference between any of the model variants or exponents.

TABLE 1

Number of subjects (total = 100) having their actual choice correctly predicted by the additive model.

Model variant / Exponent E	Variant 1 ($S_{jk} = S'_{jk}$)	Variant 2 ($S_{jk} = S'_{jk}—A_k$)	Variant 3 ($S_{jk} = B_k—S'_{jk}$)
5	69	69	69
1*		70	
1.5	70	70	72
2	71	69	72

* For E = 1 the three model variants only differ by a constant.

Instead of comparing only the alternative selected by the model with that selected by the subject, we can compare the subject's evaluation of the overall attractiveness V'_j of all alternatives with the theoretical values V_j ($j = 1 \ldots 8$) obtained by means of the model. The degree of relationship between V_j and V'_j is indicated by the product-moment correlation coefficient. This coefficient has been calculated for each combination of model variant and exponent.

TABLE 2

Distribution of the subjects according to their highest correlation coefficient.

Model variant / Exponent E	Variant 1 ($S_{jk} = S'_{jk}$)	Variant 2 ($S_{jk} = S'_{jk}—A_k$)	Variant 3 ($S_{jk} = B_k—S'_{jk}$)	Σ
.5	9	26	12	47
1*		2		2
1.5	3	2	5	10
2	9	12	20	41
Σ	21 + ⅔	40 + ⅔	37 + ⅔	100

* For E = 1 the three model variants only differ by a constant.

For all of the combinations the average (of all subjects) correlation coefficient was rather high, ranging from .80 to .86. Differences between subjects were, however, often large. Table 2 shows for each combination of model variant and exponent the number of subjects for which the highest correlation coefficient was obtained with this combination.

About one half of the answers (47 %) best fit a model in which the exponent E of the scale value S_{jk} is less than one, while the other half (51 %) better fit a model with exponent E greater than one. Only 2 % of the answers best fit a simple linear scale ($E = 1$) for S_{jk}. This means that there may be important individual factors affecting the way in which individuals integrate subjective component values (W_k, S'_{jk}) to obtain the subjective global attractiveness V'_j of a multi-dimensional alternative. The former half ($E = .5$) of the subjects seem to be attaching relatively less importance to large scale values than to small ones, while the latter half ($E = 1.5$ or 2) seem to be doing the opposite.

Table 2 also shows that model variants 1 and 2 get almost the same score (40 % of the subjects), while model variant 1 only gets 20 %. There also seems to be some interaction between exponent and model variants, the highest scores being obtained by variant 2 with exponent .5 on one hand, and by variant 3 with exponents 1.5 and 2 on the other. These results suggest that subjects which minimize „regret" (model variant 3) are tending to attach relatively more importance to large „regret"-values than to small ones, while subjects which are maximizing „pay-off" (with respect to their component „aspiration levels", i.e. model variant 2) tend to attach relatively less importance to large pay-off's than to small ones. Perhaps pay-off maximizers are more concerned about the mere fact that the scale value S_{jk} of alternative j is better than their aspiration level A_k than about the amount by which it is better. The distribution of the average intercorrelations (using EBEL's formula, cf. GUILFORD, 1954, pp. 395-397) between the S_{jk}'s of the 8 alternatives expressed by 20 randomly chosen subjects (out of the total group of 100) are depicted in table 3.

TABLE 3

Distribution of the average intercorrelations between the S'_{jk}'s of 20 randomly chosen subjects.

Intercorrelation	0-.19	.20-.39	.40-.59	.60-.79	.80-1.00
Number of Subjects	3	7	6	3	1

The wide dispersion suggests that there may be important interindividual differences in the possible „halo-effect". Taking the median of $r = 0.395$ as a measure of the central tendency it can be estimated that the covariance

among partial judgments amounts to ± 16% in most of the cases, a figure which, in our opinion, does certainly not point to an overwhelming influence of the global judgment upon the partial judgments.

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