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## Conjoint measurement of individual preference functions: some tests of validity

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*Summary.* This article reports on the results of some validity tests on the additive and multiplicative conjoint measurement models in the context of spatial shopping behaviour. The findings of the study suggest that these models can successfully describe consumer decision-making under hypothetical situations and that utility measurements obtained under hypothetical circumstances are positively related to utility scores expressed for real world shopping centres.

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Behavioural geography has prompted geographers to examine the appropriateness of psychological measurement models for describing individual decision-making processes in spatial contexts. One such model, which has been examined in the context of spatial shopping behaviour (Prosperi and Schuler, 1976; Schuler and Prosperi, 1978; Schuler, 1979), is the conjoint measurement model. It is concerned with simultaneously measuring the joint effect of two or more independent variables on the ordering of the dependent variable (Krantz, 1964; Krantz and Tversky, 1971; Luce and Tukey, 1964). Basically, it involves the derivation of part-worth utilities for the levels of the independent variables, such that the ordering of the joint effects of a prespecified composition rule is as monotonic with the manifest order relations in the dependent variable as possible. That is, when using nonmetric conjoint measurement respondents are typically requested to rank order a set of stimulus combinations, which are designed according to some factorial or fractional factorial design. Next, scale values or part-worth utilities are derived for each level of each stimulus in such a way that the combined effect of these scale values is as nearly monotonic as possible with the observed rank ordering of the respondent. A measure called stress is commonly used to measure the departure of the predicted rank ordering from the observed rank ordering of the stimulus combinations. A low stress-value indicates a good fit of the scaling solutions. Several combination rules such as a linear or a multiplicative rule may be used to measure the joint effect of the stimuli. (For further details see Timmermans, 1980).

Although conjoint measurement represents a valuable step forward in our ability to study individual decision-making processes, several unresolved methodological issues are related to the application of this type of measurement in studying consumer choice behaviour. In a previous article published in this journal, Timmermans (1980) has drawn attention to such issues as the inclusion of relevant attributes, the assumption of independence of attributes and the diagnostic ability of conjoint measurement to distinguish between alternative rules of decision-making. It was concluded that systematic tests of validity in a variety of spatial and behavioural contexts are needed in order to assess more adequately the potentials of conjoint measurement models in geographical research.

Following this suggestion, the aim of the present article is to assess the validity of nonmetric conjoint measurement models in accounting for subjects' evaluations of hypothetical shopping centres. More specifically, this article reports on a study

designed to investigate whether a) either an additive or a multiplicative model can be employed successfully as a representation of the nature of individual decision-making in hypothetical situations, b) the part-worth utilities which are derived by non-metric conjoint measurement models are monotonic in *a priori* hypothesised directions and c) the utility scales obtained in hypothetical situations using conjoint measurement models are systematically related to overall utility scores of real world shopping centres which are gathered by using rating scales.

### Method

The study area selected for the present analysis was the Woensel District of Eindhoven. Within this area 13 shopping centres (zones) can be distinguished. These shopping centres vary considerably in terms of size, age, morphology and lay-out.

The data for this study were obtained in the summer of 1980 from a sample of 91 housewives. All interviews were conducted on a personally administrated basis by trained interviewers. The sample was quite diverse in terms of the subjects' socio-economic and demographic characteristics.

The interviewers collected a variety of data from the subjects, but for the following analysis only some of the data are relevant. Firstly, each subject was asked to express her degree of preference for each of 27 hypothetical shopping centres. Thus, the stimuli for the conjoint measurement analyses consisted of 27 hypothetical shopping centres. Each stimulus described a three-attribute profile. The attributes used in the study were number of shops, travel time to shopping centre and parking. The choice of these attributes was dictated by the results of a previous analysis in which the repertory grid methodology and the factor listing approach had been used to identify the factors influencing consumer destination choice in the context of buying durable goods (Timmermans *et al.*, 1982). Each attribute was varied over three levels: number of shops varied from small, through medium to large, travel times varied over 5, 25 and 45 minutes and parking varied over 4, 12 and 20 minutes search time to find a free parking lot. The levels of the three attributes were combined into a  $3 \times 3 \times 3$  factorial design to yield the 27 hypothetical shopping centres. Each combination of these factors appeared on an index card. Each subject was asked first to sort the index cards into three ordered categories of preference and to rank the cards within each category from most preferred to least preferred. Finally, each subject was asked to ascertain that the resulting rank ordering of the hypothetical shopping centres was correct. Otherwise, shifting cards across categories was allowed.

Secondly, each subject was requested to express her overall evaluation of each of the 13 shopping centres in Woensel on a 1-100 mm graphic rating scale, ranging from extremely bad to excellent. The subject was asked first to examine all 13 shopping centres. Then she was asked to select the shopping centre for which her evaluation was best. She was then asked to evaluate the remaining 12 shopping centres on the rating scale relative to her evaluation of the most preferred shopping centre. Where the subject did not possess any knowledge about a particular shopping centre she was asked not to evaluate it in order to avoid bias in the measurements. In fact subjects rarely evaluated more than six shopping centres, as might be expected given the results of recent studies of consumer information fields (e.g. Potter, 1977, 1979).

### Analysis and results

The first step in the analysis was to test the adequacy of the additive and the multiplicative model to represent the nature of an individual's decision making process in the

hypothetical context. The additive model implies that a subject's overall utility for the stimuli can be represented by the sum of the part-worth utilities defined on the attribute levels. The multiplicative model assumes that a subject's overall utility can be decomposed as the product of the part-worth utilities. To test these competing models each subject's preference ranking of the 27 hypothetical shopping centres was submitted individually to Roskam's UNICON algorithm (Roskam, 1974). UNICON finds the set of part-worth utilities, given the hypothesised representational model, such that the predicted ordering of the stimuli is as monotonic as possible with the observed rank ordering. This is accomplished by iteratively adjusting trial scale values until a badness of fit measure, called stress, is minimised. Since this process may land in a local minimum solution, the iteration procedure was repeated twice starting from different trial points in the parameter space. In this way it is possible to check whether the solutions converge to the same scale values. Obviously, a second iteration does not guarantee a global solution.

The adequacy of the additive and multiplicative conjoint measurement models was assessed by examining their stress values and by seeing if the derived part-worth utilities were monotonic in anticipated directions. The results of this analysis indicated that the rank ordering of 32 subjects was represented best by the additive model, implying that the multiplicative model yielded the lowest stress values for the remaining 59 subjects. Table 1 gives a tabulation of the lowest stress value associated with each subject's rank ordering of the 27 shopping centres. The Table clearly shows that all subjects display acceptably low stress values. The highest stress value is 0.020, the average stress value is only 0.004. A total of 40 of the 91 subjects exhibit a stress value of 0.0000, indicating that the applied conjoint measurement model is capable of fully reproducing the subject's rank ordering of the hypothetical shopping centres.

Table 1. Frequency distribution of stress values

Stress value (s)	Total number of subjects	Percentage of total sample
$0.000 \leq s < 0.004$	66	72.5
$0.004 \leq s < 0.008$	10	11.0
$0.008 \leq s < 0.012$	4	4.4
$0.012 \leq s < 0.016$	8	8.8
$0.016 \leq s < 0.020$	3	3.3
Total	N=91	100.0

In assessing the adequacy of the conjoint measurement models the derived part-worth utilities of each subject's preference functions were also examined for monotonicity in hypothesised directions. It was found that all part-worth utility functions of all subjects were monotonic in anticipated directions. That is, the results of the analysis showed that the part-worth utilities invariably increase with increases in the number of shops and parking capacity of the shopping centres and decrease with increases in the distance to the shopping centres.

The next step in the analysis was to test whether the utility functions derived from the conjoint measurement analyses were systematically related to the subjects'

expressed overall evaluation scores for the 13 shopping centres in Woensel. This step necessitates that each of the 13 real world shopping centres is defined in terms of the three attributes which have been used to characterise the hypothetical shopping centres in the experiment. The part-worth utility scores of the continuous attributes for each of the 13 shopping centres were obtained by intrapolating the fitted parameter values of each subject's preference function. This intrapolation was based upon the subjective travel time and evaluation of the parking facilities as expressed by each subject. Overall predicted utility scores of each shopping centre were computed by summing or multiplying the (intrapolated) part-worth utility scores, depending on the nature of the conjoint measurement model which represented a subject's rank ordering of the hypothetical shopping centres most successfully. If a subject did not possess any knowledge about a particular shopping centre no overall predicted utility score was computed. Thus, this procedure resulted for each subject in a predicted and an expressed overall utility (evaluation) score for each shopping centre about which she possessed knowledge.

The relationship between these predicted and expressed utility scores was examined by calculating Spearman's rank order correlation coefficient for each subject. Table 2 shows a frequency tabulation of the resulting correlation coefficients. This table indicates that generally the predicted utility scores were reasonably monotonic with the expressed utility scores. Only a total of six of the 91 subjects exhibited rank correlations of less than 0.4; 70.3% of the subjects evidenced rank correlation coefficients exceeding 0.8. Thus, it might be concluded that the utility scores obtained in hypothetical settings using nonmetric conjoint measurement models are in general closely related to expressed utility scores for real world shopping centres.

A final analysis was concerned with the question of whether the derived utility scores were *linearly* related to the expressed utility scores. To answer this question each of the predicted utility scores was correlated with each subject's expressed utility scores of the shopping centres in Woensel using Pearson's product-moment correlation coefficient. The results of the analysis are shown in Table 3, and as can be seen, the predicted utility scores generally appear to be related to the expressed utility scores in a reasonably linear fashion. Only a total of six of the 91 subjects exhibit correlations less than 0.4; 70.3% of the subjects experience correlations of 0.6 or more. This result would imply that both measures of utility are interchangeable as independent variables in a mathematical model of consumer spatial choice behaviour.

Table 2. Frequency distribution of Spearman's rank correlation coefficients between derived and expressed utilities

Value (Rs)	Total number of subjects	Percentage of total sample
0.8 < Rs ≤ 1.00	64	70.3
0.6 < Rs ≤ 0.8	12	13.2
0.4 < Rs ≤ 0.6	9	9.9
0.2 < Rs ≤ 0.4	2	2.2
0.0 < Rs ≤ 0.2	1	1.1
≤ 0.0	3	3.3
Total	N=91	100.0

Table 3. Frequency distribution of Pearson's product-moment correlation coefficients between derived and expressed utilities

Value (r)	Total number of subjects	Percentage of total sample
0.8 < r ≤ 1.00	47	51.6
0.6 < r ≤ 0.8	17	18.7
0.4 < r ≤ 0.6	21	23.1
0.2 < r ≤ 0.4	4	4.4
0.0 < r ≤ 0.2	1	1.1
r ≤ 0	1	1.1
Total	N=91	100.0

### Conclusions

The basic purpose of the present study was to assess the validity of conjoint measurement models as representations of the nature of individual decision-making processes in the context of spatial shopping behaviour. The findings of the study suggest that either an additive or a multiplicative model can be used successfully to portray the way in which individuals appear to combine part-worth utilities defined on attribute levels of multi-attribute choice alternatives to arrive at an overall utility or preference measure, at least in the context of spatial shopping behaviour in Woensel. In general the obtained stress-values are acceptably low and the fitted scale values are monotonic in *a priori* anticipated directions. Additionally, a test of external validity indicated that the utility scores obtained in a hypothetical setting using conjoint measurements are in general closely and linearly related to expressed utility scores for real world shopping centres. The most important implication following from these conclusions appears to be that the results of conjoint measurements in hypothetical contexts may be used as independent variables in predictive models of real world consumer choice behaviour. Such an approach assumes that overall utility scores obtained from conjoint measurements can be related to consumer choice probabilities. Subsequent papers will attempt to address this issue.

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## Rural development

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*Report of a symposium organised by the International Geographical Union Commission on Rural Development, held in Mexico City, 16-20 May 1983*

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About 35 participants, the majority of them Mexicans, attended this symposium organised by Silvana Levi de López and sponsored by the Institute of Geography of the National Autonomous University of Mexico. The Palace of Mining, an imposing building in the city centre, provided the venue for the formal part of the conference; this in itself was a considerable relief to the nine visiting participants because of the distance to University City (with a current student population of 300,000) and the almost insurmountable problems of traffic congestion.

Of the 22 papers scheduled for the first three days only 15 materialised, perhaps as well in view of the fact that the majority of papers markedly overran the allocated half hour. There being no central theme running through the proceedings, papers tended to fall into two categories, viz. those given by Mexican academics on themes such as 'The agricultural crisis in Mexico' and those presented by participants from overseas on a wide range of topics. These included: 'Rural development versus resource development: a study of coal hauling in Indiana County, Pennsylvania' (G. Kulkarni, USA/India); 'Rural planning in arid lands—a case study of Egypt' (E. Kedar, USA); 'Modernisation and changes in traditional land occupation systems in the Brazilian northeastern sertão' (J. A. F. Diniz, Brazil); 'Women's agricultural work in São Paulo state' (R. E. Rossini, Brazil); 'The economic and social impact of tobacco farming in a specific region of Costa Rica' (J. M. Miranda, The Economist Intelligence Unit, UK) and 'Conflicting values in community change: some reflections on rural development in Bolivia's Lake Titicaca region' (J. M. Benton, UK).

Lively and fruitful questioning and discussion followed most of the papers but the lack of an integral theme and a plenary session was felt by some participants to be a shortcoming. At the end of the conference those Commission members present held a meeting to consider the future of the Rural Development Commission: the consensus of opinion was that it should not be dissolved after the normal life span of eight years because it provides an invaluable forum for international, comparative approaches to rural development issues.

The final two days of the conference were devoted to a varied and fascinating rural excursion arranged by the Institute of Geography. Participants visited an *ejido*, where they were given an opportunity to talk with *ejidatarios*: after a walk around the archaeological ruins at Xochicalco, the night was spent in the beautiful colonial silver town of Taxco. The following day's highlights included a visit to the Emiliano Zapata sugar mill at Zacatepec, where those from cooler climes found a working temperature approaching 45°C somewhat daunting! A guided tour of University City completed the programme.

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