Non-compensatory decision rules and consumer spatial choice behavior : a test of predictive ability

NON-COMPENSATORY DECISION RULES AND CONSUMER SPATIAL CHOICE BEHAVIOR: A TEST OF PREDICTIVE ABILITY*

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Two major possible shortcomings of existing spatial choice models are addressed: the inclusion of distance as a monotonically decreasing utility function and the use of compensatory utility-maximizing composition rules. A conceptual framework is outlined incorporating distance as a spatial constraint and non-compensatory composition rule. The findings of a case study which evaluates the predictive ability of this approach suggest that these rules perform satisfactorily, although less so than compensatory rules. **Key Words: non-compensatory composition rules, spatial shopping behavior, spatial constraints.**

This paper is a preliminary investigation regarding the predictive ability of some non-compensatory decision rules within the context of consumer choice of shopping centers. I consider it is a question of scientific interest to study the effects of alternative conceptualizations and hence model specifications of spatial choice processes. The research stems from two possible shortcomings of existing spatial choice models which predict the probability that an individual will select an alternative from among the set of all possible alternatives: (1) by relating choice probabilities in some way to a preselected set of objective or subjective attributes of the alternatives [*1, 2, 3*] or (2) by using multinomial logit models on the basis of Luce's choice theory or Lancaster's consumption theory [*4*]. First, most of the above models include a distance variable, which is considered to be a monotonically decreasing part-worth utility function. That is, it is assumed that the probability of choosing an alternative is an ever decreasing function of the distance between the location of the decision maker and the location of the choice alternatives, ceteris paribus. That distance is being included into the models reflects its assumed relevance to spatial decision making strategies, however, this tradition is somewhat at variance with the findings of empirical research on factors influencing consumer decision making. Potter [*12*] and Timmermans [*14*] found that distance was not held to be very important by the majority of consumers, a result confirmed by Schuler [*13*] who concluded, using conjoint measurements, that only 61 percent of the respondents had monotonically

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decreasing distance scales. These research findings suggest that we might reconsider the role of the distance factor in the context of consumer spatial decision making. It might be that distance does not enter the decision making process as a variable, decreasing the probability that an alternative will be chosen, but rather as a spatial constraint within which a locational choice will be made [cf.5].

An alternative conceptualization of the distance factor in consumer decision making is that a consumer is indifferent toward an increase in distance within the zone of indifference. Distance is then no longer considered as a factor which contributes to the overall utility of an alternative, but rather as one of the constraints which define the choice sets of individuals. Also, given this schema, it becomes relevant to reconsider the specifications of the utility functions. Spatial choice models derivable from strict or random utility theory assume that the part-worth utilities of the separate attributes composing the utility function are linear additive, while the logistic form of most models is obtained by assuming, among others, utility maximizing choice rules for every individual. Empirical results [*2, 13, 15*] indicate that the linear additive composition rule performs well whenever the predictor variables have conditionally monotone relationships to the dependent variable. Other authors, however, have argued that spatial decision making processes are described even better by multiplicative rules [*8, 9, 10, 16*], indicating that if one of the part-worth utilities goes to zero the overall utility will also be very low. Given these contrasting rules, it is evident that more empirical research is needed to identify the circumstances in which a particular composition rule performs best. Such research should not restrict itself to additive and multiplicative rules but should also include non-compensatory composition rules. The idea that the distance factor may have a categorical effect as a constraint is in agreement with this characteristic of non-compensatory decision rules.

A Conceptual Framework

Consider a spatially distributed population of N different individuals, located on fixed points in space, and a set of K shopping centers $S = \{S_1, \ldots, S_K\}$, also in fixed locations. Each shopping center can be characterized in terms of m ($m \geq 2$) attributes; it can be described as the ordered m-tuple

$$x = (x_1, x_2, \ldots, x_j, \ldots, x_m)$$

where x_j represents the level of shopping center x on the j-th attribute. Each individual is supposed to choose a particular shopping center from among the total set of K shopping centers. The problem is how the decision making strategy of the individual may be modeled.

It is suggested that this decision making task involves the formation of a choice set and the specification of a decision rule by which the separate utilities of the attributes are combined to arrive at a choice. It is evident that not all K shopping centers are considered for patronage by an individual consumer. First, the choice set is constrained by the consumer's information field [*7, 11*]; such shopping centers are not evaluated. Second, I assume that the choice set of a consumer is constrained by the idea of "reasonable travel time," which reflects a willingness to travel in order to buy a particular item. Thus, distance separation between the location of an individual consumer and the shopping center is not considered to be a disutility, but a spatial constraint. A more realistic postulate of spatial shopping behavior is assumed, that of spatial indifference. Within this indifference zone, indicated by the consumer's idea of a reasonable travel time, shopping centers are evaluated only in terms of their nonlocational attributes.

The decision rule is a procedure by which the subjective information is processed in order to arrive at a choice [6]. Several rules developed in psychology, decision theory and marketing research are applicable. Well known in geography are the compensatory rules, such as the linear additive rule, which indicates that low values on some attribute can be compensated for by high values on one or more of the other attributes. Compensatory rules assume that a single utility value is attached to each choice alternative. Non-compensatory rules do not admit trade-offs between the relevant attributes of the choice alternatives as they assume decisions are made on an attribute-by-attribute basis and that the separate utilities are not combined into a single utility value.

Perhaps the best known non-compensatory decision rule is Tversky's [17] elimination-by-aspects model which states that the processing of the subjective information regarding the attributes of the choice alternatives proceeds sequentially. Shopping centers are first ranked according to an attribute, which is chosen with a probability proportional to its relative importance. All shopping centers below some value on this attribute are then eliminated from the choice set. This process proceeds sequentially using different attributes until all shopping centers are ranked and a single shopping center remains.

An alternative decision rule is the lexicographic rule which also assumes that the decision making process proceeds sequentially. Shopping centers are first ranked on the basis of the most important attribute. If a single shopping center exhibits the highest evaluation or utility score on this attribute, it will be chosen. However, if some shopping centers are tied on the most important attribute, the process proceeds to the next important attribute. This process proceeds sequentially using different attributes until all shopping centers are ranked and a single shopping center remains.

In contrast to the elimination-by-aspects model and the lexicographic decision rule, dominance, conjunctive and disjunctive decision rules do not involve a sequential decisionmaking process. A dominance rule states that a shopping center will be chosen if it is evaluated more positively than all others on all attributes. A conjunctive rule implies that each shopping center which fails to meet a minimum value on each attribute will be eliminated from the choice set. The disjunctive decision rule involves an evaluation of the shopping centers on the basis of maximum rather than minimum values on each attribute. Only shopping centers which meet or exceed at least one of these maximum values are accepted for further consideration. Conjunctive and disjunctive decision rules will therefore not generally result in unique choices, however, they can be used as the first phase of a two-phase decision process. For example, in the second phase a compensatory decision rule or another disjunctive/conjunctive rule with more stringent criteria of acceptability could be used. In case of a conjunctive rule the worst attribute is vital whereas in a disjunctive rule the best attribute of a choice alternative becomes vital.

An Empirical Analysis

General Considerations

A serious methodological problem in assessing the validity of non-compensatory decision rules is that the nature of the mental decision making process must be inferred from observed processes. Several methods exist, ranging from laboratory experiments to comparisons of predictive choices with observed choices; each has its own advantages and drawbacks. Therefore, much research involving various analytical methods and designs is needed to identify the circumstances in which a particular decision rule may be applied validly. A necessary condition, though,

seems to be that a particular decision rule gives a satisfactory prediction of observed choice behavior. It must be emphasized that a satisfactory predictive ability of a decision rule is only a necessary, not a sufficient, condition for validity because various decision rules may account almost equally well for observed choice behavior. If it turns out that the predictive ability of a particular decision rule is insufficient, it might be wasteful to devote greater efforts to develop more sophisticated research designs for testing the validity of alternative decision rules.

Bearing the above in mind, the predictive ability of the conjunctive, the disjunctive and the lexicographic decision rule was tested within the context of consumer choice of shopping centers for shopping goods in Kempenland, the Netherlands. Testing the conjunctive and disjunctive decision rules requires subjective data on the minimum and maximum levels of acceptability for each relevant attribute of shopping centers. Since these data were not gathered in the survey, it is assumed that consumers will choose the shopping center with the highest evaluation score on the relevant attribute. This is obviously a very specific interpretation of conjunctive and disjunctive decision rules, implying that the results on the basis of these rules are rather conservative. Relaxation of this operational decision will probably result in more satisfactory predictions. Conjunctive and disjunctive rules implicitly assume that the relevant attributes are equally important for a consumer's decision making task. It is also assumed that the importance weight a consumer attaches to an attribute is reflected in its level of acceptability. Because data on the levels of acceptability were unavailable, conjunctive and disjunctive models were tested which have the evaluation scores for each attribute weighted with corresponding subjective relative importance scores as input. The dominance decision rule was not tested because no such shopping center exists in the study area. The elimination-by-aspects decision rule was not tested because no laboratory data were available.

Data Collection

Data were obtained from a randomly selected sample in seventeen settlements in Kempenland in the southern part of the country, a typical agricultural region with many small villages, each with its own shopping center. Three higher order centers outside the study area were identified. The study area has approximately 15,000 households. The data were collected through personal interviews with 771 households during June 1978. The sample is considered representative of the population. The households were randomly selected from municipal population registers which contain information about the location of the households. All interviews took place at the respondents' homes. The person responsible for shopping, mainly the wife, was interviewed. The survey was conducted by interviewers hired locally and trained in the office of the regional planning agency. The interviewers told the respondents that they were conducting a survey to obtain information for the design of better shopping facilities in the Kempenland area. Respondents were asked to express the time they were willing to travel in order to purchase goods. These scores were taken as an operationalization of the concept "reasonable travel time." Also, scores on the respondents' familiarity with the shopping centers were obtained. The combined scores on the reasonable travel times and the information fields yielded the respondent's constrained choice set. A typical constrained choice set consisted of four to five shopping centers. Respondents were also asked to evaluate the shopping centers within their choice set on the eleven attributes listed in Table 1. These attributes were obtained from an initial extensive list, developed during interviews in a pilot study, and a limited examination of the relevant literature. Respondents were asked both to evaluate the shopping centers on a nine point rating scale

TABLE 1

THE SELECTED SET OF SHOPPING CENTER ATTRIBUTES

Parking facilities	Quality of the goods
Hindrance of traffic	Choice range in goods
Distances between shops	Quality of service
Availability of specialty shops	Window display
Availability of superstores	Number of shops
Prices of the goods	

ranging from extremely bad to excellent and to evaluate the relative importance of the selected attributes. A pairwise comparison design, with one constant attribute as a reference item, was employed.

Respondents were asked to allocate ten points to the two attributes in correspondence with the importance they assign to the first attribute as compared with the reference attribute. Data were gathered in this manner for three replications with different reference items. Relative importance scores were obtained by transforming the data to the same scale range and then by calculating geometric means of the scores in the three replications. Respondents with low correlations between their individual scales were eliminated from the final analysis. Finally, the respondents were asked to specify their frequency of visiting the shopping centers included in the analysis. The most frequently visited shopping center was assumed to be the most preferred.

Results

The results, presented in Table 2, illustrate that the lowest proportion of correct predictions occurs for the lexicographic decision rule. The highest proportion of correct predictions was obtained for the conjunctive decision rule; it gave a correct prediction of the spatial choice behavior of 57 percent of the sample respondents compared to only 39 percent for the lexicographic rule. This difference in proportions is statistically significant at the .05 level. This result implies that more respondents appear to base their behavior on some minimum acceptable levels defined on the attributes of the choice alternatives than on a screening of the choice alternatives on the most important attribute. It merits mention that the predictive ability of lexicographic decision rules is relatively highly influenced by the accuracy of the measurement model, that is, capitalizes on the most important attribute. Thus small

TABLE 2

PREDICTIVE ABILITY OF THE DECISION RULES

Decision rule	Proportion
Conjunctive (unweighted)	.57
Conjunctive (weighted)	.55
Disjunctive (unweighted)	.52
Disjunctive (weighted)	.48
Lexicographic	.39
Additive (unweighted)	.78
Additive (weighted)	.77
Multiplicative (unweighted)	.78
Multiplicative (weighted)	.77

Source: [14].

inaccuracies in measuring importance weights, possibly due to chance mechanisms, might result in a wrong prediction of choice behavior. The probability of such a wrong prediction evidently will increase as the number of almost equally important attributes increases. On the other hand, it might be expected that the conjunctive and disjunctive decision rules capitalize more on those attributes for which profound differences exist between the shopping centers. If this is true, the probability of a wrong prediction might be lower.

The unweighted versions of the conjunctive and disjunctive decision rules perform better than their weighted counterparts, although the differences in predicted proportions are not statistically significant at the .05 probability level (Table 2). This result suggests that in general importance weights are monotonically related to subjective evaluation scores. The proportion of correct predictions for all decision rules is also higher than would be expected by chance. It follows that some systematic relationship exists between a consumer's evaluations of attributes of shopping centers and choice behavior. The results in Table 2 suggest that the decision making process of at least some consumers may be described adequately by non-compensatory decision rules. Further research using more sophisticated designs is needed because my previous work [*14*] has suggested that the additive and multiplicative rules account quite acceptably for the choice process of consumers. In fact, the proportion of correct predictions for the additive and multiplicative rules even exceeded that for the non-compensatory rules (Table 2). The result here implies that most consumers do not arrive at a choice by evaluating the shopping centers in their choice set according to some non-compensatory rule, but rather by integrating their separate evaluations into some overall evaluation score. It appears that at least in the present case consumer decision making encompasses elements of trade-off.

Conclusions

This empirical study offers an exploratory investigation of the predictive ability of non-compensatory decision rules in the context of consumer choice of shopping centers. The results indicated that the predictive ability of these rules, is satisfactory, although less than that of compensatory rules at least in predicting the shopping center a consumer will choose for buying shopping goods. To obtain a clearer understanding of the decision making involved additional research must be conducted in which consumer decision making is simulated in experimental settings.

This study has also indicated an alternative way in which the distance variable might be included in existing spatial choice models. The idea of reasonable travel times is consistent with the main assumptions of non-compensatory decision rules. Distance separation is not considered to be a disutility variable in a trade-off process but a criterion on the basis of which shopping centers are screened for possible patronage. The concept of "reasonable travel time" is in agreement with the postulate of spatial indifference.

Literature Cited

1. Burnett, P. "The Dimensions of Alternatives in Spatial Choice Processes." *Geographical Analysis,* 5 (1973), 181–204.
2. Cadwallader, M. "A Behavioral Model of Consumer Spatial Decision-Making." *Economic Geography,* 51 (1975), 339–349.
3. Cole, H. S. D. "A Computer Model for the Comparison of Alternative Foodstuffs Shopping Environments." *Socio-Economic Planning Sciences,* 6 (1972), 329–348.
4. Domencich, T. and D. McFadden, *Urban Travel Demand: A Behavioral Analysis.* Amsterdam: North Holland Publishing Co., 1976.
5. Getis, A. "Residential Location and the Journey to Work." *Proceedings of the Association of American Geographers,* 1 (1969), 55–59.
6. Green, P. E. and Y. Wind. *Multiattribute Decisions in Marketing.* Hinsdale, IL: The Dryden Press, 1973.

7. Hanson, S. "Spatial Variation in the Cognitive Levels of Urban Residents." In *Spatial Choice and Spatial Behavior,* pp. 157–177. Edited by R. G. Golledge and G. Rushton. Columbus: Ohio State University Press, 1976.
8. Louviere, J. J. and R. J. Meyer. "Behavioral Analysis of Destination Choice." *Technical Report 112.* Iowa City: Institute of Urban and Regional Research, University of Iowa, 1979.
9. ——— et al. "Theory and Empirical Evidence in Real-World Studies of Human Judgment: Three Shopping Behavior Examples." *Research Paper 1.* Laramie, WY: Center for Behavioral Studies, Institute for Policy Research, University of Wyoming, 1977.
10. ——— and E. Wilson. "Predicting Consumer Response in Travel Analysis." *Transportation Planning and Technology,* 4 (1978), 1–9.
11. Potter, R. B. "Perception of Urban Retailing Facilities: An Analysis of Consumer Information Fields." *Geografiska Annaler B,* 61 (1979), 19–29.
12. ———. "Factors Influencing Consumer Decision-Making." *Psychological Reports,* 44 (1979), 674.
13. Schuler, H. J. "A Disaggregate Store-Choice Model of Spatial Decision-Making." *Professional Geographer,* 31 (1979), 146–156.
14. Timmermans, H. J. P. "Consumer Spatial Choice Strategies: A Comparative Study of Some Alternative Behavioural Spatial Shopping Models." *Geoforum,* 11 (1980), 123–131.
15. ———. "Unidimensional Conjoint Measurement Models and Consumer Decision-Making." *Area,* 12 (1980), 291–300.
16. ———. "Consumer Choice of Shopping Centre: An Information Integration Approach." *Regional Studies,* 16 (1982), 171–183.
17. Tversky, A. "Choice by Elimination." *Journal of Mathematical Psychology,* 9 (1972), 341–367.

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