COMPOSITIONAL ATTITUDE MODELS AND NON-IIA MODELS IN SHOPPING CENTER CHOICES

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Traditionally, the problem of consumer choice of shopping center has been addressed by using revealed preference models. This means that the actual choices observed in real markets were used to estimate choice models, which allow one to predict future shopping choice. However, especially in cities where the dominant shopping center is the city center, such data present some typical problems to the modeller. The most important of these is that a large share of the consumers will have to travel a relative long distance to reach this shopping center. Consequently, the parameters of a choice model, based on revealed prefer data, may have a positive distance parameter, suggesting that people prefer to travel longer distances. In reality, however, either consumers may be relatively indifferent within some distance band, or such a finding does not reflect preferences, but is the result of strong multicollinearity in the data.

To circumvent this problem, stated preference models of shopping center choice have been developed. At least, two diverging approaches can be identified in this regard. The first approach is the so-called compositional approach, which means that preferences for a shopping center are calculated by measuring individuals' attitudes of judgements about the attributes of a shopping center, which are subsequently combined according to some combination rule to arrive at an overall preference. Different rules can be used. The second approach is the so-called decompositional approach. In this case, hypothetical profiles of shopping centers are created and individuals are asked to express some degree of preference for the profiles. These overall preferences are then decomposed into the partworth utilities of the shopping centers. If one wishes to predict choice, for both approaches, the derived preference functions need to be linked to choice rules. For the second approach, however, choice designs can be used which allow one to measure choices directly. In that case, the profiles are positioned into choice sets. Choices for a series of choice sets are typically modelled in terms of a multinomial logit model. This model is characterised by the so-called IIA property, which states that the probability of choosing a particular shopping center is independent from the composition of the choice set. This assumption may be unrealistic in the sense that more similar shopping centers may compete stronger for the same market. To either test the IIA-assumption or estimate a non-IIA model, the multinomial logit model needs to be replaced by the universal logit model, which assumes that the utility of a particular choice alternative is not only influenced by its characteristics but also by the characteristic of other alternatives in the choice sets (so-called cross-effects). If indeed these cross-effects are significant, there is evidence that the IIA-property is violated.

This paper briefly described two case studies of shopping center choice. The first study represents and example of the compositional approach, the second study is an example of a non-IIA model.

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1. CASE STUDY 1: COMPOSITIONAL MODELS

1.1 Aim

This study was conducted to assess the performance of different compensatory and non-compensatory decision rules in consumer choice of shopping center.

1.2 Conceptual Framework

The following framework was used. Shopping centers can be characterised in terms of a set fo attributes. Consumers evaluate each of these attributes and arrive at some overall preference, which subject to constraints constitutes the basis for their choice. The choice set of a consumer is assumed to be constrained by the idea of "reasonable travel time," which reflects a willingness to travel in order to buy a particular item. 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.

A decision rule is a procedure by which the subjective information is processed in order to arrive at a choice. Several rules can be applied. Compensatory rules, such as the linear additive rule, indicate that low values on some attribute can be compensated 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 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 wilt be chosen. However, if same 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 decision making process. A dominance rule states that a shopping center wilt be chosen if it is evaluated more positively than alt others on alt 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 wilt 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.

1.3 Data

Data were obtained from a randomly selected sample in seventeen settlements in Kempenland in the southern part of the Netherlands, 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 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. 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. Respondents were asked to evaluate the shopping centers on a nine point rating scale 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.

Table 1. 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

1.4 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 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.

Table 2. Predictive success of 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

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 same 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 same consumers may be described adequately by non-compensatory decision rules. However, the proportion of correct predictions for the additive and multiplicative rules exceeds that of the non-compensatory rules. Thus, its seems 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 same overall evaluation score. It appears that at least in the present case consumer decision making encompasses elements of trade-off.

2. CASE STUDY 2: NON-IIA MODELS

2.1 Aim

The aim of the second case study was to estimate a non-IIA model of consumer choice of shopping center. At the same time, this represents a test of the validity of the commonly used multinomial logit model.

2.2 Conceptual framework

Similarly to the first case study, it is assumed that consumers arrive at some choice by integrating their evaluations of attributes. Commonly, a multinomial logit model is assumed.

However, this model will not be valid if any of the following assumptions are violated:

- the error terms of the utility function are independently and identically distributed;
- a choice alternative's utility is a function of its attributes only and not a function of the attributes of other alternatives in the choice set; and
- individuals process the attributes of interest simultaneously and not sequentially or
- hierarchically.

Various non-IIA models have been developed by relaxing any of these assumptions. Some non-IIA models allow for different variances and covariances among the error terms of the utility function. A second class of models avoids IIA by explicitly including some measure of (dis)similarity in the alternatives utility functions. These models differ mainly in the specification of the similarity component. The third class of models circuments the IIA property by assuming hierarchical or sequential decision making processes. The best-known of these models are the elimination by aspects model and its preference tree version and the nested logit model.

In this study, a universal logit model was used, estimated from experimental design data. The estimation of a universal logit model requires one to design choice sets such that both the attribute correlations within and between choice alternatives are orthogonal. Respondents select from each choice set the shopping center they like best or possibly estimate the proportion of their total trips or expenditure that they would be likely to allocate to each choice alternative. The choices or allocations typically are aggregated into frequency counts across respondents to estimate choice probabilities. The universal logit model is then estimated using these choice frequencies.

The IIA (or constant cross-substitution) property implies that pairwise choice probabilities will be independent of the presence of or variation in the attributes of other choice alternatives in consumer choice sets. Hence, an approach to avoid the IIA property is to create choice experiments that allow the utility of a choice alternative to depend upon the presence/absence of other options or changes in the attributes of the other alternatives in the choice set.

The mother logit model represents a generalization of conventional MNL models in that the utility of choice alternatives depends not only upon their attributes, but also upon the attributes of other alternatives in the choice set. Technically, this is accomplished by including additional constants and attribute effects in the specification of the utility function. These so-called cross-effects represent corrections on the utilities as predicted by the conventional MNL model to account for differences in choice set composition (e.g., competition, agglomeration, etc.). Significant cross-effects imply violations of the IIA property. Negative cross-effects indicate that the utility (hence, market share) of an alternative is significantly lower than that predicted by the IIA model (e.g., due to similarity or substitution effects), whereas positive cross-effects indicate that an alternative's utility is significantly underestimated by the IIA model and should be corrected upwards (e.g., due to agglomeration or complementary effects). Both types of effects may violate the regularity condition of conventional MNL models.

2.3 Data

The model was estimated for a planning case concerning the two major municipalities in the Eindhoven region of The Netherlands: Eindhoven and Veldhoven. Both municipalities have developed proposals to improve the attractiveness of their main shopping centers. These proposals resulted from collaboration among commercial developers, retailers, and municipal planning authorities. In the Eindhoven case, consideration was being given to whether to build a new in-town shopping complex on a former hospital site. The complex would be integrated with a new music hall and abundant parking spaces in an underground parking garage. In the Veldhoven case, the municipality had just given approval for a major clothing store to operate in a former library. In addition, they were developing plans to improve the accessibility of the main shopping center by creating additional parking spaces. The present research project was concerned with predicting how the actions of competing shopping centers would affect the shopping choices of consumers in the specific neighborhood in the municipality of Veldhoven. The data were collected in September 1988 based on random sample of 158 respondents who were responsible for shopping.

The choice experiment was developed as follows. First, the consumers' typical choice set was identified. Consumers in the study area mainly chose among 3 shopping centers: Veldhoven-city-center, Eindhoven-city-center and Veldhoven-Burgemeester van Hoofflaan (a neighborhood center). Next, for each shopping center, a separate set of possible actions was envisaged. The actions for "Veldhoven-city-center" were: 1)10% increase of total ftoorspace; and 2) a 10% extension of the number of parking spaces. Possible actions for "Eindhoven-city-center" were: 1) a new major in-town hypermarket located close to the market square; 2) a 15% increase of parking costs; 3) 600 additional underground parking spaces; and 4) a 10% increase in floorspace for shops.

The actions for "Burgemeester van Hoofftaan" consisted of: 1) a diversification of shop types; 2) pedestrianization of a shopping street; and 3) the opening of a major appliance store. Each action was assigned 2 levels: it could be implemented or not. A fraction of the 2^9 factorial was constructed to represent different combinations of actions. This design produced 16 choice sets consisting of a description of a combination of actions that each shopping center might take. The choice of "any other shopping center" was added to each choice set as a fourth option. Respondents evaluated each of the 16 choice sets. They were asked to allocate a fixed number of shopping trips among the 3 shopping centers and "any other" if the actions described in each choice set were to occur. Order of appearance of choice sets was randomized across respondents.

<u>2.4 Results</u>
Individual trip allocations were aggregated across respondents to yield choice frequency data. Parameter estimates for the universal logit model are presented in Table 3. Table 3 indicates that all main effects are statistically significant beyond the 5% probability level. The alternative-specific intercept is highest for "Burgemeester van Hoofflaan" shopping center and lowest for Eindhoven city center, which reflects respondents' tendency to shop less in Eindhoven. The opening of a magnet store seems to exert the most positive influence on "Eindhoven city-center" attractiveness, followed by creation of additional parking facilities and a 10% increase in retail floorspace. The parameter associated with a 15% increase in parking costs suggests that this policy would decrease the center's attractiveness and market share.

Table 3 also shows that an increase of the amount of retail ftoorspace would improve the attractiveness of the "Veldhoven city-center," and increasing the amount of parking by 10%, although positive, is not statistically significant. Finally, the attractiveness of the Burgemeester van Hoofflaan would seem to benefit most from a diversification policy, followed by opening a major appliances store. Restricting this shopping street to pedestrians negatively affects its attractiveness, but the effect is not statistically significant at the 5% probability level.

The choice experiment only allowed the estimation of interaction effects for Eindhoven city-center. Table 3 shows that only 2 interaction effects are statistically significant: 1) the interaction between the opening of a magnet store and a 10% increase of floorspace for retailing; and 2) the interaction between 600 additional parking spaces and a 10% increase in retail floorspace. The former interaction effect bas a negative sign, which is surprising because one usually assumes that shopping center attractiveness increases with increases in both additional floorspace and number of magnet stores.

This result suggests that there may be a saturation point in shopping center attractiveness for this study area.

Table 3. Parameter Estimates and t Values of the Universal Logit Model.

Attribute	Parameter Estimate	t Value
Eindhoven city center (EHV)		
Alt. specific coefficients	-1.3433	215.1309
Main effects		
1. Opening magnet store	0.0335	5.3705
2. 15% increase parking costs --	0.0300	4.8108
3. 600 additional parking spaces	0.0193	3.0858
4. 10% increase retail floorspace	0.0159	2.5406
Interaction effects		
1 x 2	-0.0040	-0.7063
1 x 3	0.0051	0.8946
1 x 4	-0.0118	-2.0739
2 x 3	0.0041	0.7202
2 x 4	-0.0042	-0.7419
3 x 4	0.0119	2.0914
Veldhoven city center (VCC)		
Alt. specific coefficients	0.7094	230.7770
Main effects		
10% increase floorspace	0.0241	7.0239
10% more parking spaces	0.0037	1.0693
Burgemeester van Hoofflaan (BvH)		
Alt. specific coefficients	0.9623	288.0714
Main effects		
Diversification of shops	0.1388	41.5503
Pedestrianization	- 0.0054	-1.6108
Opening appliances store	0.0401	12.0019

Table 4. Cross-effects.

Cross effects	Parameter estimate	t-value
BvH diversification on EHV	0.0275	4.4109
BvH diversification on VCC	-0.0233	-6.8106
BvH appliance store on VCC	-0.0190	-5.5610

Table 4 reports the estimated cross-effects. It shows that only 3 cross-effects that were significant at the 0.05 alpha level. A diversification policy in "Burgemeester van Hoofflaan" has a less than proportional effect on Eindhoven city-center, but a more than proportional effect on "Velhoven city center." Likewise, the opening of a major appliances store in "Burgemeester van Hoofflaan" decreases the attractiveness of "Veldhoven city-center" proportionally more than expected under the simple MNL model. Hence, the cross-effects provide useful information regarding substitution effects among these shopping centers.

The analysis involves assessing the goodness-of-fit of the estimated model. The estimated parameters were used to predict the choice probabilities for each choice set and the expected market share of the shopping centers. These predictions were then compared with observed choice data in the real world. First, model predictions were compared with observed choices under experimental conditions. As expected, the universal logit model reproduced the observed choices very well. The correlation coefficient is 0.999; Robinson's agreement measure, which depicts the degree of deviance from a perfect linear relation through the origin, is 1.0; the standardized root mean square is 0.02 and the standardized mean absolute error is only 0.016. Data on observed choices were obtained by asking respondents where they shop. Consumer choices were predicted by the universal logit model and compared with these observed choices. Although the goodness-of-fit was slightly lower in this case, the measures were still very high. For example, the Pearson correlation coefficient was 0.983, Robinson's agreement measure was 0.99, the standardized root mean square was 0.127, and the standardized mean absolute error was only 0.127.

3. CONCLUSIONS

This paper has pulled together two case studies of modelling consumer choice of shopping center. The first study explored the use of compositional attitude models; the second used a complex conjoint choice experiments to estimate a non-IIA choice model. The case studies illustrate the typical characteristics of the two modelling approaches. The compositional approach involves a simple data collection process that does not require a lot of expertise. Individual level models can be developed and a variety of decision rules can be tested. It also shows however that the modelling approach is not very sophisticated.

In contrast, the conjoint approach is much more sophisticated. It requires considerable expertise on constructing the experimental design and on applying an appropriate statistical technique. The approach is much more rigorous and allows one to test assumptions underlying the model. However, the case study also shows that one cannot compare alternative choice models, except for nested ones: in this study, additive versus nonadditive utility functions to the extent that interactions are estimable, and MNL versus universal logit model. In that sense, when designing a conjoint-based study, it is recommendation to construct a larger experiment that allows one to test a larger number of effects, including cross effects because it means that one does not have to rely on perhaps too simplistic assumptions related to the multinomial logit model or to the specification of the utility function. Significant cross-effects implies that a non-IIA model is required. Similarly, significant interaction effects are indicative of a nonadditive utility function.