Retail environments and spatial shopping behavior

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CHAPTER 14

Retail Environments and Spatial Shopping Behavior

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The interplay between aspects of retail environments and consumer spatial shopping behavior has traditionally been an area of major concern in geography, urban planning and related disciplines. It reflects an interest in explaining the relationship between locational and nonlocational attributes of stores or shopping centers and consumer choice behavior either for theory development or as a fundamental component of planning models that are used to predict the likely impact of retail planning decisions on consumer behavior and store performance measures. The purpose of this chapter is to review this literature to evaluate the state of the art and identify future research directions. The chapter focuses on both theo-retical and empirical studies involving analytical as well as modeling approaches.

The chapter is organized into seven major sections. The second section presents a conceptual framework underlying most research on consumer shopping behavior. This is followed by discussions of analytical studies of consumer perception and cognition, attitudes and preference structures, and choice of shopping centers in sections 3, 4, and 5, respectively. The sixth section traces the development of predictive models of store or shopping center choice. Finally, some directions for future research are discussed.

A Conceptual Framework of Consumer Spatial Decision Making in Retail Environments

Over the years a number of different conceptualizations of consumer decision making and choice processes has been suggested in the literature. While there are some clear differences between them, they nevertheless share a set of common elements (Timmermans, 1982). Spatial shopping behavior is considered to be the outcome of an individual decision making process. Individuals are assumed to choose a single alternative from a choice set such as to optimize individual welfare or utility. Each shopping alternative is characterized by a set of objective attributes. Individuals attach some utility value to each of these attributes, given the decision problem at hand and their values, motivations, information levels, etc. It is assumed that individuals have perceptions of the objective attributes. This perceptive act typically involves a subjective filtering based upon imperfect information, the result of which is a cognitive space. It is assumed that individuals are only familiar with a subset of the shopping alternatives. Moreover, it is assumed that individual decision making is based upon only a few, not necessarily perfectly known attributes. It is assumed that this cognitive space rather than the objective physical space determines individual choice behavior.

Individuals are assumed to discriminate between the shopping alternatives on the basis of a set of attributes. They are assumed to combine their evaluations of the attributes according to some utility function which they use to form an overall evaluation of the shopping alternatives. This involves a subjective weighting and results in a subjective preference scale on which the shopping alternatives are positioned. Finally, individuals are assumed to use some decision rule to relate their preferences to actual choice behavior. Often, it is assumed that individuals will choose the shopping alternative with the highest preference, but more sophisticated, probabilistic rules have been suggested as well.

Different conceptualizations may differ on some aspects, but as will become evident in subsequent sections, most analytical studies and mathematical models of consumer spatial shopping behavior address components of this conceptual framework, or even strictly adhere to it.

Consumer Perception and Cognition of Retail Environments

Analysis of the perception of stores or shopping centers has received considerable attention in the retailing literature. Different approaches to the measurement of retail images have been applied (Jenkins & Forsyth, 1980; Marks, 1976), the most important of which are a univariate analysis of respondents' evaluations of the attributes of the stores or centers, a multivariate analysis of respondents' evaluations of stores or centers, and a multivariate analysis of similarity or perceptual proximity data. The univariate analyses typically result in direct descriptions of the shopping alternatives. The aim of most of the multivariate analyses has been to identify the basic dimensions underlying the perception of retailing structures.

One of the first geographic studies in this tradition in the literature was conducted by Garner (1968) who examined 17 female students' attitudes towards 10 clothing stores in Bristol using the semantic differential technique. Another study on the cognitive dimensions of retailing alternatives was conducted in Sydney by Burnett (1973). The aim of her study was to determine the attributes of stores relevant to consumer choice behavior and to incorporate these attributes into a general cognitive-behavioral theory of spatial choice processes.

In terms of research design, Burnett's study should be viewed as an important step forward in measuring consumer perception of retailing structures. The main advantage of this approach is that respondents are not requested to respond to a set of attributes a priori selected by the researcher. In contrast, the aim is to identify the constructs used by the respondents when ranking the shopping centers in terms of overall preference. This approach therefore became the standard in the late 1970s. Other studies conducted along similar lines can be found amongst others in Singson (1975), and Spencer (1978, 1980).

Although multidimensional scaling was considered a more valid approach compared to the semantic differential technique in analyzing consumer perceptions of retailing structures, the approach still had one major drawback: the interpretation of the constructs was still largely subjective. To avoid this subjectivity, some researchers used the repertory grid to identify the dimensions underlying the perception of shopping centers. The method is based on Kelly's personal construct theory (Kelly, 1955) who assumes that individuals base their decisions on conceptual models of reality. These models are strictly personal. The repertory grid (e.g., Downs, 1970; Fransella & Bannister, 1977; Hudson, 1974) involves presenting real-world objects in triads and asking respondents in what way two objects are alike and thereby different from the third object. Once the constructs are obtained, the objects may be positioned on each construct using rating scales. Standard multivariate techniques may be used to analyze the data. Hudson (1974) was one of the first to use the repertory grid in a retailing context, while Timmermans, van der Heijden and Westerveld (1982a, 1982b) applied the repertory grid to analyze consumers' cognitions of a shopping center. The results reconfirmed the basic findings obtained in earlier studies. The repertory grid technique has found increasing popularity since these initial studies (e.g., Coshall, 1985; Hallsworth, 1985; Opacic & Potter, 1986).

Recently, Louviere and Johnson (1990) suggested using conjoint measurement to examine retail images. They used store names as the levels of the attributes of interest. The positioning of the stores can be accounted for by describing the attributes such as "prices like x", "service like y", etc. Respondents are then asked to express their opinion about the resulting profile. A model that represents the way in which respondents arrive at such overall opinions, often a linear additive model, is assumed. These data are then analyzed using multiple regression analysis. The approach was illustrated in a study of supermarket images in Edmonton, Canada. Their results indicated that consumers' perceptions were primarily driven by price differences, followed by selection, convenience, quality and friendliness. The market shares predicted by the model proved to be consistently, monotonically related to the market shares observed in a follow-up survey. The result was replicated in a second study (Louviere & Johnson, 1990). This so-called brand-anchored conjoint analysis approach seems to be very promising in the study of retail image.

A specific aspect of perception concerns the issue whether consumers know the various shopping centers in their environment. Consumers are generally not familiar with all shopping opportunities in their direct environment, nor will they patronize them all. The concepts "spatial informational field" (Potter, 1979; Smith, 1976) and "awareness space" (Horton & Reynolds, 1971) have been suggested to express the notion that consumers will only be familiar with a subset of shopping opportunities within a zone. Likewise, concepts such as activity space, action space, and spatial usage field have been introduced to identify the subset of shopping opportunities a consumer actually patronizes.

Smith (1976) examined two properties of spatial information fields: the total number of supermarkets a consumer is familiar with and the average distance between a consumer's residence and the locations of the known shops. He concluded that the number of years at the present address and social status were important variables explaining variability in spatial information fields. Hanson (1977) also concluded that consumers have limited information about shopping opportunities and that this information is unequally distributed across urban space. The level of information tends to drop with increasing distance from one's residence, albeit not symmetrically. The spatial distribution of the stores tends to have an effect on information levels; stores located in areas of a higher density are better known. Potter (1977) arrived at similar conclusions, as did Timmermans, van der Heijden, & Westerveld (1982c). Consumer information fields also tend to be reasonably predictable (van der Heijden & Timmermans, 1984).

Consumer Attitudes and Preference Structures for Retail Environments

In our conceptual framework, we explicitly distinguished a phase of preference formation in consumer decision making. While this may have some analytical advantages, it should be noted that it is difficult to find studies in the retailing literature that are restricted to consumer attitudes or preferences per se. In most cases, the measurement of attitudes or preference is part of a wider approach that attempts to relate them to subsequent choice behavior. For example, while Rushton's (1969) preference scaling model was originally focused at deriving preference scales from overt shopping patterns, his approach was later extended into a model of choice behavior. Likewise, while conjoint measurement has been used to analyze consumer preferences (see, e.g., Timmermans, 1980b), these measurement can be linked to overt shopping behavior to generate a model that can be used for impact assessment and predictions of consumer spatial shopping behavior.

The majority of the seminal research on consumer attitudes has relied on attitude statements and rating scales. Jonassen (1955), for example, examined attitudes towards downtown versus suburban shopping by asking shoppers to indicate how much they agreed or disagreed with various statements on a five point rating scale. Williams (1981) used 27 attitude statements that expressed a particular aspect of shopping predispositions. Three groups of consumers were identified on the basis of these data. Group 1 had a predominantly economic character. The second group comprised the social aspects of shopping, while the third group was made up of two statements which related to limited time available for shopping. These attitude statements appeared to be related to aspects of shopping choice behavior (see also Ezell & Russell, 1985).

Over the years, more studies have adopted the attitudinal theories developed by Rosenberg and Fishbein. Attitudes are held to be a function of the strength of beliefs about a store or shopping center and an evaluation of these beliefs. A typical example of the approach is given in James, Durand, and Dreves (1976) who tested the predictive ability of the multi-attribute attitude model with respect to men's clothing stores. Six attributes were selected: assortment, personnel, atmosphere, service, quality, and price. Respondents were asked to rate each of these six attributes on a seven point scale in terms of importance. They were also requested to evaluate each store along each attribute. Attitudinal scores were then computed and a preference ranking derived. Traditionally, studies in this tradition have adopted this straightforward methodology.

More recently, structural equation models have grown in popularity (e.g., Korgaonkar, Lund, & Price, 1985).

Consumer Spatial Shopping Behavior: Empirical Regularities

Underlying most studies of spatial shopping behavior is the assumption that the utility consumers derive from a shopping opportunity is a function of the attractiveness of that opportunity and some distance factor. If it is assumed that the functional relationship between a shopping center's utility and some combination of attractiveness and distance is multiplicative, the above notion can be expressed as

$$U_{ij} = A_j^{\alpha} D_{ij}^{-\beta} \quad (1),$$

where U_{ij} is the utility of shopping opportunity *j* for consumers located at *i*; A_j is the attractiveness of the *j*-th opportunity, D_{ij} is the distance between *i* and *j*, and α and β are parameters ($\alpha + \beta = 1$). It should be noted that the assumption of a multiplicative functional relationship is not crucial for the subsequent discussion. There is, however some empirical evidence (e.g., Louviere & Wilson, 1978) supporting this assumption.

Two extreme postulates of spatial shopping behavior can be derived from equation (1). If it is assumed that $\alpha = 0$, a consumer's utility for a shopping center is determined only by distance. If, in addition, it is assumed that consumers maximize their utility, they will invariably choose the nearest shopping opportunity. This is the case of distance-minimizing behavior. In contrast, if it is assumed that $\beta = 0$, and hence $\alpha = 1$, utility will depend on attractiveness only. Again, if utility-maximizing behavior is assumed, consumers will choose the shopping opportunity with the highest attractiveness. This is the case of spatial indifference.

The postulate of distance-minimizing behavior has been subject of empirical verification, especially in the context of central place theory. According to this postulate, consumers will choose the nearest store or shopping center that offers the required good. Therefore, this postulate was often referred to as the nearest town hypothesis (Clark & Rushton, 1970; Golledge, Rushton, & Clark, 1966; Rushton, Clark, & Golledge, 1967). The validity of this postulate was tested both at the interurban and intraurban level. It did not get much empirical support at the interurban scale, except that a few studies indicated that the distance-minimizing postulate might have some empirical validity in developing countries (Lentnek, Lieber, & Sheskin, 1975; Lentnek, Charnews, & Cotter, 1978;

Wood, 1974). Rushton et al. (1967) concluded that in Iowa only 35% of all trips to grocery stores were made to the nearest center.

Surprisingly, the results obtained at the intraurban scale are less consistent. Tennant (1962) and Brush and Gauthier (1968) concluded that consumer shopping behavior in Chicago and Philadelphia, respectively, was generally consistent with the postulate of distance-minimizing behavior. In contrast, Marble (1959) found in Cedar Rapids and Sussex respectively, that the postulate of distance-minimizing behavior does not describe spatial shopping behavior very well.

The lack of empirical support for the nearest-center postulate led some researchers to introduce different concepts for explaining consumer spatial shopping behavior. Some authors suggested that it is not distance per se that is of interest, but rather the difference or ratio between the distance to a shopping opportunity and the distance to the nearest opportunity. Clark and Rushton (1970), for example, found that the greater the distance to the nearest shopping opportunity, the less the impact of distance on consumer choice. Others suggested that consumers are inclined to choose other than the nearest shopping opportunity if distance is compensated by higher attractiveness as exemplified by, for example, lower prices or larger assortment. This very assumption is consistent with the assumptions underlying models of spatial consumer behavior reviewed below.

The most extreme concept in this respect is that of spatial indifference which suggests that distance does not have an impact at all on consumer choice, but rather that choice is dictated only by attractiveness considerations. The postulate of spatial indifference is however very difficult to operationalize. Perhaps one of the few real attempts to test the validity of this postulate can be found in Timmermans (1980a). He found that the overall subjective evaluation of the attractiveness of shopping areas correctly predicted 70% of shopping destination choices. The concept of reasonable travel time was used to measure a zone of spatial indifference (Timmermans, 1979, 1980a) to reflect the notion that at least within certain limits, distance does not affect consumer spatial choice behavior. Thus, although very few studies indeed have attempted to test the validity of the postulate of spatial indifference, there is ample empirical evidence suggesting that the attractiveness of shopping opportunities has some influence on consumer shopping choice behavior (e.g., Hudson, 1976; Wood, 1974).

Predictive Models of Consumer Spatial Shopping Behavior

Spatial Interaction Models

Urban planning and geography have traditionally been concerned with predicting the impact of new retailing developments on the existing retail structure. Especially in many European countries, planning authorities ask for information on the likely effects of changes in the retail environment in order to reach intelligent decisions regarding approval of new retail proposals. The predictions typically concern the impact new developments would probably have on turnover levels in existing shopping centers, consumer satisfaction, and accessibility of shopping centers. In general, approval for new developments is granted only if there would be no adverse effects.

The most widely used models are the spatial interaction models. The first applications of this type of model appeared in the late 1950s and early 1960s. Spatial interaction models, and especially the gravity model, were developed in analogy with Newton's law of gravity which states that the gravitational force or interaction between two bodies of masses m_1 and m_2 and a distance d_{12} between them equals

$$F_{ij} = \frac{Km_1m_2}{d_{12}^2} \qquad (2).$$

Underlying spatial interaction models is the analogous assumption that the share of customers that a shopping center attracts from its environment is inversely proportional to distance and proportional to the attractiveness of the shopping center. This is consistent with Reilly's Law of Retail Gravitation (Reilly, 1931), further developed and confined by Converse (1949). The gravity principle was used to delimit retail market areas. It was assumed that two cities attract customers from an intermediate town in direct proportion to the populations of the two cities and in inverse proportion to the squares of the distances from these two cities to the intermediate town.

In the early 1960s, the focus of interest shifted from the delimitation of market areas to probabilities of interaction. Huff (1963, 1964) was one of the first to propose a spatial interaction model for predicting shopping trips. He suggested that the probability of choosing a shopping center is positively related to its size and decreases with some function of distance. Although this formulation is consistent with the gravity principle, Huff used Luce's choice axiom to derive his model. Luce's axiom states that when faced with several choice alternatives, the probability of an individual choosing a particular alternative is equal to the ratio of the utility of that alternative to the sum of the utilities of all alternatives considered by the individual. Applied to the problem of choice of shopping centers, this axiom implies that the probability of a consumer visiting a particular shopping center is equal to the ratio of the utility of that store to the sum of utilities of all the stores considered by the consumer:

$$p_{ij} = \frac{F_j \ / \ d_{ij}^{\beta}}{\sum_{j'} F_{j'} \ / \ d_{ij'}^{\beta}} \qquad (3),$$

where p_{ij} is the probability of a consumer at i visiting shopping center j, F_j is a measure of attractiveness of shopping center j, d_{ij} is the distance between i, and j, and $\beta$is a distance decay parameter. Utility is thus conceptualized as a trade-off between attractiveness and distance decay. Attractiveness in turn was measured in Huff's model as a function of size.

Working independently, Lakshmanan and Hansen (1965) modified a traffic model to arrive at a similar model of spatial shopping behavior. Although much empirical work has been conducted on spatial interaction models in the context of shopping behavior since this seminal work, no major conceptual breakthroughs have been achieved. Instead, most of the relevant literature concerned problems of application and operational definitions. For example, different measures of distance and attractiveness have been suggested. Distance has been measured as straight-line distance, city-block distances, or as travel time. Likewise, attractiveness has been measured as square footage of retail space, number of establishments, etc. (see, e.g., Haines, Simon, & Alexis, 1972). In the early applications, attractiveness was typically measured by a single surrogate indicator, representing some objective measure of shopping center size. However, attractiveness is a multidimensional concept (e.g., Nevin & Houston, 1980), while, in addition, people may have imperfect impressions of these objective attributes. In order to deal with this problem, Stanley and Sewall (1976), for example, used a multidimensional scaling procedure to incorporate the effect of differing store images. This significantly improved predictive performance. Gautschi (1981) found that including additional measures of accessibility (such as availability of mass transit) in addition to image also improved the model's predictive performance. Likewise, different functions for representing the distance decay effect have been proposed. Power, exponential, and even more complex functions have been used to represent distance separation effects.

The traditional version of the spatial interaction model assumed that the probability of choosing a shopping center is proportional to its attractiveness. Later versions of the model, however, included an exponent in the specification of attractiveness to allow for the fact that the larger shopping centers tend to have an extra level of attraction beyond their greater size because of the increase in choice of goods and benefits of economies of scale.

The estimation of spatial interaction models is typically based upon aggregate, zonal data of shopping flows. Once the study area is delineated carefully to avoid large external flows, the area is divided into a number of smaller zones which are as homogeneous as possible in their demographic and socioeconomic characteristics. Consumer shopping patterns are then observed for this zonal system. The spatial interaction model is calibrated using these observations of shopping trips among the zones. This involves finding the parameter values of the spatial interaction model that provide the best fit between the observed spatial pattern of shopping trips in the study area and the pattern of trips predicted by the model. These parameter values are typically derived using iterative optimalization methods that systematically evaluate different combinations of parameter values to find the ones that give the best fit between actual and predicted trip patterns (see, e.g., Stetzer, 1976). A multitude of goodness-of-fit statistics is available to quantify the correspondence between observed and predicted flows (Timmermans & Borgers, 1985b). Much of the literature in the 1960s and 1970s has dealt with these operational problems of design of the zoning system, model calibration and goodness-of-fit. The conceptual underpinnings of the models did not change however.

Wilson (1967, 1971) improved the theoretical underpinnings of the spatial interaction models by deriving an entropy-maximizing interpretation. He showed that the spatial interaction model is consistent with principles of entropy-maximization if the distance decay function is exponential. Consequently, for some time, most shopping models based upon the spatial interaction model used this formalization (see, e.g., Gibson & Pullen, 1972), whereas many previous models used a power function (see, e.g., Murray & Kennedy, 1971; Turner, 1970). Other authors supplied different ad hoc theoretical underpinnings of the spatial interaction model. Some conceptualized travel costs as a constraint (e.g., Niedercorn & Bechdolt, 1969), or as a negative stimulus (Golob & Beckmann, 1971; Nijkamp, 1975; Smith, 1976). Still others derived the spatial interaction model from psychological theories of choice behavior (Smith, 1975; Okabe, 1975). Although this improved the basis of these models substantially, many applied researchers were not attracted by these ad hoc rationalizations (Williams, 1977; Sheppard, 1978). Especially the fact that the model was still based on zonal orientation patterns and the finding that parameters of the spatial interaction model were highly influenced by the geometry of the study area (see, e.g., Cliff, Martin, & Ord, 1976; Curry, 1972; Ewing, 1974; Sheppard, 1979a, 1979b; Sheppard, Griffith, & Curry, 1976) caused a search for improvements of the model, or even for different modelling approaches based on different assumptions. A simple improvement is to use the ratio of distances to the closest and farthest shopping centers or stores as a measure of distance separation (Ghosh, 1984; Timmermans & Veldhuisen, 1979). This has led some authors to derive models that estimate the effect of attraction variables endogenously (Baxter, 1979; Baxter & Ewing, 1979; Cesario, 1975, 1976; Ewing, 1978). Hence, these models do not include attraction variables, but rather an attraction parameter. In a separate modelling step, the estimated attractiveness terms are regressed on a series of variables that are assumed to account for the attractiveness of the destination. To some extent, these models represent an attempt to derive attractiveness independently of spatial structure. Most of these models have however not been applied in a retailing context with the exception of the model suggested by Timmermans and Veldhuisen (1979). This is not to say that there are any reasons why these models cannot be applied to problems of spatial shopping behavior.

Another way of dealing with this problem was to incorporate some measure of spatial structure into a spatial interaction model. The so-called competing destinations model, originally suggested by Fotheringham (1983) to study migration, but later also applied in a retailing context (Fotheringham, 1988a; Guy, 1987) is based on this notion. When applied to spatial shopping behavior, the choice behavior of interest is conceptualized as a hierarchical choice process in which individuals first select a part of their environment or a shopping center, and then select the shopping center within that environment or a store within a shopping center. This hierarchical choice process is modelled by incorporating the accessibility of a shopping alternative to all the other potential shopping alternatives in the attractiveness argument. The simplest approach to the specification of this additional term is the use of a Hansen-type accessibility measure. The competing destinations model was with applied mixed results by Guy (1987) to data on food and grocery shopping behavior in the Cardiff area. The improvement in fit over a conventional spatial interaction model was small but led to improvements in the aggregated predictions of shopping flows. However, the sign of the parameter was counterintuitive in that shopping centers facing greater competition tend to attract more trade. Thus, agglomeration effects appeared to be present, which is unexpected for food and grocery shopping. Including a competing destinations term on origin-specific distance decay estimates resulted in more negative distance decay parameters. This finding was at variance with that of Fotheringham (1983), suggesting that more research is needed into the application of the competing destinations model to spatial shopping behavior.

The versions of the spatial interaction model discussed in this section are all static. This field of study gained a new impetus by Wilson's attempts to develop dynamic models (see, e.g., Wilson, 1988). This was done by adding a submodel of retailer behavior. The revenues, D_j, at a particular site are known from the spatial interaction model. If the costs, C_j of supplying facilities at site j are given, the total amount of floorspace at j is assumed to grow; and vice versa. Equilibrium exists if revenues at site j equal retailer's cost. This specification led to some important insights (Harris & Wilson, 1978). There is a global equilibrium which maximizes consumer surplus, but there are also other stable equilibria. It can also be shown (Wilson & Oulton, 1983) that small parameter changes may lead to jumps in the type of patterns of critical parameter values. A formal dynamic representation of the basic hypothesis is:

$$W_j^{\cdot} = \epsilon \; (D_j - c_j) \; F(W_j) \qquad (4)$$

where $W_{\cdot j}$ is the rate of change of W_j. The factor $F(W_j)$ determines the form of the trajectory to equilibrium and is usually equal to 1 or W_j.

This model has received much interest probably because it fits well into popular bifurcation and chaos theory. Simulation experiments showed that realistic retail structures can be generated (see, e.g., Clarke & Wilson, 1983). This work has not been restricted to size dynamics and the production constrained spatial interaction model. Fotheringham and Knudsen (1986), working with the competing destinations model, modelled location dynamics and discontinuous change in both the size and the spacing of retail establishments.

The multiplicative competitive interaction model

One of the limitations of conventional shopping models derived from spatial interaction models is their restriction to a single variable operationalization of attractiveness. Obviously, in many contexts more than one attribute is of interest. This has led to attempts to specify the attractiveness component in terms of multiple variables. One of these more general forms of the spatial interaction model is the Multiplicative Competitive

Interaction model which has its roots in marketing where it has been used initially for the description of competitive market behavior, determining brand share, and the measurement of advertising and promotion effectiveness. The model has gained increasing popularity since Nakanishi and Cooper (1974, 1982) demonstrated how this model could be estimated by weighted or generalized least-squares analysis. The model is expressed as:

$$p_{ij} = \frac{\prod_{k=1}^{K} X_{kij}^{\alpha_k}}{\sum_{j'=1}^{J} \prod_{k=1}^{K} X_{kij'}^{\alpha_k}} \quad (5),$$

where p_{ij} is the probability that an individual located at i will choose shopping alternative j, X_{kij} is the value of the k-th attribute of shopping alternative j for individuals located at i, J is the total number of shopping alternatives, K is the total number of attributes considered, and α_k is a parameter for the k-th attribute.

In this model, multiple attributes of shopping centers are considered along with size as determinants of attractiveness. Jain and Mahajan (1979) in their study of food retailing, for example, used consumer evaluations of appearance, price, service level, and store image, as well as objective measures like the number of checkout counters, employee composition, location at an intersection, and availability of credit card services as components of the attractiveness function. Timmermans (1981b) used number of parking facilities, number of shops, variety of shops/functional complexity, number of employees, and number of superstores. Proximity to shopping centers was included by Hansen and Weinberg (1979). Black, Ostlund and Westbrook (1985) developed an outlet specific model. Often the variables of interest are highly intercorrelated. Consequently, the estimates may have high variances and be far removed from the true population values. They may even be of the wrong sign. The use of ridge regression analysis has been suggested to avoid this problem of near-multicollinearity (Mahajan, Jain, & Bergier, 1977; Timmermans, 1981b).

The Revealed Preference Model

As we have seen, a potential disadvantage of the spatial interaction model is its dependence on the geometry of the study area. To avoid this problem, Rushton (1969, 1971) developed a preference scaling model. Shopping centers are classified into so-called locational types which are based on a combination of an attractiveness variable and a distance category. Shopping choice behavior is assumed to reflect a trade-off between attractiveness and distance separation. Pairwise choice data are then used to calculate the proportion of times a particular locational type is chosen given that both are present. The locational types are positioned on a unidimensional preference scale using a nonmetric multidimensional scaling algorithm.

The basic model has been extended over the years in a number of important respects. First, Rushton (1974) showed how graphical methods, trend surface analysis or conjoint analysis can be used to decompose the preference scale into the contributions of the two basic variables. This is an important step forward if the model is used for prediction or impact assessment. Second, the model focuses on preferences, not on choice. Girt (1976) therefore suggested to link the preference function to overt behavior by relating distances on the preference scale to choice probabilities. Third, Timmermans (1979) suggested to derive individuals' choice sets from data on information fields and consumer attitudes.

Although Rushton's preference scaling model has considerable appeal, it never received the attention it deserved. One of the reasons might be that the model is based on only two explanatory variables, while heterogeneity in preferences is not accounted for. The model has also been criticized for its conceptual basis. It has been suggested that the model may not represent preferences but rather (in)consistencies of choice (MacLennan & Williams, 1979 1980; Pirie, 1976; Timmermans & Rushton, 1979). Some successful applications have been reported in the literature of consumer shopping behavior (Lentnek et al., 1975; Timmermans, 1979; 1981a).

Discrete Choice Models

The spatial interaction model has been criticized for its reliance on aggregate, zonal shopping flows. It has led to the development of disaggregate discrete choice models that are based on individual choice behavior, although it should be noted that many authors have used the term rather loosely in the past.

Discrete choice models focus on discrete choices made by consumers on individual shopping trips rather than on aggregate proportions of trips made from the various zones. Conventional discrete choice models may be derived from at least two formal theories: Luce's strict utility theory (Luce, 1959) and Thurstone's random utility theory (Thurstone, 1927). Strict utility theory can be considered an extension of constant utility theory to account for intransitivities in choice. In particular, Luce extended the weak and strong utility model for binary choices to the multiple alternative choice case. His theory assumes that the probability of choosing some alternative, say a shopping center, is equal to the ratio of the utility associated with that alternative to the sum of the utilities for all the alternatives in the choice set. Luce thus assumed deterministic preference structures and postulated a constant ratio decision rule. In contrast, random utility theory assumes that an individual's utility for a choice alternative is assumed to consist of a deterministic component and a random utility component. In addition, random utility theory assumes a utility-maximizing decision rule which implies that the probability of choosing some choice alternative is equal to the probability that the utility associated with a particular choice alternative exceeds that of all other choice alternatives included in a choice set. The specification of the choice model then depends on the assumptions regarding the distributions of the random utility components. If it is assumed that the random utility components are independently and identically normal distributed with zero mean, the independent multivariate probit model can be derived. If, however, it is assumed that these random components are independently, identically Type I extreme value distributed, the multinomial logit (MNL) model is derived. It may be expressed as

$$p_{ik} = \frac{\exp[U(X_k,S_i)]}{\sum_j \exp[U(X_j,S_i)]} \qquad (6),$$

where $U(X_k,S_i)$ is the deterministic part of the utility of choice alternative k of individual i with socioeconomic characteristics S_i. This model has become very popular in many fields of application including modelling consumer spatial shopping behavior.

Under strict utility theory, many different utility functions are allowed provided they are unique (except for multiplication by a positive constant). Under random utility theory many specifications are still possible, but for ease of estimation a deterministic utility component, linearity is usually assumed. The estimation of the parameters of discrete choice models typically involves establishing the functional relationship between (the evaluation of) the choice alternatives' attributes and overt choice behavior. Applications of the MNL model in retailing can be found in Richards and Ben-Akiva (1974), Recker and Stevens (1976), Timmermans (1984c), and Fotheringham (1988b).

One of the most important criticisms of the MNL model concerns the fact that the utility of a shopping center is independent from the attributes of other shopping centers in the choice set (Independence from Irrelevant

Alternatives [IIA] property): this implies that the model cannot account for so-called substitution. This assumption appears to be counterintuitive when two or more shopping centers show a high degree of similarity and hence may be substitutes. Under such circumstances, the introduction of a new, similar shopping center will not reduce market shares in direct proportion to the utility of the existing shopping centers as is implied by the MNL model, but will reduce market shares proportionally more from similar shopping centers. In recent years, various alternative models have therefore been developed which attempt to relax the IIA assumption (see Timmermans & Golledge, 1990, for a review).

Substitution models which impose more general conditions on the variance-covariance matrix differ in terms of their assumptions regarding the type of distribution of the error terms (negative exponential distribution, extreme value distribution or normal distribution), and assumptions on the error terms. To understand these models, it should be realized that increasing the error variance of a choice alternative implies that the probability of choosing that alternative increases, even if the deterministic part of the utility function is equal to that of other alternatives. Likewise, the effect of introducing covariances between the error terms of two alternatives is that, ceteris paribus, they draw more shares from each other. Only few of these more sophisticated models have actually been applied in a retailing context; hence we will restrict our discussion to these models.

Meyer and Eagle (1982) suggested capturing substitution effects by defining a single overall substitution measure. Thus, they developed a substitution model with an extended logit formula that explicitly incorporates the degree of similarity between shopping centers. The model introduced by Borgers and Timmermans (1987, 1988) avoids some of the negative aspects of the Meyer-Eagle model in that substitution for each attribute can be estimated separately and that a more direct measure of substitution is used. This model can be considered as the multinomial logit equivalent of Fotheringham's competing destinations model that is derived from the spatial interaction model, although it also includes substitution effects.

A problem with the model, and Fotheringham's competing destinations model as well, is that it does not predict spatial choice behavior as theoretically expected when the choice alternatives are located at more than three different locations. Following an idea introduced in the marketing literature by Kamakura and Srivastava (1984), Borgers and Timmermans (1985a, 1985b) developed a second model that allows the estimation of substitution and spatial structure effects. Similarity and spatial structure effects are incorporated into the variance-covariance matrix of the random disturbance terms of the utility function of the logit model. The covariance structure is modelled explicitly in terms of distances in the attribute space between the shopping centers as a measure of substitution.

An analysis of consumer choice data for hypothetical structures (Borgers & Timmermans, 1986b) indicated that when two shopping centers are located close to each other, choice probabilities of the remaining shopping centers decrease (agglomeration effects). When, in addition, both centers differ in terms of their attractiveness, the choice probability of one shopping center may increase while the choice probability of the other center decreases (redistribution effects). The predictive ability of both models was tested and compared to that of other substitution models using data on the choice of 34 shopping centers in the Maastricht region, The Netherlands (Borgers & Timmermans, 1986a). The substitution/spatial structure effects models performed only slightly better than the conventional MNL model: a finding consistent with the results obtained for simulated data sets (Borgers & Timmermans, 1987). The models that accounted for spatial structure effects produced the best results. Similar results were obtained in a follow-up study in the Eindhoven region (Borgers & Timmermans, 1992). This study also led to the conclusion that the spatial transferability of the substitution and spatial structure models is slightly better than that obtained for the MNL model.

An alternative approach to the issue of context effects is to let the degree of attribute similarity among choice alternatives directly influence the overall utility of alternatives. Meyer and Eagle (1982) and Eagle (1984, 1988) have argued that consumers shift weights associated with the attributes of alternatives. More specifically, attributes with little variation are less important. Empirical support for this hypothesis was accumulated in laboratory experiments.

Another way of avoiding the IIA-property is to develop hierarchical models, the best known model of which is probably the nested logit model. Like the MNL model, this model assumes that an individual evaluates shopping centers according to a utility function. Unlike the MNL model, the shopping centers which are supposed to be correlated are grouped into nests. Each nest is represented by an aggregate alternative with a composite utility consisting of the so-called inclusive value and a parameter to be estimated. To be consistent with utility-maximizing behavior, the inclusive values should lie in the range between 0 and 1, and the values of the parameters should change consistently from lower levels to higher levels of the hierarchy.

Compositional Attitudinal Models

The compositional approach involves measuring, explicitly and separately, an individual's evaluations of the shopping centers and the importance weights he attaches to the attributes. The overall utility of a shopping center is then computed by combining these self-explicated quantities according to some combination rule. Often, a linear additive rule, which represents a compensatory decision making process, is assumed. Thus, overall utility is composed using attribute-specific measurements. Sometimes, these importance weights are not measured explicitly, but are estimated by multiple regression analysis. The overall evaluations of the shopping centers then constitute the dependent variable of the regression equation, while the independent variables consist of the self-explicated evaluations of the various attributes of the shopping centers. This would be an example of a so-called hybrid model. Because these more sophisticated models have not found any application in retailing, the present discussion is limited to the simpler versions.

Cadwallader (1975) used a compositional model that was derived in analogy with conventional spatial interaction models. He used the following model:

$$p_j = \frac{\sum_{k=1}^{K} W_k A_{jk}}{d_j} I_j \tag{7}$$

where p_j is the proportion of consumers choosing store *j*, A_{jk} is the aggregate subjective attractiveness of store *j* on attribute *k*, W_k is the relative importance of attribute *k*, d_j is the aggregate cognitive distance to store *j*, I_j is the proportion of consumers familiar with store *j*. Note that both attractiveness and distance are measured in subjective terms. Choice probabilities are thus calculated without any calibration. Cadwallader assumed that the attractiveness of supermarkets is determined by speed of service, assortment, number of sold items and price. Respondents evaluated each of these four factors on a seven point scale. The median of these four scales was used as input to the model. Respondents were also requested to rank the four factors in order of importance. These data were used to calculate the relative importances. Distance was measured as the median of the subjectively estimated distances and information level was used as a dichotomized variable: consumers were familiar with a supermarket or not. Although the results of the application indicated that this model produced better results than a conventional spatial interaction model, it is obvious that this model can be heavily criticized on the basis of the simplistic way in which the variables are measured. Cadwallader's model was also used by Lloyd and Jennings (1978) with an extended number of attractiveness variables.

In a study of spatial shopping behavior in Eindhoven, The Netherlands, Timmermans (1980a) assumed that consumers will choose the shopping center of highest subjective attractiveness after screening the centers in terms of travel time. Thus, travel time is not used as a negative attribute in a compensatory decision making process, but as a noncompensatory screening variable. Different rules can be used to represent the integration of attribute evaluations into some overall measure of subjective attractiveness. Timmermans (1980a) compared weighted and unweighted versions of additive and multiplicative rules in terms of predictive success and found that the models performed almost equally well. In a later study, Timmermans (1983) compared the predictive success of these compositional models to that of noncompensatory decision rules. Noncompensatory decision rules assume that consumers do not arrive at some overall evaluation or preference by combining their attribute evaluations according to some algebraic rule, but that they arrive at some choice by screening the shopping centers on an attribute-by-attribute basis (see, e.g., Timmermans, 1984b). For example, a dominance rule states that a shopping center will be chosen only if it is evaluated more positively than all other shopping centers on all attributes. The conjunctive rules states that each shopping center which fails to meet a minimum value on each attribute will be eliminated from a consumers' choice set. In contrast, the disjunctive rule involves an evaluation of the shopping centers on the basis of the maximum rather than the minimum values of each attribute. Only shopping centers which meet or exceed at least one of these maximum values are accepted for further consideration. Finally, the lexicographic rule 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 score on this attribute, it will be chosen. If some shopping centers are tied on the most important attribute, the process proceeds to the next most important attribute. This process proceeds sequentially using different attributes until all shopping centers are ranked and a single shopping center remains. Although these rules sound appealing, their predictive success was much less than that of the compositional models.

Decompositional Multiattribute Preference and Choice Models

Decompositional multiattribute preference models have in common with discrete choice models the assumption that individuals cognitively integrate their evaluations of a shopping center's attributes to derive the utility for a shopping center and arrive at a choice by selecting that center with the highest utility. However, unlike discrete choice models, the parameters of the decompositional multiattribute preference models are not derived from real-world data, but from experimental design data. Decompositional models differ from compositional models in that overall preferences for shopping centers are measured rather than calculated. Part-worth utilities associated with attribute levels are derived by decomposing overall preferences into attribute contributions rather than by measuring them explicitly and separately (e.g., Timmermans, 1984a).

Decompositional models involve the following steps when applied to problems of spatial shopping behavior. First, each shopping center is described by its position on a set of attributes relevant to the consumer or of planning interest. Decompositional decision models are based on the assumption that consumer choices are the result of a decision making process which involves a subjective evaluation of the positions of each shopping center on each attribute, an integration of the separate subjective evaluations of each attribute position into an overall evaluation of each shopping center, and development of a rule for translating the overall evaluations of competing shopping centers into a single choice. Decompositional decision models have in common procedures for simultaneously measuring the joint effects of two or more attributes on the individual's overall evaluations of a statistically designed set of multiattribute alternatives. In order to do so, the second step of the approach involves a definition of the attributes of interest in terms of a set of attribute levels. One then creates an experimental design to generate a set of hypothetical shopping centers that varies the positions of the attributes in a controlled manner. The creation of an appropriate design is largely determined by the model that one assumes to describe how the separate attribute positions are integrated into an overall preference or choice. Once the design is created, an evaluation task is developed in which individuals rank order or rate the hypothetical shopping centers with respect to preference. The individuals' overall evaluations of the designed shopping centers are decomposed into a set of part-worth utilities associated with every level or position of each attribute. The ability of the estimated part-worth measures to recover an individual's observed evaluation responses is assessed by a goodness-of-fit measure. The best fitting conjoint model for a given decision task is identified by comparing these goodness-of-fit measures for alternative models.

Once part-worth utilities have been estimated, a choice rule is postulated to predict the choices that an individual is likely to make given the estimated preference function. A simple, commonly used postulate is that an individual will choose the shopping center with the highest overall evaluation. Alternatively, different probabilistic rules can be postulated (e.g., Timmermans & van der Heijden, 1984). Individual choice behavior can then be simulated by defining real-world shopping centers in terms of their positions or levels on each attribute varied in the experimental task, calculating each individual's overall utility score for each shopping center on the basis of the estimated preference function, and applying the postulated choice or decision rule to map an individual's estimated overall preference or utility into choices. Applications of this approach to retailing can be found in Prosperi and Schuler (1976), Schuler (1979), Recker and Schuler (1981), Louviere and Meyer (1981), Timmermans (1980b, 1982), Verhallen and de Nooij (1982), Moore (1990). Decompositional preference models are not necessarily restricted to the domain of experience, but they can be used also to examine the potential market shares of new innovations, such as teleshopping (Timmermans, Borgers, & Gunsing, 1991). Their transferability properties seems to be promising (van der Heijden & Timmermans, 1988).

Most current decompositional multiattribute decision models applied to problems of spatial shopping behavior try to predict real-world choice behavior by assuming that the shopping center with the highest predicted overall utility will be chosen. This approach is theoretically inadequate because a deterministic rule is used to predict a probabilistic phenomenon. Furthermore, the statistical properties of the part-worth and overall utility measures derived from rankings of hypothetical shopping centers are unknown and may be inappropriate for predicting choice behavior. Some of these problems may be avoided by making explicit assumptions regarding the distribution of the error of the derived utility measures (see e.g., Timmermans & van der Heijden, 1984). Unfortunately, while distributional assumptions allow for probabilistic choice processes, they do not allow one to test the validity of the assumptions except with respect to some external criterion like real-world choice behavior. Current models typically require a fairly rigorous and restrictive set of assumptions.

Another approach that has received some attention in the retailing literature is the exploded logit model (Chapman & Staelin, 1982; Moore, 1990). This model is based on the Luce and Suppes Ranking Choice Theorem.

Given the rigorous and often limited assumptions underlying these approaches, Louviere and Woodworth (1983) suggested an approach that examines the preference formation and choice processes simultaneously. As with more traditional decompositional approaches, a set of decision attributes together with appropriate positions or levels for those attributes is first identified. Multiattribute choice alternatives are then generated by means of fractional factorial experimental designs in which each attribute is treated as a factor with varying numbers of levels. If the number of alternatives among which individuals will choose is constant (say n), and each alternative has M attributes with L levels, one can construct choice sets that satisfy the MNL or Luce choice model by designing an L^{N*M} main effects, orthogonal, fractional factorial experimental design to create joint combinations of attribute levels. Choice sets created in this way have a fixed number of alternatives, but the positions of these alternatives on the decision attributes vary from choice set to choice set. Often a constant choice alternative is added to each choice set to set the origin of the utility scale.

In contrast to the rating or ranking tasks of traditional decompositional models, the Louviere and Woodworth (1983) approach involves choice tasks in which individuals select one and only one alternative in each of several experimentally designed choice sets. That is, consumers are asked to indicate which shopping center in a set is the one that they would be most likely to patronize for a particular product class. Alternatively, consumers may be asked to estimate the proportion of their total patronage that they would be likely to allocate to each center, or, in general, to allocate some fixed set of resources (e.g., dollars, points, trips, etc.) to the available alternatives. If the MNL choice model is approximately correct, a sufficient condition for estimating the part-worth utilities for the shopping centers is that the independence of alternatives across choice sets be preserved. If one has reason to expect that the MNL model will provide a reasonable approximation to the choice data, one can also construct choice designs by first using separate fractional factorial designs to generate attribute combinations for each shopping alternative. The separate fractional designs for each shopping alternative are then randomly assigned without replacement to each choice set. The effect of competitive environments might be studied along similar lines (Louviere, 1984b).

A major advantage of this design approach is that one can test for the validity of various MNL model properties, such as testing IIA by including the cross-effects of an alternative on another alternative in the utility arguments. This specification which has been referred to as the universal or mother logit model allows one to generalize the MNL model to account for violations of the IIA property due to nesting of or similarities among alternatives. It is also possible to test for the effect of choice set composition on utilities. 2^N designs are appropriate in this case. First, the hypothetical choice alternatives are constructed in a way similar to traditional decompositional preference models. These profiles are then placed into choice sets of varying size and composition. Timmermans and Borgers

(1985) used this approach to estimate a choice model involving generic alternatives and generic effects in shopping for groceries. Price and distance were assumed to be the most important decision attributes in grocery shopping and were each assigned two levels. Four combinations or hypothetical shopping alternatives were produced from the two levels of the two attributes. A one-half fraction of the 2^2 factorial was used to place the four price/distance combinations into choice sets. The design permitted the estimation of some of the two-way interaction effects among the alternatives. A constant base alternative was added to each choice set, and weighted least-squares regression analysis was used to estimate the parameters of a generalized MNL choice model. The statistical results indicated that the cross-effects between alternatives were not significant, suggesting that the simple MNL model was a good approximation for these data. Timmermans, Borgers and van der Waerden (1991a) used this approach also to predict the impact on consumer choice of major changes in an existing shopping center. In a follow-up, before-after study, Timmermans, Borgers and van der Waerden (1991b) found the mother logit model predicted actual shopping choice behavior after the changes were implemented slightly better than conventional revealed choice models.

Perhaps the most important problem associated with decompositional preference models is that task demands for individual respondents become more and more onerous as the number of attributes and/or the number of levels of attributes increase. A possible solution to this information overload problem has been suggested by Louviere (1984). This so-called Hierarchical Information Integration method is based on the hypothesis that in complex decisions involving many influential attributes, individuals first group the attributes in sets. Each set defines a separate, higher-order decision construct. The idea is to structure an experimental preference or choice task in such a way to allow to study and analyze each of these integration processes separately. Louviere and Gaeth (1987) provide an example of this approach applied to an analysis of supermarket shopping behavior.

Disadvantages of the hierarchical information task are that it is restricted to preferences. In addition, the assumed hierarchical structure cannot be tested. Louviere and Timmermans (1990) showed how this method can be extended to problems of spatial choice behavior by replacing the overall preference task with a choice task. Oppewal, Timmermans, and Louviere (1991) suggested to use multiple choice experiments to test the implied hierarchical structure. Their method involves using in each subdesign the attributes of the higher-order decision construct of interest plus overall evaluations of the remaining decision constructs.

Although this work is still in a developing stage, decompositional preference and choice models can also be used to simulate the dynamics of retail systems. First, one predicts consumer shopping choice behavior by assuming some choice simulator or applying a choice model directly. Then, retailers' reactions are modelled as a function of the estimated demand for retail locations. Their behavior may influence the objective or perceived attributes of the shopping centers, resulting in possible adjustments in consumer choice of shopping centers. In this way, the dynamics may be simulated (Oppewal & Timmermans, 1988, 1989; Timmermans & van der Heijden, 1987).

Conclusions

The interplay between retail environments and consumer spatial choice behavior constitutes a longstanding field of research in geography and urban planning. The objective of this chapter has been to summarize the main research approaches in the field. The discussion has necessarily been restrictive, both in terms of depth of coverage and the various approaches that have been discussed. The discussion has been concentrated on descriptive analytical studies on shopping behavior and static models of single shopping choices. Other important areas such as dynamic models of shopping behavior, trip chaining and pedestrian movement, and normative location/allocation models have not been discussed in any detail at all. The reader is referred to Timmermans and Borgers (1989), O'Kelly (1981), Borgers and Timmermans (1986a, 1986b), and Craig, Ghosh and McLafferty (1984) respectively.

If the existing literature is examined, one cannot escape the conclusion that most of this literature aims at finding facts about consumer shopping behavior. The interest focuses primarily on describing determinants and patterns of consumer shopping behavior. Theories are not very well developed. At best, theories are directly applied from other disciplines without much modification. The geographical component is treated as just another variable of interest that can be accommodated in the analysis in similar ways as the other non-spatial variables are incorporated. It is difficult to speak of any theoretical progress. Too often, the same phenomenon is examined, the difference only being the use of different research methods.

The only exception in this respect is the area of the modelling of spatial shopping behavior. Over the years, the theoretical underpinnings of the models have improved considerably. Moreover, one can really speak of accumulation of knowledge. The spatial dimension has been given special treatment as exemplified, for instance, by the inclusion of competition, agglomeration, and spatial structure effects. It is also in this subfield of spatial shopping behavior that more progress is to be expected. Two research themes come to mind if one thinks about avenues of future research. One is the area of modelling multiple-purpose shopping trips, and related developments such as sequential choice behavior, trip-chaining, and activity analysis. Although these topics have received some attention in the past, it is difficult to speak of accumulated knowledge. Now that the major operational problems of models of single choice behavior have been solved, the time seems ripe to tackle the much more complicated problem of multiple choice behavior with the same rigor. This problem is currently being examined by various scholars working in any one of the mentioned modelling approaches, and the first major publications are expected in the next couple of years.

Second, existing models of single choice behavior are expected to be improved even more by incorporating competitive structures into the utility functions assumed to underlie shopping choice behavior. Scholars working in different modelling traditions are currently developing models of this type. For example, Timmermans, Borgers and van der Waerden (1991) have tested such a model in the decompositional framework, Laroche and Brisoux (1989) have developed such structures in attitudinal models of consumer behavior, Borgers and Timmermans (1992) developed and tested such models in the discrete choice tradition, and Fotheringham's competing destinations model (Fotheringham, 1988a) has been advanced using the spatial interaction approach.

Finally, it is expected that the issue of developing dynamic models of spatial shopping behavior will receive more attention in the near future. As briefly indicated, this topic is now being addressed by all modelling approaches. It is very likely though, that most of this research will remain theoretical as the costs and effort of collecting reliable time-series data are often prohibitive. Yet, developments like these, and the fact that spatial shopping behavior is a field of study that is approached by scholars from different disciplinary backgrounds, continue to make consumer spatial shopping behavior an exciting field of inquiry.

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