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Investigating Consumers' Tendency to Combine Multiple Shopping Purposes and Destinations

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Abstract
Due to the increasing time pressure that they face, many consumers are becoming more concerned about the efficiency of their shopping patterns. Retailers have recognize this trend, have improved shopping convenience by offering greater variety in product categories and making it easier for consumers to combine visits to multiple stores. However, little is known about how consumers improve the efficiency of their shopping trips, or how changes in retail supply affect the way in which consumers combine multiple purposes and destinations. Building on previous work in consumer shopping trip modeling and conjoint design theory, this paper introduces a choice-based conjoint approach to studying and modeling this phenomenon. The approach is illustrated in a case study which investigated the tendency of Dutch shoppers to combine grocery, drugstore and clothing purchases across multiple shopping destinations. It was observed that the tendency of consumers to combine purchases differed from category to category and also depended on category availability. In general, consumers combined considerably less purchases than could be expected if their shopping trip planning were based purely on travel cost minimization.

INTRODUCTION

Many consumers in North America and Western Europe are confronted with the fact that their time-budgets are becoming tighter and tighter. Major socio-economic shifts, such as the increased number of dual-earner households, more active out-of-home recreational life styles, and increased transport mobility levels, have created a culture where time rather than money is rapidly becoming the scarcest commodity. Due to the growing number of professional and personal commitments that they face, many people seem to have less and less time available to undertake more and more different activities.

It is not surprising, therefore, that many consumers are becoming increasingly concerned about optimizing the efficiency of their shopping patterns. Retailers have recognized this trend, and over the years have improved shopping convenience considerably. Many retail chains now offer a greater variety of product categories and have located their stores at more accessible sites, thus making it easier for consumers to combine purchases in several different categories and to visit several different stores.

Although these trends in retail supply and demand are well recognized at the macro level, little is known about the micro behavior underlying them. For example, little insight exists into how consumers combine multiple purposes and destinations in planning their shopping trips, or how consumer shopping trip patterns respond to changes in retail supply. Typically, current research approaches assume that consumers visit only one shopping destination in each shopping trip. This ignores the potential spatial agglomeration benefits that stores enjoy by locating in adjacent places. For example, specialty stores located near to - but not inside- a shopping mall may be able to attract more consumers than specialty stores located far away from other shopping locations. Similarly, a cluster of specialty stores located in the same suburb may be able to attract more consumer demand than stores located in separate suburbs.

The purpose of this paper is to start to address this issue. Specifically, our objective is to introduce and illustrate a new integrated econometric and experimental approach that allows one to measure consumer choices of multi-purpose multi-stop shopping trips. Our approach adds to the existing literature in the following ways:

(i) it models the impact of multi-stop as well as with multi-purpose shopping behavior,

(ii) it uses experimental designs to create hypothetical shopping scenarios which allow one to measure *independently* the impact on consumer choice of different features of spatial structures of shopping facilities such as distance, store category availability, and the availability of specific retail chains, as well as measure the impact of truly new shopping facilities on consumer shopping trip choices.

Thus, our approach allows researchers and retail managers to gain a better understanding of complex consumer shopping behavior and to conduct more insightful simulations of the potential impact of changes in retail structure in a particular geographical area.

We build on previous work in consumer shopping trip modeling and conjoint choice design to develop a new approach to investigating the tendency of consumers to combine multiple shopping purposes and destinations in their shopping trips.[1] Our proposed approach is based on a combination of a multi-layered nested logit structure which captures the different purposes and stops in consumer shopping trips, and a purposely designed consumer choice experiment which allows one to measure aspects of consumer shopping trip decision making that are difficult to deduce from real world shopping data.

In modeling terms, we build mainly on two previous models in the consumer shopping behavior literature. The first, introduced by Kitamura (1984), used the concept of prospective utility to model consumers' choices of shopping trip chains. Prospective utility is defined recursively and the utility of each shopping destination is expressed in terms of its own utility plus the utility of possible other destinations in the trip chain, which itself again includes the utility of other destinations, etc. The model offers a framework to model trip chains or multi-stop trips that consumers make, but unfortunately falls short in that it does not allow for multi-purpose trips (i.e. trips where consumers buy several different types of products).

The second model we build on was introduced by Arentze, Borgers and Timmermans (1993) and largely deals with this latter element. Arentze, Borgers and Timmermans introduced a model that recursively describes consumer store choices for different categories of products. Products are ordered hierarchically on the basis of purchase frequency, and the utility of a shopping center is described as a function of two types of variables: the distance between the consumer's home and the shopping center, and the shopping center's range of product categories. However, their model does not incorporate multi-stop trips and it is not developed in the utility maximization framework of random utility theory. This makes it difficult to interpret the parameters of the model, to compare the model to empirical data that is stochastic in nature, or to compare the model to more conventional random utility approaches.

The modeling approach we propose combines the random utility framework and the multi-stop feature of Kitamura's (1984) approach with the multi-purpose feature of the Arentze, Borgers and Timmermans (1993) approach. We apply a recursive nested logit structure similar in structure to Kitamura's model, but extend it to include multi-purpose shopping behavior.

Thus, our model describes consumers' choices of shopping trip chains including both multiple shopping purposes and visits to multiple destinations.

Data to estimate such complex model structures are quite hard to collect and often need to be gathered by using specifically designed surveys. Typically, if data on consumer shopping trip behavior exist, they are origin-destination type data describing the number of consumers arriving and departing from different shopping locations and/or residential areas. These data rarely describe consumer trip chaining or directly identify combinations of product categories in which consumers make purchases. Furthermore, the explanatory variables describing shopping center features, such as size, quality and travel distance, typically are highly correlated, making it difficult to evaluate the impact of each separate attribute on consumers choices. It is not surprising therefore that many of the model applications reported in this area are either quite limited in terms of the shopping center and trip characteristics that were incorporated (Kitamura 1984), or largely based on simulations (Arentze, Borgers and Timmermans 1993, Ghosh and McLafferty 1984, Ingene and Ghosh 1990, Mulligan 1987).

To avoid these data limitations, and to obtain more precise measures of the independent effects of the different factors that affect consumers' choices of multi-purpose, multi-stop shopping trips, we integrate our modeling approach with a conjoint choice experiment design strategy that allows us to capture much of the complexity of the proposed model.

Conjoint choice experiments allow one to avoid many of the traditional limitations of revealed choice or real-market data because of their reliance on orthogonal statistical experimental designs to generate the alternatives from which consumers make their choices (e.g., Louviere 1988; Carson et al. 1994). Moreover, conjoint experiment data collection is often very efficient, since one can collect several observations from each individual by presenting him or her with more than one hypothetical shopping trip choice scenario. Finally, recently developed methods now make it possible to 'rescale' conjoint choice experiment models to real-world choice data (e.g., Swait and Louviere 1993, Morikawa, Ben-Akiva and McFadden 1990), thus allowing one to combine the precision and internal validity of conjoint experiments with the external validity of revealed preference data. We believe this combined approach can offer important benefits for shopping behavior research.

The experimental design approach we propose builds on recent work by Dellaert, Borgers and Timmermans (1996, 1997) who introduced experimental designs to support the estimation of nested logit and heteroscedastic logit models of consumer choices of activity patterns. Specifically, they applied a structure of independent sub-experiments to obtain independent estimates of consumer utilities of different elements in consumer service portfolios. We extend their framework to construct an experimental design that supports both separate and integrated estimation of consumer utility functions for different purposes and locations in consumer shopping trip choices.

To achieve our objectives, this paper is organized as follows. In the next section we give a formal description of the proposed multi-purpose multi-stop model. This is followed by two brief sections which introduce the proposed experimental approach and discuss model estimation. An empirical application, which investigates the tendency of Dutch shoppers to combine grocery, drugstore and clothing purchases across multiple shopping destinations, is given in the next section. The paper closes with a summary of our main conclusions, a discussion of potential management implications of the model findings, and some suggestions for future research.

CONCEPTUAL FRAMEWORK AND MODEL

We define the following basic elements to describe consumer shopping trips:

1. *Product order.* Each product is categorized as being of a certain order which indicates the frequency with which the product is bought. The lowest order products (order 1) are purchased most frequently, higher order products are purchased less frequently. For example, durable products typically are higher order products and fresh food items typically are lower order products. Note that different products can have the same product order.
2. *Stores.* Each store sells products of one or more product orders. These products are the basis for determining the order(s) of the store. It is assumed that a store of a certain order sells all products of that order.
3. *Retail chains.* Stores have a brand name in the sense that each store is defined as belonging to a certain retail chain (e.g., Woolworth's). Consumers are assumed to have different preferences for stores belonging to different retail chains. Products of the a certain order can be offered by several competing retail chains.
4. *Locations.* Each location (or shopping center) houses one or more stores. Thus, products of one or more orders can be available at each location. These products are the basis for determining the order of the location.
5. *Trip chains.* A trip chain is a shopping trip that includes visits to multiple locations to purchase products of multiple orders. A trip chain can include purchases of products of several orders. It is named after the highest order product that is included in the trip. For example, a trip of order 3 represents a trip that includes a purchase of a product of order 3 and possibly purchases of products of order 2 and 1. We define a single-purpose trip as a trip

to purchase products of one order only, and a multi-purpose trip as a trip to purchase products of several orders.

We model the consumer choice process as an evaluation process in which the consumer compares the utility of possible trip chains. Given G product orders, ordered from high to low according to purchase frequency, G orders of trips are distinguished. A trip of order g is a trip aimed at purchasing products of order g, and possibly also of products of lower order g' that are purchased more frequently. Thus, g=1 for a trip where only the lowest order products are purchased (i.e. the products that have the highest purchase frequency), and g=G for a trip where products of the highest order are purchased (i.e. products with the lowest purchase frequency). Thus, each trip chain is defined by the highest order products (i.e. least frequently purchased products) in the trip. It follows from this definition that trips of order 1, which is the lowest trip order, are necessarily single-purpose trips.

If consumers need to purchase products of several orders, they can choose to combine purchases of different orders and/or to visit more than one location to create a trip chain. The utility of a trip chain consists of a weighted sum of the utility of the stores visited to purchase products of the different orders and the disutility of travel to the locations at which these stores operate.

Although in our approach we assume that product purchase frequencies are exogenous to the model, the timing of purchases and the choice of the total number of shopping trips is left to the consumer. The consumer can choose to combine purchases of different orders so as to optimize the total number of shopping trips. Though there is an important stream of research in economic geography where the purchase frequency itself is also included in the consumer optimization task, based on a trade-off between storage costs and travel costs (e.g., Ghosh and

McLafferty 1984, Ingene and Ghosh 1990 and Mulligan 1987), we do not include this element in the present model. The reason is that there is strong recent empirical evidence of the inability of consumers to optimize stockpiling patterns (Meyer and Assunçao 1990), as well as of strong regularities in consumer inter-purchase timing (Kahn and Schmittlein 1989). These results indicate that :

(i) Consumers have very short time horizons (i.e. one or two periods) in optimizing their product stock, and

(ii) Consumer purchase intervals show strong peaks at weekly and bi-weekly inter-purchase times. Behaviorally this can be explained by the fact that most consumers face strong external time constraints, form shopping habits that are inconvenient to change and/or are forced by product perishability to limit their stocks (e.g., for stocks of fresh foods or dairy products).

On this basis, we think it justified to include only the choice of shopping trip as a dependent outcome of our proposed model and maintain purchase frequency as exogenous to the consumer choice of shopping trip pattern.

To incorporate the multi-stop aspect in the choice process, the model should not only allow for trips from home to each shopping location, but also for trips between different shopping locations. Therefore, the option not to include a certain purpose in the trip chain is also included in the model by allowing consumers not to visit any destination for a given purpose. In effect this implies that the purchase of products of that order is postponed to a later trip.

In each phase of the modeling process the extra distance that needs to be traveled to reach the next destination is calculated and assigned to that destination on the basis of an optimal routing strategy. The usage of different routing strategies by consumers is largely an empirical question that we leave for future research. In the present study we assume that consumers use a shortest path route selection principle.

The probability that a certain trip chain of order G is selected can be described as the product of the conditional probabilities of the location choices for the purchase of products of all orders G and lower that are included in the trip. This can be expressed in the following recursive formula:

$$\begin{cases} P(\{j_g, H_{g+1}\}) = P(H_{g+1})\, P(j_g | H_{g+1}) & G \geq g \geq 1, \\ P(H_{G+1}) = 1 & H_{G+1} = \{Home\},\ H_{g+1} = \{j_{g+1}, H_{g+2}\},\ j_g \in J_g \end{cases} \tag{1}$$

where, $P(\{j_g, H_{g+1}\})$ is the probability that the chain $\{j_g, H_{g+1}\}$ is chosen, j_g is the location selected from all locations J_g where products of order g are offered plus the option of not including products of order g in the current trip chain; H_{g+1} is the set of locations selected to purchase products of the $(G-g)$ higher orders than g (in case of a trip chain of order G), H_{G+1} is the home location, $P(H_{g+1})$ is the probability of location set H_{g+1}, which is defined by the same recursive formula, and $P(j_g | H_{g+1})$ is the probability of choosing location j_g to purchase products of order g given the set of previous destinations H_{g+1}.

Figure 1 gives an example of a simple multi-purpose multi-stop shopping trip selected by a consumer in a hypothetical shopping situation. In this example the consumer is forced to travel from location C to another location if he or she wants to save on travel cost by combining purchases of order 2 and order 3 in the same shopping trip. For example, locations A and B may not have exclusive fashion stores and location C may not have a book shop and consumers wanting to combine fashion and book purchases would need to travel between C and A or B. This type of decision can only be captured in a model that allows for both multiple purposes and multiple stops to be made in the same shopping trip. In this example the consumer could choose to purchase products of order 1 in any of the three locations *A,B,C* and has selected location *B* for this purpose. Location *C* also could have been selected without a loss of travel costs, as this location is visited also for purchases of order 3. The formal trip and probability structures are summarized in table 1.

--INSERT FIGURE 1 ABOUT HERE-

-INSERT TABLE 1 ABOUT HERE-

Let us now consider the multi-purpose multi-stop model structure that we propose to determine these probabilities. Assume that for a trip of order *g*, consumers evaluate for each order of products of *g* and lower the locations and stores that offer those products plus the option of not including products of that order in the current trip. Assume that the evaluation of each possible trip chain can be described by a random utility function in which the utility of each chain is a weighted sum of :

(i) The utility of the locations in the chain selected for purchasing products of order g and lower,

(ii) The travel costs required to reach each location, and

(iii) A set of error components which can be structured hierarchically according to the different product orders in the chain such that they follow a nested or tree logit structure (e.g., Ben-Akiva and Lerman 1985 p.292).

In constructing this utility structure for trip chains, we have built on the principle that consumers' purchase frequencies are more or less fixed, but that they do have to decide on whether or not they want to combine multiple shopping purposes and/or multiple destinations in their trips. The minimum number of trips they make is determined by the most frequently purchased goods (i.e. goods of the lowest order). If consumers take full advantage of multi-purpose shopping opportunities, purchases of higher order goods are always combined with purchases of lower order goods. However, some purchases of the lowest order goods can not be combined, as the lowest order purchase frequency is higher than that of the second lowest order goods.

Every trip decision is regarded as a choice of a trip chain including locations for purchases of all orders of goods that are needed at that point in time. The key assumption in the proposed nested logit structure is that trip chains that share locations for higher order goods are more similar in their unobserved variables than trips that share locations for lower order goods. In other words, the error terms in consumers' utilities for trip chains that share a location for a higher order are assumed to have a higher covariance than the error terms in consumers' utilities for trip chains that share a location for a lower order. This assumption can be supported by the following arguments:

(i) Consumers' trade-offs for lower order purchases are expected to be more 'rational' in the traditional sense, in that they can more accurately be explained by distance and the store characteristics incorporated in most models,

(ii) On average, consumers are expected to be better informed about the stores that are available to them for lower order purchases, which strengthens the relationship between actual store characteristics and consumer utilities, and

(iii) Consumers' preferences for lower order stores are expected to be more consistent and show less variation from purchase to purchase.

Taken together, these effects lead to lower random error in consumers' utilities for locations for lower order purchases, which is captured in the nested logit model by the greater covariance between trip chains that share higher order locations.

We recognize that a probit specification could potentially be a viable competitor to the proposed nested logit framework. However, an aspect often overlooked in probit modeling is that probit models can easily result in unidentified modeling specifications (e.g., Bunch 1989). Although there is no formal solution to distinguish between well- and non-identified probit variance-covariance structures, an informal rule of thumb is that only those models are identified which can be re-expressed in terms of a hierarchical covariance structure, much along the line of nested logit models (Bunch 1989). This implies that even if probit models are applied to capture similarities between trip chain alternatives, the researcher has to decide on the appropriate hierarchical variance-covariance structure.

It should be noted that the assumed hierarchical order in the error structure of the model does *not* imply an identical ordering of choices, cognitive evaluations and/or visits to destinations in the trip chains. That is, the model does not require that products be purchased from high to low order or choices be made from less to more frequently purchased goods. Rather, the actual physical and cognitive sequencing of purchasing products can be the result of a variety of mental evaluation methods and route selection strategies implemented by the consumer. The structure in error terms merely assumes that there is less random variation in the shopping location choices that consumers make for more frequently purchased products than in their choices of locations for less frequently purchased products.

Thus, the nested logit model to describe the trip chain choice probabilities can be constructed as follows (for reasons of explanatory clarity we will first present a representation of a two-order system):

Let J_1 be the set of purchasing locations available for products of order *1*, and J_2 be the set of purchasing locations available for products of order *2;*

$U_{j1}\{j2\}$ the total utility of location j_1 for purchasing products of order *1*, given that location j_2 has been visited to purchase products of order *2;* and $U_{j2}\{\}$ the total utility of location j_2 for purchasing products of order *2*, given that no locations have been visited to purchase higher products;

$V_{j1}\{j2\}$ and $V_{j2}\{\}$ the corresponding structural utilities;

$\boldsymbol{\beta}'\mathbf{x}_{j1}$ the structural utility (excluding the distance component) of location *j* for purchasing products of order *1*, $\boldsymbol{\beta}'\mathbf{x}_{j2}$ the structural utility (excluding the distance component) of location *j* for buying products of order *2;*

θ_1 and θ_2 the parameters for the distance component in orders *1* and *2;*

$d_{j1}\{j2\}$ the extra travel distance required to visit location j_1 based on the shortest route strategy and given that location j_2 is visited, and $d_{j2}\{\}$ the travel distance required to visit location j_2;

ε_1 and $(\varepsilon_1 + \varepsilon_2)$ the error components for orders *1* and *2*, with ε_1 and $(\varepsilon_1+\varepsilon_2)$ following Gumbel distributions and ε_1 and ε_2 being independent; and

μ_1, μ_2 the scale values related to orders *1* and *2.*

Then:

$$\begin{cases} U_{j1}^{\{j2\}} = \mu_1\ \beta'\mathrm{x}_{j1} + \mu_1\ \theta_1\ d_{j1}^{\{j2\}} + \varepsilon_1 \\ \qquad\quad = V_{j1}^{\{j2\}} + \varepsilon_1 \end{cases} \tag{2}$$

$$
\begin{cases} U_{j2}^{\{1\}} = \mu_2 \beta' \mathbf{x}_{j2} + \mu_2 \theta_2 d_{j2}^{\{1\}} + \frac{\mu_2}{\mu_1} \ln \sum_{j1=1}^{J_1} \exp(\mu_1 (\beta' \mathbf{x}_{j1} + \theta_1 d_{j1}^{\{j2\}})) + \varepsilon_1 + \varepsilon_2 \\ \quad = V_{j2}^{\{1\}} + \varepsilon_1 + \varepsilon_2 \end{cases} \tag{3}
$$

the probability function for both orders are formulated analogously, and are expressed as:

$$
P(j_2) = P(U_{j2}^{\{1\}} \geq \max_{j2' \varepsilon J2} (U_{j2'}^{\{1\}});\ j_2' \neq j_2)
$$

$$
P(j_2) = \frac{\exp(V_{j2}^{\{1\}})}{\sum_{j2' \varepsilon J2} \exp(V_{j2'}^{\{1\}})} \tag{4}
$$

Given this structure, the model can be formulated in a recursive form, in which the relationship between the structural utility of visiting a location for a purchase of order g and the structural utilities of visiting locations for purchases of orders lower than g are expressed. This equation offers a framework for describing trips of any desired order. In formula:

$$
\begin{cases} U_{jg}^{Hg+1} = \mu_g \beta' \mathrm{x}_{jg} + \mu_g \theta_g d_{jg}^{Hg+1} + \frac{\mu_g}{\mu_{g-1}} \ln \sum_{jg-1=1}^{J^{g-1}} \exp(V_{jg-1}^{\{jg, Hg+1\}}) + \sum_{k=1}^{g} \varepsilon_k \\ \quad = V_{jg}^{Hg+1} + \sum_{k=1}^{g} \varepsilon_k \\ U_{j1}^{H2} = \mu_1 \beta' \mathrm{x}_{j1} + \mu_1 \theta_1 d_{j1}^{H2} + \varepsilon_1 \\ \quad = V_{j1}^{H2} + \varepsilon_1 \end{cases} \tag{5}
$$

The choice probability of a location j for buying products of order g is expressed as:

$$
P(j_g) = \frac{\exp(V_{jg}^{Hg+1})}{\sum_{jg' \varepsilon J_g} \exp(V_{jg'}^{Hg+1})} \tag{6}
$$

where H_{g+1} is the set of locations present in the route selected up till order g, which consists of only the home location if $g = G$; J_g is the set of purchasing locations available for products of order; $P(j_g)$ is the probability that location j_g is selected to buy a product of order g; and all other elements are defined as above, with g taking on values from G to 1. Typically, μ_1 is set arbitrarily to a value of 1 and the other scale values are estimated in relationship to this value as only the ratio of the scale values can be estimated.

Figure 2 illustrates the proposed recursive nested logit structure for the case of a trip of order 3. It shows the tree like structure of the error terms in the model and the way in which the utility for locations for stores for lower order products is incorporated in the utility of locations for higher order products.

--INSERT FIGURE 2 ABOUT HERE--

It may be noted that in this model the single purpose trip is a special case. A G-trip possibly, but not necessarily, involves the purchase of lower order products g. The choice not to purchase a product of order g in the present chain is included as a choice alternative at each level g of the trip. In the single purpose case the model describes a G-trip as a set of G home-based trips.

In sum, the model allows one to evaluate typical competitive scenarios between stores at different locations, and also allows for consumers not only to decide to whether to visit a store, but also to make complex trade-offs between different trip chains which vary according to the retail chains that operate at the different locations, the types of products that are available at each location and the travel costs that they incur. The degree to which different types of products, different types of stores at each location and the distances between locations impact on consumer choices can all be measured in the proposed model.

The differences between the proposed model and most earlier models are that:

(i) The present model allows for combinations of both destinations and purposes, whereas previous models only for one of these factors,

(ii) The present model is easier to estimate and more straightforward to interpret since it is formulated in terms of a nested logit structure that fits within the random utility framework, which allows for measurement error and unobserved attribute effects.

(iii) This framework also allows one to make more direct comparisons of the model with simpler non-nested random utility models of single-stop single-purpose shopping behavior.

(iv) The random utility framework enables rescaling of the conjoint model estimates to revealed choice data to increase the external validity of the model.

EXPERIMENTAL DESIGN

Experimental designs used in conjoint choice analysis are typically based on assumptions similar to those of the simple multinomial logit model. The most important assumption for our discussion is that the error components in the consumer utility function are independently and identically distributed (IID) (e.g., Louviere and Woodworth 1983, Louviere 1988). If this assumption holds, orthogonal experimental designs can be used to create the choice alternatives in the conjoint choice experiment and obtain statistically efficient estimates of the parameters in the model (assuming that one has no a priori knowledge of the size of the parameters in the model). An orthogonal design guarantees that attributes within choice alternatives vary independently. One commonly applied design strategy is to create an orthogonal fractional factorial design and then place the profiles from this design in choice sets. Typically, a base alternative is added to each choice set to obtain orthogonality between the relative differences of the alternatives. In that case, all estimates are made in relation to the same base alternative.

However, in the proposed model structure, differences in the error components exist between the location choices for purchases of each different product order. Therefore, we apply a modified version of the stage dependent experimental design approach for choices of consumer activity patterns proposed by Dellaert, Borgers and Timmermans (1997).

In our approach, consumers are presented with choice sets describing choices for G different orders of trips. The consumer is asked to plan a number of trips to make purchases of products of different orders. Each consumer decides if and how to combine visits to multiple stores and/or to buy products of several orders in each trip. In the experimental choice sets the number of purchases is higher for each lower order product, which matches the hierarchical ordering of products on the basis of their purchase frequency. For example, only one trip a month would be required to buys books at the book store, but one trip a week would be required to buy fresh fruit and vegetables. Thus, for each product order g we can observe consumers' choices both in cases where it potentially is part of a combined purchase in a higher order multi-purpose multi-stop trip of order $G>g$ and where it itself is the highest order in a shopping trip of order g.

The aim of the proposed approach is to support estimates of scale differences between shopping location choices for different orders of products. and model comparisons across different stages of activity pattern choices. This can be done by simultaneously estimating parameters across consumers' choices of shopping location for each product order, and the scale correction parameters indicating the impact of the utility of locations for lower order product purchases on the higher order utilities.

Summarizing, a schematic representation of the shopping trip choices in the experimental task for the purchase of G product orders is given below:

$$\begin{bmatrix} \textit{Order } G \textit{ trip: } \textit{ Location choice for purchases of order } G \textit{ and lower orders} \\ \cdots \\ \textit{Order } g \textit{ trip: } \textit{ Location choice for purchases of order } g \textit{ and lower orders} \\ \cdots \\ \textit{Order } 1 \textit{ trip: } \textit{ Location choice for purchases of order } 1 \end{bmatrix}$$

Estimation and Model Tests

A full information maximum likelihood (FIML) estimation of the model can be conducted by maximizing the log-likelihood of the overall model simultaneously with respect to the β parameters and scale parameters μ. In the present study this was done by applying the computer program HieLoW (Bierlaire 1995) that allows one to define and estimate complex multi-level hierarchical structures in nested logit estimations. The program applies a combined global and regional optimization procedure to estimate the parameters in the log-likelihood function (Dennis and Schnabel 1983).

The nested logit structure can be tested against an overall simple multinomial logit model on the basis of the significance of the scale corrections between the different hierarchical levels. If the corrections are significantly different from 1, parameters at different hierarchical levels have significantly different scales. The contribution of lower hierarchical levels to choices at higher levels can be measured by the significance of the parameters for the lower order choices in the utility functions of higher order choices. If lower order parameters do not affect consumer choices of locations to purchase higher order products, the impact of the absence or presence of certain lower order stores on the location choices for higher order purchases is zero.

The multi-purpose multi-stop (MS-MP) model can be compared to simpler models that were previously reported in the literature and that are nested within the more complex MP-MS structure. For example, the single-purpose single-stop model (SP-SS) proposed by Oppewal, Louviere and Timmermans (1994) is nested within the MS-MP model, as is the multi-purpose single-stop model (MP-SS) proposed by Arentze, Borgers and Timmermans (1993). The SP-SS model is defined as a MP-MS model where consumers do not combine visits to several destinations in one trip and make separate trips for each different type of product. The MP-SS model is defined as a MP-MS model that allows for combined purchases of different types of products, but assumes that consumers do not visit several destinations in one trip.

As these models are nested within the MP-MS a likelihood ratio test (Theil 1971) can be used to test for a significant difference. Technically, the MP-MS model nests the SP-SS and MP-SS models as follows. The MP-MS model reduces to the SP-SS model if the scale parameters that indicate the impact of subsequent destinations and orders of products on the present choice are set to zero, and if all distances are calculated on the basis of a routing algorithm that requires separate trips to each destination. Similarly, the MP-MS model reduces to the MP-SS model if the utility of subsequent shopping options only includes the shopping facilities present at the destination that is being visited and not those in other facilities, and the routing algorithm does not allow for combined trips to several destinations. The log-likelihood ratio tests we conducted are expressed as follows:

-2 (*L(MP-MS model) - L (SP-MS model)*)

and

$$-2\,(L(MP\text{-}MS\ model) - L\,(SP\text{-}SS\ model))$$

EMPIRICAL APPLICATION

The proposed approach is illustrated in a case study of the choices of Dutch consumers of grocery, drug store and clothing products. An experimental choice design was constructed describing three hypothetical generic shopping locations with experimentally varied shopping opportunities. Retail chains differed by location. Distances between shopping locations were varied.

Method

Respondents were asked to assign shopping trips over three generic shopping locations (*A*, *B*, *C*) so as to make the following purchases: One purchase in a clothing shop (order 3), two purchases in a drug store (order 2), and four purchases in a supermarket (order 1). This structure of store availability and purchase ordering described a relatively realistic choice scenario to respondents in the sense that it largely corresponds with the typical structure of small scale sub-urban shopping centers and consumers shopping patterns in the Netherlands. Respondents were free to assign multi-purpose and multi-stop trips and combine several orders of products or several locations in their shopping trips. As the distances between locations as well as the availability of stores were varied systematically, the effect of the presence of the stores and the distance effect could be estimated independently. Figure 3 presents an example of a hypothetical scenario of locations and stores as it was presented to the respondents. Each respondent sequentially faced several scenarios, and in each scenario was asked to allocate the same seven purchases. Table 2 presents the attributes that were varied in the experiment and the levels they could assume.

-- INSERT FIGURE 3 ABOUT HERE --

-- INSERT TABLE 2 ABOUT HERE --

In the statistical experimental design, the three orders of stores (*clothing shops (order 3), drug stores (order 2),* and *supermarkets (order 1)*) potentially were present in each of three generic shopping locations (*A, B, C*). A supermarket was always present in each location. The retail chain with which stores were affiliated ('brand') varied by location. Location C was the 'base' location in the experiment in which all orders of stores were always present but at a relatively unattractive level (i.e. in the form of stores affiliated with relatively unpopular retail chains). In locations *A* and *B* the absence and presence of the stores of order 2 and 3 was varied; that is, depending on the specific profile in the experimental design, a drugstore and/or clothing store would be present in locations *A* and *B*.

Distance between the home location and the base location *C* was varied over three levels (*4*, *6*, or *8* minutes of travel), as was the distance between shopping locations *A* and *B* (also *4*, *6*, or *8* minutes of travel). Distance between home and locations *A* and *B* was constant at *4* minutes.

A $2^4 3^2$ fractional factorial design in 27 profiles was used to construct the profiles for the choice experiment in which the attribute levels were varied systematically. This design supported independent estimation of the absence/presence effects of the stores and the distance effects in the choice experiment.

Each respondent was presented with 9 choice situations and one hold out choice task. A convenience sample of 144 households was approached in March 1994. In each household, the member of the household most involved in daily shopping was requested to complete the questionnaire.

Results

The estimation results of the multi-purpose multi-stop model are presented in table 3. Shopping location *C* was the base alternative in the estimations and its utility was set at a value of zero. Therefore values presented in the table represent relative utilities of the facilities in locations *A* and *B* as compared to those in *C*.

The parameter estimates show that the supermarket chains available in *A* and *B* (*Albert Heijn* and *Edah*) were preferred over the supermarket in *C* (*Aldi*), that the drugstore chain in *C* (*Kruidvat*) was preferred over those in *A* and *B* (*Etos* and *DA*) and that the clothing store chains in *A* and *B* (*C&A* and *MARCA*) were preferred over the one in *C* (*Zeeman*). Between *A* and *B*, retail chains in *A* were preferred.

Parameters estimated for 'no-drugstore' and 'no-supermarket' were negative, indicating that respondents preferred to include lower order purchases in their higher order trips. The parameters in table 3 indicate the strength of the respondents preference for multi-purpose trips. By comparing the values of the 'no-purchase' parameters for drug store and supermarket, it can be seen that the tendency of respondents to include a visit to the drugstore in a higher level trip was considerably higher than their tendency to include a supermarket visit.

--INSERT TABLE 3 ABOUT HERE--

Three parameters were estimated for the distance components in the multi-stop trips: (i) a parameter to indicate the disutility of distance between home and the lowest order store in the shopping trip, (ii) a parameter to indicate the disutility of distance between a supermarket and a higher order store, and (iii) a parameter to indicate the disutility of distance between a drugstore and a clothing store. The distance parameters had signs as expected and were all of the same order of magnitude. Interestingly, the disutility for traveling between a clothing store and drugstore was slightly higher than that for the other types of travel.

The scale values between hierarchical layers had values as expected in a nested logit structure and indicated that the absence and presence of drugstore and supermarket stores had relatively little impact on clothing store location choices. However, the absence and presence of supermarket stores had a considerably stronger impact on drugstore location choices.

Taken together, these observations show that

(i) As expected, consumers preferred to combine purchases of multiple types of products in their trips to reduce their overall travel. This was shown by the significant negative value of the no-purchase option for both the drugstore and supermarket purchase and by the fact that absence or presence of lower order stores had a significant impact on higher order purchase location choices,

(ii) However, consumers also attached a less than 'rational' (in the strict micro-economic sense) value to lower order purchase opportunities in the sense that they weighed higher order purchase opportunities much more heavily in their choices than the possibility and travel costs to combine those purchases with lower order purchase opportunities. In the model this is captured by the scale parameters that indicate the difference in weight between the different shopping layers. The values of these scale parameters were significantly lower than 1 indicating the lower weight consumers attached to lower order combination possibilities. This implies that the trip chain choices that consumers made were not optimal from the point of view of minimizing travel distance.

(iii) When making clothing purchases, consumers tended to be less sensitive to possibilities of reducing travel costs by combining their purchases than when purchasing drugstore products. This was apparent in the difference between the scale values for lower product order purchases in the clothing and drugstore choices.

Model comparisons

Using the likelihood ratio test (Theil 1971), the multi-purpose multi-stop (MP-MS) model was compared to:

(i) The single-purpose single-stop model (SP-SS) (e.g., Oppewal, Louviere and Timmermans 1994), and

(ii) The multi-purpose single-stop model (MP-SS) (Arentze, Borgers and Timmermans 1993).

The SP-SS model is defined as a model where it is assumed that consumers do not combine visits to multiple destinations and/or purchases of multiple orders of products in one trip and preferred to make separate trips for each different order of products. The MP-SS model allows for combined purchases of different orders of products, but assumes that consumers do not visit several destinations in one trip. Both models are nested under the MP-MS model in the sense that they can be expressed as restricted versions of this latter model. Table 4 presents the fits of the three models and the null model.

--INSERT TABLE 4 ABOUT HERE--

The observed test statistics for testing the MP-MS model against the MP-SS and SP-SS models were 515.84 and 1966.08 respectively. Both values are highly significant at the 0.05 Chi-square level for respectively $\nu = 2$, and $\nu = 8$ degrees of freedom. This shows that the multi-purpose multi-stop model performed significantly better that the other two models in describing the consumer shopping trip choice outcomes.

The model specifications were compared also on their capacity to predict consumer choices in three hold-out conjoint scenarios which differed from the original estimation scenarios in the sense that stores of all three orders were always available in all three locations. This structure should considerably reduce the benefits of multi-stop shopping, as no travel cost gains can be made from traveling from one location to the other. However, multi-purpose shopping should still be considerably more attractive than single-purpose shopping, and consumers might still be willing to travel from one location to another to purchase products of different orders, if locations offer stores of different retail chains.

The log-likelihood values for predicted versus observed consumer choice frequencies of the three models for these additional scenarios were -969.15, -909.77 and -970.53 for the MP-MS, MP-SS and SP-SS models respectively. These results show that in these 'full availability' conjoint scenarios the MP-SS model outperformed the more complex MP-MS model and also the simpler SP-SS model. A tentative interpretation of this finding would be that consumers' tendency for multi-stop travel depends in part on whether all product orders are available in all locations. Multi-stop shopping would be expected to occur much more often in scenarios where certain locations lack stores for one or more product orders. For example, in spatial settings where food oriented shopping malls are located separately from apparel and durable product oriented malls, multi-stop shopping trips may occur considerably more often than in scenarios where all malls have stores for all product orders. However, one would still expect that consumers may travel between locations to visit retail chains that are unique to certain locations.

DISCUSSION

Summary

In this paper we have introduced a recursive nested logit model extension of the conventional MNL-model to account for complex multi-purpose multi-stop shopping behavior. The model uses a structure in which the utilities of trip chains take into account shopping locations for lower order products (i.e. more frequently purchased products) as part of the utilities of shopping locations for higher order products (i.e. less frequently purchased products). The scale parameters in the recursive function provide information on the influence that locations for lower order products have on the choices for locations for higher order products.

To circumvent some of the difficulties in collecting adequate consumer shopping trip data to support the estimation of multi-purpose multi-stop models, the proposed modeling approach was integrated with a conjoint choice experimental design approach. This involved choices between stores at different shopping locations and concerning different orders of products. The experiment was deliberately designed to enable measurement of all different orders of trips, ranging from the highest available order of product choice to the lowest order.

A case study was conducted to test the combined experimental and modeling approach. Dutch consumers' choices between three different locations and for purchases of three orders of products were observed. It was found that consumers take into account both multi-purpose and multi-stop shopping opportunities when choosing their trip chains. The proposed recursive model predicted consumer shopping trip choices significantly better than the conventional SS-SP model and the multi-purpose extension of this model. We observed also that consumers attached lower weights to lower order combination options than to the higher order product purchases. This was captured by the scale parameters in the proposed recursive nested logit structure. Furthermore, in a separate test it was observed that consumers attached lower utility to multi-stop shopping options in cases where stores for all products orders were available in all shopping locations.

Managerial implications

Our research approach provides the potential for retail managers to gain better insight into the way in which consumer combine different types of purchases and visits to different locations when making shopping trips. We have shown that individuals may be less optimal in their shopping trip behavior than could be expected from a purely travel cost minimizing perspective. We have also shown that differences exist in the way in which consumers weigh lower order purchase combination opportunities for different orders of goods. For example, in choosing locations for clothing purchases, opportunities for lower order purchases weighed less heavily than in choosing locations for drugstore purchases. We also observed that consumers' tendency for multi-stop shopping may depend on the availability of product orders at each shopping location. Insights like these can be highly valuable to retail managers wanting to evaluate the risk of new competition from other locations, develop opportunities for co-marketing their stores with other stores, gain insight into consumers' desire to vary between locations and/or stores, and evaluate the potential benefits and risks of locating new outlets at certain locations.

An adequate understanding of consumer shopping trip choices may be difficult to gain from existing real world shopping data because little variation may exist in the absence and presence of different types of stores and the geographical structuring of retail supply. The proposed conjoint approach can help overcome this difficulty. Specifically, it may help to gain insight into the trade-offs consumers make between travel costs and selecting their favorite store for each order of products. Typically, consumers will undergo some loss in their store utility to gain some in their travel costs. However, the outcome of this trade-off may be specific to a certain geographical structure, and unless hypothetical changes in this structure are presented to consumers, it may be very difficult to gain insight into consumers' likely responses to a shift in retail supply.

Though not applied in this present study, recently developed methods for rescaling conjoint choice data allow retail managers to combine the outcome of conjoint studies like the one in this paper with existing shopping behavior data (e.g., Swait and Louviere 1993, Morikawa, Ben-Akiva and McFadden 1990). This combination can provide a valuable mixture of the construct validity of conjoint analysis and the external validity of real-world data. The methods to support such combinations are based on the principle of a joint estimation of parameters in both the real-world and the conjoint data models. Typically only a small number of parameters can be estimated on the real world data due to factors such as high collinearity between explanatory variables and a lack of variation in attribute levels. This limited set of real-world parameters is used to 'anchor' the scale of the conjoint parameters which include the same parameters as present in the real-world model as well as additional parameters. Thus, this approach allows one to combine the precision and the possibility of including non-existing options provided by conjoint experiments, with the greater external validity of real-world data.

As the purpose of the present paper was to introduce and illustrate our proposed conjoint approach we have not pursued such an exercise in our study. However, examples of such approaches can be found elsewhere in the literature. For example, Dickie, Fisher and Gerking (1987) combined and compared data from real and hypothetical market transactions for fresh strawberries, Kapteyn (1994) combined and compared real-world and subjective preference measures on food expenditure, and Swait, Louviere and Williams (1993) combined and compared real-world and conjoint data on freight shippers' choices of courier companies.

Future research

The present model assumes that the error structure in the consumer trip utility function can be modeled hierarchically. It would be interesting to test the validity of this assumption against models that allow for non-hierarchical variance-covariance structures in the trip chain utilities. Probit models are most commonly used to describe such structures and may enhance further the possibilities of modeling complex consumer shopping center choices. For example, they may be able to:

(i) Capture some of the effects that occur if different and unknown frequency structures apply for different segments of consumers. Recently developed models that allow for structural heterogeneity in consumer preference functions may offer further opportunities to capture such heterogeneity effects (Kamakura, Kim and Lee 1996); and

(ii) Allow for further precision in modeling unobserved similarities between the utilities of locations within a certain product order. For example, if different locations offer supermarkets that belong to the same retail chain, the error terms in their utilities could be expected to have a higher covariance than if they offer different supermarkets.

Consumer shopping pattern research could benefit from a further integration of temporal modeling and discrete choice modeling along the lines of the work that has been done in product purchase modeling (e.g., Gupta 1988, Jain and Vilcassim 1991). A further understanding of consumers' choices of where to go and when to go there could be developed from including aspects like temporal habit formation (e.g., the choice of a favorite day to shop, and strong habits in purchase frequency) and variety seeking (e.g., subsequent choices from a consideration set of shopping malls) in consumer shopping trip choice models. Hazard type model structures may be helpful to further understand this type of shopping behavior (e.g., Jain and Vilcassim 1991).

Finally, we believe that it is important to include some aspect of choice uncertainty and/or risk in future shopping trip choice models. Consumers typically only have a limited knowledge of product and store availability, current market prices and even their own preferences. Especially in areas such as clothing retailing, an important function of shopping travel is to develop a better understanding of current product availability, fashion and pricing. Consumers' uncertainty may be driving a lot of their shopping travel patterns, which is only partly accounted for in the present model structure.

FOOTNOTE

1 In the remainder of this paper we will refer to this type of trip as multi-purpose multi-stop (MP-MS) shopping trips (as opposed to single purpose (SP) and/or single stop (SS) trips).

TABLE 1

FORMAL TRIP AND PROBABILITY STRUCTURE FOR FIGURE 1 EXAMPLE

Trip order	Destination Selected	Travel	Probability	Available set
3	C_3	home - C	$P(C_3)$	$\{C_3, Home\}$
2	B_2	C - B	$P(B_2 \mid C_3)$	$\{A_2, B_2, Home\}$
1	B_1	-	$P(B_1 \mid B_2, C_3)$	$\{A_1, B_1, C_1, Home\}$
		B - home		

TABLE 2

ATTRIBUTES AND ATTRIBUTE LEVELS

	Generic Shopping Center		
	A	*B*	*C (base)*
Clothing store	absent, present	absent, present	present
(retail chain)	(C&A)	(MARCA)	(Zeeman)
Drugstore	absent, present	absent, present	present
(retail chain)	(Etos)	(DA)	(Kruidvat)
Supermarket	present	present	present
(retail chain)	(Albert Heijn)	(Edah)	(Aldi)

	Distance	
	Location A - B	Home - Location C
Travel time	4 min, 6 min, 8 min	4 min, 6 min, 8 min

TABLE 3

ESTIMATION RESULTS MULTI-PURPOSE MULTI-STOP MODEL INCLUDING RESCALING

Attribute	Parameter estimate	standard error	*t*-value
Distance to home (return)	**-0.403**	0.038	-10.660
Distance to supermarket	**-0.466**	0.011	-43.190
Distance to drugstore	**-0.524**	0.050	-10.500
Clothing store *A* (C&A)	9.448	6.522	1.449
Clothing store *B* (MARCA)	3.900	2.637	1.479
Clothing store C (Zeeman)	0.0	-	-
Drugstore *A* (Etos)	**-0.834**	0.133	-6.268
Drugstore *B* (DA)	**-0.891**	0.117	-7.605
Drugstore *C* (Kruidvat)	0.0	-	-
No Drugstore	**-1.158**	0.096	-12.040
Supermarket *A* (Albert Heijn)	**2.026**	0.069	29.470
Supermarket *B* (Edah)	**0.962**	0.071	13.580
Supermarket *C* (Aldi)	0.0	-	-
No Supermarket	**-0.124**	0.048	-2.569
scale clothing-drugstore	**0.264**[*]	0.164	-4.483
scale drugstore-supermarket	**0.763**[*]	0.070	-3.398

[*]Significance of scale parameters is tested against a value of 1
McFadden's Rho bar sqr: 0.31160

TABLE 4

COMPARISON OF MULTI-STOP MULTI-PURPOSE MODEL WITH TRADITIONAL MODELS

Model	Log-likelihood	Mc Fadden's Rho bar squared	Number of parameters	Theil test *2L(MPMS-other model)*
multi-purpose multi-stop model (*MP-MS*)	-6170.65	0.31160	13	-
multi-purpose single-stop model (*MP-SS*)	-6428.57	0.28311	11	515.84* (ν=2)
single-purpose single-stop model (*SP-SS*)	-7153.69	0.20306	5	1966.08* (ν=8)
null model	-8982.68	-	0	5624.06* (ν=13)

*significant at 95% confidence interval

FIGURE 1

EXAMPLE OF MULTI-PURPOSE MULTI-STOP SHOPPING TRIP OF ORDER 3

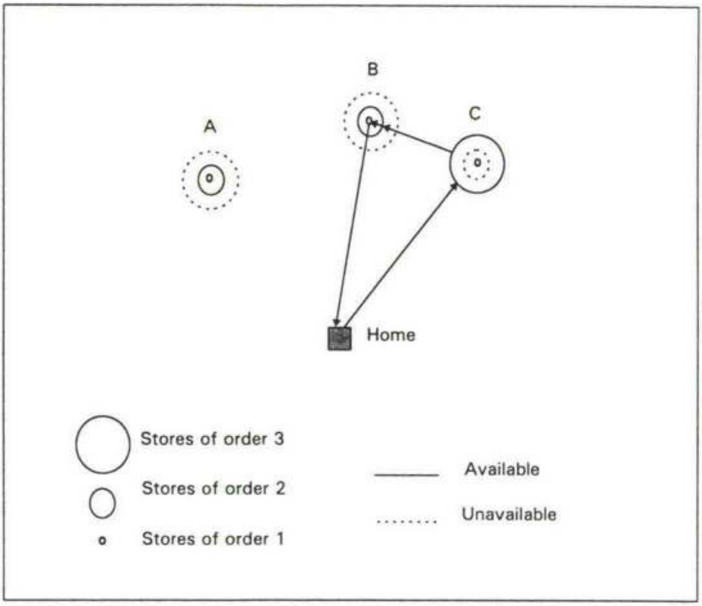


FIGURE 2

EXAMPLE OF PROPOSED NESTED LOGIT STRUCTURE FOR TRIP OF ORDER 3

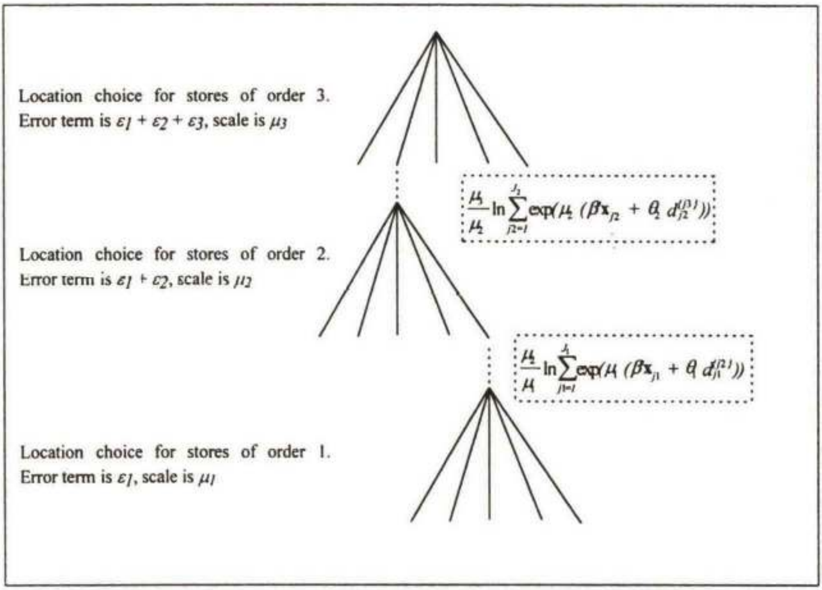
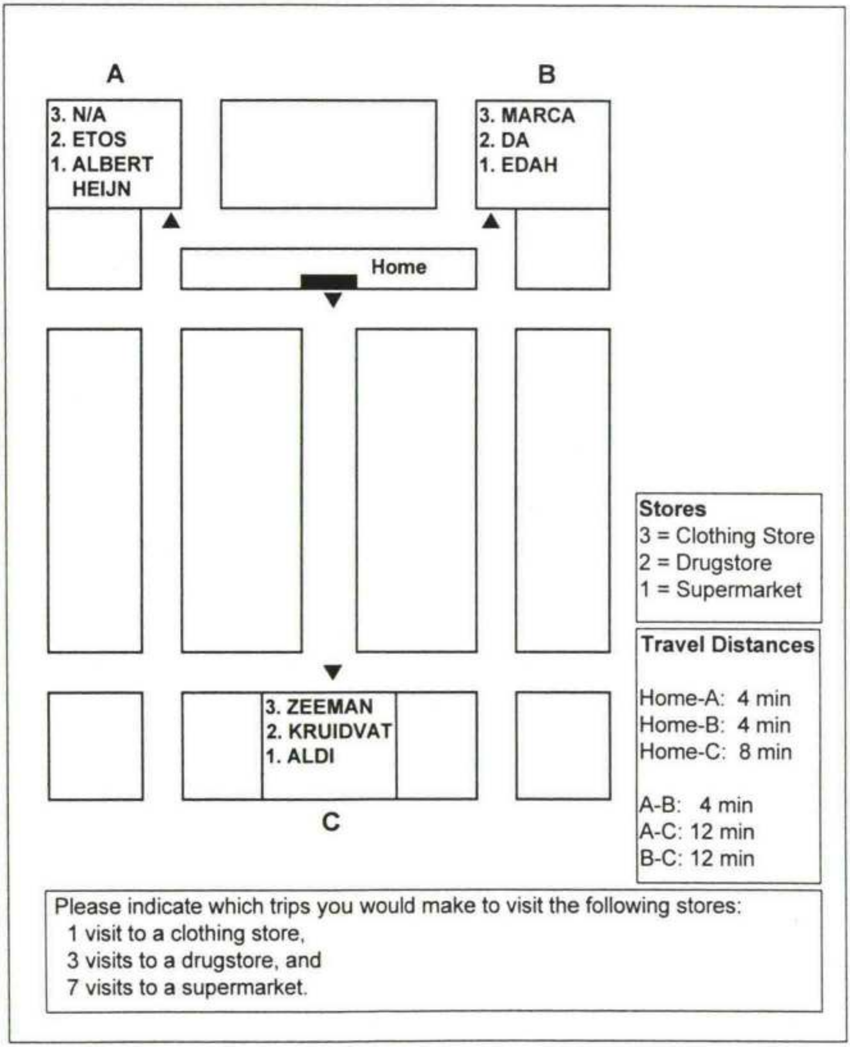


FIGURE 3

EXAMPLE OF HYPOTHETICAL CHOICE SITUATION



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