Intraurban Variations of Destination Choice: A Case Study of the Nearest Store Choice

Shigeo TAKAHASHI*

Consumers do not always visit the nearest store to purchase groceries. In this study, a dichotomous destination choice model was developed to explain the type of consumers and the situation in which they choose the nearest supermarket. The model includes variables to represent the utility of a destination, travel constraints, and the effects of multiple stops. The model was calibrated for three different areas in Hamilton, Ontario, Canada to examine intraurban variations in destination choice. The results indicate that the effect of travel mode on the choice of the nearest store is important for the three areas, but the effects of other variables vary over space. It seems that the differences in store distribution consumers confront relate to the variation in coefficients of the model.

Key words: destination choice, nearest center hypothesis, grocery shopping, multiple stops, intraurban variation.

I. Introduction

The nearest center hypothesis has drawn the attention of geographers who study central place theory. The hypothesis has been criticized on the ground that it is unrealistic and that it weakens the applicability of the theory (CLARK and RUSHTON, 1970; HUBBARD, 1978; RUSHTON *et al.*, 1967). Empirical studies have shown that only half of the purchases of low-order goods are made at the nearest store (AMBROSE, 1968; CLARK, 1968). Consumers do not always patronize the nearest store, or some consumers do visit the nearest store while others do not. These findings raise two questions. What types of consumers are likely to visit the nearest store? Under what circumstances do people visit the nearest store?

To answer these questions, we can find some clues in previous studies and build hypotheses. Studies of the relationships between consumer characteristics and shopping behavior help to find the types of consumers who are likely to patronize the nearest store. For example, consumers tend to increase travel distance from home to a store as their income increases, which may make it less likely for them to visit the nearest store. It is thought that the characteris-

tics of consumers affect the need to travel, constraints on travel, and preference, which in turn influence travel behavior.

Concerning the circumstances of visiting the nearest store, several shopping studies have indicated that consumers' efforts to combine stops on a single trip before returning home may well be one of the factors that affect the likelihood of patronizing the nearest store. Multiple stops are popular on shopping trips, and they affect the choice of retail destinations. A shopping trip is a travel circuit leaving from and ending at home to pursue shopping activities at a stop or stops. A stop is a location where a consumer visits to shop or to conduct other activities such as work and recreation. Thus, a single stop trip consists of one stop to shop followed by returning home, and a multistop trip consists of two or more stops before returning home. Empirical studies have shown that multistop trips are common (HANSON, 1980*a* and 1980*b*; HANSON and MARBLE, 1971; HEMMENS, 1966; NYSTUEN, 1967; O'KELLY, 1981; WESTELIUS, 1973; WHEELER, 1972), and consumers tend to travel longer from home to a store to purchase groceries on multistop trips (GARRISON *et al.*, 1959; TAKAHASHI, 1986). Multiple stops also encourage diversification of retail destinations, that is, a variety of stores are visited for the same good

*Research Student, Institute of Geoscience, the University of Tsukuba, Tsukuba-shi, Ibaraki 305

over some time period (HANSON, 1980a). The number of stops on a trip and the order of stops affect the distance traveled from home to a grocery store (TAKAHASHI, 1986). Specifically, travel distance from home to a store increases with the number of stops, and it is shortest when consumers purchase groceries at the last stop on a trip. Travel distance is longest when purchases are made at intermediate stops. From these results, it can be hypothesized that consumers' efforts to combine stops on a single trip affect the choice of retail destinations, thereby changing travel distances.

It is likely that the influence of multiple stops on destination choices varies according to the residential location of consumers. The distribution of stores alters consumer behavior in the short-run (HANSON, 1979, p. 82). This is the case in many travel demand models which deal with travel choices at the time that data were collected. One study has suggested that the propensity to make multipurpose shopping trips varies with the consumer's location relative to shopping opportunities under the principle of shopping cost minimization (GHOSH and MCLAFFERTY, 1984). As the travel costs for a single purpose trip increase, a larger portion of a good should be purchased on multipurpose trips. Since multipurpose shopping usually involves multiple stops and travel costs relate to travel distances, it is hypothesized that consumers evaluate the importance of multiple stops differently depending on their residential location, thereby affecting the likelihood of visiting the nearest store.

On the basis of these hypotheses, a model of destination choice was developed and applied to different areas in a city. To predict the choice of the nearest store, the model uses information about the characteristics of consumers and the structure of multistop trips. The model contributes to our understanding of consumer behavior concerning the applicability of a norm in central place theory to the real world. The results of model calibration will explain what types of consumers are likely to visit the nearest store under what circumstances. When the model is calibrated in different parts of the city, it is expected that the results are different reflecting the influence of residential location on destination choices. Thus, the determinants of the model were com-

pared to speculate the possible influence of residential location.

To focus on destination choices, a sequential decision-making process is assumed. A simultaneous approach, in which decisions about several elements of travel such as mode and route choices are made together, is more realistic (BEN-AKIVA, 1974, pp. 26–27; KANAFANI, 1983, p. 94). For empirical studies, however, the approach involves mathematical difficulties due to a large number of choice alternatives (BEN-AKIVA, 1974, p. 26; KANAFANI, 1983, p. 96), and the complexity of the computation is daunting. In contrast, a sequential approach assumes that a consumer makes a series of travel decisions in some order. Each decision is independent of decisions about other aspects of a trip (KANAFANI, 1983, p. 135). This approach reduces the number of alternatives to a manageable size (KITAMURA, 1984, p. 68).

The model developed in this study shares the limitations of current destination choice models. The model is based on associative relationships rather than on causal ones. Although ultimately it is desirable to identify and replicate the actual decision-making process, the development of this type of model is difficult, given our limited understanding of travel behavior (RICHARDS, 1982). Until a model based on causal relationships can be developed, a model based on associative relationships serves as the best alternative.

The rest of the paper is organized as follows. The next two sections describe the model and the data for the study. The results of calibrating the model for different areas are presented next. This is followed by tests and discussion of variations in the results among different parts of the study area. The last section concludes the implications of intraurban variations in destination choice patterns.

II. Model and data

A binominal logit model¹⁾ was developed to predict the probability of visiting the nearest grocery store. The model takes the following form:

$$P_i = \frac{1}{1 + e^{-(a + bX_i)}}$$

In this notation, e represents the base of natural logarithms, which is approximately equal to 2.718. P_i is the probability of visiting the nearest grocery store on trip i , given the knowledge of X_i , which represents factors that are hypothesized to affect the choice of retail destinations. In introduction, consumers' characteristics and efforts to combine stops on a shopping trip are thought to affect the choice of retail destinations. In addition, it is important to include the utility of visiting a destination, which is a fundamental element in destination choice. A discussion of travel data for this study is necessary to specify the independent variables that represent these factors.

The data were collected in the Hamilton-Wentworth region, Ontario, Canada as part of a larger study of urban residential structure. The

data consist of travel diaries completed by areally-stratified sample households. A household recorded all trips made by its adult members during a two-week period in May and June of 1978. The location of a stop is coded as one of 149 neighborhood districts defined by the city of Hamilton (Fig. 1).

Several neighborhood districts constitute a zone. Three zones were chosen to explore the effects of residential location on the use of the nearest store (Fig. 1). These zones were chosen because consumers there face different distribution of shopping opportunities. Zone 5, east of downtown, is close to a cluster of shopping establishments that includes a large downtown mall with a farmers' market (Fig. 2). Several supermarkets are located in zone 5, and other supermarkets are also available in adjacent zones.

Figure 1. Study area

Figure 2. Distribution of shopping establishments

Zone 10 is south of downtown and zone 5, above the Niagara Escarpment, which rises about 250 feet (Fig. 1). The escarpment acts as a major transportation barrier to downtown, but several supermarkets on the upper area are concentrated in zone 10. Zone 15 is located in the east end of the city. A few supermarkets are located at the southwest corner of the zone. In zone 15, many residents travel farther to the nearest supermarket than residents of zones 5 and 10. All trips that included grocery purchases made by residents of these zones were analyzed. Multistop trips are popular for consumers in these zones,²⁾ and it is expected that destination choices by consumers in zones 5, 10, and 15 will show some influence of multiple stops.

Distance was measured by the travel time between neighborhood districts. The general con-

sensus is that temporal measures are better than physical measures (BURNETT and PRESTWOOD, 1976, p. 114), since people tend to perceive space in terms of time and cost rather than physical distances (ABLER *et al.*, 1971, p. 75). Consequently, many studies of destination choice have used travel time (*e.g.*, ADLER and BEN-AKIVA, 1979; HOROWITZ, 1978; KITAMURA, 1984; KITAMURA and KERMANSHAH, 1984; LERMAN, 1979; MEYER and EAGLE, 1982). For the data, times were measured at least twice and up to six times by car along each of the streets used as neighborhood boundaries during the non-peak travel period. The average travel times between pairs of neighborhood districts and within each district were computed. WEBBER (1979) explains the calculation in detail.

Table 1 List of independent variables

Variable name	Description	Expected sign
<i>NRTL</i>	Number of retail establishments in the nearest retail neighborhood.	+
<i>COST</i>	Travel time by car in minutes between home neighborhood and the nearest retail neighborhood.	-
<i>STOP</i>	Number of stops on a trip.	-
<i>ORDER1</i>	1 if groceries were purchased at an intermediate stop, 0 otherwise.	-
<i>ORDER2</i>	1 if groceries were purchased at the last stop, 0 otherwise.	+
<i>MODE</i>	1 if a consumer walked from home to a grocery store or vice versa, 0 otherwise.	+
<i>WORK</i>	1 if a work stop was included on a trip, 0 otherwise.	+ or -
<i>CHILD</i>	Number of children in a household.	+
<i>INCOME</i>	Annual income of a household in 1978 Canadian dollars classified into six categories.	-
	1 = \$ 0-10,000	
	2 = \$10,001-20,000	
	3 = \$20,001-30,000	
	4 = \$30,001-40,000	
	5 = \$40,001-50,000	
	6 = exceeds \$50,000	

III. Variables in the model

To calibrate the model, retail alternatives were defined as the nearest supermarket and all other stores.³⁾ The nearest store is a store located in the neighborhood district that is closest to the neighborhood district where a consumer resides. Therefore, the nearest store may not be the closest one to the consumer's home location. This definition of the nearest store is, however, the best one available in the data. Also, the definition seems reasonable because the size of each neighborhood district is fairly small (Fig. 1).

The choice of a store is explained by nine variables (Table 1), which describe the utility of a destination, effects of multiple stops, and effects of consumer characteristics. The number of retail establishments in the nearest retail neighborhood (*NRTL*) and travel costs to the neighborhood (*COST*) are thought to be related to the utility of the nearest retail neighborhood. As in standard models of destination choices, it is hypothesized that the larger the number of retail establishments, the more attractive the neighborhood, and the higher the probability of visiting it. Travel costs, measured by the time required to travel by car between home and a store, are thought to be related inversely to the probability of visiting the neighborhood.

Based on the empirical observation of travel

distances on multistop trips, it is hypothesized that the structure of shopping trips relates to the likelihood of visiting the nearest store. It has been shown that consumers tend to increase travel distance from home to a store as the number of stops on a trip increases (TAKAHASHI, 1986). This leads to a hypothesis that the probability of visiting the nearest store decreases as the number of stops on a trip (*STOP*) increases. Also, it has been observed that travel distance from home to a store is shortest when groceries are purchased at the last stop on a trip, and it is longest when purchased at intermediate stops (TAKAHASHI, 1986). The mean distance from home to the first stop falls in between the mean distance to the last stop and that to intermediate stops. Based on this observation, it is hypothesized that the probability of visiting the nearest store is high when a consumer purchases groceries at the last stop on a trip, and the probability is low at an intermediate stop. It is possible to distinguish these three types of stops, first, intermediate, and last, by using two dummy variables. The dummy variable *ORDER1* takes the value of one if groceries were purchased at an intermediate stop and zero otherwise. Similarly, *ORDER2* is a dummy variable that takes the value of one if a consumer bought groceries at the last stop on a trip and zero otherwise.⁴⁾ *ORDER2* has the value of one when only one stop is made on a trip, since the mean travel time

from home to a grocery store on such a trip is shorter than the time to the last stop on a multistop trip (TAKAHASHI, 1986).

The characteristics of consumers are thought to reflect travel constraints. Several types of constraints are likely to affect decision-making in various stages of travel behavior (DESBARATS, 1983). Among available classification of constraints, this study follows one by DAMM (1983) to include the effects of temporal and spatial constraints on each trip. The following variables are chosen to consider travel constraints on each trip.

Travel mode imposes spatial constraints, that is, it constrains the distance traveled from home to a store. When a consumer walks from home to a store or from a store to home, the consumer's travel distance is restricted so the probability of visiting the nearest store would increase. The dummy variable *MODE* takes the value of one when a consumer walked from home to a store or vice versa.

Temporal constraints are also considered in the model. In the three zones, more than half (54%) of the 126 sample households are two-income, single-parent, or single-person households. Members of these types of households spend less time shopping (HANSON and HANSON, 1981a, p. 173). To save time, they often shop on the way to and from work (HANSON, 1980b; OSTER, 1979). A consumer may patronize a store located near home under time constraints. Alternatively, a consumer may stop by a store near the place of work or bus stop, which may not be the closest store to the home location. Thus, it cannot be specified a priori, whether or not the inclusion of a work stop increases the likelihood of visiting the nearest store. The dummy variable *WORK* takes the value of one when a work stop was included on a trip and zero otherwise.

The model includes two household characteristics that contribute to individual differences in travel behavior. The first one relates to time constraints. The number of children in a household affects the number and kind of out-of-home responsibilities which must be met by adult members (DAMM, 1983). It is hypothesized that the presence of children restricts the amount of time available for shopping, so the probability of visiting the nearest store would increase as the num-

ber of children (*CHILD*) increases.

Income also has an important influence on travel behavior (STOPHER and MEYBURG, 1976, p. 39). Income is related positively to travel distance (HANSON and HANSON, 1981b; HORTON and HOLTQUIST, 1971; LLOYD and JENNINGS, 1978; THOMAS, 1974). It is hypothesized, therefore, households with high incomes are less likely to visit the nearest store. Household income (*INCOME*) was classified into six categories with code 6 being highest (Table 1).

These variables were used to predict whether a consumer visited the nearest supermarket to purchase groceries on each trip. The variables are not strongly interrelated. The largest value of correlation coefficient for a pair of explanatory variables is 0.43. Of 36 pairs for each zone, only three or four values are larger than 0.20, and half of the values are smaller than 0.01. The following sections discuss the results of calibrating the model with maximum likelihood estimation in the three zones of Hamilton.

IV. Estimation results

For all three zones, the model approximated the observed choices with reasonable accuracy. The goodness of fit of the model was measured by a value of p^2 , which was calculated as follows.

$$p^2 = 1 - LL1/LL0,$$

where *LL1* is the value of the log likelihood function⁵ for the vector of estimated coefficients, and *LL0* is the value of the log likelihood function when all coefficients except the constant are zero. The resulting value follows approximately a chi-square distribution. Values of p^2 tend to be considerably lower than those of R^2 , and values of 0.2 to 0.4 for p^2 represent an excellent fit (McFADDEN, 1979, p. 307). In addition, the statistic generally has low values for logit models of destination choice, for example, 0.066 and 0.086 (HOROWITZ, 1978) and 0.19 (ADLER and BEN-AKIVA, 1976). Values for the three zones are comparable with the values in these previous studies.

A more appropriate measure of goodness of fit may be the frequency of correctly predicting destination choices (DOMENCICH and McFADDEN,

Table 2 Estimation results^a

Variable ^b	Zone 5	Zone 10	Zone 15
<i>NRTL</i>	-0.00106 (-0.81)	-0.00638 (-1.45)	0.0397* (3.56)
<i>COST</i>	-0.192 (-0.44)	-0.553 (-1.09)	-0.117 (-0.39)
<i>STOP</i>	0.0524 (0.31)	-0.360* (-1.68)	-0.131 (-0.70)
<i>ORDER1</i>	1.636* (2.29)	0.130 (0.13)	0.373 (0.52)
<i>ORDER2</i>	0.791 (1.37)	1.774* (2.56)	0.135 (0.26)
<i>MODE</i>	1.698* (4.45)	2.532* (4.76)	1.653* (3.02)
<i>WORK</i>	-0.197 (-0.34)	0.558 (0.87)	-0.349 (-0.62)
<i>CHILD</i>	-0.340* (-2.24)	-0.0341 (-0.19)	0.0353 (0.20)
<i>INCOME</i>	0.228 (1.04)	0.152 (0.40)	0.0598 (0.39)
Constant	-1.323 (-1.16)	-1.250 (-0.78)	-1.773* (-2.21)
<i>N</i>	164	182	202
<i>LL0</i>	-113.08	-112.34	-126.90
<i>LL1</i>	-97.95	-80.25	-106.50
$p^2 = 1 - LL1/LL0$	0.144	0.286	0.161
Likelihood ratio test (<i>d.f.</i>)	30.26 (9)	64.18 (9)	40.79 (9)

^aFor each variable, coefficients are shown with *t*-statistics in parentheses.

^bSee Table 1 for the description of variable names.

*Significant at the 0.05 level.

N is the number of choices.

LL0 is the value of the log likelihood function when all coefficients, except the constant, are zero, and *LL1* is the log likelihood function for the vector of estimated coefficients.

1975). Between 66 and 80 percent of destination choices were correctly predicted by the model (Table 3). These percentages are similar to those reported for the choice models of shopping trip frequency and time of day to travel, 71 and 75 percent (DOMENCICH and McFADDEN, 1975).

The overall significance of the model is verified by the log likelihood ratio test.⁶ For all three zones, the test indicates that together the explanatory variables have a significant impact on the probability of visiting the nearest store at the 0.001 level (Table 2).

Despite the overall significance of the model, a relatively small number of variables had significant effects ($p \leq 0.05$) on destination choice in each zone. Of the nine explanatory variables, two or three were significant in each equation. The results are usual. Review of previous studies shows that generally few explanatory variables

Table 3 Prediction success table

(A) Zone 5

	Actual choice	Predicted as:	
		Nearest	Other
Nearest	75	49	26
Other	89	30	59
Total	164		
Percentage of correct prediction = 65.9			

(B) Zone 10

	Actual choice	Predicted as:	
		Nearest	Other
Nearest	56	29	27
Other	126	9	117
Total	182		
Percentage of correct prediction = 80.2			

(C) Zone 15

	Actual choice	Predicted as:	
		Nearest	Other
Nearest	65	24	41
Other	137	6	131
Total	202		
Percentage of correct prediction = 76.7			

are significant in a destination choice model, for example, two of seven (BEN-AKIVA, 1974), two or three of five (HOROWITZ, 1978), and two of four (SOUTHWORTH, 1981). Destination choices need to be studied further to understand the choice process so that better explanatory variables can be specified.

The spatial constraint represented by the variable *MODE* had a constant effect on the probability of patronizing the nearest store in every zone. The coefficient has the expected positive sign and it is significant at the 0.05 level. In contrast, the variable representing time constraint, *WORK*, was not related to the probability of visiting the nearest store in any part of the study area. The coefficients for the variable were not significant in the three zones. This result indicates that, although work trips often include grocery purchases on the way home (HANSON, 1980b), time constraint on a work trip does not necessarily force the selection of the nearest supermarket. Consumers seem to choose various stores on work trips in terms of the proximity to the home location.

Other variables have a significant influence on the choice of the nearest store, but the significance varies among the three zones (Table 2). The effects of multiple stops, represented by variables *STOP*, *ORDER1*, or *ORDER2*, are significant ($p \leq 0.05$) for zones 5 and 10 located at the center of the city. The effects are not significant, however, for zone 15 located at the periphery of the city. Previous studies have implicated that multiple stops affect destination choices (e.g., GARRISON *et al.*, 1959; HANSON, 1980a). This study has empirically confirmed that consumers' efforts to combine stops on a trip affect whether or not consumers choose the nearest supermarket. In addition, it appears that there are intraurban variations in the effects of multiple stops on the choice of the nearest store.

Intraurban variations are also seen in coefficients for the utility of the nearest store and household characteristics, which seem to have marginal effects on the choice of the nearest store. The number of retail establishments (*NRTL*) and the number of children in a household (*CHILD*) have significant effects ($p \leq 0.05$) for only one zone. Surprisingly, travel costs (*COST*) and household income (*INCOME*) are not significant. Usually, travel costs affect destination choices significantly. This is not applicable to the special case of choosing the nearest store. The result may indicate that, even at a distance, the nearest store has higher utility than farther stores. Household income is also important in explaining shopping behavior (e.g., LLOYD and JENNINGS, 1978; STOPHER and MEYBURG, 1976). In the choice of the nearest supermarket, however, household income has little influence.

In the results above, it is of geographical interest that the effects of many explanatory variables are context dependent, resulting in variations among the three zones. For example, the significant coefficient for the effect of intermediate stops, *ORDER1*, has the unexpected positive sign for zone 5. This might have been caused by unique local circumstances. There are a large number of supermarkets and other stores in the zone (Fig. 1 and 2), so the distance from home to an intermediate stop can be short as the distances to first and last stops. The following sections statistically test these intraurban varia-

tions and discuss possible causes.

V. Transferability analysis

To evaluate the variations in the results from calibrating the model in the three zones, transferability analysis was conducted. The transferability of a model refers to its ability to be transferred from one area, time period, or group of people to another for the prediction of travel choices. Theoretically, a transferable model is desirable, because transferability is a direct indication of the forecasting ability of a model (BEN-AKIVA, 1981, p. 666). Pragmatically, a transferable model is desirable when resources are limited. A transferable model developed elsewhere can be used to avoid costly data acquisition and model development (ATHERTON and BEN-AKIVA, 1976, p. 12; BEN-AKIVA, 1981, p. 666).

Previous empirical studies have been mainly interested in mode choice models. Calibration of the models in different areas has had mixed results. Some studies have found that the coefficients are similar (ATHERTON and BEN-AKIVA, 1976; KOPPELMAN and WILMOT, 1982), and others have reached the opposite conclusion (GALBRAITH and HENSHER, 1982; OU and YU, 1982; TALVITIE and KIRSHNER, 1978). We know little about the transferability of destination choice models. Destination choices are more complex than mode choices, because potentially each consumer has a unique choice set (BURNETT and PRESTWOOD, 1976). A consumer may have various stores near the residence while another consumer may have no stores within walking distance. Furthermore, consumers at the identical location may have different taste, leading to different sets of stores as potential destinations. We need to understand if and how destination choices differ among consumers with different characteristics at various locations.

Two statistics, the model equality test statistic (*METS*) and the transferability test statistic (*TTS*) measure transferability. Each is defined as follows when a model calibrated in area *j* is applied to area *i*:

$$METS_{ij} = -2[LL_{i \cup j}(\beta_{i \cup j}) - LL_i(\beta_i) - LL_j(\beta_j)],$$

$$\text{and } TTS_i(\beta_j) = -2[LL_i(\beta_j) - LL_i(\beta_i)].$$

In the equations, β indicates a vector of model coefficients. $LL_i(\beta_j)$ is the log likelihood that the behavior observed in area i was generated by the model estimated in area j , and $i \cup j$ indicates the union of areas i and j .⁷ These statistics are chi-square distributed with degrees of freedom equal to the number of coefficients in the model. Each statistic measures a different aspect of transferability. The transferability test statistic (*TTS*) is based on the concept that transferability is directional, that is, transferability is possible in one direction between a pair of areas but may not be possible in the other direction (KOPPELMAN and WILMOT, 1982). The model equality test statistic does not take account of direction.

Table 4 Model equality test statistics

Estimate based on:	Prediction based on:		
	Zone 5	Zone 10	Zone 15
Zone 5		29.64 ^b	26.09 ^a
Zone 10	29.64 ^b		36.31 ^b
Zone 15	26.09 ^a	36.31 ^b	

^aSignificant at the 0.01 level.

^bSignificant at the 0.001 level.

Table 5 Transferability test statistics

Estimate based on:	Prediction based on:		
	Zone 5	Zone 10	Zone 15
Zone 5		66.53 ^a	54.37 ^a
Zone 10	169.70 ^a		67.74 ^a
Zone 15	2288.22 ^a	301.74 ^a	

^aSignificant at the 0.001 level.

Both statistics indicate that the model of destination choice developed in this study is not transferable among the three zones (Tables 4 and 5). The results suggest that, in each zone, consumers respond to the determinants of destination choice in a different way. A model of destination choice must be calibrated for each area in the city for better prediction of choices unless a model is transferable over space.

Having established the differences in the results of model calibration among the three zones, the following section will speculate the effect of store distribution on the use of the nearest store as one potential cause of the variations.

VI. Intraurban variations of destination choice and distribution of stores

The destination choice model is not transferable over space, because both the magnitude and the significance of the coefficients estimated for the explanatory variables differ among the three zones. The unique results in each zone may reflect differences in the distribution of potential destinations. The probability of visiting the nearest store was expected to be higher on single stop trips than on multistop trips. Consumers in zone 10 follow this expectation. The percentage of the nearest store use on single stop trips, 57 percent of all visits to purchase groceries, is much higher than that on multistop trips, 19 percent (Table 6). The coefficient for the variable *STOP* is, therefore, significant ($p \leq 0.05$) for zone 10.

Table 6 Frequency of nearest store visit

(A) On multistop trips

	Zone 5	Zone 10	Zone 15
Nearest	43 (46%)	23 (19%)	40 (29%)
Other	50 (54%)	101 (81%)	100 (71%)
Total	93 (100%)	124 (100%)	140 (100%)

(B) On single stop trips

	Zone 5	Zone 10	Zone 15
Nearest	32 (46%)	33 (57%)	25 (40%)
Other	39 (55%)	25 (43%)	37 (60%)
Total	71 (100%)	58 (100%)	62 (100%)

In contrast, the relationship is less noticeable for consumers in zone 15 with a smaller difference in the percentages of the nearest store patronage on single and multistop trips (Table 6). Due to the concentration of stores at a corner of the zone, many consumers in zone 15 do not have the nearest store near their homes. In this situation, it seems that the convenience of patronizing the nearest store on single stop trips diminishes. Similarly, when supermarkets and many other stores are available nearby home as for most consumers in zone 5 (Fig. 1 and 2), there seems to be little effect of the number of stops

on the visit to the nearest store. In this case, consumers tend to visit the nearest store on multistop trips as well as on single stop trips (Table 6), decreasing the effect of the variable *STOP*. One possible explanation is that the number of stops affects the use of the nearest supermarket when sufficient supermarkets are distributed around home but other stores that stimulate multiple stops are not readily available.

In addition, the distribution of stores may explain the unexpected sign of the coefficient for *ORDER1*. It was hypothesized that the probability of visiting the nearest store would be low when consumers purchase groceries at an intermediate stop, but zone 5 shows the opposite result. Unlike other consumers, those in zone 5 often visited the nearest supermarket at intermediate stops.⁸⁾ One explanation of this unique pattern is that, since zone 5 is in the cluster of stores, there exist great opportunities of additional shopping around the nearest supermarket after grocery purchases.

The distribution of stores also seems to have influenced the values of the coefficient estimated for *ORDER2*. In zones 5 and 10, many consumers can use the nearest store around their homes just before returning home, making the variable *ORDER2* more meaningful.⁹⁾ In contrast, the absence of stores near home for consumers in zone 15 seems to have discouraged the use of the nearest store at the last stop on a trip.

In zone 15, the number of stores in the nearest neighborhood district (*NRTL*) has a significant influence ($p \leq 0.05$) on the choice of the nearest store with the expected positive sign (Table 2). The variable has insignificant coefficient values, however, for zones 5 and 10. Again, differences in the distribution of stores may explain the result. In contrast to zones 5 and 10, where several supermarkets are scattered within the zones, few supermarkets are located in zone 15 and they are concentrated at one corner. When other trip purposes are combined with grocery shopping as often observed in the three zones, consumers may visit a more attractive neighborhood with a major shopping center. Consumers from zones 5 and 10 may stop by a supermarket that is not attractive in terms of the number of retail establishments after a visit to a shopping center. In contrast, many consumers from zone 15 may

visit a supermarket within or near a major shopping center due to the scarcity of supermarkets near home. Consequently, the attractiveness of the nearest neighborhood district may have become significant for zone 15.

VII. Conclusion

A model was developed to explain the choice of the nearest supermarket under the influence of multiple stops and travel constraints. The results from three different zones in the city of Hamilton, Ontario, Canada show that the model as a whole significantly explains the choice of the nearest supermarket. The model can correctly predict about 66 to 80 percent of destination choices in the study area. Multiple stops, time and spatial constraints, and the attractiveness of shopping destination relate to the use of the nearest store.

The results also indicate that residential location affects the coefficients of the model. Although travel mode significantly affects the probability of visiting the nearest supermarket in all three zones, the effects of other variables vary among the zones. Consequently, the model is not transferable within the city. The distribution of shopping opportunities may contribute to the poor transferability of the model within the city.

The limited transferability of the destination choice model has important implications. To estimate the number of shopping trips in the entire city using the results of destination choice patterns, a model must be calibrated several times for different areas in the city. Estimation for the entire city by using a spatially clustered sample may cause distortion.

The intraurban variation in destination choices also confirms the notion of behavior in space. Actual destination choices are likely to be related to the spatial structure of opportunities (RUSHTON, 1969). Behavior in space describes the rules of choice, movement, and interaction as they are constrained by the existing spatial structure, while spatial behavior is independent of the spatial system (COX and GOLLEDGE, 1981, p. xvii). The effects of spatial constraints on the choice of the nearest store seem to be consistent

over space, but the effects of other determinants particularly those of multiple stops seem to be context dependent. In this study, it has been suggested that the distribution of shopping opportunities has a significant influence on the variations in choice patterns. Response to the same determinant of store choice was different between consumers who had many shopping opportunities close to their homes and those who had few nearby opportunities.

Further investigation is necessary to understand the relationship between the variation in coefficient values in the model and the distribution of stores in reference to consumers' residential location. Understanding of this relationship would allow us to divide a city into several segments within which similar patterns of destination choices are made.

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Notes

- 1) Logit models are the extension of linear regression to models in which the dependent variable is discrete. A binominal logit model has its dependent variable dichotomized. In a multinominal logit model, the dependent variable has more than two categories. Both types of logit models are explained in several references including ALDRICH and NELSON, 1984; DOMENCICH and MCFADDEN, 1975; HENSHER and JOHNSON, 1981; and PINDYCK and RUBINFELD, 1976.
- 2) Fifty-seven percent of grocery purchases were made on multistop trips by consumers residing in zone 5. The percentages for other zones are 79 for zone 10 and 69 for zone 15.
- 3) It is assumed that the majority of grocery purchases were made at supermarkets. The data do not allow us to separate purchases at supermarkets from those at other grocery stores.
- 4) First stops are identified by the value of zero for both dummy variables, *ORDER1* and *ORDER2*.
- 5) The likelihood function represents the likelihood of obtaining the sample results. The log likelihood function, *LL*, is defined as:

$$LL = \sum_{i=1}^N [f_i \log P_i + (1 - f_i) \log (1 - P_i)],$$
 where P_i is the probability of choosing the nearest store on trip i , N is the total number of trips, and f_i is one if the nearest store is chosen on trip i and zero otherwise.
- 6) Analogous to the F statistic in linear regression analysis, the log likelihood ratio statistic for a logit model, C , is calculated as follows to test the joint hypothesis that all coefficients except the constant are zero.

$$C = -2 \log(LL0/LL1) \\ = -2(\log LL0 - \log LL1),$$
 where $LL1$ is the value of the likelihood function for the vector of estimated coefficients, and $LL0$ is the value of the likelihood function when all coefficients except the constant are zero. The resulting statistic is approximately chi-square distributed with $K-1$ degrees of freedom where K is the number of coefficients.
- 7) For example, the following three values of log likelihood are necessary to compute the model equality test statistic between zones 5 and 10. We obtain two log likelihood values by calibrating the model separately for zones 5 and 10, and then obtain the third value by calibrating the model for both zones. The computation of the transferability test statistic when the model calibrated in zone 5 is applied to zone 10 requires the following two values of log likelihood; one when the model is calibrated in zone 10, and the other when model coefficients for zone 5 and destination choices in zone 10 are used.
- 8) Of 23 purchases at intermediate stops, 13 (57%) were made at the nearest store. The percentages are lower for zone 10 (6%) and for zone 15 (29%).
- 9) Forty-six percent and 42 percent of all grocery purchases at the last stop on a trip were made at the nearest store by consumers in zones 5 and 10, respectively. The percentage by consumers in zone 15 is 34.

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目的地選択パターンの都市内部における相違

——最近隣店舗選択の場合——

高 橋 重 雄*

消費者が食料品の購入のため最寄りの店を訪れる場合とそうでない場合とがある。本研究では、消費者が最も近いスーパーマーケットを利用する確率を説明するための目的地選択モデルの構築を行った。モデルは、目的地を訪れることから得られる効用、外出に伴う制約条件、1回の外出で複数の目的地を訪れることが、どのように目的地の選択に影響を及ぼすのかを説明できるように構

築された。カナダのオンタリオ州にあるハミルトン市内の3ヶ所にこのモデルを適用した結果によると、消費者の居住地によって、これらの説明変数の目的地選択に及ぼす影響に相違が生ずることが認められた。この結果の一因として、近くに店舗があるのか遠くまで出かけなくてはならないのかというように、消費者からみた店舗の分布が関係しているものと考えられる。

* 〒305 つくば市天王台 筑波大学地球科学研究科研究生