ESTIMATING MARKET SHARES FOR NEW BANK LOCATIONS: THE APPLICABILITY OF THE HUFF MODEL

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Lorman L. Lundsten & Martin R. Warshaw

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Lorman L. Lundsten

Vice President, Lundsten Plastics Corporation

Formerly Financial Economist, Office of the

Comptroller of the Currency

Martin R. Warshaw

Professor of Marketing and ~~head of the~~ CHAIRMAN,

Marketing Faculty, the University

of Michigan

ABSTRACT

Data from a study of consumer behavior in one retail banking market are used to determine whether six critical assumptions of a model of retail gravitation would be met in the context of its use as a predictor of bank patronage. The assumptions are generally upheld.

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Marketing research has provided considerable evidence that convenience is the most important factor in a consumer's decision to patronize a specific banking location (Bennet 1975). It is, therefore, not surprising that bank managements seek those locations for their main offices and branches which will afford maximum convenience for potential customers. Experience has taught these executives that conveniently located banks attract more deposits and engage in more loan activity than do less well-located banks.

What bankers have needed for some time is a way to predicting the performance of a proposed location prior to its construction and opening. First, such a prediction would be invaluable in convincing the regulatory authorities of the need for a new bank location and second, such predictions would enable management to make better selections of locations from those available to them.

The ideal solution to this estimation problem would be some type of algorithm which would utilize the "convenience" effect of a given location to estimate the share of market a given bank might gain if built on that location. Because of the close analogy between the problem of locating a bank and the more general problem of locating a retail store for the sale of convenience goods, it is reasonable to start the search for a banking model among those models which have been developed for the location of non-bank retail outlets.

RETAIL GRAVITATION MODELS

The oldest and best-known approach to estimating the extent of retail activity in a market area was developed by Reilly (1929). His model was the first of a series to be known as retail gravitation models and was originally developed to predict how retail patronage would be divided between adjacent communities. Even today its use by bank managers is occasionally recommended (Kramer 1972).

A second-generation model developed by Huff appears to overcome many of the problems associated with the application of the Reilly model to the location of individual retail outlets (Huff and Batsell 1972). The Huff model is based on estimates of individual probabilities of patronage for a specific retail establishment and appears to provide a logically consistent approach to the retail location problem.

Huff's statement of the share of market model follows the axiomatic approach set out by Luce (1959). It is possible to derive models similar to Huff's model ~~using~~ from several different starting points. Kotler (1971) cites work by Urban, Krishnan and Gupta, and Weiss in developing models of this type and, although he avoids the formal statement of axioms, he presents a discussion that leads to a multiple-variable gravitation model very similar to that suggested by Huff.

Bell, Keeney, and Little (1975) approach the problem of determination of market share by offering a set of four axioms that can be developed into a model similar to that of Huff. The axiomatic structure of BKL centers ~~around~~ on the properties of the firm, while that of Luce centers ~~around~~ on individual choice. If one assumes homogeneous choice behavior by individuals, the BKL model and the Luce model differ on no major point.

The literatures of mathematical psychology (Coombs et al. 1964, 1975), marketing (BKL et seq. 1975), and sociology (Zipf, Stewart 1947, 1949) ~~show~~ contain many instances of the formulation and testing of models of interaction and influence. The models ~~show some differences~~ differ in some respects, but it is unlikely that any empirical data ~~will allow the acceptance of~~ would support any one model over the others on the grounds of goodness of fit. Table 1 traces the history of some models of this type. Here, as elsewhere, the final choice of a model rests with the researcher. Because of its long period of acceptance and use, its grounding in individual behavior and its orientation to marketing, the authors prefer the Huff model. This work will ~~offer a~~ test of several important assumptions of this model in the context of bank marketing.

HUFF'S MODEL

The Huff model is based on an adaptation of Luce's choice axiom to the retail patronage problem. Huff assumes that a measure of size is available for the relevant retail facility and that distance from the consumer to the location is a reasonable surrogate for convenience. The Huff model is stated below:

$$P_{ij} = \frac{V(j)}{V(all)}$$

where:

P_{ij} = the probability of consumer i patronizing facility j

$V(j) = A_j^{\gamma} D_i^{\lambda}$ and $V(all) = \sum_{j=1}^{n} V(j)$ for n competitors and

A_j = an attraction index for retail facility j

D_{ij} = the accessibility of a retail facility j to a consumer located at i

γ & λ = empirically determined parameters (Huff 1962)

Originally, γ, the exponent of the attraction measure (mass or size in terms of gravitation) was set at unity for ease of computation. The similarity to Reilly's model is striking. Both set the mass exponent at unity and both allow empirical determination of the exponent on distance.

Unfortunately, the application of the Huff model to problems of market share estimation for proposed retail facilities has been fraught with difficulty. Huff and his associate Batsell have noted that unless certain conditions are met the model may be misapplied or results emanating from its application may be misleading. They have identified six key problem areas which will be considered below in some detail (Huff and Batsell, 1975).

(A) PROBLEM AREAS

(B) Trip-type

The Huff model assumes that the set of retail alternatives specified as choice alternatives is most likely to be associated with single-purpose shopping trips. If choice alternatives are associated with multiple-purpose trips, "the proximity of a retail facility to a consumer's place of origin may not be nearly as important as the proximity of a retail facility to other retail facilities in which purchases are intended, or to those non-shopping activity places that the individual intends to visit " (Huff and Batsell 1975).

(B) Product-type

"It is important that the attraction values that are specified for those retail facilities comprising the set of choice alternatives be in keeping

with the product purchase intentions of the customer" (Huff and Batsell, 1975). Thus in those cases where the specific product is not specified, or if specified is ~~the wrong one,~~ not the one the consumer intends to purchase, results of model application will be less dependable.

(R) Spatial Equilibrium

The Huff model assumes that the consumer will share his purchases among feasible alternatives in keeping with a constant probability vector (e.g., .6 probability of purchasing from store A and .4 probability of purchasing from store B). The model provides an equilibrium solution without any guarantee that the individual consumer is in equilibrium.

(B) Choice alternatives

If the subset of choice alternatives is not defined correctly, two types of problem can occur. First, those arising from ~~non-inclusion of~~ omitting a consumer choice alternative and second, those which arise from including an alternative which is not in the consumer's set of feasible alternatives. The former error results in overstatement of estimated values, the latter error results in understated expected values which depend on the alternatives which were included in the model.

(B) Group Behavior

The model is based on a choice axiom of individual behavior. If group behavior is being analyzed as it is in a market share estimation problem, great care must be exercised to make certain that behaviors in small segments of the market can be averaged out to predict correctly behavior in the total market area.

(B) Choice Determinants

The model requires only two variables (size and distance) to compute a

probability measure. However, the consumer's perceived utility of a retail facility may be a function of several variables other than the two noted previously. If the variables used in the model are not truly surrogates for other important factors the resulting measures may be misleading.

Given the availability of the Huff model and a recognition of the problems associated with its application, the question arises as to how useful it might be when applied to the problem of market share estimation for a new banking office. To answer this question a telephone survey of 600 families in Farmington, Michigan was taken. Farmington, Michigan is a close suburb of Detroit and contains a good representation of Detroit's major financial institutions.

The survey, undertaken in December, 1975, was based on a sampling frame of the homes listed in the most recent city directory. Approximately one out of each 32 homes was contacted. The remainder of this article will examine the Huff assumptions in the light of the survey data to determine whether or not the Huff model may be usefully applied to the banking problem.

EMPIRICAL EXAMINATION OF HUFF AND BATSELL'S AREAS OF CONCERN

Trip and Product Type

The attraction function in the Huff model applies for a given single-purpose shopping trip. Also, the distance function is applicable between the consumer's present location and a single destination. If several stores are visited, a consumer might seek to maximize some joint utility and to minimize total distance traveled. Hilliard (Hilliard, Vaughn and Reynolds, 1975) reports some results that indicate that this effect is mixed and may be negligible.

When questioned about when the household banking was done, Farmington consumers gave the reasons shown in Table 2.

The most frequent response was "special trips to bank." Of the twelve different responses to this question, only three clearly indicate multiple-purpose trips. These account for 43 percent of the responses; however, a clear majority of the responses do not involve multiple-purpose trips.

~~The application of a gravity model would also be inappropriate if, on a single-purpose banking trip, several banks were visited.~~

The survey results for Farmington show that most families use only one bank for checking services (the question was not asked for savings services). Table 3 shows these figures.

(B) Spatial Equilibrium

The model does not specify consumer loyalty and does not consider~~ation~~ ~~of~~ temporal and spatial dynamics. In considering any well-established product, it may be reasonable to assume that the survey sample used to specify the model is a reasonable cross-section of the steady-state universe of buyers. Golledge indicates that, or when this is not true, model errors may be significant (1970).

~~For the Farmington consumer,~~ Tables 4 and 5 show the distribution of the length of time Farmington consumers have utilized the major retail services. It is obvious that banking services have very loyal patrons and that any predicted change in market share may take a long time to materialize.

For this reason, most users of gravity models speak of the prediction of equilibrium market share (Bennett, or 1975), which is defined as the market share that would result if the modeled conditions were to persist for an indefinite period of time.

(12) Choice Alternatives

Systematic exclusion of establishments that are patronized by the public for the type of good in question can cause ~~over-prediction~~ overstatement of the market share of the included establishments. Similarly, inclusion of alternatives not actually considered by the purchaser will result in an understatement of the predicted market share of the establishments actually used.

Table 6 shows the usage of each of the major types of competitive alternatives for the primary consumer services. The major conclusion to be drawn from this table is ~~the need~~ that there is a necessity to include commercial banks and thrift institutions in any banking market share model.

(13) Group Behavior

The use of a model of individual choice (Luce's choice axiom [Luce, 1959]) in a model of group behavior requires assumptions about the homogeneity of the choice process which may not be acceptable to some. A fully equivalent set of assumptions which deal only with group behavior is offered by Bell, Keeney, and Little (Bell, Keeney, and Little, 1975). These assumptions may be used to derive Huff's model directly.

As a practical matter, models of the gravity type have been successfully used for some time to ~~successfully~~ predict human behavior (Olsson, 1965). We offer no empirical tests of this assumption, as none are appropriate.

(14) Choice Determinants

Huff's final comment deals with the need for a multidimensional model of consumer utility. The original model requires only two variables to compute the utility measure, distance (either actual or subjective), and size. Two exponents serve as sensitivity measures and mediate the effects of those measures.

Huff states that those variables are surrogates for a number of other correlated measures and that two variables were chosen to make parameter estimation possible. Obviously, many variables might enter the consumer choice process, and a method of deciding upon important variables and specifying coefficients for the resultant model would be desirable. Huff notes the recent work of Nakanishi and Cooper in showing that least squares regression is an appropriate means of specifying such multivariate multiplicative models (Nakanishi and Cooper 1974). Several authors have reported that such models are effective (Nakanishi and Cooper 1974; Eilon and Fowkes 1972; Lundsten 1976).

SUMMARY AND CONCLUSIONS

Data from a study of consumer behavior in one retail banking market were used to determine whether or not six critical assumptions of a model of retail gravitation would be met in the context of its use as a predictor of bank patronage. It appears that five assumptions are realistic in light of reported consumer behavior in the use of banking services. The assumption of a single-purpose shopping trip is, however, less supportable given survey data which indicate that over 40% of households consider their banking to be part of multi-purpose shopping trip.

The authors believe that this last finding should not eliminate the use of retail gravitation models such as the one developed by Huff in estimating market shares for new bank locations. The fact that over half of the respondents did make a single-purpose trip to do their banking, and the findings of Hilliard (Hilliard 1975) that the single trip assumption was probably not critical indicate that the retail gravitation model is a useful tool for those persons in bank management or bank regulation who have a need to predict patronage levels of bank locations before they are built.

FOOTNOTE

1. Strictly speaking, the use of retail gravitation models in this fashion for new banking offices requires an assumption (treated briefly earlier) that the predictions made for an office not yet opened may be meaningfully interpreted as equilibrium market shares. The market share for all banking offices, both actual and proposed, may be computed and the results assumed to describe the market after the new branch has undergone a period of growth. The duration of this period and the rate of growth are not specified. Kramer (1971) has shown that the deposits at a bank branch grow in a regular fashion, typical of a given market, so that once the equilibrium market share is known, it is possible to estimate deposit levels for prior years.

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Table 1.

Some Important Dominance Models (See Note 1)

Individual Models (See Note 2)

Date	Researcher(s)	Comments
1927	Thurstone	Led to the Probit model.
1952	Bradley & Terry	Led to the Logit model
1959	Luce	Equivalent to Bradley & Terry's model
1961	Restle	Set theoretic adaptation of Luce's model
1964	Coombs	Probabilistic unfolding

Group Models

Date	Researcher(s)	Comments
1858	Carey	"Social gravitation" model
1885	Ravenstein	Migration model
1924	Young	Migration model
1929	Riley	"Retail gravitation" model
1940	Stouffer	Spatial interaction model
1947	Stewart	Spatial interaction model
1949	Zipf	Social interaction model
1962	Huff	Market share, based on Luce's axioms
1969	Hlavic & Little	Similar to Huff's model
	Nakanishi	Market share model
1970	Nakanishi & Cooper	Multiplicative competitive interaction model

Table 1.
(continued)

1971	Kotler	Several related models of market share
1975	Bell, Keeney & Little	An axiomatic model for grouped data
1976	Barnett	A refinement of Bell, Keeney & Little

Note 1: Many of these models measure absolute phenomena like migration. Share-of-market models, however, measure a relative phenomenon. This distinction is not material, as any absolute model may be converted into a relative one by simply dividing by the total of the phenomenon under study. (I.e. A model of sales may be converted into a model of market share by dividing by total sales.)

Note 2: The distinction between individual and group models is not as important as it might seem, as nearly all individual models were tested using aggregate group data.

Table

TABLE 2

QUESTION 5: WHEN DO YOU BANK?*

Do you do your banking . . .	Code Value	1	2	3	Total	Percentage
When shopping for groceries	1	124	---	---	124	16.4
While doing nongrocery shopping	2	36	47	3	86	11.4
While travelling to or from work	3	104	8	4	116	15.4
During working hours	4	55	13	1	69	9.2
Special trips to bank	5	233	43	16	292	38.7
Whenever handy	6	9	1	4	14	1.9
Bank by mail	7	16	4	1	21	2.8
On pay day during work	8	3	1	1	5	.7
On Fridays or Saturdays	9	8	4	---	12	1.6
When pension check comes	10	5	---	---	5	.7
Not ascertained	10	1	477	568	---	---
First of month	11	4	1	2	7	.9
Other times	12	2	1	---	3	.4
Total		600	600	600		
Total		599	123	32		
Base for percentages					754	100.0

* Up to three mentions were coded.

Table

TABLE 3

QUESTION 7: NUMBER OF BANKS USED?

How many different banks do you and other members of your household use for checking account services?	Code Value	n	Percentage
1	1	475	83.8
2	2	74	13.1
3	3	13	2.3
4	4	2	.4
5 or more	5	3	.5
Refused to answer	11	6	---
Don't use any	10	27	---
Total		600	
Base for Percentages		567	100.0

Table

TABLE 4

QUESTION 10b: LENGTH OF TIME AT THIS OFFICE FOR CHECKING

Approximately how many years have you used this particular office for checking account services? Would you say . . .	Code Value	n	Percentage
1 or less years	1	69	12.1
About 2 years	2	69	12.1
About 3 years	3	55	9.6
4 to 5 years	4	70	12.2
6 to 10 years	5	135	23.6
More than 10 years	6	174	30.4
Don't use checking	10	27	---
Refused	11-12	1	---
Total		600	
Based for Percentages		572	100.0
Median: 5.9 years			

Table

TABLE 5

QUESTIONS 13c AND 18b: LENGTH OF TIME AT THIS OFFICE

And how long have you used the savings services at this particular office? Would you say . . .*	Code Value	Save at Checking Bank		Save Elsewhere		All Savers	
		n	Percentage	n	Percentage	n	Percentage
1 year or less	1	41	12.1	22	10.0	63	11.3
About 2 years	2	34	10.0	30	13.5	64	11.4
About 3 years	3	34	10.0	22	10.0	56	10.0
About 4 or 5 years	4	38	11.2	32	14.5	70	12.5
6 to 10 years	5	72	21.3	36	16.3	108	19.3
More than 10 years	6	120	35.4	79	35.7	199	35.5
Refused	12	4	---	4	---	8	---
Base for percentages		339	100.0	221	100.0	560	100.0
Median: 6.7 years							

* The wording on question 18b was: Approximately how many years have you used this particular office for savings account services? Would you say . . .

Table

TABLE 6

TYPES OF INSTITUTIONS USED

	n	Percentage
Commercial Bank Only	336	56.0
Savings and Loan Association Only	6	1.0
Credit Union Only	1	.2
Commercial Bank and S & L	108	18.0
Commercial Bank and Credit Union	126	21.0
Commercial Bank, Credit Union and S & L	14	2.3
None or N.A.	9	1.5
	600	100.0

incident 2nd cities

Get date on Nakanishis Model

Proceedings of the AMA Spring conf 1968.

~~1973~~ 1972

* MASAO NAKANISHI. "Measurement of Sales Promotion Effect at the Retail ~~L~~ Level -- A new Approach" IN Combined Proceedings - Marketing Education and the Real World and Dynamic Marketing in a Changing World. Edited by Boris W. Becker and Helmut Becker. Chicago: American Marketing Association, 1973, Series No. 34, pp 338 - 343.

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