THE DEVELOPMENT OF SPATIAL THEORY IN RETAILING AND ITS CONTRIBUTION TO MARKETING THOUGHT AND MARKETING SCIENCE

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ABSTRACT

This paper takes an historical look at contributions to marketing thought made by scholars studying spatial behavior by emphasizing the work of "rëtail gravitationalists." These researchers are applauded for their work based on its parsimony, scientific rigor, theoretical contribution, and its ability to provide normative guidelines to marketing practice.

INTRODUCTION

The reason that the people of a society need some form of marketing is that producers and consumers are separated.... The separations of producers and consumers however, are of many types: spatial, temporal, informational, and financial. Whatever is done in the marketing process must contribute to the removal of these and other separations (Bartels 1968, p. 32).

The inclusion of a theory of market separations within Bartels' outline of a general theory of marketing clearly indicates the importance of research aimed at removing separations between producers and consumers. A paramount question raised by the issue of market separations concerns locating business enterprises in such a manner as to be attractive to as many prospective customers as possible. During the relatively brief history of marketology, retailing scholars and practitioners have contributed a significant body of knowledge to resolving this question (Craig, Ghosh, and McLafferty 1984; Hollander 1980). Therefore, it seems fitting that any account of the development of marketing thought, science, or theory acknowledges these contributions.

Marketing scholars have often criticized consumer and marketing research for their lack of a scientific approach or their inability to make substantive theoretical contributions (Alderson and Cox 1948; Anderson 1983; Bartels 1951; Calder and Tybout 1987; Maholtra 1988; Olson 1981;). Prominent among the leaders in theoretical and scientific advances within our discipline have been the retailing scholars (Bartels 1962; Hollander 1980; Sheth 1983). More specifically, retailing scholars toiling to advance knowledge related to removal of market separations have been singled out for their contribution to marketing science (Schwartz 1963). Perhaps an even greater accolade for these researchers has been their ability to produce practical normative guidelines concerning locational decisions which could easily be employed by large numbers of retailing practitioners (Lilean and Kotler 1983; Nelson 1958).

As in other areas of marketing and consumer research, retailing scholars addressing locational concerns have made advances by both borrowing from other disciplines and by developing specific knowledge. While Brown (1989) has recently reviewed the contributions of numerous economists to locational theory, the purpose of this paper is to focus on historical advancements made by retail researchers and practitioners studying market separations, and to demonstrate how researchers working within a spatial framework may remain on the forefront of advancement within marketing science. In doing so, this paper is not only a tribute to the scientists who have made these advances, but also an acknowledgement of the durability of locational decisions and the generalizability of a spatial framework.

DEVELOPMENT OF EARLY SPATIAL BEHAVIOR MODELS

Interest in studying spatial behavior appears to have increased in prominence during the early decades of the 20th century (c.g., Chamberlin 1935; Hotelling 1929; Reilly 1929). It is perhaps more than coincidental that this increased interest coincided with dramatic increases in transportation alternatives and in urban and rural infrastructures necessary to support them. In addition to marketers, scholars from other disciplines participated in studying spatial behavior as well.

Brown (1989) has recently noted the contribution of Harold Hotelling (1929) to location theory. Hotelling advanced the principle of minimum differentiation as an attempt to explain why stores of one type tend to locate in a central location. Taking an opposing view, Ed Chamberlin also contributed to spatial theories of behavior (1935). In his much heralded text, The Theory of Monopolistic Competition, Chamberlin advances a normative theory of spatial behavior which demonstrates how product differentiation can be accomplished by changing locations so as to be nearest to the greatest number of consumers (Dickson and Ginter 1987) -- even if your ice cream is all alike. The result would be firms spatially dispersed in a configuration approaching social optimality. Other economists, certainly, contributed much to location theory. However, their contributions neither predate, nor are they clearly more important to the advancement of marketing knowledge than are the contributions made by those involved in the practice and study of retailing. Perhaps most prominent among these contributors is William Reilly.

GRAVITY MODELS (SPATIAL INTERACTION THEORY)

William Reilly was one of the earliest retailing scholars to study spatial consumer behavior and was self-described as a "Sometime Marketing Specialist and Professor of Business Administration" (Reilly 1929a). The work of Reilly deserves mention on several accounts. First, he is recognized as among the earliest marketing scientists (Bartels 1962; Schwartz 1963). His interest in developing the scientific method of marketing research is clear in his text on survey research entitled *Marketing Investigations* (1929b). Second, he was dedicated to developing a culpable body of theory, but only after it met rigorous empirical and conceptual standards (Reilly 1931). Third, Reilly was capable of providing research which spanned the boundary between market and marketing research. His work not only provided a rich theoretical basis for basic research, but it also provided useful information to marketers in the field. Indeed, for fear of appearing too complex for retailers of his era, he suggested the use of newspaper subscription tracing as proxy for the Law of Retail Gravitation; "...since retailers who will use this law are, as a rule, not mathematicians, the application of the law has been simplified" (Reilly 1929a p. 16). Since his main contribution to the study of market separations is the Law of Retail Gravitation, further discussion is warranted.

TABLE
Evolution of the Gravity Model

Equation	Year	Description
(1) $(B_a/B_b) = (P_a/P_b)^N (D_b/D_a)^n$	1929	The general form of the "law" as first proposed by Reilly.
(2) $BPD = (D_{a-b}) / [1+(P_a/P_b)^{.5}]$	1948	A mathematical restatement of Reilly's "law" determining "Breaking Point Distance" between competing towns, a and b (Converse).
(3) $(B_a/B_b) = (P_a/P_b)(4/d)^2$	1948	Converse introduces the "inertia factor" in this form which allows for the determination of trade shares between towns a and b.
(4) $p_{ab} = (S_b/T_{ab}^n) / (\sum_{b=1}^{m} S_b/T_{ab}^n)$	1964	Huff uses shopping center size as a measure of attraction and travel time as a deterrence measure in a model which determines the likelihood of travel from a to shopping center b, considering m alternative centers.
(5) $p_{ab} = \dfrac{(\pi A_{ab}^N * \pi D_{ab}^n)}{(\sum_{k=1}^{m} \pi A_{abk}^N * \pi D_{abk}^n)}$	1985	A multiplicative interaction model reflecting multiple measures of attraction (A) and deterrence (D) allowing probabilities to be computed as above (Black 1987).

The Law of Retail Gravitation.

The general form of the law of retail gravitation as proposed by Reilly is Equation (1) in the Table where B represents business from an intermediate town to cities a and b, P represents the population of the cities, and D represents the distance of cities a and b from the intermediate town. The values of N and n represent the sensitivity of the dependent variable, business, to the individual predictors. Reilly states that unpublished studies support a value of one for N. He does, however, publish the results of a frequency analysis that supports a value of n equal to two when shopping goods are involved. Thus the more familiar representation of Reilly's Law:

$$B_a/B_b = (P_a/P_b)^1 \ (D_b/D_a)^2$$

While economists and geographers working in this area were not influenced by Copeland's (1923) influential work on classification of goods, it is evident Reilly's work was. He was very clear about the limitations of this specific form of the relationship. The familiar form of the law, as expressed above, pertained only to shopping, or 'style' goods, and, in his original work (1929a), the state of Texas. He later (1931) conducted tests which led to the conclusion that, *on average*, this relationship would hold for the entire country.

Reilly (1929a) was also careful to point out that there are many factors that influence the actual decision of place of patronage, and he provides a rather exhaustive list. However, he feels these factors are very closely related to population and density, thus the use of these measures as composite indicators.

Basic Extensions of the Law

Another marketing researcher, Paul Converse (1948), contributed to spatial interaction theory by conducting studies to test and to extend the scope of the general form of Reilly's Law. Using this general relationship, he developed modifications of the law represented by Equations (2) and (3) given in the Table. Equation (2) determines the breaking point distance (BPD) between two towns, thus representing the distance at which someone is indifferent concerning which town to patronize. The division of business between two towns can also be determined by Equation (3) in the Table, where B represents the proportion of trade going to an outside town (a) and the proportion of trade retained by the home town (b). P represents population of the respective towns, and d represents distance to the outside town. The inertia factor, which was found to be usually close to 4, represents what must be overcome to visit any store.

Converse used these relationships to determine the breaking point distance for and the division of business between a small town and a large metropolitan center as well as for a small town versus Chicago. In each application he recognized how the parameters can change, thus implying the inherently probabilistic nature of his work. Thus, he reiterated that these relationships hold on the *average* and not necessarily in every instance. Extending to other classes of goods may not provide similar results.

David Huff (1964) extended the gravitational concept to intra-urban applications. He altered the general form of Reilly's Law to Equation (4) in the Table where P_{ab} is the probability of a consumer at point a traveling to shopping center b, T_{ab} is the time required to travel from a to b, S_b is the size in square feet of center b, and n, once again, is an empirically derived sensitivity factor.[1] This model allows for the evaluation of probabilities associated with someone selecting a particular location to patronize over a multitude of other alternatives, not just one. Using this idea, overlapping stochastic market areas can be configured for a number of locations, which provides for the capability of mapping market areas, even in an urban setting. Huff also suggests using size of stores to measure the amount of selection offered at a center. He considers size to be the predominant factor comprising attractiveness in urban settings.

Further extensions of Reilly's general model have resulted in a multiplicative interaction model (Black 1987). Equation (5) in the Table represents multiple measures of attraction (A), such as store size and appearance, and deterrents (D), such as travel time and travel cost, that are used to determine patronage probabilities. The main contribution of this work is that multiple indicants of attraction and deterrence are used instead of simply the single proxies of population and distance.

The substitution of other surrogates became quite common as other researchers attempted to extend the gravity concept. This suggests that the general form of Reilly's Law may be restated as:

$$(B_a/B_b) = (A_a/A_b)^N \, (C_b/C_a)^n$$

Where A represents attractiveness and C costs associated with the selection of a center. In applying this equation one has to decide on the appropriate measures of cost and attractiveness for that application. The result is a quite general relationship which is capable of accounting for a wide range of phenomena.

The Versatility of the Gravity Model

Just as Newton's Law of Gravity proved to be a quite versatile relationship, spawning numerous forms explaining various related phenomena (force, inertia, momentum, etc.), it could be argued that Reilly's behavioral application of the physical concept of gravity to retailing is multifaceted as well. It appears, for example, that the general form of the gravity model is consistent with, or provides the basis for, a number of other advances in location theory.

As an illustration, it would appear that the gravity model has something to offer the principle of minimum differentiation. Brown (1989) cites the Canadian fur trading

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1. This sensitivity factor can be thought of as a measure of the amount of time someone is willing to spend shopping for a particular good. For instance, n would be expected to be higher for convenience goods than style goods (Huff 1964). Small n also recognizes the intuitively obvious geometric properties associated with these relationships. (If the choices are extremely far apart, the attractiveness is not very important.)

industry of the 18th and 19th centuries as a prototypical case of agglomeration. Rather than locating in a dispersed fashion, as Chamberlin (1935) would suggest, the two fur trading competitors, the Hudson's Bay Company and the North West Company, tended to locate their wilderness trading post within close proximity of one another. In an effort to gain competitive advantage, posts began offering incentives (mainly fire-water) to their customers (mainly Indians) in return for their patronage. Given no real differences in distance to the posts, the Indians patronized posts perceived as being most attractive depending upon the incentives offered. Although economic theory would imply this to be a less than optimal economic arrangement, it may be that the incentives increased the attractiveness of the 2-post centers to a far greater extent than would have been the attractiveness of 2 1-post centers. The Gravity model would seem to be able to account for this phenomena by deriving and applying the appropriate sensitivity factors.

Similarly, Brown (1989) notes how Hotelling's model can be used to explain the agglomeration of retailers with similar product offerings, the introduction of a store with a different assortment of goods considerably complicates things.

> **If the apocryphal ice-cream sellers cluster together today, it is ... because they realize that sun-bathers prefer to compare prices and flavors before purchase. The arrival of a hot-dog seller, however, considerably complicates the competitive landscape** (Brown 1989, p. 462).

However, a straight forward application of a gravity model can easily accommodate the hot-dog vendor. In particular, Huff (1964) employed a gravity framework to study this problem. The hot-dog vender increases a consumer's probability of patronizing the center in proportion to the increase in attractiveness created by having a larger and more encompassing center.

Likewise, the gravity model implicitly underlies many principles of central place theory (Christaller 1966; Losch 1954). For example, the familiar hexagonal arrangement of centers, in the absence of certain geographic constraints, can be explained using Reilly's Law (Mason and Mayer 1990). Also, the concept of threshold indicates that a store has a minimum level of attractiveness that must be achieved given the population of an area. In addition, other central place concepts (Kivell and Shaw 1980), such as the greater patronage associated with higher order centers (those with a wider assortment of goods) and the threshold of a good, are also consistent with the law or retail gravitation.

Perhaps more familiar to retailing practitioners are the numerous heuristics and checklist methods used to guide them in selecting a retail site. Strohkarck and Phelps (1948) developed a shopping goods "market area map" showing the marketing areas for each market center in the continental United States. The basis of this map was the Law of Retail Gravitation. Likewise, most typical checklists (e.g. Nelson 1958) include a rather exhaustive inventory of indicators of a center's cost and attractiveness. Factors commonly considered are traffic patterns, what side of the street a center is on, how protected is it from the weather, what other shops are in the area, etc. Another popular locational technique, known as the analog technique (Applebaum 1966), also implicitly represents some of the gravity model's principles. A major component of the analog method is that as the distance of a trade area from a center increases, the proportion of consumers a retailer could hope to attract from those centers decreases. Applebaum's method demonstrates a fairly strait-forward way of determining what could be thought of as various "breaking points."

These examples provide further evidence of how versatile and encompassing, particularly from a behavioral standpoint, the gravity framework has proven to be. In addition, it is worth noting that the law of retail gravitation predates most economic and geographic location theory, and has been around the same length of time as Hotelling's theory of minimum differentiation. The remainder of the paper briefly reviews what has happened since the early days of the retail gravity model, and suggests reasons for this framework's past, and perhaps, future success.

RECENT ISSUES IN SPATIAL INTERACTION MODELS

Interest in spatial behavior models, or models of separations, has continued since the period of substantive revelations offered earlier in this century. However, the popularity of this research has fluctuated in both quantity and content within the retailing and marketing literature. Recently, two interesting issues have gained the attention of spatial researchers. First is the issue of various estimation techniques used to uncover model parameters. A second concern is decomposition of attractiveness and deterrents (cost) composites into actual variables which they may represent, thus increasing specificity of the model. On both of these issues it is clear that this group of scholars continues on the forefront of advancement in marketing science and continues to make substantive contributions to other areas of marketing, consumer behavior, and other disciplines as well.

Modeling Issues

The most common form of the original law of retail gravitation assigns parameters of 1 to population (attractiveness) and 2 to distance (deterrents) in a multiplicative model (Engel, Blackwell, and Miniard 1990). However, these parameter values were expected to hold only under specific conditions outlined by Reilly (1929a). Reilly obtained these values through statistical regression analysis. In doing so, his work represents one of the earliest applications of regression in marketing research. Later, Converse (1948), also using regression analysis, specified parameter values for a variety of conditions not covered in Reilly's original work.

However, as gravity models evolved increasingly into explicit choice axioms (e.g., Luce 1959), the statistical assumptions normally associated with linear regression, and least squares parameter estimation, became inadequate in many instances. To be more precise in estimating parameters, store choice researchers were among the first researchers to apply both the multinomial logit (Arnold, Roth, and Tigert 1978) and probit (Maholtra 1983) models in consumer or marketing research. While logit seems to have become the model of choice, primarily because of its simplicity (Maholtra 1984), current research is underway testing the appropriateness of its assumptions to store choice phenomena. The assumption called most into question is one which forces crosselasticities to be equal (Maholtra 1988). It is likely that researchers striving for applications of gravity type models will play a role in resolving this and similar issues, and perhaps, contribute to the advancement of all of marketing science.

Like Reilly, other gravitationalists have demonstrated a great concern for scientific precision and rigor. However, the real strength of the gravity model is not so much in its techniques or mathematics, but rather, its simplicity is its greatest virtue.

Weaknesses

Along with its many strengths, gravity models have often been criticized for its limitations in serving as a general location tool (Mason, Mayer, and Ezell 1991). Reilly (1929) himself acknowledged that, in practice, it may be too mathematical to apply. Thus, he offered a useful heuristic involving measurement of newspaper subscriptions to aid retail practitioners in location decisions.[2] Also in practice, it is more often applied successfully in rural rather than urban settings. Perhaps its greatest disadvantage as a locational tool is its inability to explicitly take into account numerous competitive and logistical forces which could greatly determine the success of a marketing operation (Porter 1990). For example, a conglomeration of similar industries may often lead to economies of scale. Thus, formal gravity models may be more useful as an explanatory, rather than as a general locational, device.

Specification Issues

What is often overlooked when considering gravity models is that they do not limit us to studying behavior related only to geographic or actual physical distances (Stanley and Sewall 1976). Reilly's (1929a) original work clearly recognized that distance and.population were merely composite indications of various other factors which make a shopping alternative either attractive or unattractive. As previously indicated, more recent research has attempted to increase model specificity by decomposing surrogates into their individual components (Black 1987; Hubbard 1978). This decompositional approach, while having similar aims, is an attractive alternative for studying consumer behavior because it avoids many of the problems associated with traditional multiattribute models of retail patronage (Darden et al. 1983).

Other attempts at increasing specification have led to the development of novel concepts. Thompson (1963) introduced the concept of "subjective distance." He felt that subjective, rather than actual, distance increased the precision of gravity models because individual perceptions better captured consumer inclinations. Thus, shopping centers which are more attractive are likely to be perceived as geographically closer than they actually are.

An interesting application of this concept has recently appeared in the *Journal of the Academy of Marketing Science*. Mayo, Jarvis, and Xander (1988), in applying a gravity model to vacation alternatives, have demonstrated how increased subjective

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[2]Many of the heuristics mentioned earlier may well be explained mathematically by some sort of gravity model.

distance can actually make an alternative more attractive. Applications of subjective distance in this vein may be useful in explaining outshopping or "shopping vacations" (Darden and Perreault 1976), which comprise a substantial segment of new retail developments in major urban markets. In part, subjective distance may capture the "pull" associated with sensory qualities associated with these new shopping alternatives (Grossbart et al. 1989; Meoli and Feinberg 1989).

Other applications of future research can be envisioned. The inertia factor first introduced by Converse (1948) is worthy of further attention (Mayo et al. 1988). Given dramatic increases in in-home shopping alternatives, a study of how these alternatives have affected consumer inertia may be warranted. If consumer inertia is increasing due to increased in-home shopping opportunities, it may mean that traditional retailers will have a more difficult time motivating consumers to leave the comfort of their homes to do their shopping. Also, the inertia factor may provide a useful segmentation variable to help in separating those consumers who enjoy shopping from those that do not. Another area of future research which may greatly improve studies of market separations lies in greater use of longitudinal studies. Since spatial theories in marketing research deal with consumer behavior through both time and space, longitudinal studies would seem an appropriate avenue for extending knowledge in this important area.

Thus, study of market separations has proven to be a very useful method for uncovering important concepts and techniques which have found widespread acceptance across market as well as marketing research. Based on recent studies like those briefly described above, this trend can be expected to continue in the future.

CONCLUSIONS

An argument has been made in this paper that the study of spatial market separations has led to many advances in the state of knowledge of marketing. Among researchers studying related phenomena, "retail gravitationalists" can be singled out as responsible for numerous major contributions to both marketing science and marketing theory. Early gravitationalists, such as Reilly and Converse, provided us with a conceptually simple, yet, scientifically rigorous framework for studying consumer behavior through time and space. Despite its apparent simplicity, the gravity framework appears to be one of the few models in marketing worthy of the label "theory" (Hunt 1983).

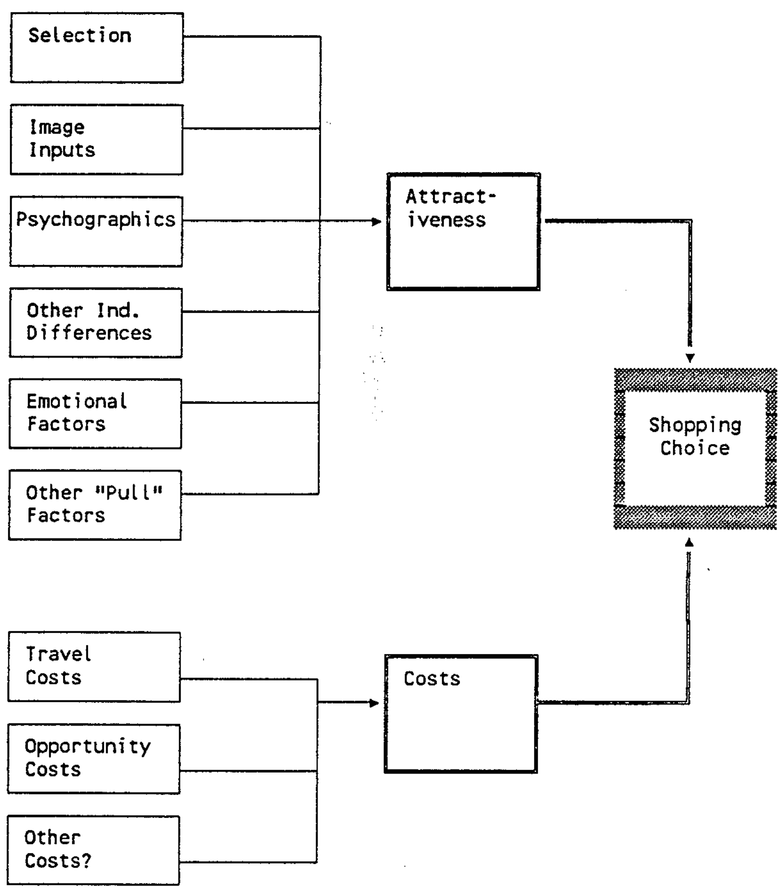
As time has progressed there have been many more complex models advanced in marketing. It is perhaps safe to say that many of these have not enjoyed the success of the gravity framework in providing a useful tool for both research and application. If it is true that simplicity is a virtue, then it is clear why the gravitationalists have been successful. The simplicity and usefulness of the theory are made clear when it is summarized.

Gravitationalists provide a framework for studying market separations which simply says consumers make patronage decisions by summarizing and comparing the attractiveness and costs associated with each alternative. Mathematically, this simple relation can be expressed as:

$$P_a = f(\ A_a\ )\ X\ \ f(\ C_a\ )$$

The probability of selecting a shopping alternative, a, is equal to some function of a's attractiveness times some function of costs associated with choosing a. The Figure pictorially represents this simple framework and various individual measures which may comprise attractiveness and costs.

FIGURE
A Pictorial Representation of a General Theory of Retail (Consumer) Spatial Behavior



Future research should recognize that the designation of variables as contributing to an alternative's attractiveness or costs is somewhat arbitrary.[3] Factors may be derived which are a cost to some segment of consumers but contribute to the attractiveness of an alternative to another. Further, some variables may contribute to both an alternative's attractiveness and costs. Image inputs, emotional factors, and individual differences would seem likely to introduce such paradoxes. Additionally, the gravity model provides us with a simple yet versatile framework capable of including both cognitive and emotional considerations in explaining consumer behavior. This capability may allow the model to extend beyond what is considered traditional "rational" consumer behavior. Therefore it seems that this general form of a spatial theory may allow applications involving all types of market separations -- not simply geographic ones.

In addition, more work needs to be done specifically demonstrating the similarity of various cross-disciplinary locational theories. Mathematical representations might be developed, at least in some instances, which might accomplish this task.

In conclusion, it is clear that the development of spatial theory in retailing research represents a significant achievement in marketing thought. These researchers have left us with many contributions through the history of marketing. In addition, their impact will almost certainly be seen in the future as well.

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[3]An even more parsimonious representation may be to include only benefits as a construct. In such a representation costs are merely negative benefits while positive benefits make up attractiveness. However, the conceptually rich notion of trading off benefits versus costs is retained by keeping both concepts.

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