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Another Look at Retail Gravitation Theory: History, Analysis, and Future Considerations

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Abstract

This paper provides a detailed look at retail gravitation theory. The authors cite six primary objectives of the work: 1) to explain gravitational models and their significance, 2) to discuss the history and evolution of retail gravitation theory, 3) to provide a partial formalization of retail gravitation theory to facilitate analysis of the theory, 4) to examine the potential limitations of gravitation theory in the Internet era, 5) to evaluate the future of retail gravitation theory, and 6) to present a gravity-type model that accounts for Internet shopping behaviors.

An Introduction to Retail Gravitation Theory

William J. Reilly was the originator of retail gravitation theory. He was not the first to study retailing, nor was he the only academic interested in trade areas. He was, however, the first scholar to articulate a gravitational model that could explain and predict consumer shopping patterns with reasonable accuracy. Through revisions and extensions by such noted scholars as P.D. Converse, David Huff, and others, gravitational models have proven to be very useful throughout their 80-year existence. Why, then, do so few current marketing textbooks mention retail gravitation theory? And why have the major marketing journals recently neglected gravitational models? Sheth and Sisodia (1999) and Anderson, Volker, and Phillips (2010) provide some answers to these questions. One contribution of this article is to evaluate their discussion of the downward trajectory of gravitation theory, but there are many significant historical and theoretical implications that are also addressed. The six objectives of this paper are to 1) explain gravitational models and their significance, 2) discuss the history and evolution of retail gravitation theory, 3) provide a partial formalization of retail gravitation theory to facilitate analysis of the theory, 4) examine the potential limitations of gravitation theory in the Internet era, 5) evaluate the future of retail gravitation theory, and 6) present a gravity-type model that accounts for Internet shopping behaviors.

Gravitational Models

Gravitational models are supposed to apply to all types of retailing situations in which a spatial dimension is present. In brick-and-mortar retailing environments, the retailer's physical location defines the "target geographical market" where the firm competes for customers (Ingene and Lusch 1981, p. 108). Traditional retailing norms hold that the retailer has little hope of attracting customers beyond its established geographical market. Ingene and Lusch (1981) argue that this emphasis on spatial location separates retailing from most of the other functional areas of marketing. In the other areas, spatial location may be an important factor, but it is not the critical factor. Numerous studies suggest that "retailing success or failure is more under the influence of the establishment's precise location than is the case for other marketing endeavors" (Ingene and Lusch 1981, p. 108). The importance of the spatial perspective to the analysis of retail structure, growth, and competition cannot be overstated (Gonzalez-Benito 2005). Therefore, research efforts to explain and predict competition derived from spatial coverage strategies have become foundational parts of the retailing literature (Babin, Boles, and Babin 1994).

The importance of the spatial perspective has carried over to the Internet era, despite the fact that electronic commerce has had major impacts on retailing. Websites a viable alternative to traditional brick-and-mortar stores. During the 2012 holiday season, U.S. retailers sold over $1 billion worth of goods through online outlets (Tuttle 2013). However, approximately 69% of American consumers still prefer to shop in stores, according to a survey by Ipsos Public Affairs (Alabassi 2011). Certain online-only retailers, such as Amazon.com, have enjoyed great financial success over the last decade, yet most retailers view their websites as a complement to their existing brick-and-mortar stores, not as a replacement. Initial concerns that e-commerce would take over the retail arena now seem "overblown" and "exaggerated" (Keen, Wetzels, de Ruyter, and Feinberg 2004). Thus, the spatial dimension of the retailer's environment continues to be a relevant and oft-studied construct in the retailing literature.

Marketing academics have primarily relied upon four theoretical frameworks for analyzing store location potential and trading areas: analog models, regression models, central place theory, and retail gravitation theory. Analog models use existing data and growth patterns from similar retailers or trade areas to project sales (Anderson, Volker, and Phillips 2010). Regression models use mathematical formulas to determine potential sales from variables like population size, average income of the population, and the number of households in the area (Anderson, Volker, and Phillips 2010). Central place theory maintains that customers are willing to travel greater distances to retail establishments that carry a relatively wide selection of valuable goods. Gravity models assert that groups of customers are drawn to certain locations because of factors like the distance to market, distance between markets, market population, the size of the retail establishment, the location of competitors, etc. The fourth approach focuses on retail agglomeration and consumer transaction costs (Eppli and Shilling 1996).

Gravity models derive their name from William J. Reilly's *The Law of Retail Gravitation* (1953). *The Law of Retail Gravitation* ultimately derives its name from Newton's Law of Gravity, which explains and predicts the gravitational attraction between astronomical bodies of varying mass (Reilly 1953; Ingene and Lusch 1988). Gravitational models have occupied an important place in the retailing literature since the 1930s (Ingene and Lusch 1988; Anderson, Volker, and Phillips 2010). Scholars from disciplines outside of marketing have also found gravitational models useful in predicting commodity flows, migration patterns, and urban travel (Mayo, Jarvis, and Xander 1988).

The History and Evolution of Retail Gravitation Theory

Reilly's Law. William J. Reilly was the founder of what Sheth, Gardner, and Garret refer to as the "Regional School of Thought" (1988). Reilly combined census information with consumer surveys and city-level retail data to produce his first major work on trade areas, *Methods for the Study of Retail Relationships*, in 1929. His seminal work, *The Law of Retail Gravitation*, came two years later. This longer work is largely an extension of the shorter monograph. The central premise of both is that people living in rural communities will necessarily travel to larger communities for most of their shopping needs. *The Law of Retail Gravitation* differs in that it is much more mathematically-oriented than the former. Reilly published a second edition of the work in 1953. Unfortunately, both editions are now out of print.

Reilly's Law holds that trade centers draw consumers from neighboring communities in proportion to the trade areas' populations and in inverse proportion to the distances between the communities and the trade areas. He expresses this relationship in the following formula (Reilly 1953, p. 70-73):

$$\left(\frac{Ba}{Bb}\right) = \left(\frac{Pa}{Pb}\right)\left(\frac{Db}{Da}\right)^2$$

where:

Ba = the proportion of the trade from the intermediate city attracted by city *a*
Bb = the proportion of the trade from the intermediate city attracted by city *b*
Pa = the population of city *a*
Pb = the population of city *b*
Da = the distance from the intermediate town to city *a*
Db = the distance from the intermediate town to city *b*.

Much of *The Law of Retail Gravitation* (1953) consists of applications of Reilly's Law to trade areas throughout the United States. Another major section details how retailers, sales managers, newspaper editors, and manufacturers might use the Law (Reilly 1953). The lengthy appendix provides further mathematical detail and formulae derivation for skeptics (Anderson, Volker, and Phillips 2010; Reilly 1953). Reilly also discusses a number of important theoretical and managerial implications in the monograph, which are summarized below:

1. Reilly's Law recognizes that consumers will travel farther to obtain a better selection of goods and/or better prices.
2. The rate at which outside trade is drawn by a city increases with the population of that city on a linear basis. Therefore, *Pa/Pb* = 1.0
3. Empirical estimates of the formulae distance component (*Db/Da*) place its value at 2.0.
4. At the breaking-point in trade between two cities, the business drawn by City A is equal to the business drawn by City B. Therefore, *Ba/Bb* equals 1.0 at the breaking-point.
5. Through the use of Reilly's Law, a retailer can determine the optimal location to sell a certain class of goods.
6. Through the use of Reilly's Law, a retailer can compare the calculated trade area with known media geographic circulation or coverage to improve promotional strategies.

Reilly's Law has several limitations. Perhaps the most significant of these is the use of population as a "surrogate measure of the number and quality of retail stores" in a trade area (Sheth, Gardner, and Garrett 1988, p. 62).Yet no one would make a serious attempt to extend, revise, or refute Reilly's original work until P.D. Converse in 1949.

Converse's New Law and the Breaking-Point Model. P.D. Converse took Reilly's idea of the breaking-point and expanded it. In a concisely written article for the *Journal of Marketing*, Converse first introduces a formula for determining "the boundaries of a trading center's trade area" (1949, p. 379):

$$Breaking\ Point, miles\ from\ B = \frac{Miles\ between\ A\ and\ B}{1 + \sqrt{\frac{Population\ of\ A}{Population\ of\ B.}}}$$

This formula would later be known as the "Breaking-Point Model" (Anderson, Volker, and Phillips 2010, p. 3). After a brief example in which Converse describes how managers of a department store can use the Breaking-Point Model to determine where to advertise, he then produces a formula to "predict the proportion of trade a town will retain and the proportion it will lose," as follows (1949, p. 380):

$$\left(\frac{Ba}{Bb}\right) = \left(\frac{Pa}{Hb}\right)\left(\frac{4}{d}\right)^2$$

where:

Ba = the proportion of trade going to the outside town
Bb = the proportion of trade retained by the home town
Pa = the population of the outside town
Hb = the population of the consumer's home town
d = the distance to the outside town
4 = the inertia factor.

Converse arrived at the second formula after solving for *Db* in Reilly's original equation (Converse 1949, p. 379). Using secondary data obtained by the Bureau of Economic and Business Research at the University of Illinois, Converse discovered that the value of *Db* was typically close to 4.0, which he labeled the "inertia-distance factor" (1949, p. 381). This inertia-distance factor is the inertia that consumers "must overcome to visit a store even a block away" (1949, p. 381-382).

The Breaking-Point Model and the revision to Reilly's Law provides the platform for Converse's "New Law of Retail Gravitation" (1949, p. 382). Converse defines his New Law in the following terms: "a trading center and a town in or near its trade area divide the trade of the town approximately in direct proportion to the populations of the two towns and inversely as the squares of the distance factors, using 4 as the distance factor of the home town" (1949, p. 382). Like Reilly's Law, this new Law relies upon two simple variables, population and distance, but it has certain advantages over Reilly's formula. According to Converse, the new Law "can be applied to satellite towns or other towns inside the trade area of a larger town" (1949, p. 382). Furthermore, "it gives an approximate measure of how the trade is divided without making a survey" (Converse 1949, p. 382). Converse's first formula makes it possible for retailers to approximate a town's trade area "in a very few minutes, without any field work" (1949, p. 380). All a retailer needs to determine the boundaries is a highway map and population figures.

Despite its aforementioned benefits, Converse's New Law has many limitations. In the article, Converse acknowledges that its predictive capacity is compromised when town *a* is much larger than town *b*. Furthermore, Converse determined the distance factor solely from "shopping goods" and "fashion goods" data (1949, p. 380). The generalizability of the inertia-distance factor is thus questionable. Does it hold for different categories of retailers? And what about possible confounding variables that Reilly's Law also ignores, such as traffic, available parking space, and the quality and costs of the retailer's products? Unfortunately, these questions remain unanswered in Converse's revision.

Huff's Model of Trade Area Attraction. In his seminal article, Huff initially lauds the "pioneering efforts" of Reilly and Converse to "provide a systematic basis for estimating retail trading areas" (1964, p. 35), but he also acknowledges three principal limitations to their research. First, Huff notes that Converse's Breaking-Point model is "incapable of providing graduated estimates above or below the break-even position between two competing centers" (1964, p. 36). This makes it impossible to calculate aggregate demand for the products of a trade area. He also notes, "when the breaking point formula is used to delineate retail trading areas of several shopping areas within a given geographical area, the over-lapping boundaries that result are inconsistent with the basic objective of the formula's use: to calculate the boundaries between competing shopping areas where the competitive position of each is equal" (1964, p. 36). When multiple boundaries overlap, some trading areas remain unaccountable by Converse's formula. Third, Huff explains that neither Reilly's parameter estimate nor Converse's inertia-demand factor should be "interpreted as a constant for all types of shopping trips" (1964, p. 36). Huff estimates that the inertia value would vary depending upon the type of shopping trip. In order to overcome such limitations, Huff then develops a new model to explain "the process by which consumers choose…a particular distribution center" (1964, p. 36). A mathematical representation of Huff's Model of Trade Area Attraction follows (Huff, 1964, p. 36):

$$P_{ij} = \frac{\frac{S_j}{{T_{ij}}^{\lambda}}}{\sum_{j=1}^{n} \frac{S_j}{{T_{ij}}^{\lambda}}}$$

where:

Pij = the probability of a consumer at a given point of origin *i* traveling to a particular shopping center *j*

Sj = the size of a shopping center *j* (measured in terms of the square footage of selling area devoted to the sale of a particular class of goods)

Tij = the travel time involved in getting from a consumer's travel base *i* to a given shopping center *j*

λ = a parameter which is to be estimated empirically to reflect the effect of travel time on various kinds of shopping trips.

By manipulating the above formula, Huff points out that he can now calculate the expected number of consumers from a given town *i* that would shop at shopping center *j*, as follows:

$$E_{ij} = P_{ij} \bullet C_i$$

where:

Eij = the expected number of consumers at *i* that are likely to travel to shopping center *j*
Pij = the probability of consumers at *i* that will shop at shopping center *j*
Ci = the number of consumers at *i*.

Huff transformed the deterministic models of retail gravitation into statistical explanations, thus overcoming the limitations he saw in Reilly's Law and Converse's Breaking-Point Model. More importantly, Huff shifted the emphasis from the retailer to the consumer, which subsequent gravitational studies would follow. This may have been his most significant addition to retail gravitation theory, but there are six other theoretical contributions that Huff also describes in the article (1949, p. 37-38):

1. "A trading area represents a demand surface containing potential customers for a specific product(s) or service(s) of a particular distribution center."
2. "A distribution center may be a single firm or an agglomeration of firms.
3. "A demand surface consists of a series of demand gradients or zones, reflecting varying customer sales potentials." (An exception to this condition would be a monopoly.)
4. "Demand gradients are of a probabilistic nature, ranging from a probability value of less than one to a value greater than zero."
5. "The total potential customers encompassed within a distribution center's demand surface (trading area) is the sum of the expected number of consumers from each of the demand gradients."
6. "Demand gradients of competing firms overlap; and where gradients of like probability intersect, a spatial competitive equilibrium position is reached."

Huff found empirical support for his version of retail gravitation theory into the 1980s, and he also developed a way to estimate area sales by multiplying the trade area population by an estimate of expenditures per customer (Huff 1966; Huff and Batsell 1977; Huff and Rust 1984). In addition, he was the first to use the square footage of the retail area in his formula, which produces more precise estimates of consumer shopping patterns than Reilly's Law and Converse's New Law (Shaw and Jones 2005). Furthermore, his 1964 definition of trade area provides the basis for the American Marketing Association's current definition of trade area (Shaw and Jones 2005). For these reasons, Huff's Model of Trade Area Attraction "is widely regarded as the industry standard for determining the probability of a retail location to attract customers" (as qtd. in Anderson, Volker, and Phillips 2010, p. 3). Still, Huff's model, like both of the gravitational models before it, has limitations.

Modifications to Huff's Model. Shortly after Huff's original model appeared in the *Journal of Marketing*, Lakshmanan and Hansen (1965) produced a modified model to estimate aggregate sales in shopping centers. Their model is unique in that it allows the size of the retail center to vary in importance. Earlier models, going all the way back to Reilly's Law, fixed the retail size parameter to 1.0 while the distance parameter was free to vary. Their slight modification to Huff's distance parameter allows researchers greater flexibility in assessing the consumer utility trade-off between distance and size. A similar modification is proposed by Bucklin (1967), who points out that store image is a key determinant of retail attraction that is left out of Huff's model. He adds an image dimension to the Model of Trade Area Attraction, which is basically a second-order construct consisting of attributes like price, service quality, store ambience, selection, brand equity, etc. (Bucklin 1967; Gonzalez-Benito 2005).

Building on Bucklin's suggestions, the next major improvement to Huff's model came from Nakanishi and Cooper (1974; 1988). They are the creators of the multiplicative interaction (MCI) model, which substitutes an index of store attractiveness for Huff's store size (S_j) variable. In their model, the attractiveness of a retail facility is based on a set of attributes to be determined by the researcher, rather than a lone proxy. Their work has since been expanded by Jain and Mahajan (1979), Achabal, Gorr, and Mahajan (1982), Ghosh and Craig (1992), Drezner (1994), Gonzalez-Benito (2005), Gonzalez-Benito, Munoz-Gallego, and Kopalle (2005) and others, who account for consumer heterogeneity, market heterogeneity, and longitudinal effects in their additions to the MCI model. The latter are often so complex that they can only be tested via simulation.

The Inverted Breaking-Point Model. Mayer and Mason's retailing textbook (1990) is one of the few modern marketing texts to elaborate on the Converse Breaking-Point Model and Reilly's Law. The authors rearrange Converse's original formula thus:

$$\text{Da} \rightarrow \text{b} = \frac{d}{1 + \sqrt{\frac{Pb}{Pa}}}$$

where:

Da → b = the breaking-point from city *a* measured in miles to city *b*
d = the distance between city *a* and city *b*.
Pb = the population of city *b*
Pa = the population of city *a*.

They then produce a revised formula in which the denominator is represented as (*Pa/Pb*), an inversion of the breaking-point distance between cities *a* and *b*:

$$\text{Da} \rightarrow \text{b} = \frac{d}{1 + \sqrt{\frac{Pa}{Pb}}}$$

where:

all the variables are the same as in Converse's original equation.

As Anderson, Volker, and Phillips (2010) explain, this is not a typographical error. In fact, Mason and Mayer's (1990) inversion of the Converse Breaking-Point formula provides "an opportunity for gravity theory and improved Converse Model application" (Anderson, Volker, and Phillips 2010, p. 7). The authors contest that "the 'existing conditions' from which the Reilly and Converse formulae were derived have changed substantially and reflect consumer retailing, shopping, choice, and mobility factors peculiar to the late 1920s and early 1930s that no longer currently exist or apply" (2010, p. 7). The authors cite four primary catalysts of this change: 1) the "increased availability of product assortment in rural areas," 2) "the expansion of Wal-Mart locations and superstores [and] rural factory outlets," 3) "increased cable television shopping channels," and 4) "increased broadband Internet shopping activity" (Anderson, Volker, and Phillips 2010, p. 8). They concede that Converse's model "is pleasing and well accepted in retailing theory," before mentioning that "it may be equally intuitively pleasing to also assert that 'the size of a trading area increases as population density decreases,' reflecting urban concentration and reduced travel distance and time requirements" (Anderson, Volker, and Phillips 2010, p. 8). Anderson, Volker, and Phillips argue that modern "consumers may travel several miles to shop at a small rural village but would be willing…to travel only a few blocks in a major metropolitan area due to urban concentration and higher retail land use" (2010, p. 7). Therefore, the inverted distance formula reflects the fact that modern metropolitan areas have smaller trading areas than they did in the days of Reilly, Converse, and even Huff. In the final pages of their article, Anderson, Volker, and Phillips provide empirical support for their argument, but they also cautiously recommend that further tests of the Inverted Breaking-Point Model are needed to ultimately determine the value of their theory.

A Partial Formalization of Retail Gravitation Theory

According to Hunt, "the primary purpose of formalization lies in *evaluating* theoretical structures" (2010, p. 182). Even partially formalizing a theory may have important benefits. Because partial formalization lays bare the central tenets of a theory, it "sharpens the discussion of the theory" and puts the theory into "a framework suitable for testing" (Hunt 2010, p. 182). Therefore, Hunt concludes that "the partial formalization of a theory is an absolutely necessary precondition for meaningful analysis" (Hunt 2010; Hunt 1981; Hunt 1976). The following partial formalization of retail gravitation theory follows the methods outlined in Hunt (2010). It represents an attempt to describe the key propositions of the theory in precise terms and to arrange them in a way that facilitates analysis:

> 1. A trade area is "a geographically delineated region, containing potential customers for whom there exists a probability greater than zero of their purchasing a given class of products or services offered for sale by a particular firm or by a particular agglomeration of firms" (Huff 1964, p. 38).
> 2. Larger trade areas usually draw more trade than comparably situated smaller trade areas.
> 3. A trade area usually draws more consumers from nearby towns than it does from distant ones.
> 4. The propensity of one trade area to attract trade from a nearby town is determined by Huff's Model of Trade Area Attraction. (Huff's Model of Trade Area Attraction applies to all retailing situations in which a spatial dimension is present and when travel acts as a deterrent to consumption.)
> 5. A breaking-point between two cities refers to the point up to which two cities have an equal chance of drawing consumers from intermediate towns to their trade areas.

6. The breaking-point from city *a* measured in miles to city *b* is determined by the Inverted Breaking-Point Model. (The Inverted Breaking-Point Model applies to all modern retailing situations in which a spatial dimension is present.)

The partial formalization reveals that retail gravitation theory, as it currently stands, is mainly composed of Huff's original definition of trade area along with his Model of Trade Area Attraction, modified versions of this theory (such as the MCI model), and the Inverted Breaking-Point Model. Huff's model predicts the outer limits of a trade area, whereas the Inverted Breaking-Point Model predicts the breaking-point between trade areas, and the various versions of the MCI model enhance predictability of both by allowing researchers to account for consumer and market heterogeneity, rather than just floor space.

Furthermore, the latest revisions to retail gravitation theory rely upon two basic assumptions:

1. Travel acts as a deterrent to consumption.
2. The size of a trading area decreases as population density increases.

The first assumption goes back to Reilly's *Law of Retail Gravitation* (1953/1931). Reilly, and subsequently Converse, assume that given the choice between two equally attractive retail centers, consumers would choose to shop at the closest location. This assumption makes sense, as does Huff's more precise use of "travel time" in place of distance. Although Converse and Huff recognized that their models might not apply to people shopping during vacations to exotic locales, neither of them was quite sure how to approach this difficulty. More than fifty years later, Mayo, Jarvis, and Xander (1988), Mason and Mayer (1990), and Anderson, Volker, and Phillips (2010) likewise fail to account for vacation shopping in their models.

In *Beyond the Gravity Model*, Mayo, Jarvis, and Xander (1988) discuss several implications of the distance-travel relationship. They observe that travel time may be a more accurate measure than distance, as Huff suspected and Brunner and Mason (1968) demonstrated, but they also determine that distance does not always act as a deterrent to travel (Mayo, Jarvis, and Xander 1988). In the case of "long-distance leisure travel," the authors find that many consumers view distance as "a utility rather than a friction to be overcome" (Mayo, Jarvis, and Xander 1988, p. 23). Their results lead to two undiscovered factors that could influence a consumer's decision to travel between points: "subjective distance" and "attraction of the far-off destination" (Mayo, Jarvis, and Xander 1988, p. 27-28). The authors define subjective distance as "a force acting to stimulate travel beyond a certain point because each additional mile is perceived to be less than a measured mile" (Mayo, Jarvis, and Xander 1988, p. 27). They note that gravity models often underestimate the number of trips between two very far-off points because they fail to account for subjective distance perceptions. Furthermore, they find that some consumers travel to far-off destinations simply because they are far-off. To the consumer, such far-off destinations are thought "to provide the elements of escape, excitement, or novelty being sought through the travel experience more so than closer destinations" (Mayo, Jarvis, and Xander 1968, p. 28). The authors caution that vacation shopping does not fit into an existing theoretical framework. Moreover, the fact that travel time does not deter consumption in some contexts is an anomaly, rather than the norm. As such, gravity models remain applicable to most of the spatial problems encountered in retailing.

As concerns the second assumption, Reilly was the first to concede that “a wide variety of factors” may affect a trade area’s ability to attract outside trade (1953, p. 30). However, he also believed that all of the other factors, such as the quality of the retailers’ goods, advertising outlets, and “amusement attractions,” were captured by his population variable (Reilly 1953, p. 30). Reilly argued that the population of a trade area “condition[s] the retail trade influence of that city,” that population is “a reliable index of the behavior of the other factors,” and that the significance of dependent factors fades away when population is used in the model (1953, p. 31-32). Reilly’s Law and Converse’s New Law predict larger trade areas for larger cities—but this may not be the case. Huff would later determine that the square footage of the retail space, and not the trade area’s population, was a much better predictor of modern consumer shopping patterns. Subsequent studies affirm Huff’s revision of the population variable (Huff 1966; Huff and Batsell 1977; Huff and Rust 1984), and further revisions to Huff’s model, such as those proposed by Nakanishi and Cooper (1974; 1988), offer even greater flexibility and predictability. As a result, current gravitational models (e.g., Gonzalez-Benito 2005; Gonzalez-Benito, Munoz-Gallego, and Kopalle 2005) are more closely related to Huff’s Model of Trade Area Attraction than Reilly’s Law or Converse’s New Law. In addition, current gravitational models incorporate the Inverted Breaking-Point Model and not Converse’s original formula to predict breaking-points. As Anderson, Volker, and Phillips assert, “decentralization of urban trading areas, new retail models and increased mobility in rural areas may serve to reverse traditional and actual trade area dominance based on population” (2010, p. 6). They argue for a more precise method of delineating breaking-points, one based on population density and not just population.

Challenges to Retail Gravitation Theory

Electronic Commerce

In *Revisiting Marketing’s Lawlike Generalizations*, Sheth and Sisodia claim, “the primary impact of the Internet revolution on marketing is to break the time- and location-bound aspects of traditional ‘gravitational’ commerce” (1999, p. 74). This is a serious charge against retail gravitation theory. The primary objective of any theory is “to explain, predict, and understand” (Hunt 2010, p. 211). Therefore, if retail gravitation theory can no longer explain, predict, or help marketers understand current shopping patterns, then it is no longer useful. Sheth and Sisodia’s principal argument against gravitational models hinges on transaction cost analysis (TCA), as evident in the following discussion:

> “With the Internet's ability to fundamentally change the reach (time and place) of companies, retail gravitation laws have become less relevant. Companies small and large are able to achieve a high level of accessibility and establish a two-way information flow directly with end users almost immediately and at low cost. Serving huge numbers of customers efficiently and effectively is made possible by the automation of numerous administrative tasks. Every company is potentially a global player from the first day of its existence (subject to supply availability and fulfillment capabilities).” (Sheth and Sisodia 1999, p. 74)

They point out that transaction costs are much lower in E-commerce environments than traditional brick-and-mortar shopping environments, which is a common result in related studies (Lynch and Ariely 2000; Brynjolfsson and Smith 2000; Alba et al. 1997). Under the TCA framework, consumers and retailers should prefer online exchanges to physical interaction, thereby making gravitational models "less relevant".

Hedonic Consumption

A second major criticism of gravitational models is that they do not capture aspects of hedonic consumption. Retail gravitation theory cannot explain the phenomenon of destination shopping, for example (Mayo, Jarvis, and Xander 1988). Nor can it explain why groups of teenage girls congregate at malls when they have no intention to buy anything (Bloch, Ridgway, and Dawson 1994; Haytko and Baker 2004). Unlike the concept of shopping as a "mission" to be accomplished (Babin, Darden, and Griffin 1994), hedonic-oriented shopping can provide entertainment value and emotional worth (Bellenger, Steinberg, and Stanton 1976). Studies of hedonic consumption focus on arousal, heightened involvement, fantasy, and escapism (Bridges and Florsheim 2008), emotionally laden and subjectively-experienced facets of the shopping trip (Hirschman and Holbrook 1982), the in-store experience (Wakefield and Baker 1998), and shopping as a means of socialization (Arnold and Reynolds 2003). Thus, consumers "buy so they can shop, NOT shop so they can buy" (Langrehr 1991). Retailers' efforts to satisfy consumers' hedonic experiences are so diverse that they include rock-climbing walls in shoes stores, singles nights in grocery stores, and off-road test tracks at Land Rover dealerships (Arnold and Reynolds 2003).

Considering the significance of hedonic consumption, it is surprising that the bulk of the retailing literature has focused on utilitarian consumption (Arnold and Reynolds 2003). Retail gravity theory is no exception. Although a consumer's satisfaction with a retailer stems from both affective and cognitive elements (Jones, Reynolds, and Arnold 2006), retail gravitation theory focuses only on the cognitive aspects of the shopping decision.

Counterarguments

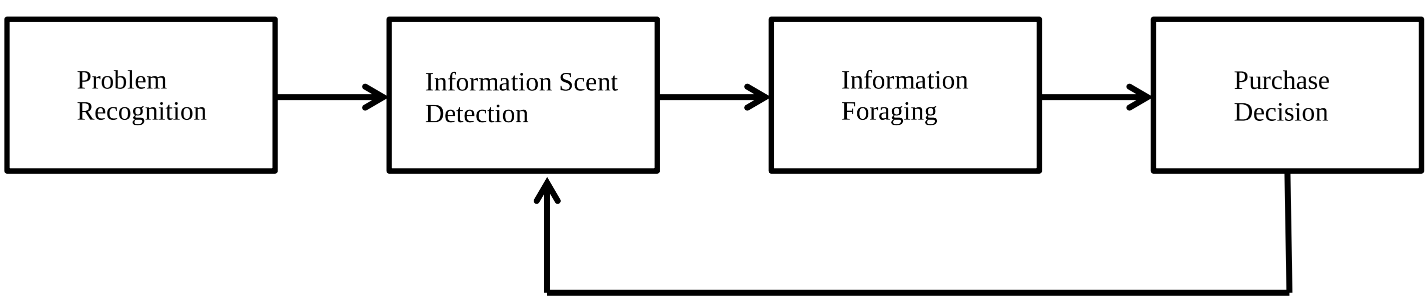
Although Anderson, Volker, and Phillips (2010) similarly conclude that E-commerce changes the nature of consumer shopping patterns, they do not believe the Internet will make gravitational models irrelevant. They note that many people continue to shop at brick-and-mortar retail stores despite the growth of online giants like Amazon.com, and their observation has merit. It is true that traditional gravitational models cannot predict consumers' online shopping behaviors, but this fact does not imply that researchers should completely abandon gravitational models. Several empirical studies, including Brennan and Lundsten (2000), Bronnenberg and Mahajan (2001), Gonzalez-Benito (2005), and Gonzalez-Benito, Munoz-Gallego, and Kopalle (2005), suggest that the predictive validity of gravitational models remains high, despite the fact that consumers shop online in addition to visiting stores. In all likelihood, gravitational models will continue to be relevant as long as retailers maintain physical stores.

Furthermore, recent advances in mobile technologies may actually make gravitational models more relevant instead of less relevant. Take the case of smart phones and location-based marketing strategies. Smart phones are equipped with accelerometers and positioning capabilities that allow retailers to use location-based marketing messages to entice consumers to their businesses. Location-based advertising and couponing are two extremely popular strategies of tech-savvy retailers. A modified version of retail gravitation theory, such as the one discussed in the following section, could therefore apply to location-based retailing strategies because the spatial dimension is the central component of both. Sheth and Sisodia's conclusions are based on Internet shopping patterns from consumers' laptop and desktop computers; therefore, it is a matter of conjecture if the traditionally accepted assumptions, problem spaces, and normative decision rules also hold in the case of shopping from mobile devices. Perhaps the rise of location-based marketing will stimulate a renewed interest in gravitational theory.

A second concern is that current gravitational models largely ignore the hedonic side of consumer shopping behaviors. In order to increase explanatory power, retail gravitation theory must incorporate the "two-appraisal" model of satisfaction evaluation, which integrates hedonic and utilitarian components of the shopping trip (Oliver 1989). Bucklin (1967) and Nakanishi and Cooper (1974; 1988) have provided important first steps in this regard. They have introduced modifications that allow researchers to add subjective variables, such as service quality, store image, and retail atmospherics, to gravitational models. However, these modifications are still a long way from the "two-appraisal" framework advocated by Oliver (1989) and other noted scholars (e.g., Arnold and Reynolds 2003; Jones, Reynolds, and Arnold 2006)

A Gravity-Type Model for Internet Shopping

The current gravitational models are of little use in predicting and explaining Internet shopping behaviors. However, one gravity-type model that has recently emerged in the field of human-computer interaction can help researchers understand how retailers' websites attract consumers. This theory is known as information foraging theory (Pirolli 2007), and it borrows heavily from optimal foraging theory, which is a well-established theory in ecology (Stephens and Krebs 1986). The information foraging model presented in this paper is adapted from Pirolli's refereed journal articles (Pirolli and Card 1999), his conference presentations (Pirolli 1997; Pirolli et al. 2005), and his monograph, *Information Foraging Theory* (Pirolli 2007). Nowhere does Pirolli provide a step-by-step diagram of the information foraging process. Therefore, the authors distilled the major components of Pirolli's theory and put them into the framework below. The following model is an interpretation of Information Foraging Theory (IFT) from a consumer behavior perspective:



An Overview of Information Foraging Theory

The model is quite parsimonious. It consists of four basic constructs (i.e., problem recognition, information scent, information foraging, and purchase decision) and four possible links. The model posits that a consumer begins the online shopping process by first recognizing some sort of consumption-related problem or query. Once this problem is identified, the consumer will then try to find an information scent (e.g., in the form of a Yahoo! results list or a hashtag from a friend's Tweet). Detecting an information scent puts the consumer on a scent trail that leads to an information patch (such as a website, blog, or app), where information foraging takes place. Because consumers "like to get maximum benefit for minimum effort" (Pirolli 2007, 167), information seekers follow the strongest scents in the belief that they will lead them to patches of the highest possible utilities. If the consumer can locate the bits of information he/she is searching for (e.g., reviews or pictures of the desired product) during the foraging process, then the consumer will ultimately make a purchase decision based on that information. If the consumer cannot find the desired information within the information patch, the consumer will leave the information patch and attempt to pick up a different scent. The consumer will then follow another information trail to a new information patch, where foraging begins again. This iterative process continues until the consumer reaches the desired outcome or quits surfing the Internet for the desired product.

A More Detailed Look at Information Foraging Theory

The authors provide further explanation of the model in this section of the paper. The first step in the online shopping process, problem recognition, is a well-established construct in consumer research and is adopted from Engel, Kollat, and Blackwell's (1968) seminal text on consumer behavior. The meaning of the term problem recognition is self-evident. During this phase, "the consumer becomes aware of a difference between the desired state with regard to the fulfillment of some consumer goal and the actual state" (Arndt 1976). This cognitive gap initiates the information search process.

The second construct, information scent, has not yet been established in the marketing literature. Pirolli (2007) coined the term "information scent" in the late 1990s to describe the heuristics that consumers employ during the information search phase of the online shopping process. More precisely, information scent is defined as "the detection and use of cues…that provide users with concise information about content that is not immediately available" (Pirolli 2007, 68). Heuristics come in many forms. For example, in online contexts, primacy effects have important market consequences (Baye et al. 2009; Animesh et al. 2011; Pan et al. 2007). Similarly, research on information representation suggests that open access to information leads consumers to better and faster information acquisition and more confident decision making (Lurie and Mason 2007). Therefore, presentation and ordering effects are very important components of the "strength" of the information scent (Pirolli 2007). In the current example, well-organized, easy-to-find websites have relatively stronger scents than those that are not well-organized or highly visible on a search results page. Herein lies the connection to gravity models—online retailers that produce strong information scent profiles are more likely to attract consumers than retailers with weak scent profiles. Consumers gravitate to the online retailers that produce the strongest scent profiles in much the same way that they gravitate to large, highly diversified brick-and-mortar retailers in populous areas.

Information foraging is the next construct in the model, and it also originated in the human-computer interaction literature (Pirolli 2007). Throughout his monograph, Pirolli uses the terms "foraging" and "searching" interchangeably. Thus, information foraging is the way a consumer searches for useful bits of information within an information patch. That information could be on a website, blog, app, etc. Thus, the website, blog, or app in question represents an information patch. The online environment is full of patches of information, some more useful than others. Information sources have different probabilities in regard to the amount of information they possess per the cost of extracting that information (Pirolli 2007; Pirolli and Card 1999; Pirolli et al. 2003). Furthermore, information is not uniformly distributed across the Internet. Some websites, for example, may be accessed by simply clicking on a link at the top of a results list; others require more diligent investigation, such as specifying a URL, entering through a secure portal requiring an encrypted password, etc. Websites also exhibit large variances in utility. Because of these factors, consumers face difficulties in allocating time amongst between-patch foraging tasks and within patch foraging tasks.

To predict the amount of time consumers will spend in one patch before leaving to find another, information theory relies on an adaptation of Charnov's Marginal Value Theorem from the ecology literature. Pirolli (2007, 37) refers to this theorem as the "conventional patch model in optimal foraging theory." The theorem suggests that a forager should continue foraging in the same patch as long as the marginal value of the patch is greater than the average rate of gain for the environment. For situations involving only one type of information patch, Charnov's Theorem is expressed by the following mathematical formula:

$$R(tW) = \frac{\lambda g(tW)}{1 + \lambda(tW)}$$

where:

$R(tW)$ = the overall rate of gain as a function of time allocated within the patch
$\lambda =$ the rate at which patches are encountered
$g(tW)$ = the gain from foraging within the patch.

Therefore, the optimal time to spend within each patch is the value t* that satisfies the equation,

$$g'(t^*) = R(t^*) = \frac{\lambda g(t*)}{1 + \lambda t*}$$

where:

g' = the marginal value of the gain function, g
R = the overall rate of gain
$\lambda =$ the rate at which information patches are encountered.

Charnov's Marginal Value Theorem gives rise to what Pirolli (2007, 81) calls the rule of patch foraging: the optimal forager will "forage in an information patch until the expected potential of that patch is less than the mean expected value of going to a new patch." When the expected utility of foraging in an information patch drops below the average rate of gain for the decision environment, consumers are expected to leave the patch in order to seek more productive patches. For example, if the consumer cannot find what he/she is looking for on Wal-Mart's website in a certain amount of time, the consumer may turn to a competitor's site, such as Amazon.com, and take up the search there. For an environment in which there exist P types of patches, Charnov's Marginal Value Theorem is expressed by the following equation:

$$g'(t_{WP}) = R(t_{W1}, t_{W2}, \ldots, t_{WP})$$

where:

$g'(t_{WP})$ = the marginal value of foraging within P types of patches
t_{Wi} = the time allocation policy for each type of patch i.

Pirolli (2007, 137) has successfully relied on Charnov's Marginal Value Theorem and its variations to predict user flow (i.e., "the pattern" of users' individual and aggregate Web surfing behaviors), success metrics (i.e., "the average number of steps" or iterations it takes for Web users to accomplish their information search goals), and website stickiness (i.e., how long a user will stay search within a website before leaving it).

The purchase decision represents the final state in the model. The results of the purchase decision can be positive or negative. If the consumer is satisfied with the purchase decision, the outcome is positive, and the information search is complete. If the consumer does not reach his/her goal, the outcome is negative, and the consumer will return to the information scent phase or terminate the search. The consumer again makes a comparison at this stage of the process. According to Arndt (1976), "the consumer may compare the degree of goal-fulfillment with the original expectations. The degree of satisfaction felt is then believed to be stored in the consumer's mind as part of an attitude." This attitude undoubtedly plays a role in future online shopping experiences, perhaps taking the form of another important decision heuristic.

Conclusion

Retail gravitation theory has a rich and interesting history, dating back to the late 1920s. The primary objectives of this study have been to discuss that history, review gravity models, explain the latest version of the theory through a partial formalization, analyze recent criticism of the models that have risen in the literature, and provide an alternative, gravity-type model to explain online shopping behaviors. As a result of this discussion, it is evident that through several revisions and extensions to Reilly's original work, retail gravitation theory has proven to be a useful way to predict retail trade areas and trade area breaking points for more than eighty years—and it will continue to be an important resource for future studies in retailing. Of course, the theory is not without limitations. To increase the explanatory power of retail gravitation theory, the authors call for further revisions to current models, revisions which fully incorporate online shopping behaviors and the hedonic aspects of shopping behaviors. It is the authors' hope that their adaptation of Information Foraging Theory provides another step forward in the evolution of gravity models, at least as far as e-commerce is concerned. Information Foraging

Theory is important in that it can help explain why consumers are drawn to certain websites and not others, why they "stick" to a website for a particular amount of time, and why they surf the web looking for a website of the highest utility given a particular decision task.

References

Alba, J. & Lynch, J. (1997). Interactive home shopping: Consumer, retailer, and manufacturer incentives to participate in electronic marketplaces. *Journal of Marketing*, *61*, 38-53.

Anderson, S. J., Volker, J.X., & Phillips, M.D. (2010). Converse's breaking-point model revised. *Journal of Management and Marketing Research*, 1-10.

Animesh, A., Viswanathan, S., & Agarwal, R. (2011) Competing "creatively" in sponsored search markets: The effect of rank, differentiation strategy, and competition on performance. *Information Systems Research*, *22*(1), 153-169.

Arnold, M. J., & Reynolds, K. (2003). Hedonic shopping motivations. *Journal of Retailing*, *79*(2), 77-95.

Arndt, J. (1976). Reflections on research in consumer behavior. In *Advances in Consumer Research*, Vol. 1, ed. Beverlee B. Anderson, Cincinnati, OH: Association for Consumer Research, 213-221.

Babin, B.J., Boles, J.S., & Babin, L. (1991). The development of spatial theory in retailing and its contribution to marketing thought and marketing science. Proceedings from the *Fifth Conference on Historical Research in Marketing and Marketing Thought*. East Lansing, MI.

Babin, B. J., Darden, W.R., & Griffin, M. (1994). Work and/or fun: Measuring hedonic and utilitarian shopping value. *Journal of Consumer Research*, 644-656.

Baye, M. R., Gatti, J.R., Kattuman, P., & Morgan, J. (2009). Clicks, discontinuities, and firm demand online. *Journal of Economics & Management Strategy*, *18*(4), 935-975.

Bellenger, D. N., et al. (1976). The congruence of store image and self-image. *Journal of Retailing*, *52*(1), 17-32.

Bridges, E. & Florsheim, R. (2008). Hedonic and utilitarian shopping goals: The online experience. *Journal of Business Research*, *61*(4), 309-314.

Brunner, J. A. & Mason, J.L. (1968). The influence of driving time upon shopping center performance. *Journal of Marketing*, *32* (April), 57-61.

Brynjolfsson, E. & Smith, M.D. (2000). Frictionless commerce? A comparison of internet and conventional retailers. *Management Science*, 563-585.

Converse, P.D. (1949). New laws of retail gravitation. *Journal of Marketing*, *14* (January), 379-384.

Engel, J.F., Kollat, D.T., & Blackwell, R.D. (1968). *Consumer behavior*. New York, NY: Holt, Rinehart and Winston.

Hirschman, E. C. & Holbrook, M.B. (1982). Hedonic consumption: Emerging concepts, methods and propositions. *Journal of Marketing*, 92-101.

Huff, D. L. (1964). Defining and estimating a trade area. *Journal of Marketing*, *28*, 34-38.

Huff, D.L. (1966). A programmed solution for approximating an optimal retail location. *Land Economics*, *42*, 293-303

Huff, D. L. & Batsell, R.R. (1977). Delimiting the areal extent of a market area. *Journal of Marketing Research*, *14* (November), 58-65.

Huff, D. L. & Rust, R.T. (1984). Measuring the congruence of market areas. *Journal of Marketing*, *48* (Winter), 68-74.

Hunt, S.D. (1976). The nature and scope of marketing. *Journal of Marketing*, *40* (July), 17-28.

Hunt, S.D. (2010). *Marketing theory: Foundations, controversy, strategy, resource-advantage theory*. Armonk, NY: M.E. Sharpe.

Hunt, S.D, Muncy, J.A., & Ray, N.M. (1981). Alderson's general theory of marketing: a formalization. In *Review of Marketing*, ed. Ben M. Enis and Kenneth J. Roering, 267-282.

Ingene, C.A. & Lusch, R.F. (1981). A model of retail structure. In *Research in Marketing*, ed. Jadish N. Sheth, 101-164.

Jones, M.A., Reynolds, K.E., & Arnold, M.J. (2006). Hedonic and utilitarian shopping value: Investigating differential effects on retail outcomes. *Journal of Business Research*, *59*(9), 974-981.

Langrehr, F. W. (1991). Retail shopping mall semiotics and hedonic consumption. *Advances in Consumer Research*, *18*(1), 428-433.

Lurie, N. H. & Mason, C.H. (2007). Visual representation: Implications for decision making. *Journal of Marketing*, *71*(1), 160-178.

Lynch, J.G. & Ariely, D. (2000). Wine online: Search costs affect competition on price, quality, and distribution. *Marketing Science*, *19*(1), 83-103.

Mason, B. J. & Mayer, M.L. (1990). *Modern Retailing: Theory and Practice*, Homewood, IL: BPI-Irwin.

Mayo, E. J., Jarvis, L.P., & Xander, J.A. (1988). Beyond the gravity model. *Journal of the Academy of Marketing Science*, *16* (Fall), 23-29.

Oliver, R. L. (1989). Processing of the satisfaction response in consumption: A suggested framework and research propositions. *Journal of Consumer Satisfaction, Dissatisfaction and Complaining Behavior*, *2*(1), 1-16.

Pan, B., Hembrooke, H., Joachims, T., Lorigo, L., Gay, G. & Granka, L. (2007). In Google we trust: Users' decisions on rank, position, and relevance. *Journal of Computer-Mediated Communication*, *12*(3), 801-823.

Pirolli, P. (2007). *Information foraging theory*. Oxford, England: Oxford UP.

Pirolli, P., & Card, S.K. (1999). Information foraging. *Psychological Review*, 106, 643-675.

Pirolli, P., Card, S.K., & Van Der Wege, M.M. (2003). The effects of information scent on visual search in the hyperbolic tree browser. *ACM Transactions on Computer-Human Interaction*, *10*(1), 20-53.

Pirolli, P., Fu, W., Chi, E., & Zhang, S. (2005). Information scent and web navigation: Theory, models, and automated usability evaluation. *Human-Computer Interaction International Conference*, Las Vegas, NV.

Reilly, W. J. (1929). *Methods for the study of retail relationships*. Austin, TX: Bureau of Business Research.

Reilly, W.J. (1953). *The law of retail gravitation* (2^{nd} ed.) New York, NY: Pilsbury Publishers.

Shaw, E. H. & Jones, D.G.B. (2005). A history of schools of marketing thought. *Marketing Theory*, *5*(3), 239-281.

Sheth, J. N., Gardner, D.M., & Garrett, D.E. (1988). *Marketing theory: Evolution and evaluation*. New York, NY: Wiley.

Sheth, J.N. & Sisodia, R.J. (1999). Revisiting marketing's lawlike generalizations. *Journal of the Academy of Marketing Science*, *27*(1), 71-87.

Stephens, D.W. & Krebs, J.R. (1986), *Foraging theory*. Princeton, NJ: Princeton UP.

Wakefield, K. L. & Baker, J. (1998). Excitement at the mall: Determinants and effects on shopping response. *Journal of Retailing*, *74*(4), 515-539.

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