Assumptions of Central Place Theory and Gravity Models with Special Reference to Consumer Spatial Behaviour

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Abstract
Central Place Theory and gravity models have been the basic operational procedures to study consumer spatial behaviour. But, with major shifts in the socio-economic status and the newfound complex nature of movement of modern retail consumers, the underlying assumption of these models don't fit in the present context and needs to be revisited. The present study attempts to examine these assumptions in the light of these observed changes.

Key Words: Consumer Spatial Behaviour, Retail Location, Central Place Theory, Gravity models

Introduction
It is said that "location, location, location" is the major factor leading to a firm's success or failure. Location decisions are complex in nature and there is little flexibility in retracting from the decision once a site is chosen. A good location lets a retailer succeed even if there is any lacuna in the strategy mix. But, it is found that there is negligence of retail location studies. In most of the marketing research studies, the central concern is channel of distribution, store environment and image and not the location. Location analysis is basically done on the basis of geographical research and most of the strategic dimensions of location in marketing research are borrowed from it (Ian Clarke, David Benison and John Pal, 1997).

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Geographical research and consumer spatial behaviour

One of the important areas of research that links retailing and geography is consumer spatial behaviour. Consumer behaviour traditionally has been a fertile area of research in geography and paradoxically the study of consumer spatial behaviour has been the object of a relatively small number of publications in scientific marketing reviews. In general, consumer spatial behaviour is defined as "the ways in which consumers relate to the distribution of the various goods and services over space (market area)" (Huge James Gayler, 1974). It is the reactions of an individual or groups of individuals with relation to the immediate surrounding market area. It studies the question "Where" of the consumer research. "Where" the consumer is likely to shop directly affects the location and organization of the retail market system and vice-versa (Reginald G. Golledge and Robert J. Stimson, 1997). Many researchers in the past "Where" the consumer is likely to shop directly affects the location and organization of the retail market system and vice-versa (Reginald G. Golledge and Robert J. Stimson, 1997). Many researchers in the past have tried to explore relationship between consumer behaviour and spatial structure of the retail environment. Among the earliest approaches is that of Reilly's law of retail gravitation (1931), Christaller's central place theory (CPT) (1933) and Huff's law of shopper attraction (1962, 1964). But, these approaches are based on certain assumptions about consumers that are not reasonable now.

Analysis of Assumptions of Central place Theory (CPT) and Gravity models:

There is a similarity between Christaller's central place theory, Reilly's law of retail gravitation and Huff's law of shopper attraction and that is they all seek to analyse the trade performance of retail centres based on consumer behaviour. The central place theory proposes a hierarchy of retail centres. A large retail centre that offers a variety of different retail functions is surrounded further by with less choice and specialist retailers, which is surrounded further by small centres with less choice and specialist retailers (David Gilbert, 2009). It states that location, number, size and spacing of these centres are based on certain assumptions of rationality on the part of retail and consumer behaviour.

There are three important concepts in CPT. The first one is the "range"; it is the maximum distance people are willing to travel to avail a retail function (J D Forbes, 1987). It denotes the area from which consumers will come to purchase a particular good. As the distance to retail centre increases, the demand for a product decreases and ultimately drops to zero. Beyond the limit of the range the total cost and the friction involved in the purchase of the good is such that demand declines rapidly (Hugh James Gaylor, 1974). The second concept is that of "threshold", it is the minimum size of an agglomeration of people necessary before a function is provided. And the third one is the "function" ie any type of institution serving a population. The central place theory makes broad generalizations about the nature of retail function and the ways in which consumers relate to them.

The retail gravity models explain the way consumers behave over space with the help of Newtonian physics ie the force between two masses is proportional to the size of those masses and inversely proportional to the distance between them. Reilly's law states that "Greater shopping centre size increase consumer utility, thus increasing the gravitational pull of a centre and that distance to that centre decreases consumer utility, which exponentially decreases the gravitational pull of the centre" (Mark J Eppli and James D Shilling, 1992). It establishes a point of indifference between two cities or communities so the trading areas can be determined. This law may be algebraically expressed as:

$$D(ab) = d/1 + \sqrt{Pb/Pa}$$

where D(ab) is the limit of city A's catchment area measured in miles along the road to city B, d is the distance in miles along a major roadway, Pa is population of city A and Pb is population of city B. This model assumed rational economic and spatially invariant individual behaviour on the part of the consumer. Similarly, Huff's law of shopper attraction states that the probability of any shopper choosing a particular retail centre is equal to the ratio of the utility of that centre to the sum of utilities of all competing centres in the system. It delineates trade area on the basis of the product assortment at various shopping locations, travel times from the shopper's home to alternative locations and the sensitivity of the kind of shopping to travel time. Unlike Relliy's law which works on a two centre

specification, Huff's model includes the possibility of having an unlimited number of competing stores in market as well allowing for a varying distance parameter (Mark J Eppli and James D Shilling, 1992). This model incorporates the realistic notion that customer do not always select one centre for exclusive shopping. It describes the process by which potential consumers choose from among acceptable alternative retail centres to obtain specific goods and services. Huffs's law is expressed as:

$$P_{ij} = S_j/(T_{ij})\lambda \div \Sigma jn \; S_j/(T_{ij})\lambda$$

where P_{ij} is Probability of a consumer's travelling from home i to shopping location j, S_j is square footage of selling space in shopping location j, T_{ij} is Travel time from consumers home i to shopping location j, n is the number of different shopping locations under consideration and λ is the parameter to estimate the effect of travel time on different kind of shopping trips.

These three broad theoretical approaches are based on certain assumption about consumers. The CPT considers all consumers to be identical. It is based on single purpose shopping trip and on patronizing the nearest shopping centre. The Reilly's law of gravitation assumes that the consumer trades off the attractiveness of alternative shopping area against the deterrent effect of distance (Richard M Clarkson, Colin M Clarkhill and Terry Robinson, 1996).

Assumption 1: "All consumers are identical"
A fundamental part of scientific research has been to show that differences in overt behaviour are related to differences in people's personal situation (family background, income, age etc.) Consumer spatial behaviour is no exception. Differentiating consumers only on the basis of what they purchase, where they purchase, where they live and how far they travel will not suffice (Eliot Hurst et al. (1992). The study of possible relationship between consumer spatial behaviour and the attributes which allow us to describe and group consumers is required. A study (H. J. Gayler, 1980) carried out in Vancouver, Canada tried to establish a relationship between consumer spatial behaviour and the socio-economic characteristics of consumers.

The study analysed the distance travelled by the consumers for different goods categories to see if there was any significant difference when the consumers were differentiated into different social class. It was further analysed from the point of view of the store type and the shopping centre patronized. It was hypothesized that the higher the social class position, the greater the distance that is travelled to shop. This hypothesis was found to be statistically significant for two goods categories i.e. Grocery and dress.

A similar study (S Martin Taylor, 1979) carried out at the same place by classifying the consumers on the basis of personal disposition could not yield significant results. At the macro level when consumer is choosing between different shopping centres the influence of dispositional variables were not pronounced, but, at micro level when choosing between different stores, the consumer's disposition assumed far greater significance. The methodology usually employed in social sciences and marketing research is that the population is differentiated into different groups on the basis of certain variables (Income, Age, Socio-economic attributes). A need is felt here to study consumer spatial behaviour on the basis of these variables and to find out which variable predicts consumer spatial behaviour in a better way.

Assumption 2: "Consumer patronises the nearest shopping centre"
CPT is based on the assumption that consumer always patronises the nearest shopping centre, also termed as "nearest centre hypothesis". Studies have proved that consumers are prepared to travel further to purchase a good in a central business district or other high order centres than to purchase the good at a low order centre (Clark W A V, 1968). In the Vancouver, Canada study (H J Gaylor, 1980), it was found that there was a greater tendency for upper/upper-middle and lower-middle class consumers to travel the greater distances and this was invariably implied by passing one of the major chain stores in favour of food floors in department stores. It has been also found that the patronization of the shopping centre is influenced by the type of goods purchased. For convenience goods, which is bought frequently, a consumer might not travel to other places and will patronize the nearest centre but in case of speciality good, which is bought less frequently, location becomes less important and consumer might travel to other places (Ward Nefstead, 1988). It has also been found that low income group travel shorter

distances to shop than higher income group because of the socio-economic constraints placed on their mobility. This assumption of CPT is based on the premise that the purchase response is based upon price and product range, where the consumer tries to reduce its transportation cost. Here, a rational economic behaviour is assumed.

Assumption 3: "Consumer trades off the attractiveness of alternative shopping area against the deterrent effect of distance"
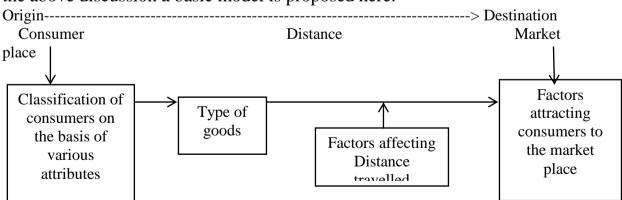
There is over emphasis on distance in gravity models. Distance has been extensively studied, (called "the principle of least effort") in psychology and still remains paradoxically the variable that is often the most difficult to understand. In gravity models the consumer spatial behaviour is summed as the analysis of distance travelled between home and point of sale. The strict definition of the law of gravitation and its application to retail impose this restriction, for gravitation is defined in terms of distance and mass (Gerard Cliquet,2006). In contrast with Reilly, Huff used "time" as a measure of distance. Use of time as a measure of distance seems to be more appropriate, as the time spent in getting from one point to the other is more important than the distance between them. Because of the major socio-economic shifts, more out of home recreational lifestyle and increased transport mobility levels time is becoming the scarcest commodity. The consumers these days are increasingly concerned about optimizing the efficiency of their shopping pattern (Dellaert et al, 1998).

However, distance in terms of time is also very deceptive. Consumers do not all have the same perception of time. These differences of perception come from various causes for e.g. Trips made at different times of the day or of the week can lead to a totally distinct appreciation between one individual and another. Apart from this, work by various researches have shown that closer and shorter distances tend to be overestimated and further and long distances tend to be underestimated (Heli Marjanen, 2000). This complexity of understanding of distance variable is now being reduced because it is now well understood that there are other variables also that affect consumer spatial behaviour. For a modern retail consumer, non-price factors are increasingly a more important determinant of a purchase decision (David Gilbert, 2009). The distance variable itself gets affected by certain intervening variables like the frequency of shopping and mode of transportation used. In general, the distance travelled varies inversely with the frequency of shopping (Peter Scott, 2007).

The CPT also assumes that trips are home location based and each good is purchased on a different trip. It has been found that 30 % of all urban travel behaviour involve trips with more than two shops and often involve more than one purpose. Given an initial stop for grocery shopping, the most likely subsequent stop is non-grocery shopping. Given an initial stop for non-grocery shopping, the most likely subsequent stop is non-grocery shopping (Losch, 1967). Consumers are increasingly connecting their shopping with their other activities and this further diminishes the explanatory power of distance. For example, daily grocery shopping is mainly done in connection with the trip to/from work; it is of limited use to measure the distance from the respondent's home to the store (Heli Marjanen, 2000). So, the assumption that all the trips are made from home and they are single purpose trips do not hold true for modern retail consumers.

Conclusion

CPT and Gravity models are based on a static and simplistic view of consumer spatial behaviour. To a large extent the gravity model and its derivatives have been the basic operational procedures to study consumer spatial behaviour. But, with major shifts in the socio-economic status of the consumers, the underlying assumption of these models needs to be revisited. The modern retail consumer moves rapidly and along complex paths. The understanding of this newfound complex nature of consumer mobility is important for the design of a location based strategy. There is a need to develop consumer spatial behaviour models that integrate the intensification and complex nature of consumer mobility. On the basis of the above discussion a basic model is proposed here.

Origin--> Destination
   Consumer   Distance   Market
place

Classification of consumers on the basis of various attributes	Type of goods	Factors affecting Distance travelled	Factors attracting consumers to the market place

BASIC MODEL OF CONSUMER SPATIAL BEHAVIOUR

When analysing the consumer Spatial behaviour three important groups of factors need to be considered. The consumer with all his/her characteristics, the characteristics of the shop or retail centre, including its location and the factors affecting distance travelled. However, the number of variables that can be included at a time might be a major concern for researchers. The detailed explanation of this model and assumptions of CPT and gravity models which are not consumer specific is beyond the scope of this paper. Since most of the researches in the field of consumer spatial behaviour belong to geographers like Christaller, who proposed central place theory was a German geographer), there is a need of input from both practitioners (managers) and academicians from the field of marketing.

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