A THEORETICAL AND EMPIRICAL INQUIRY INTO THE SPATIAL STRUCTURE OF RETAIL ACTIVITIES

by

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We have carefully read the thesis entitled A Theoretical and Empirical Inquiry into the Spatial Structure of Retail Activities submitted by Arthur Getis in partial fulfillment of the requirements of the Doctor of Philosophy and recommend its acceptance. In support of this recommendation we present the following joint statement of evaluation to be filed with the thesis.

This study is an examination of the basic assumptions of the general body of theory of the location of retail stores, assembled from the work of geographers and economists. The fusion of existing theories is accomplished through the introduction of a concept of differential decline of rent and revenue for retail stores with increasing distance from the center of business activity.

The evidence revealed in this study suggests that the portions of the theory dealing with concepts of monopolistic competition, surplus profits and normal profits are subject to serious question. On the other hand, the evidence supports the validity of notions dealing with accessibility, the importance of the location of disposable income, and the articulating concept of the spatial characteristics of rent and revenue.

New techniques of analysis are introduced where departures from conventional testing procedures are indicated. The author applies a map transformation technique to disposable income data, with which he is able closely to predict store location. A technique for estimating threshold determinants of business district location could not be developed sufficiently for testing purposes. An initial attempt is made to modify existing theory by the introduction of a potential accessibility measure based on the concept of intervening opportunity. This technique permitted a rough identification of potentially advantageous store sites.

(Continued on next page)

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In light of these findings, recommendations are made for modifying existing theory. Factors bearing on retail store location are examined and suggestions are made as to the form of a new body of theory. Finally, suggestions are presented concerning operational procedures which may be used to develop and test such a modified theory.

The committee recommends this work as a sound conceptual and empirical examination of existing theory, and as such is an important, original contribution toward a more viable body of theory for urban research.

In presenting this thesis in partial fulfillment of the requirements for an advanced degree at the University of Washington I agree that the Library shall make it freely available for inspection. I further agree that permission for extensive copying of this thesis for scholarly purposes may be granted by my major professor or, in his absence, by the Director of Libraries. It is understood that any copying or publication of this thesis for financial gain shall not be allowed without my written permission.

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CHAPTER I

INTRODUCTION

Urban land use theories have been developed in geography as well as in other academic disciplines. Geographers have attempted to discover the forces underlying the land use patterns of cities by thinking mainly in terms of market areas for central goods. Researchers in this field have been perplexed at the enormity of the problem of understanding the complex interrelations of the forces operating to mould the city into its present and future form. All realize that adequate knowledge of social, political, and economic forces acting within cities is lacking. At the core of this problem are difficult questions such as: How is it possible to develop workable schemes for study when urban areas are undergoing rapid changes in spatial character? Of the many forces, which are the most important? What data are needed to help verify notions of urban land use forces? If data needs are known, are the data available? Which approaches and techniques of research can best be used to handle these highly complex problems?

The present writer assumes that in order to begin answering these questions a theoretical approach is necessary. Theory developed to date in geography is inadequate to continue fruitful research regarding urban spatial patterns. An attempt is made in this study to bring together many apparently disjointed concepts from both geography and economics into a unified theory, and to evaluate their worth by analytically testing hypotheses derived from this theory. The study is confined to only one segment of the urban land use pattern: retail store location. The problem to be explored can be stated briefly as an attempt to evaluate the unified theory and its viability for further research.

Isard, following Christaller, suggests that one of the best ways to study the metropolitan region is "to construct a spatial structural framework in a world of uniform geographic features."[1] He realizes, of course, that a scheme of this nature "will always be deficient in one respect or another and thereby warrant continual development and refinement."[2] Our purpose is to evaluate carefully the already developed spatial structural framework (unified and modified where necessary) so that researchers may continue to study urban land use without being hampered by dependence on invalid theoretical statements.

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[1] Walter Isard, "Regional Science, the Concept of Region, and Regional Structure," Papers and Proceedings, The Regional Science Association, Vol. II (1956), p. 15.

[2] Ibid., p. 15.

One may agree that this purpose has merit, but doubt whether suitable theory has been developed which can be synthesized for testing purposes. For example, Howard states: "But when it comes down to cases, we don't really have a single adequate theory of urban land use relationships that explains the present structure, and serves as a basis for predictions and a measure of the viability of plans."[3] He poses the rhetorical question: "And if our theoretical background for understanding urban land use is weak--our fund of qualitative theory--how much weaker is our fund of quantitative theory?"[4] The problems before researchers in the urban field are no doubt great, but their task would be lightened if a suitable theoretical foundation upon which they could base their studies could be developed. Again, it is the purpose to which this research is addressed, namely to add to the work done which points the way toward a refinement of ideas dealing with urban land use.

Theory and Quantification in Geography

The field of geography has been defined many times and in many different ways. All geographers are concerned with earth-space, but the methods of studying earth-space vary widely. The author is not proposing a new method of study nor a methodology

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[3]John T. Howard, "Basic Research Problems of the Urban-Metropolitan Region: Problems Related to Planning," Papers and Proceedings, The Regional Science Association, Vol. II (1956), p. 105.

[4]Ibid., p. 105.

that all geographers should accept; he is simply looking for the most efficient procedures available to solve problems that geographers encounter. In this study we are concerned with the problem of understanding the land use pattern of retail establishments in urban areas. The question posed is: How do we best study this problem?

Most geographers would agree that a problem of this nature falls within the field of geography although they would doubtless attack it in a variety of ways. It appears to the author that it is desirable to approach any geographic problem dealing with distributional patterns from a theoretical foundation, no matter how weak the theory. Ackerman enforces this position when he discusses distributions in the abstract:

> First, thorough analysis of the nature of two-dimensional distributions <u>in the abstract</u> should be able to furnish a theoretical framework with capacity to illuminate actually observed distributional patterns and space relations. Such a theoretical framework is probably as important at this time as definition of the earth's physical matrix for observation was at an earlier stage in the science. Geography thus far has been notably weak in its attention to this possible building block. While the science has voluminous literature on methodology and procedure, geographers have done comparatively little toward considering their subject in the abstract.[5]

At another place in his work, Ackerman puts quantification in geography (implicit in theoretical-empirical work) in its right

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[5]Edward A. Ackerman, <u>Geography As a Fundamental Research Discipline</u>, Research Paper No. 53 (Chicago: Department of Geography, University of Chicago, 1958), pp. 28-29.

perspective.

> As in other sciences, qualitative description is essential to portrayal of the whole, but it is not here regarded as a strategic instrument of distributional analysis in fundamental geographic research. When quantifying devices are lacking, qualitative description may be the vehicle for insight, intuitive grasp, and logical argument for a hypothesis. However, the analysis is rarely complete without verification given in quantified measurement.[6]

Only recently have geographic studies followed theoretically based notions for explanation of retail store land use patterns. Much of this work has been reviewed in Studies of Highway Development and Geographic Change.[7] Of particular concern in this present study is the work of the authors of that book, for their research has cast much new light on urban land use patterns. Berry, for example, introduces a theory of tertiary activity based on central place theoretic notions and indicates the compatibility of the theory of tertiary activity with theories of retailing and consumer behavior.[8] Nystuen explores the effect of multiple purpose shopping trips on the distributional pattern of retail stores.[9] All of the authors emphasize the role of transportation in shaping the patterns of land use. This study attempts to build on the notions reviewed and introduced in that volume, as well as on the work of regional scientists and economists who have also contributed to urban land

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[6] Ibid., p. 12.

[7] William L. Garrison et al., Studies of Highway Development and Geographic Change (Seattle: University of Washington Press, 1959).

[8] Ibid., pp. 54-56.

[9] Ibid., pp. 181-196.

use research.

A variety of analytical techniques have been developed in recent years for the purpose of examining some of their theoretical constructs. In this study, some of these rather new as well as standard statistical techniques are used. In addition, certain techniques have been developed especially for use in this study, and these include new methods of graphically testing hypotheses, map transformations of disposable income data, threshold determinants of retail store location, and a measure of potential accessibility.

Interest in Retail Store Location and Study Format

Among other things the rapidity of urbanization in the United States has increased our interest in cities. However, despite the enormous significance of urban life in our society, knowledge of the spatial form and character of the city is conspicuously incomplete. Perhaps, the fact that on the average less than four per cent of all urban land is devoted to retail stores[10] has led geographers to spend a small amount of their efforts in understanding their distributional patterns and functional structures. Nevertheless, when it is realized that about forty per cent of personal consumption expenditures are disposed of at retail outlets,[11] and that

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[10]Harland Bartholomew, Land Uses in American Cities (Cambridge: Harvard University Press, 1955), Table 1, p. 159, and pp. 47 and 106.

[11]U.S., Bureau of the Census, Statistical Abstract of the United States (Washington, 1960), Table No. 405, p. 309.

forty-three per cent of the total number of firms in this country are concerned with retail trade,[12] the importance of retail establishments to commercial economies is therefore evident. In this study the location of retail stores is examined in the hope of increasing our understanding not only of the forces underlying the land use patterns of cities, but also of those which stem from the symbiotic relationships of other urban land uses.

In the following chapter the theory of retail store location is introduced. The work of geographers and economists has been fused through the introduction of a concept concerning the differential decline of rent and revenue curves for retail stores as distance increases from the center of business activity.

Chapters III and IV are concerned with an examination of the basic assumptions of the theory. The analytical tests of these two chapters attempt to determine if hypotheses derived from the theory can be verified and if the variables can be measured and used for prediction. In addition, it is pertinent to know if the theory can be considered as being relatively realistic in terms of our every-day experience. In Chapter III a number of hypotheses based on the theory are tested statistically and graphically, and in Chapter IV certain new techniques of analysis are introduced and tested in an exploratory manner.

In light of the findings of Chapters III and IV,

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[12] Ibid., Table No. 620. p. 484.

recommendations for a modified theory are made in Chapter V. Factors bearing on retail store location are examined and suggestions are made as to the form the new body of theory may take. Finally, suggestions are presented concerning operational procedures which might be used to develop and test such a modified theory.

CHAPTER II

THE THEORY OF RETAIL STORE LOCATION

The way in which the city is geographically organized and the character of that organization are questions that bear upon the functioning of each urban unit and of the whole. Yet the pattern is formed through a complex multiplicity of economic and non-economic forces, each force bearing directly or indirectly on many others. From the apparently haphazard arrangement of land use there appears some semblance of order if we observe the concentrations of urban activities, such as retailing in expedient economic locations.

A theoretical framework for study of the distribution of these activities is provided by the work of Walther Christaller. Christaller, in his well known work Die zentralen Orte in Süddeutschland,[1] attempted to explain the distribution of settlements. The center exists because essential services must be performed for the surrounding area. Services performed purely for a surrounding area are termed "central" functions, and the settlements performing them, "central places." Each central place is the

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[1]Carlisle W. Baskin, "A Critique and Translation of Walter Christaller's 'Die Zentralen Orte in Süddeutschland'" (unpublished Ph.D. thesis, University of Virginia, 1957).

center of an hexagonal market area, and the locations of these central places form an hexagonal lattice. The transporation cost characteristics of the various goods distributed from the central place give rise to a hierarchy of central places. Since this initial statement by Christaller, subsequent theoretical discussions have explained and expanded this system.

August Lösch evaluated and extended the notions of the arrangement of central places.[2] His work linked transporation nets among cities to central place notions, within the assumptions of the isotropic surface.[3] Some of these assumptions were relaxed by Isard, and more realistic real world market-supply relations added.[4] The result is a suggestion of the impact of urbanization economies upon the spatial pattern of production sites "except for modification with respect to population distribution."[5] The emphasis in Christaller, Lösch, and Isard's work is on an explanation of the location of economic activity where transportation costs are critical to the establishment of a production site.

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[2]August Lösch, The Economics of Location, trans. W. H. Woglom and W. F. Stolper (New Haven: Yale University Press, 1954).

[3]The term isotropic was introduced to the author by Torsten Hägerstrand in 1959. An isotropic surface is a homogeneous land surface characterized by equally distributed population and income, with every point on that surface equally accessible.

[4]Walter Isard, Location and Space-Economy (New York: John Wiley and Sons, Inc., 1956).

[5]Ibid., p. 274.

Concepts dealing specifically with retail activities depend on more explicit notions concerning the effect of transportation. As will be shown, the more incisive concepts can be linked directly to central place theory.

This chapter deals with both the theories which have broadened the Christaller and Löschian base in the direction of understanding retail location and with relevant economic theory. It includes the theory of land use and land value, the economic theory of the firm in monopolistic and imperfectly competitive states, and the theory of tertiary activity.[6] By developing the theories into a unified whole, an attempt is made to shed new light on retail service location.

The Theory of Land Use and Land Value

The emphasis upon location as the basis for urban land values had its roots in the work of von Thünen,[7] who traced the variations in agricultural land rents to differences in soil productivity and location in a theoretically isolated community. Many attempts were made to sharpen the analysis of the influence of location upon land value, but it was not until 1926 that Haig considered the relative accessibility advantages of different urban

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[6]For a more complete review of these concepts see William L. Garrison et al., Studies of Highway Development and Geographic Change (Seattle: University of Washington Press, 1959).

[7]Johann H. von Thünen, Der Isolierte Staat (Jena, original edition 1842).

sites.[8] Students of Haig refined and extended his transportation-based concepts, until Wendt found damaging flaws in the original analysis.[9] Wendt's conclusions pointed to distinguishing between factors which will affect the values of individual sites and those which will affect the values of all urban land.[10] If we assume that Haig and his students referred only to the value of individual sites, then we could extract from their work certain inferences as to the location of retail service activities. Haig spoke of efficiency in the utilization of land as being measured by rent-paying ability.[11] "Rent appears as the charge which the owner of a relatively accessible site can impose because of the savings in transportation costs [direct and indirect savings accrued to entrepreneurs and customers] which the use of his site makes possible."[12] The use that can pay the highest rent for a given site will be the

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[8]R. M. Haig, "Major Economic Factors in Metropolitan Growth and Arrangement," Regional Survey of New York and Its Environs (New York: Regional Plan of New York and Its Environs, 1927); "Toward an Understanding of the Metropolis," Quarterly Journal of Economics, Vol. XL (May, 1926), pp. 179-208.

[9]H. B. Dorau and Albert G. Hinman, Urban Land Economics (New York: The Macmillan Co., 1928), pp. 509-511; Richard T. Ely and George S. Wehrwein, Land Economics (New York: The Macmillan Co., 1940), pp. 127-128; Richard U. Ratcliff, Urban Land Economics (New York: McGraw-Hill, 1949), pp. 371-374.

[10]P. F. Wendt, "Theory of Urban Land Values," Land Economics, Vol. XXXIII (1957), pp. 228-240.

[11]Ratcliff, op. cit., p. 369.

[12]R. M. Haig, "Toward an Understanding. . . . " op. cit., p. 422.

successful bidder in a competitive market, and this will result in "an orderly pattern of land use spatially organized to perform most efficiently the economic functions that characterize urban life."[13] Land value will reflect the productivity which the landowners and entrepreneurs estimate will be achieved during the life of the establishment or during some shorter period.

The character of production will affect its rent-paying ability. Among these characteristics are the firm's desire to minimize consumer transportation costs by locating close to other stores, the firm's space needs, the scale of operation, and the many factors causing an imperfectly competitive market, such as advertising, mark-up, product differentiation, and so on. The purpose here is to make use of these variables in a general way so that we may be able to evaluate their significance for the location of retail activities. Before we proceed in that direction, mention will be made of Chamberlin's ideas related to monopolistic elements in location.[14]

Economic literature considers the character of service firms as satisfying the assumptions of monopolistic competition.[15] Under

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[13]Ratcliff, op. cit., p. 369.

[14]Edward Chamberlin, Theory of Monopolistic Competition (Cambridge: Harvard University Press, 1933).

[15]For a concise explanation of the economics of monopolistic competition see Richard H. Leftwich, The Price System and Resource Allocation (2d ed.; New York: Holt, Rinehart and Winston, 1960), pp. 268-278.

such conditions, for example, the product of each seller is in some way differentiated from the product of every other seller. Among services of the same type, the major differentiating factor is considered, in Chamberlin's analysis, to be the firm's location.[16] Monopoly can come about because only one firm can be located at a given place. Thus no other firm can have the same locational advantages and disadvantages. However, the cost of operation in more desirable locations increases due to the higher rents which are charged. The possible profit which the seller at a particular location can realize, rather than his sales volume, determines the rent. The other differentiating factors such as price and product are "determined in part by the location of the site in question."[17] The equalizing factor appears to be rent. Entrepreneurs are penalized by landlords in accordance with the value of the privilege of providing retail services at particular locations. The competition for these sites enables the landlord to maximize his returns (rent). The landlord considers the businessman's "normal" profits as a cost, and any profit surplus will be the rent. Normal profits refer to funds needed to continue the operation of a business at the threshold level, i.e., the level below which a business cannot establish. Profit surplus is revenue accrued by the businessman in excess of his normal profits. Chamberlin when summing up the

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[16]Chamberlin, op. cit., p. 112.

[17]Ibid., p. 115.

theory of urban rent as monopoly income stated:

> The differential remaining, which is due to the superiority of the profit-making opportunities afforded by one site as compared to another, is rent, and is put into the hands of the landlords by the competition of entrepreneurs for the best opportunities.[18]

From the above it seems evident that rent is the factor which is instrumental in classifying service activities as monopolistically competitive. But, rent is balanced by surplus profit. This type of equilibrium situation allows us to look at service activities from a more exacting point of view than would be otherwise possible. For a retail firm to establish, the rent cannot be so high as to limit its opportunity to balance this cost with its surplus profits. The question posed here is: Where are those locations which afford the entrepreneur the opportunity to reach that equilibrium position? In other words, where do retail firms locate? In the following section traditional economic analysis will be used to answer this question. It is based on the work of Alonso[19] and includes additions by the author.

Profit Maximization and Location

Wherever people are densely settled in cities a most accessible site can be found. This would be where transportation costs

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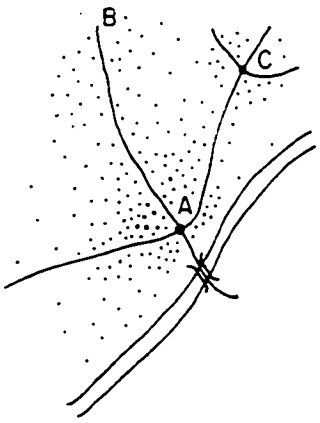
[18] Ibid., p. 115.

[19] William Alonso, "A Model of the Urban Land Market: Location and Densities of Dwellings and Businesses" (unpublished Ph.D. thesis, University of Pennsylvania, 1960), pp. 83-95.

from all sections of the populated area are minimized. This site could be thought of as the center of disposable income. If we held the size of the firm constant, sales would decrease as the store moved away from the center of disposable income. This statement implies that the firm is one of the convenience type, and that no imperfect market exists. If sales decrease rapidly from the center, then marginal revenue would be negative. It is true that operating costs would increase with movement away from the center since transportation costs (firm plus customer) would increase, but this would be more than offset, within the urban area, by rent, which will decrease away from the center because land is cheaper. The marginal costs would also be negative as distance increases from the center. The shape of these marginal revenue and costs curves provide an insight into retail location. (Figures 2.1, 2.2a, b) To determine the equilibrium location of the firm we would select the position where marginal costs equal marginal revenue. The total cost curve will decrease with distance much more slowly than the total revenue curve in the real world. This results from the fact that rent is the forecasted ability of a site to return profits to the landlord, and not the actual rent-paying ability of the site (opportunity costs over time). The total revenue curve, on the other hand, decreases much more rapidly from the center because of the exponentially increasing restraints put on accessibility as distance from the center increases. (Figures 2.1, 2.3) The landlord can expect entrepreneurs to bid

URBAN AREA: POPULATION DISTRIBUTION AND MAJOR TRANSPORT ROUTES

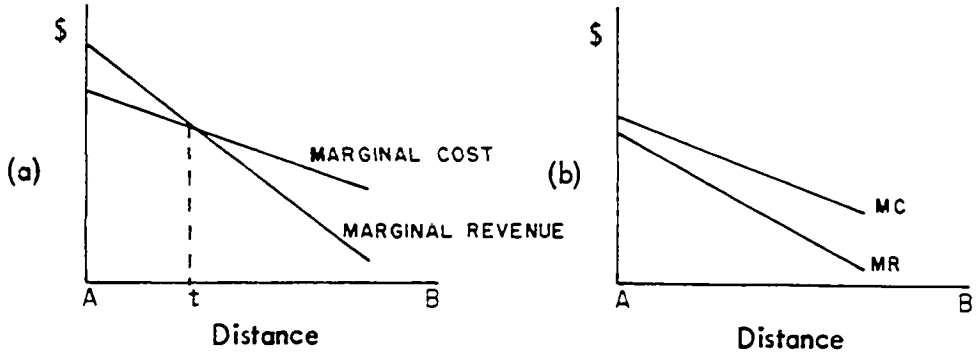


A Most accessible site for all of the urban population

C An accessible site for some of the urban population

Figure 2.1

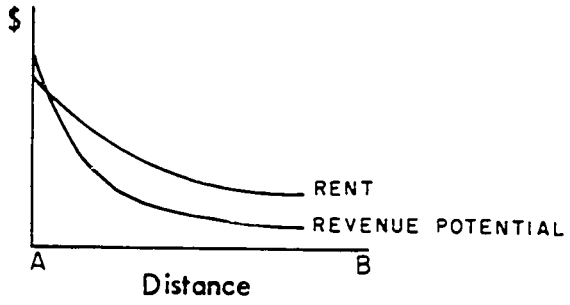
MARGINAL COST AND REVENUE IN AN URBAN AREA



A, B correspond to A, B in Figure 2.1.
t is point of profit maximization in (a), but profits can be made from A to t in (a); only at A in (b) is a store likely to locate.

Figures 2.2a, b

TOTAL RENT AND REVENUE POTENTIAL IN AN URBAN AREA



As distance from A to B increases rent decreases, but at a slower rate than revenue potential. Revenue potential of C (see Fig. 2.1) detracts from revenue potential at A.

Figure 2.3

off-center sites higher than their true value because of the hope for increased accessibility over time. Therefore, the marginal revenue curve could cross marginal costs from the top at point A in Figure 2.2a very close to or at the center. There is the possibility that the two curves will not cross, and in that case the greatests profit (or the least loss) will be realized at the center. Therefore, it appears that convenience goods firms will locate at or as close to the center as possible for profit maximization. But, certain firms, because of certain elements in their economic character, may not be able to afford the rents close to or at the city center. In this case they would select a site close to or at a secondary center within the urban area. This alludes to the compatibility between the above ideas and notions concerning the hierarchy of shopping centers derived from central place theory.

The Hierarchy of Shopping Centers: The Theory of Tertiary Activity

Central place theory deals with urban centers and the transport network linking the urban centers, with the result, under the isotropic assumptions (homogeneously distributed purchasing power being most important), that hexagonal trade areas would result. Of course, purchasing power is unevenly distributed in the real world so one would not expect an hexagonal pattern to develop. Berry and Garrison show that hierarchies of cities and/or shopping centers exist with no need for an hexagonal arrangement.[20] Berry

[20]Brian J. L. Berry and William L. Garrison, "Functional

developed a system where the assumption of no excess profits is relaxed, making an imperfectly competitive system possible.[21]

> For the sake of exposition, assume that a city is to be supplied with n types of central goods. Let these be ranked from 1 to n in ascending order of their threshold sales requirements. The business center supplying good n will require the largest market area (in terms of amount of purchasing power) for its support. Let a central place supplying good n be called an A center.
>
> As many A centers will exist in the city as there are threshold sales levels to support firms supplying good n. These firms compete spatially, hence are distributed so as to supply their own threshold most efficiently. If total sales levels are an exact multiple of thresholds for good n, market areas will be bounded by lower limits to the range of A centers. Firms will earn only normal profits and these only if they minimize costs by locating to minimize distribution costs if the product is delivered, or locating to minimize consumer movement if the consumer comes to purchase the product. Hence the extreme importance of accessibility in the system. If sales in the whole area are slightly greater than an exact multiple of threshold, but not great enough to justify another A center, then excess profits may be earned and ranges reach a more competitive upper limit.
>
> The question arises as to how good n-1 will be provided. Presumably, it will be supplied from A centers, which have sought out the most efficient least cost points of supply central to maximum profit areas at their command. Also, there will be advantages of association with other establishments providing central goods. The threshold of good n-1 is less than that of good n and spatial competition determines market areas, which are delimited by upper limit ranges. Excess profits may be earned. This argument will be the case for all other goods n-2, n-3, . . ., 1.
>
> But there may be one or more goods, say good n-i, in which case the interstitial purchasing power, located between threshold market areas of A centers supplying good n-i, will reach threshold size. In this case greater

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Bases of the Central Place Hierarchy," Economic Geography, Vol. XXXIV, No. 2 (April, 1958), pp. 145-154.

[21]Brian J. L. Berry in Garrison et al., op. cit., pp. pp. 54-56.

> efficiency is reached if a second set of centers, which may be termed B centers, supply the good. These B centers again locate most efficiently relative to their threshold market areas. If the market area is just at threshold, only normal profits are earned by firms supplying good n-i. If part-multiples of threshold are present, some excess profits are earned. Good n-i may be termed a hierarchical marginal good. B centers will also provide lower threshold goods n-(i - 1), . . ., 1.[22]

This type of analysis can continue until the firm requiring the smallest threshold is a center itself. However, one may assume that a firm can enter into one of the market areas without being at the center of the market area.

The economic analysis in the preceding section makes it clear that the convenience good establishment will locate close to or at the center (most accessible area). But, Aubert-Krier makes a distinction between convenience goods and occasional goods firms and their location.[23] Occasional goods are those which are acquired in intervals, either seasonal or annual or even more infrequently. Occasional goods firms are not necessarily dependent on maximum consumer convenience for their livelihood and will take advantage of lower rents by locating off-center. The theory of monopolistic competition, at least in so far as the geographical element is concerned, does not hold as readily for these firms but

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[22] Ibid., pp. 54-55.

[23] Jane Aubert-Krier, "Monopolistic and Imperfect Competition in Retail Trade," in Monopoly and Competition and Their Regulation, ed. Edward H. Chamberlin (London: Macmillan and Co., 1954), pp. 281-300.

corresponds fairly closely to the typical market of imperfect competition. The hierarchical force, or rather the force of the threshold would limit the firm to a particular size market area but equilibrium in site location would not act as the pervasive locational force for these firms.

The question arises as to the character of a center in terms of accessibility and potential disposable income. Artle attempted to answer the problem of potential income over distance.[24] He attempted to develop some concept analogous to Stewart's population potential[25] and Isard's income potential.[26] After dividing downtown Stockholm into a grid system, each cell being 250 by 250 meters, Artle defined the potential of income produced by any cell j on another cell i as

$$ {}_iV_j = \frac{G_{ij}Y_j}{d_{ij}} \qquad (i = 1,2, \ldots m) $$

where G_{ij} is a constant; Y_j is the income of people resident in cell j; d_{ij} is the distance between cells i and j; and m is

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[24]R. Artle, Studies in the Structure of the Stockholm Economy (Stockholm: School of Economics, 1959).

[25]John Q. Stewart, "Potential of Population and Its Relationship to Marketing," Theory in Marketing, ed. R. Cox and W. Alderson (Chicago: Richard D. Irwin, Inc., 1950), pp. 19-40.

[26]Walter Isard and G. Freutel, "Regional and National Product Projections and Their Interrelations," in Long-Range Economic Projection, Studies in Income and Wealth, Vol. XVI (Princeton, N.J.: National Bureau of Economic Research, Princeton University Press, 1954).

the total number of cells. Isard and Freutel conceive of the constant G "as a factor for converting actual distance into effective economic distance."[27] It was thought that the distance factors tend to reduce the income effects so sharply that in estimating the income potentials produced by all cells on a given cell, one need only consider its own income. Taking future demand per cell as estimates of the possible future receipts "we could then estimate the distribution over squares [cells] of the establishments and personnel of the sectors."[28] This procedure is based on several simplifying assumptions.

> . . . there is the assumption that the average propensity to consume the services in question is the same in each square, . . . that the places of residence constitute the only points of orientation as a basis for computing the income potentials, . . . that the receipts obtainable per square are the only factor influencing the spatial distribution of the establishments.[29]

It was thought that variations in the number of establishments (and in the size of their personnel) per cell would be related to ". . . variations in the estimated receipts obtainable per square and variations in the average level of rent per square, to see whether these two variables could serve as explaining variables."[30] Artle's procedure, although not theoretically (in the

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[27] Ibid., p. 436.

[28] Artle, op. cit., p. 125.

[29] Ibid., p. 125.

[30] Ibid., p. 126.

pure sense) oriented, fits well into the framework developed so far. Each site at or surrounding a center has a certain income potential depending on accessibility and location of disposable income. The number of establishments, and more succinctly, the number of employees can be determined since monopolistically competitive firms (location as the monopolistic element) are only eligible to make normal profits at their threshold. Any additional employee at the threshold level will bring diseconomies. If surplus profits are accrued because a firm's threshold requirements are less than the outer range of the good, then that firm must employ new workers to handle the "excess" customers, and surplus profits then disappear and the firm returns to the normal profit level. This leads to the conclusion that disposable income within the market area of a center will determine the size of the retail business center in terms of the number of employees needed to supply that market area. If the disposable income is great and the area small, then rents will be high; if the disposable income is low and the area large, then rents will be low.

The Theory in Summary

Within any urban area there are one or more highly accessible sites at which rents will be high because of the potential returns those sites can yield to landlords. Convenience goods firms can maximize their profits at or near these centers because potential revenue falls off more quickly than rent as distance from

the center increases. Firms which for their existence require more revenue than that potentially available to them from an urban area must locate in a larger urban area. These threshold requirements give rise to a hierarchy of market areas and business centers. Occasional goods firms are susceptible to the threshold force but are not necessarily limited to sites close to or at the center.

The fact that landlords charge higher rent if firm revenue increases limits the firm from making larger than normal profits. The size of the firm has little bearing on normal profits since larger firms must pay higher rents and more employees are necessary to supply consumers with retail goods. Of course, larger firms make more profit than smaller firms, but no more than what should be expected for these firms.

This theory does not purport to explain the selection of an individual site by an individual firm, but it does give order to the arrangement of retail land when free market forces are operating.

CHAPTER III

TESTS OF THE THEORY OF RETAIL STORE LOCATION

In this chapter an attempt is made to empirically test some aspects of the unified theory of retail store location. The purpose is to discover which parts of the theory hold up when tested, so that subsequent urban research will have a firmer groundwork on which to build.

The following statements have been extracted from the theory for testing purposes. A brief explanation of the implications of these statements in regard to the strength of the theory is given.

1. Surplus profits are balanced by rent.

2. Rent decreases more slowly from the center of business activity than revenue.

3. If the size of convenience goods establishments are held constant, sales will decrease as the stores move away from the center of disposable income.

4. Rent for retail stores decreases away from the center of business activity.

5. Convenience goods establishments locate in business centers.

6. Occasional goods firms do not necessarily locate in centers,

but must locate within a market area where the necessary effective buying power to support the store (threshold level) is in evidence.

7. The force of the threshold limits firms to a particular size market area, depending on the threshold requirements of these firms.

8. Each site at or near a center has a certain income potential depending upon its accessibility and the location of effective buying power.

9. The number of establishments or, more succinctly, the number of employees needed to supply consumers in a market area can be determined by analytical estimating methods.

Statements one through five, if verified, would show rent to be the instrumental factor in classifying convenience goods firms as monopolistically competitive, in which case their location would be of prime importance for their successful operation. Also, if these five statements are supported by tests, then accessibility will have been shown to be of major importance as a factor for retail location. Finally, if the central tendency of stores is proved, the unifying character of the theory becomes clear. By central tendency is meant that stores seek out the most highly accessible sites (in terms of convenience to consumers). The way in which sales and rent, two economic variables, react to different locations ties economic theory to central place notions. This in essence is the necessary conclusion that adds strength to the theory of retail store location.

Statements six through nine are tested not in this chapter but in Chapter IV, in which a theoretical pattern of store location is developed by analytical methods and compared with actual store locations. One can think of the analysis of the first five statements as testing aspects of the theory bearing on intra-shopping district retail store spatial patterns, while the last four statements pertain, in a general way, to business district location patterns.

The Data Used and the Terms to be Defined

Listed below are the data needed to test the nine hypotheses, together with the character and the source of the data actually used. In addition, in order to clarify certain of the terms and concepts mentioned in the previous chapter, operational definitions are given.

1. Rent.--The author was able to secure aggregate equalized valuation (assessed valuation) data for about 250 establishments in the city of Tacoma, Washington for the period 1958-1959. A number of the members of the Washington chapter of the American Institute of Real Estate Appraisers agreed that such figures for firms in Tacoma would correlate closely with rent.[1] Given this correlation and the fact that actual rent figures were unavailable and unnecessary for the study, aggregate equalized valuation data are used in lieu of actual rent paid.[2]

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[1]Telephone conversations of the Summer of 1960.

[2]In a conversation with Horace Lister, Chief Appraiser,

2. Surplus profit.--Data on surplus profits are unavailable, but are estimated as the residuals of a regression correlating the number of employees with the gross revenue of retail establishments in Tacoma (hereafter called the "test city"). A further discussion of this concept is given in the next section.

3. Convenience goods and occasional goods establishments.--Using standard definitions, stores are considered as either convenience or occasional goods establishments.[3] It is realized that convenience goods type establishments can be considered as occasional goods establishments in certain circumstances, but as long as occasional goods establishments cannot be thought of as

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Pierce County Assessor's Office, Mr. Lister in July, 1960, stated that aggregate equalized valuation (aev) figures closely approximate one-quarter of the fair market value of a retail store. Seattle appraisers assured the author that monthly rent for retail establishments closely approximates one per cent of the market value of the store. The conversion of revenue to rent appears as:

$$\text{Rent} = \frac{4\ (\text{aev})}{100} \times 12$$

Since all but aev are constants, then aev is used to study rent-sales and rent-employee relations.

[3] Richard L. Nelson provides one of the many similar definitions in The Selection of Retail Locations (F. W. Dodge Corporation, New York, 1958). He writes: Convenience goods ". . . are items of daily consumption and very frequent purchase--sometimes called 'spot necessity' items." They include ". . . groceries, drugs, hardware, liquor, and some variety items--and also include some service stores." Occasional goods (referred to in most American journals as shoppers goods) ". . . are [items] of relatively infrequent purchase. . . ." These include "apparel, appliances, jewelry, furniture, and other merchandise for longer term rather than daily consumption." P. 175.

convenience goods establishments, then the study will not be limited by the former fact.

4. Centers of disposable income.--These are considered as high land value locations. Such centers will be discussed in Chapter IV, where an attempt will be made to locate stores analytically. In the present chapter, centers of disposable income will be considered as the centers of shopping districts.

5. Sales.--These data were obtained confidentially from the planning agency of the test city.[4] Sales of 350 establishments for the year 1958 were used. The data also list the location, type, front foot distance, building area, and parking area of the stores.

6. Employees.--These data were secured from the test city for the year 1958 and are not to be reproduced in their original form by agreement.[5]

7. Thresholds.--According to the theory, the level below which a given type of retail firm cannot be established and make normal profits is the threshold level. These levels are determined analytically from a test dealing with employees and sales, which is described presently.

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[4]The author is indebted to Professor Edgar M. Horwood, Department of Civil Engineering, University of Washington, who suggested the use of sales data from the test city, and to officials of the Planning Department of that city.

[5]The author is indebted to Professor Marion E. Marts, Department of Geography, University of Washington, who supported his request for these data, and to the officials of the Employment Security Agency of the test city.

8. Market areas.--These were unavailable and they are not easily determined analytically, mainly because of the overlap of trading areas, which are dependent on the type of store, consumer demands, accessibility, and so on. An attempt is made, however, to determine the location of market areas in the next chapter.

9. Income potential of urban sites.--These are estimated for the year 1958 for use in Chapter IV.

10. Accessibility.--Driving time data were secured by driving on many arterials and secondary streets in the test city at important shopping hours. These data will not be used directly in this study, but will be mentioned in relation to potentially advantageous retail store locations in Chapter IV.

11. Effective buying power.--Effective buying power was estimated for the test city with the aid of standard tables concerning income allocated for various goods purchased by consumers in different income groups.[6]

Surplus Profits and Rent

For the verification of the first hypothesis, namely that surplus profits are balanced by rent, it is first necessary to consider the possible relation between sales and employees in retail establishments. This is due to the fact that surplus profits are defined in terms of sales above threshold levels, which are to be

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[6]One such table is reproduced in the Appendix from Nelson, op. cit., p. 222.

measured in terms of numbers of employees (see page 24). A discussion concerning the first step follows.

The Relation of Sales and Employees

It was shown theoretically that retail service industries locate at a site because demand exists at that point. In working toward a better understanding of retail site selection, the question arises: How will demand affect the employment pattern of the firm? An attempt will be made in the following paragraphs to show the spatial characteristics of employee-firm relations.

In this paper, persons who are employed directly for the sale of retail goods and services are referred to as service workers. They may be proprietors, salaried or commissioned employees. Most of these retail workers are entirely dependent for their livelihood on wages derived from the personal consumption expenditures allocated for retail goods. The demand for each particular type of good is the determinant of whether or not workers can be employed. If it is agreed that a retail establishment will successfully locate in a given area if and only if there is sufficient effective demand to justify the employment of the retail worker, then an employer will normally hire an additional worker only if the wages paid the new worker will at least equal increased gross income. We would expect to find a retail worker only in an area where the expenditures for goods and services are sufficiently large to allow for his support.

It is felt that analyses on the employee level rather than the firm level will prove more fruitful in geographic studies. Working with this smaller unit eliminates some of the possibilities for error.[7] It has been argued theoretically that surplus profits exist when there is more demand for a service in an area than can be handled effectively by the already existing firms.[8] Because this excess in demand, however, is insufficient to support a new firm, surplus profits accrue to the already existing firms. This surplus profit argument can be made somewhat more realistic by using the smaller unit--that is, the employee. Excess in demand requires more service workers to supply "extra" goods. Any surplus profit, determined in terms of the number of employees, tends to accrue to the landlord as additional rent (see page 14). If the excesses correlate with rent, then the first hypothesis would be proved within the limitations of this method of estimating surplus profits.

The first step in testing the hypothesis was to determine the relation between sales and employees. The second step correlates residuals falling below the least squares line with residuals falling above the least squares line regressing sales on rent

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[7]The fact that firms of the same type vary in physical size, number of employees, and gross sales gives one reason to believe that use of firms in geographic research might prove fallacious if numbers of firms are to be compared with other phenomena.

[8]Brian J. L. Berry and William L. Garrison, "A Note on Central Place Theory and the Range of a Good," Economic Geography, Vol. XXXIV, No. 4 (October, 1958), pp. 304-311.

(Figure 3.1). In other words, stores having fewer employees than indicated by the regression for a given sales level, thereby making surplus profits, are compared with stores having higher rents than one would expect at a given sales level.

The first step is carried out on three levels: national, state, and local. The national and state correlations are of a preliminary nature, carried out using readily available data, for the purpose of determining the feasibility of continuing the testing of this hypothesis. The results of the correlation at the local level, using store-by-store data rather than grouped city data, are used to test the hypothesis directly.

The Data

On the national level, total sales in 1954 for three retail activities--grocery stores, shoe stores, and gasoline service stations--were correlated with the number of employees participating in the exchange of the goods up for sale at that time. Each city, large or small, was considered as one observation in a total universe of 349 cities. The data source was the 1954 Census of Business, which presents the necessary city-by-city figures of employees and receipts.[9] Grouped data, that is, all stores and employees of one type in one city, were considered as one observation. For this correlation, and at the state level too, figures on a store to

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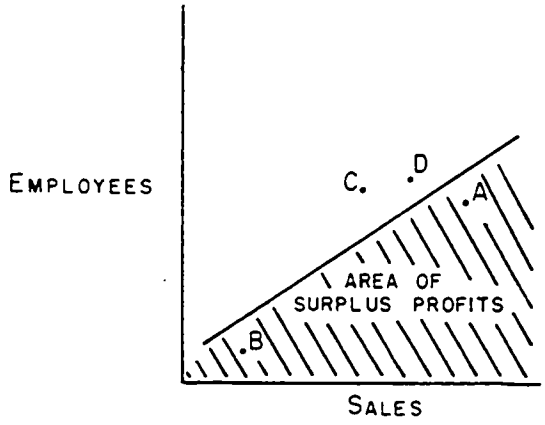
[9] U.S. Census of Business: 1954, Vol. II, Retail Trade-Area Statistics (Washington: U.S. Government Printing Office, 1956).

EMPLOYEE-SALES AND RENT-SALES RELATIONSHIPS



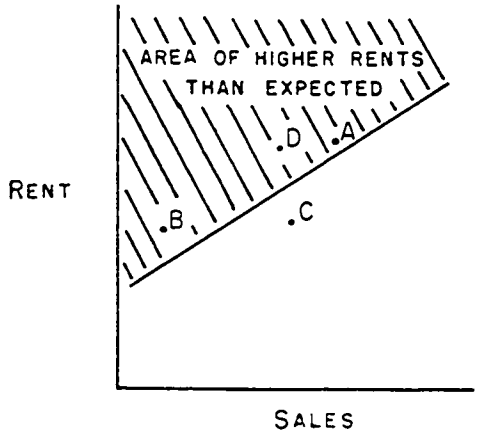


Figure 3.1

In this example stores A and B demonstrate the relationships necessary for the verification of the hypothesis, while stores C and D suggest that some other hypothesis may be true.

store basis were unavailable.

On the state level, two states--Iowa and Illinois--were considered. For Iowa, data were available for six cities; in Illinois, data from nineteen cities were used.

Results of the National and State Correlations

On the national and state levels it was found that the correlation coefficients of sales on employees for each of the three service activities were extremely high (Table 3.1). Only a very small amount of the variance in the amount of retail sales can be accounted for by the difference in the number of employees. Therefore, the test shows that retail sales are a most important factor associated with the hiring of workers. This does not mean that a cause and effect relationship is evident, but that there is a very strong association between the variances of the two variables. There may be a question as to the validity of the test when it is realized that the large cities will provide an undue weight to the correlation. Data transformations would bring a more realistic result if the transformation had as its objective the equal weighting of each observation. Coefficients of variation based on the mean measures of sales per employee were determined in order to test this notion. The coefficients ranged from five to thirty-two per cent, most being close to fifteen per cent. This result indicates that although the correlation coefficients were high, there was an undue weighting attributed to the fewer high magnitude

TABLE 3.1

THE RELATION OF RETAIL SALES AND RETAIL EMPLOYEES FOR THREE TYPES OF STORES IN THE UNITED STATES AND IN ILLINOIS AND IOWA

	Number of Cities	Sales Volume per Employee	Correlation Coefficient Employees on Sales Volume	Coefficient of Determination	Coefficient of Variation
Grocery Stores					
Total U.S.	358	$42,159	.997	.994	16.4%
Illinois	19	43,859	.985	.968	15.4
Iowa	6	43,212	.982	.955	8.9
Shoe Stores					
Total U.S.	287	$26,850	.996	.992	15.6%
Illinois	14	26,929	.987	.972	20.1
Iowa	4	28,040	.994	.982	5.0
Gasoline Service Stations					
Total U.S.	358	$22,726	.993	.985	15.6%
Illinois	19	25,211	.849	.705	15.3
Iowa	6	25,290	.965	.914	13.1

observations. The data were not transformed in the case of the national and state data, but were transformed on the local level.

Results of the Local Area Test

On the local level, the data available for Tacoma included store-by-store sales volumes in a number of shopping districts outside the central business district, and data pertaining to the number of employees in many of these establishments. The limitations on the use of these data are not found with the accurate sales figures but with the employee data. The number of employees was determined by finding the average number of workers per store for the entire year. This average may prove unrealistic when considering seasonal trade, but wherever there was doubt as to the validity of the data, they were discarded. Added to the work force of every store was one proprietor. This also may cause some variations in the data. The addition was fostered by observations of Census of Business data for many cities including the test city where the number of proprietors and the number of stores correlated rather well. One further drawback became evident with these employee data. Only employees covered by workmen's compensation were included in the figures. This tends to give a lower figure than expected for the number of employees in a particular establishment.

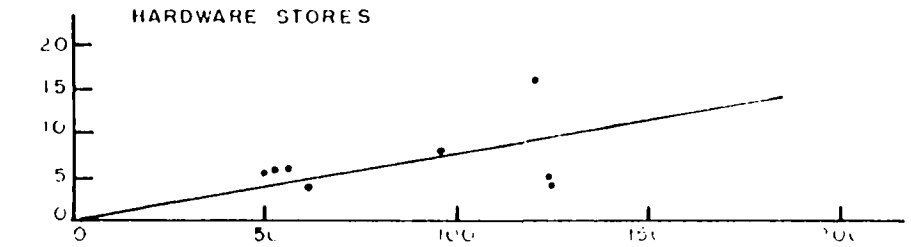
Table 3.2 summarizes the results of the correlations. The regressions were performed on eleven types of retail establishments (Figures 3.2a through 3.2g). The biases evident when using small

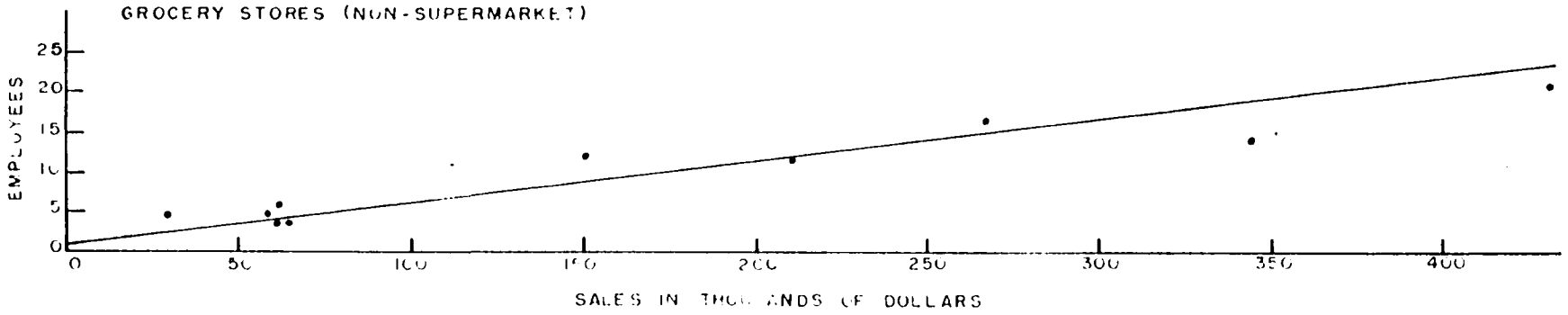
TABLE 3.2

THE RELATION OF RETAIL SALES AND EMPLOYEES
FOR ELEVEN TYPES OF STORES
IN THE TEST CITY

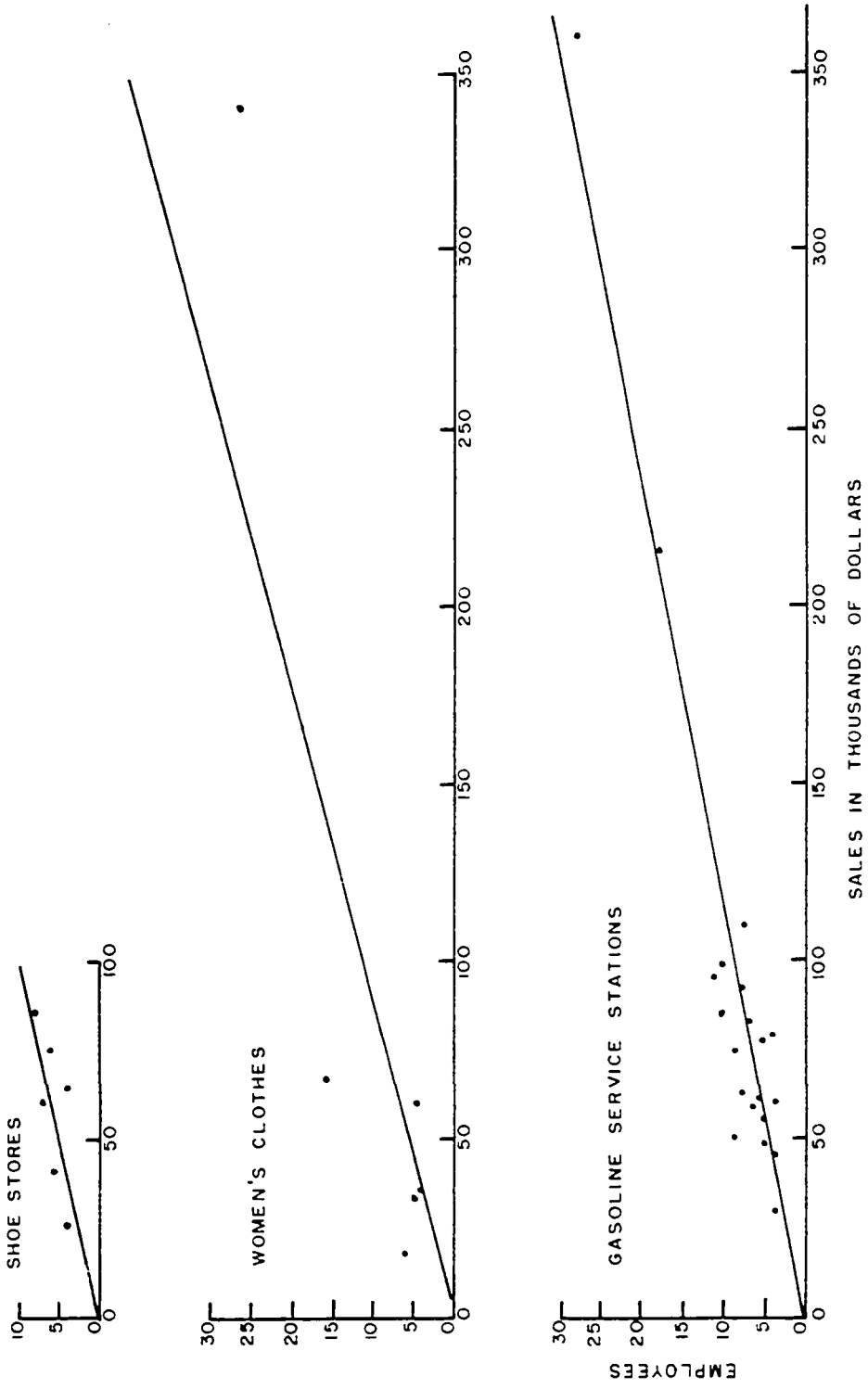
				Using Logarithmic Transformations	
	Sample Size	Sales Volume per Employee	Standard Correlation Coefficient	Correlation Coefficient	Coefficient of Determination
Store Type					
Hardware	8	$25,018	.334	.392	.013
Grocery (non-super markets)	10	34,691	.925	.941	.871
Gasoline service stations	20	21,931	.957	.311	.049
Women's clothes	6	19,571	.947	.986	.965
Shoe stores	6	20,056	.649	.617	.225
Furniture	8	23,827	.846	.832	.641
Eating places	20	7,868	.826	.374	.091
Taverns	28	14,927	.437	.439	.169
Drug	20	15,113	.515	.710	.476
Beauty shops	10	5,785	.710	.701	.427
Barber shops	17	4,226	.605	.477	.176

RELATIONSHIPS OF RETAIL SALES AND EMPLOYEES BY STORE TYPES IN THE TEST CITY





Figures 3.2a, b



Figures 3.2c, d, e

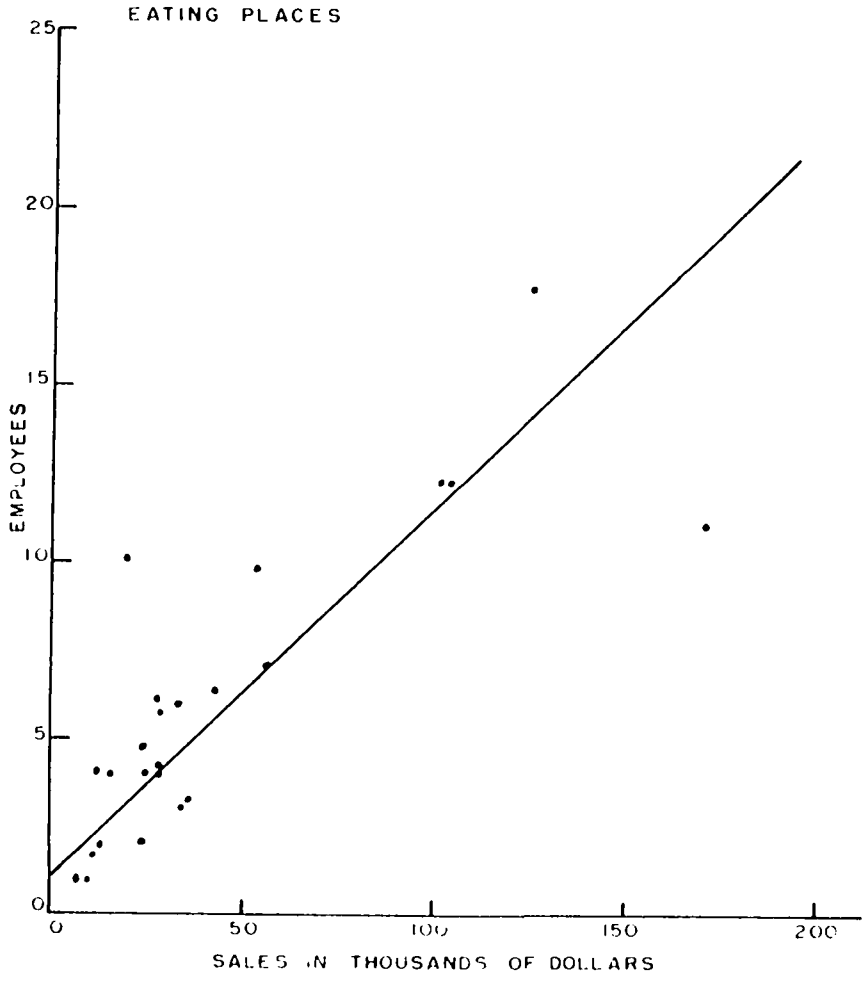


Figure 3.2f

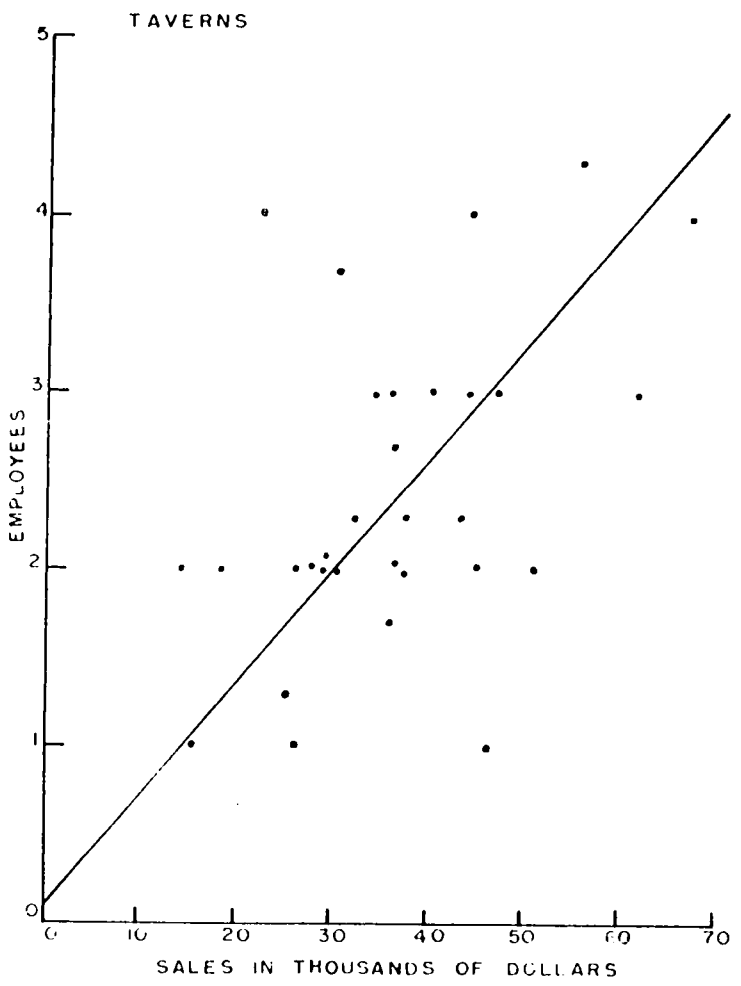


Figure 3.2g

samples and widely varying observational magnitudes called for data transformations. Before the data were transformed to logarithms, the results indicated high correlations between the two variables, as would be expected (Table 3-2). After making the transformations, certain of the correlation coefficients changed markedly. The type of retail establishments where high magnitude observations were in evidence, causing high correlations in the first test, were reduced greatly in importance in the transformed logarithmic correlation determination. By using this transformation an attempt was made to bring each observation into a more realistic perspective, that is, giving each observation as close to equal weight as possible using standard statistical techniques. The results of the logarithmic tests show six of the eleven types of stores with correlation coefficients above the .600 level. This is encouraging, especially when the shortcomings of the employment data and the small samples are considered, as well as organizational differences within individual categories of stores.

The relation that is evident with the results of these correlations and the national and state level correlations, although not examined further statistically, provide a foundation on which the hypothesis can be tested. The relatively high correlations indicate that surplus profit can be reasonably estimated by using employment data. Shortcomings in the above work might reveal themselves again in the following test, but any positive or negative results will be viewed in the light of these shortcomings.

Results of a Test Correlating Surplus Profits and Rent

This test could be carried out only on the local level, where the necessary store-by-store data were available. Synthetic methods were used to test the hypothesis, and the results were negative. Incongruities in much of the data used may be responsible for these results. In any case, the fact that the test showed that there was no relation between surplus profits and rent suggests the need for determining rent and surplus profits more accurately. If the results are also negative in a retest, then the theory of the location of retail establishments must be modified.

Before any actual statistical test was attempted, the data were scrutinized for a possible correlation, and it became evident that a statistical test was unnecessary. The data in summary form are shown in Table 3-4.

The expected sales derived from employment data were determined by summing employees and sales from the entire set of data by store type, finding the average, then converting employees into their comparable value in dollars of sales. This same technique was used for finding the expected sales derived from rent (Table 3-3). The relatively high correlations found previously, sales on employees and sales on rent, indicated that surplus profits could be determined using employment data. However, surplus profits were not balanced by higher rents than would be expected (in fact, of the 57 observations used in this test, 37 showed lower rents than

TABLE 3.3

THE RELATION OF RETAIL STORES AND RENT
FOR ELEVEN TYPES OF STORES
IN THE TEST CITY

	Sample Size	Correlation Coefficient
Store Type		
Hardware	14	.643
Grocery	15	.778
Gasoline service stations	25	.434
Women's clothes	7	.860
Shoe stores	9	.624
Furniture	13	.551
Eating places	34	.836
Taverns	39	.100
Drug	21	.739
Beauty shops	17	.356
Barber shops	33	.478

TABLE 3.4

SURPLUS PROFITS[a]

Store Type Code	Numbers[b]	(1) Actual Sales	(2) Expected Sales Derived from Employment Data	(3) Expected Sales Derived from Rent Data	(4) Surplus Profits (1)-(2)	(5) (3) - (1)
*	5251	$121,530	$ 57,541	$103,389	$ 63,989	$- 18,141
	5541	83,200	72,372	125,273	10,828	+ 42,073
		60,610	43,862	105,649	16,748	+ 45,039
		76,910	59,214	114,318	17,696	+ 37,408
		89,960	87,724	109,936	2,236	+ 19,976
		215,860	199,379	119,462	18,481	- 96,398
		78,930	43,862	93,550	35,068	+ 14,620
		361,510	313,613	143,755	47,897	-217,755
* *	5621	339,010	254,423	276,622	84,587	- 62,388
		60,070	45,013	46,380	15,057	- 13,690
* *	5665	85,020	80,224	63,121	4,796	- 21,899
		73,670	60,168	38,886	13,502	- 34,784
		64,240	40,112	48,608	24,128	- 15,632
*	5712	554,523	507,515	298,730	47,008	-255,793
		485,464	357,405	469,672	128,059	- 15,792
		215,890	142,962	319,860	172,928	+103,970
		209,650	142,962	379,337	66,688	+169,687
		364,760	285,924	201,575	78,836	-163,185

TABLE 3.4 (CONTINUED)

Store Type Code	Numbers[b]	(1) Actual Sales	(2) Expected Sales Derived from Employment Data	(3) Expected Sales Derived from Rent Data	(4) Surplus Profits (1)-(2)	(5) (3) - (1)
	5812	$ 23,890	$ 15,736	$ 21,720	$ 8,154	$- 2,170
		10,070	7,868	52,088	2,202	+ 42,018
		34,290	23,604	35,707	10,686	+ 1,419
		102,280	96,776	79,769	5,504	- 22,511
		36,220	25,964	21,864	10,256	- 14,536
		169,960	86,548	67,007	83,412	-102,953
		102,840	95,990	84,925	6,850	- 17,915
		56,985	55,076	54,392	1,909	- 2,593
	5813	37,300	34,332	45,996	2,978	+ 8,696
		43,280	34,332	27,301	8,948	- 15,979
		30,060	29,854	36,846	206	+ 6,786
		37,320	29,854	17,591	7,466	- 19,729
		47,160	44,781	40,687	2,379	- 6,473
		26,510	14,927	23,954	11,583	- 2,556
		50,930	29,854	14,936	21,076	- 35,994
		25,440	19,405	93,099	6,035	+ 47,659
		37,720	29,854	27,795	7,866	- 9,925
		67,720	59,708	44,743	8,012	- 22,977
		44.610	29,854	28,504	14,756	- 16,106
		36,210	25,376	68,005	10,834	+ 31,795

TABLE 3.4 (CONTINUED)

Store Type Code	Store Type Numbers[b]	(1) Actual Sales	(2) Expected Sales Derived from Employment Data	(3) Expected Sales Derived from Rent Data	(4) Surplus Profits (1)-(2)	(5) (3) - (1)
* *	5912	$178,750	$ 60,452	$255,433	$118,298	$+ 76,683
		221,480	120,904	85,615	100,576	-135,865
		119,430	90,678	126,020	28,752	+ 6,590
		91,450	71,031	71,905	20,419	- 19,545
		229,510	136,017	153,774	93,493	- 75,736
		64,440	60,452	56,606	3,988	- 7,834
		45,720	45,339	57,077	381	+ 11,357
*	723i	25,190	17,355	9,408	7,835	- 15,782
		21,460	17,355	11,652	4,105	- 9,808
		21,650	11,570	35,335	10,080	+ 13,685
	7241	12,890	8,452	8,105	4,438	- 4,785
		18,960	15,636	21,540	3,324	+ 2,580
		17,600	12,678	7,261	4,922	- 10,339
		14,400	9,720	6,806	4,680	- 7,594
		11,260	8,452	5,718	2,808	- 5,542
		5,202	4,226	8,538	976	+ 3,336
		5,700	4,226	1,532	1,474	- 4,168
		7,430	4,226	9,837	3,204	+ 2,407
		10,700	8,452	10,015	2,248	- 685

[a]Listed are just those stores exhibiting surplus profits based on employment data where rent data are comparable.

[b]Standard industrial classification code.

* Store type exhibiting sales-rent correlation coefficient above .600

* Store type exhibiting sales-employee correlation coefficient above .600.

would be expected), and therefore the hypothesis, within the limitations of the data and technique, must be rejected.[10]

This result would indicate that if these firms are considered as convenience goods establishments, they are not monopolistically competitive; other factors not included either in the theory or in the definition of monopolistic competition are operating in urban areas. One study offers an opposite viewpoint. Ross asked the question: "Does the establishment of market areas and the corollary of locational advantage result in economic rent?"[11] Using parking lots as a convenience good, he concluded that "Since the only other important cost besides the cost of unskilled labor is land cost, and since land is relatively unimproved, these differences in gross revenue, it is felt, result in an approximation of differences in economic rent." A firm not only sells goods, but it also sells convenience.[12] This may be the case for parking lots, which tend nearly wholly to reflect the characteristics of our use of the term monopolistic competition, but it intuitively appears that few other retail or service establishments depend to as large a degree on convenience for success. Furthermore, if the data and test are accurate, then one may presume that a measure of the

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[10]An observation falling in the shaded portions of both charts of Figure 3.1 has a plus value in Table 3.4.

[11]Myron H. Ross, "Product Differentiation in the Parking Market," Land Economics, Vol. XXXIV, No. 3 (August, 1958), p. 252.

[12]Ibid., p. 252.

"imperfectness" of competition can be made. The degree to which the rent of a particular store is lower than suspected in a monopolistically competitive market may indicate quantitatively the importance of such factors as the effect of advertising, the personality of the entrepreneur, or other factors usually attributed to an imperfectly competitive market. The testing of other hypotheses extracted from the theory may indicate that this is possible or it may prove, on the other hand, that the first hypothesis (surplus profits are balanced by rent) may in fact be true.

Rent and Revenue Curve Analysis

The verification of the second hypothesis, that rent decreases more slowly from the center of business activity than revenue, would also verify hypotheses three, four, and five. Charts and graphs are used to make the analytical testing method clear. It should be mentioned at this time that the test did not conclusively show the hypothesis to be true, and for that matter did not satisfy the assumptions of the theory presented. For this reason, an evaluation of the strength of the hypothesis is in order, as are statements regarding the validity of the associated hypotheses and the significance of the character of the test. Furthermore, because of the very questionable nature of the validity of the preceding tested hypothesis, one should not expect these hypotheses to be verified. This is based on the fact that the foregoing test tended to rule out the monopolistically competitive nature of retail establishments

upon which hypotheses two through five are based.

The data used to attempt verification of the second hypothesis came from the test city. In only a few shopping districts were adequate data available, and these were used. The central business district data were unavailable. This latter data gap is a hindrance to the study, simply because it is believed that in the downtown area of the test city, as well as most every city, the hypotheses could be verified with little difficulty. The fact that there is some doubt as to the soundness of the hypotheses beckons researchers to determine, if possible, whether this portion of the theory of retail location holds only for central business districts. If that is the case, then a modification of the theory is in order. Researchers will be forced to examine more carefully all aspects of the theory of retail location; it may only partially explain the location of commercial activity within cities.

The Identification of Business Centers

Before the test can be made, it is necessary that the centers of business activity within shopping areas be defined and identified. The center is that location where land values per unit area are higher than they are in any other location within the shopping district. The reasoning for this decision follows.

The business center has been thought of by many as the most accessible location within a shopping area, but this presumption would partly verify certain of the associated hypotheses as well as

the second hypothesis by the inference that accessibility determines the location of retail trade. One of the purposes of the following test is to find if this is the case. For that reason, some other method of center identification is necessary.

One such measure could be the determination of the highest sales or rent per unit area within the business district. However, this again would be presumptuous. If the sales or rent per building area are high at certain locations, are these locations automatically centers of retail trade activity? Although there is a strong possibility that these locations will in fact be centers, there is no guarantee that the economic forces operating at these locations are truly centripetal in nature. That is, while one would expect rent and sales per unit area at centers to be high, these rent and sales locations might also exist away from centers for a number of reasons. For example, a large grocery store of the supermarket variety may be unable to afford the rent a landowner would demand at the center, and for that reason might find a more favorable cost situation away from the center (consider the necessary parking area). However, because of the store's high sales and high improvement value, the rents may be quite high, although not higher than they would be at the center itself.

A more plausible measure for determining a center appears to be that of land values. Certainly, the land value is a reflection of the ability of a piece of land to return high rents to the landowners. If high accessibility is one of the factors which

encourages assessors to value a piece of land at some high price, then it becomes evident that in the economic marketplace accessibility is a factor in land value determination.

The following charts (Figures 3.3a, b, c) will give some idea of center location in a number of shopping districts,[13] In each case the land values as determined by official Pierce County appraisers are divided by the front foot measurement. This modification of the definition is in order because it was found that county appraisers use store frontage rather than store area as the main criterion for land value determination. On each of the charts the x axis roughly represents the distance along one side of a major street extending through the shopping district. One reading was determined for each block by dividing the total land values by the total front foot measurements of the stores. It was possible to have as many as 33 readings per block; large variations in the values made it difficult to see the trends, and therefore the use of block-by block data. Histograms could be used for graphical

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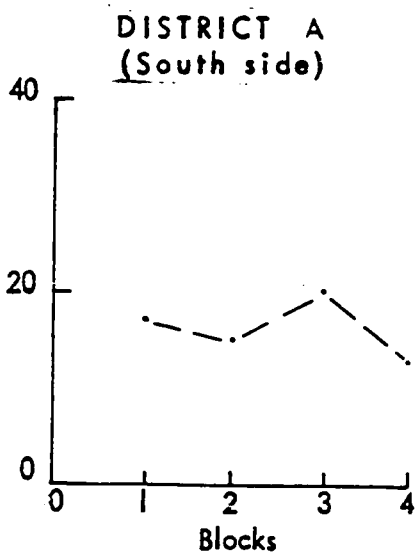
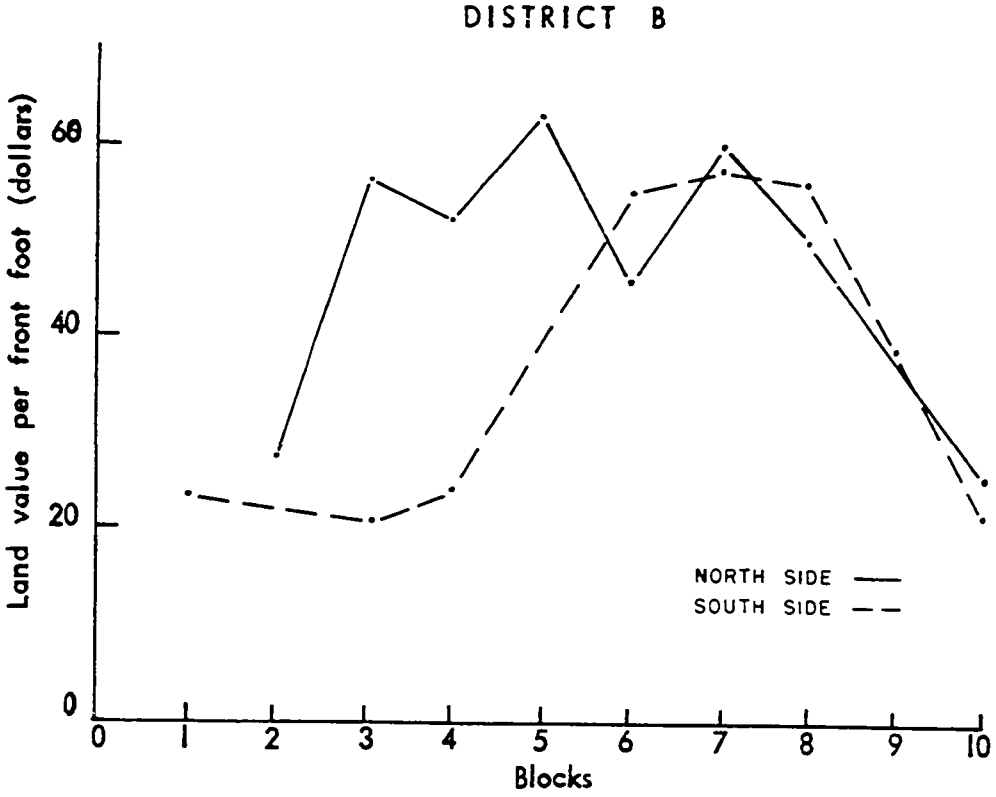
[13]The original data includes observations from fifteen non-central business districts which were defined by the Planning Agency of the test city. The basis for selecting the fifteen districts was that each contained at least one store of the general merchandise or apparel or furniture-appliance type, and at least two other comparable "shopping goods" stores. The limits of the districts were drawn to include all contiguous blocks on which retail-personal services uses appeared. Blocks containing automotive as well as other retail-service uses were included. Blocks in which there were only automotive or highway-oriented facilities, such as drive-in restaurants, were excluded. The central business district was not included. As it turned out, each of the fifteen districts grossed over one million dollars in 1958, the year for which the data were collected.

LOCATION OF BUSINESS DISTRICT CENTERS





Figures 3.3a, b

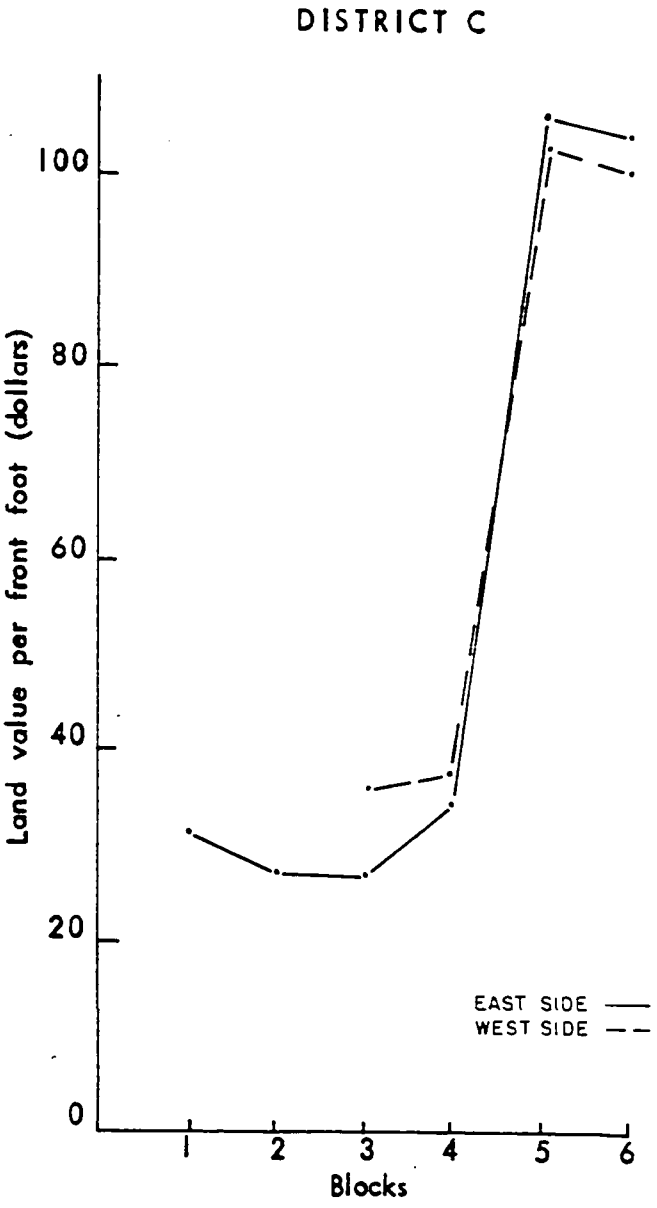

DISTRICT C
Land value per front foot (dollars)
100
80
60
40
20
0
1
2
3
4
5
6
Blocks
EAST SIDE
WEST SIDE

Figure 3.3c

depiction of these figures, but it was suggested that if a center was considered as an area rather than a point, then the inflection points on curved lines might act as the center boundaries.[14] Curved lines could be superimposed easily and clearly over the straight lines if the analysis were extended in this direction.

The charts show that in only a few cases does the curve fall off in a consistent trend from the high points on the graph. This result casts doubt on the assumption that centers in shopping areas exist. It may be that shopping areas of the non-central business district variety have no centers at all, and can be considered as points--that is, the entire shopping area is a center. Since the shopping areas used for center identification range in importance from two to five million dollars in 1958 gross sales, and contain at least fifteen different store types, one must conclude that they are second or third order centers (in the jargon of central place theory). The question arises as to how large a shopping area must be before the center is easily identifiable. Also, must the configuration of the shopping district be clustered rather than of the arterial type for a center to appear?[15] These

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[14]Suggestion made in conversation with Waldo R. Tobler, University of Washington.

[15]For a discussion of the spatial configuration of shopping districts see Brian J. L. Berry, "Shopping Centers and the Geography of Urban Areas,"(unpublished Ph.D. thesis, University of Washington, 1958); and Berry, "Ribbon Developments in the Urban Business Pattern," Annals, Association of American Geographers (June, 1959), pp. 145-55.

unanswered questions make it appear as though the hypothesis (rent falls off more slowly than revenue) cannot be tested, but a measure was constructed which makes it possible to determine if the economic forces mentioned in the theory are acting in these districts.

Testing the Hypothesis

For all stores, if sales increase exponentially as rent increases linearly, one may conclude that if sales are high, close to or at centers, then rent must fall off more slowly than sales as distance increases from the center (Figure 3.4).[16] The following empirical analysis attempts to show the sales-rent relationship just mentioned. A random sample of stores selected from the total number of stores for which data were available (50 of the 250) was graphed in the manner noted on Figure 3.5. The data were adjusted so that rent and sales could be considered in terms of the square footage of the stores. This common denominator is necessary in a spatial study of this nature because of the attempt to compare unlike things (e.g., drug stores, gasoline service stations). Sales per store area, for example, vary strikingly between store types but less within one store type category. According to the theory, stores using their building area very intensively (high sales per floor area) would tend to locate at or close to the centers of business

[16] This was not assumed for the testing of hypothesis one. In that test a linear relationship was assumed and may have resulted in lower correlations than occurred (Table 3.3). Nevertheless, this linear assumption, which was used for testing hypothesis one, does not detract from any conclusions reached as a result of that test.

EXPECTED SALES-RENT RELATIONSHIP

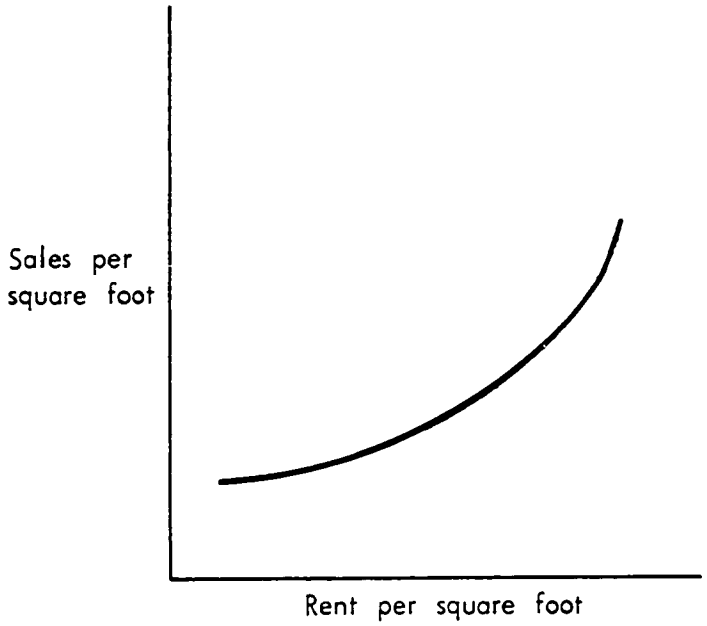
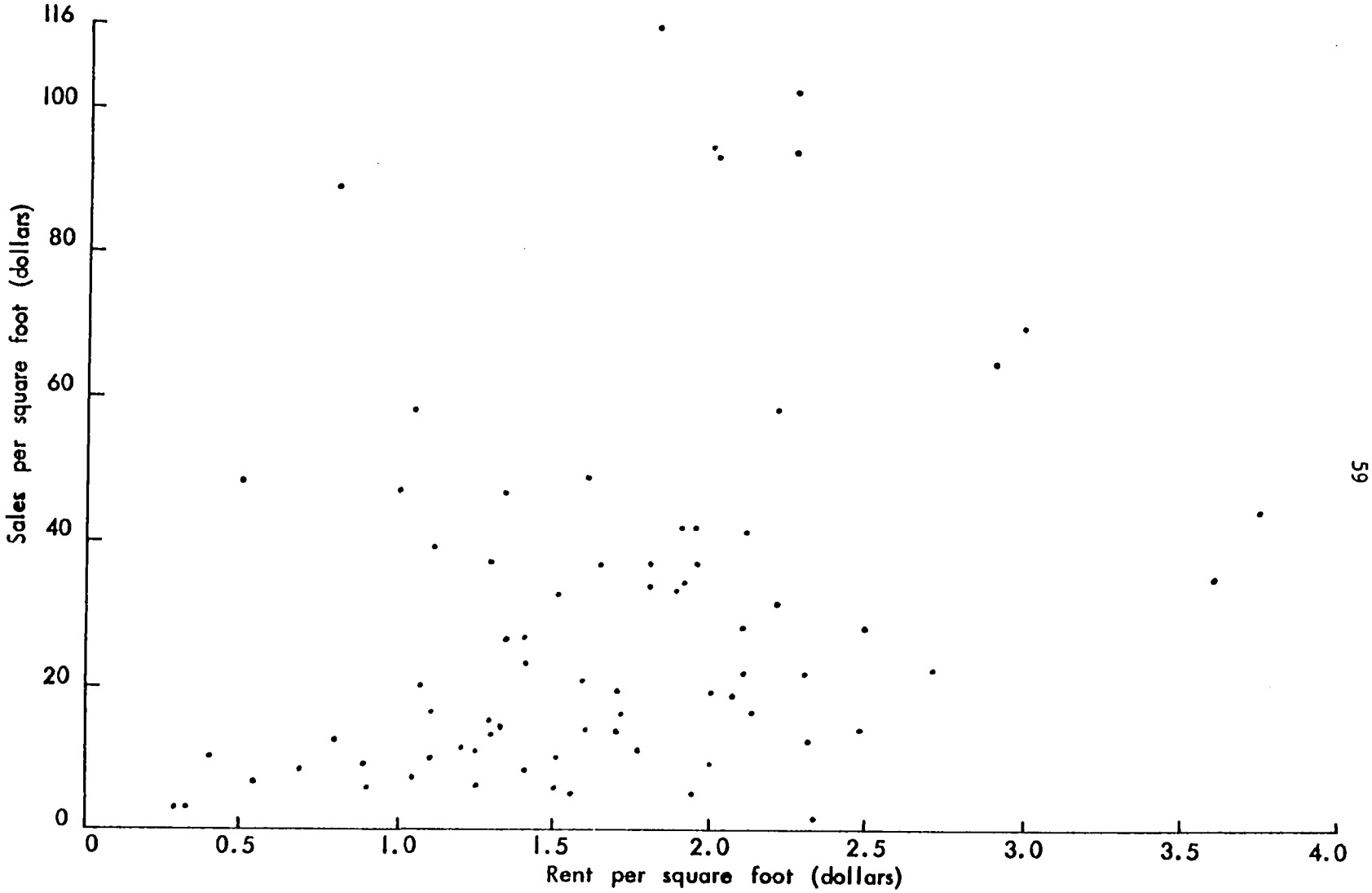


Figure 3.4

Figure 3.5 - RANDOM SAMPLE OF SALES AND RENT DATA FOR RETAIL STORES IN TEST CITY



districts. It is evident that no pattern can be easily identified on the graph. Further research revealed that a pattern does exist when all stores of a particular type are considered as one reading; that is, when averages are used (Figure 3.6). In general, one might expect that sales increase more rapidly than rent, but the variance within any particular type of store group is so high that anything less than a generalization is invalid. If the variances were not marked, and if the centers were easily identifiable, then it would be possible to test the hypothesis by graphically portraying the sales and rent data as shown hypothetically below (Figure 3.7). Rents at centers are high, but because sales increase more rapidly than rents toward centers when perfectly correlated, the slope of the rent curves from the centers would be less than the sales curves, thereby verifying the hypothesis. Since centers are not easily identifiable, and since only in a general way do sales increase more rapidly than rents, the following graphical analysis is used. These graphs do not verify the hypothesis, but show in a general way that there is a tendency for it to be true. This detracts greatly from the theory, but, again, points out a direction for further theoretical and empirical work.

The Graphical Analysis

It was found necessary to use a series of graphs in order to test the hypothesis. The same business districts that were used in the center identification analysis are used in the graphical

AVERAGES OF RENT AND SALES FOR RETAIL STORES BY TYPE IN TEST CITY

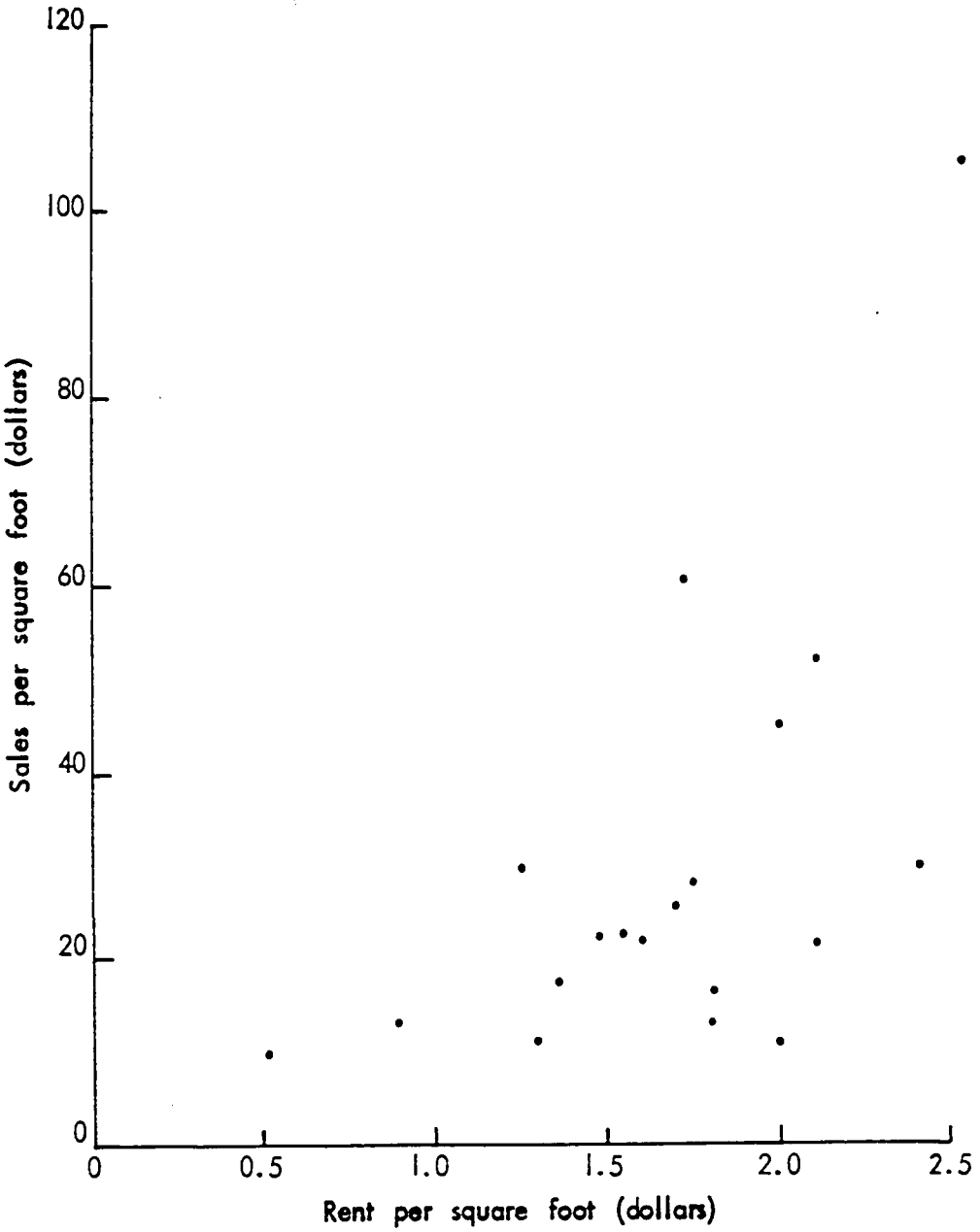
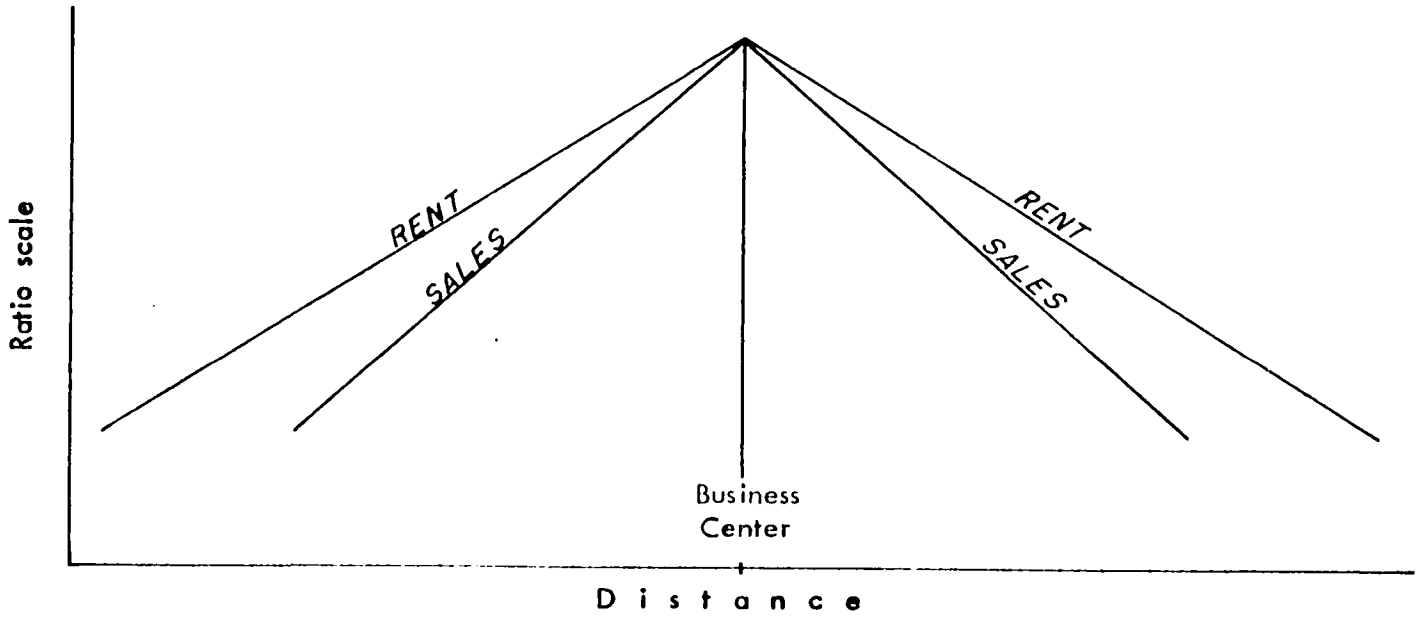


Figure 3.6

THE CENTRAL TENDENCY OF STORES



In this theoretical depiction of the central tendency of stores the curves are shown relatively, with the highest rent and sales at the business center.

Figure 3.7

analysis. Again, the major business streets were graphed, the x axis representing the store front foot distance for all retail stores on one side of the street.[17] On the y axis two scales are used: one for rent and one for sales. The graphs reveal trends that are difficult to identify, let alone measure (Figures 3.8a, b, c, d). For this reason, a three-store moving average adjusted for store size (building area) is used (Figures 3.9a, b, c, d). It makes the trends more readily apparent to the eye, but measurements of these slopes would still be meaningless.

The last attempt to discover a measurable pattern used the following method. Each of the readings for rent and sales taken from the three-store moving average charts was listed and index numbers constructed with the number 100 assigned to the highest value of each group, whether it be at the graphical center of the business district or not. Figures 3.10a, b, c, d portray these data in the manner of Figures 3.8 and 3.9. The hatched portion of the graph represents that area where rents are relatively higher than sales. The stippled portion represents that area where sales are relatively higher than rents. Since in most of the graphs, the hatched area is greater than the stippled portion, it can be concluded in a general way that rents decrease more slowly than sales from the central portions of business districts.

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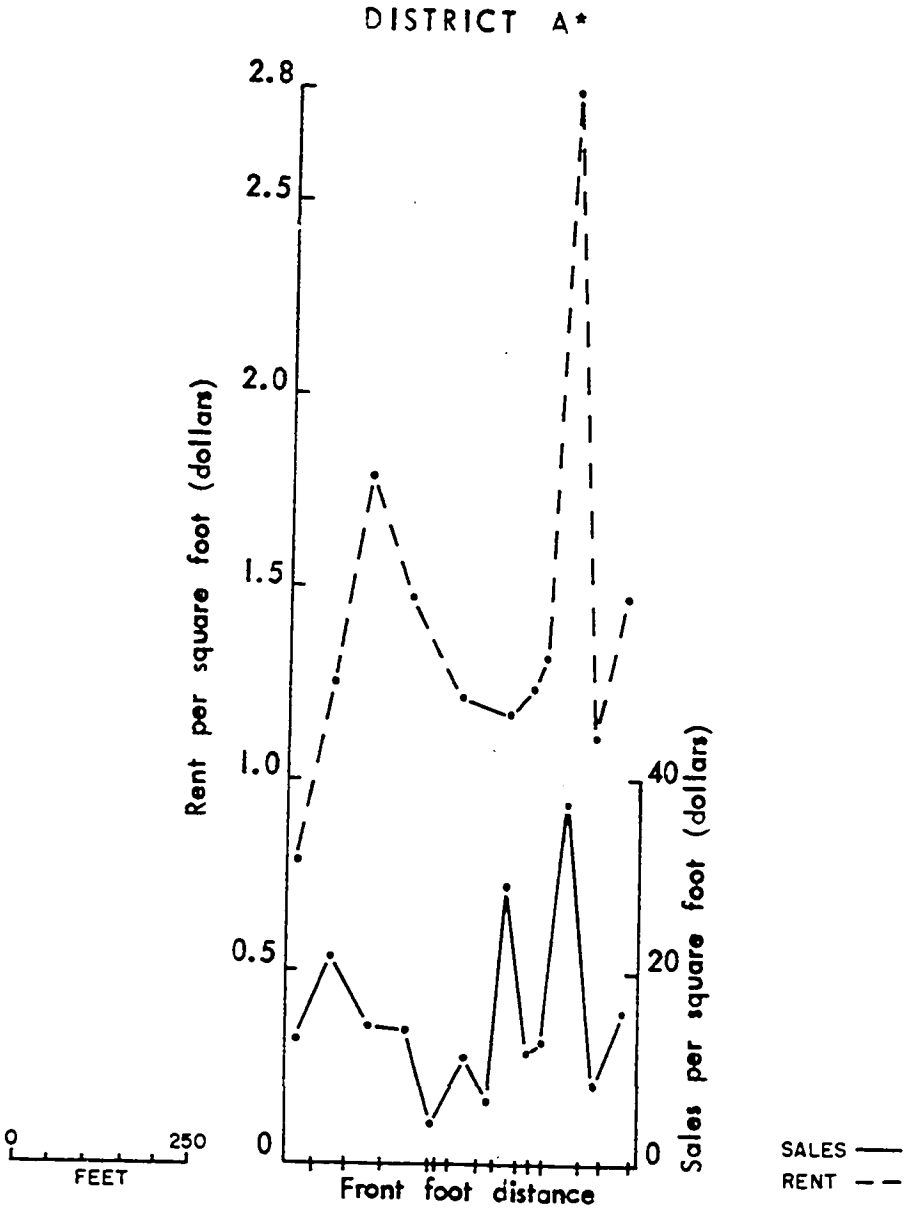
[17]Although gasoline service stations are included in the data, they are eliminated from the analysis because in the subsequent analysis, that of the adjustment for building area, these retail stores, if included, would distort the graphs in an unrealistic manner.

SALES AND RENT FOR RETAIL STORES BY BUSINESS DISTRICTS



*District A corresponds to the same district noted in Figure 3.3a. In the following figures, in a like manner, Districts B_1 and B_2 correspond to the north and south sides of the street of District B, and C corresponds to the west side of the street of District C.

Figure 3.8a

DISTRICT B_1

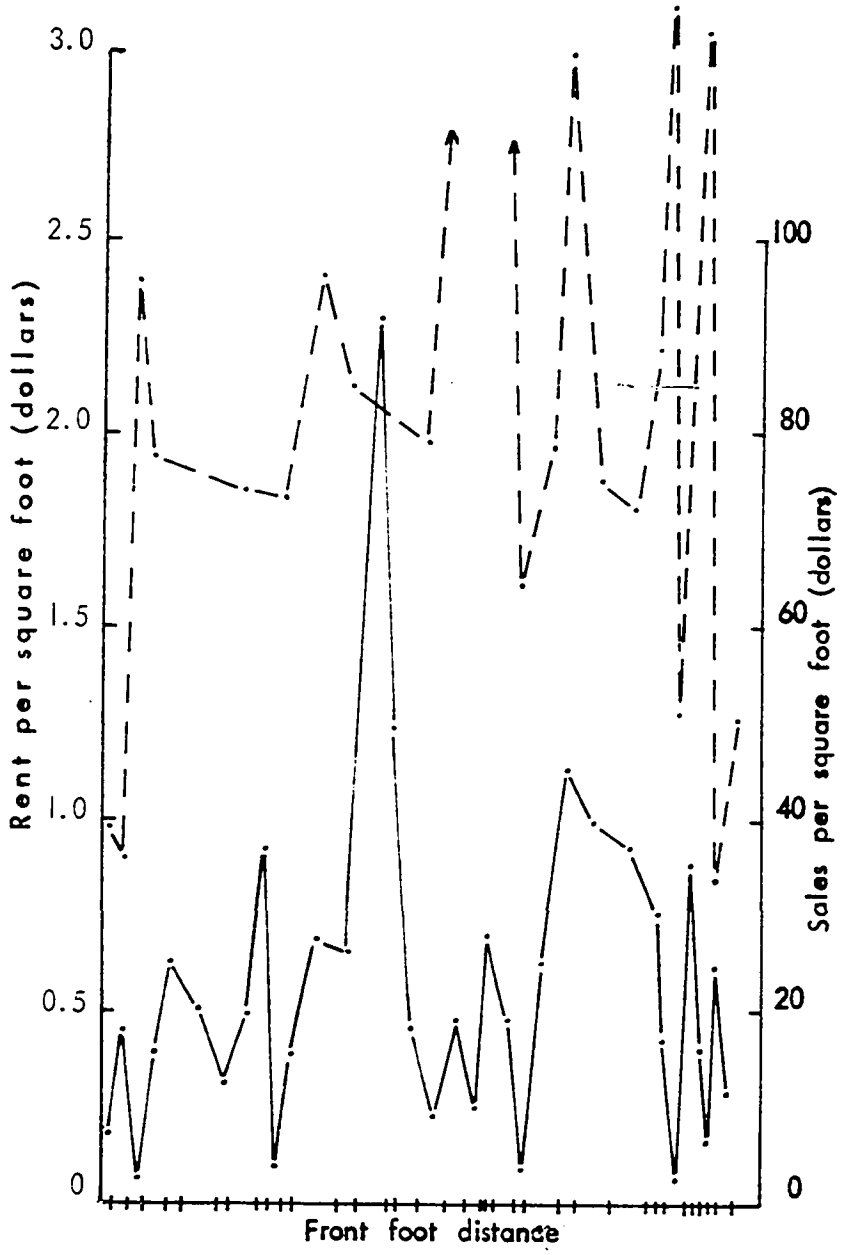


Figure 3.8b

DISTRICT B_2

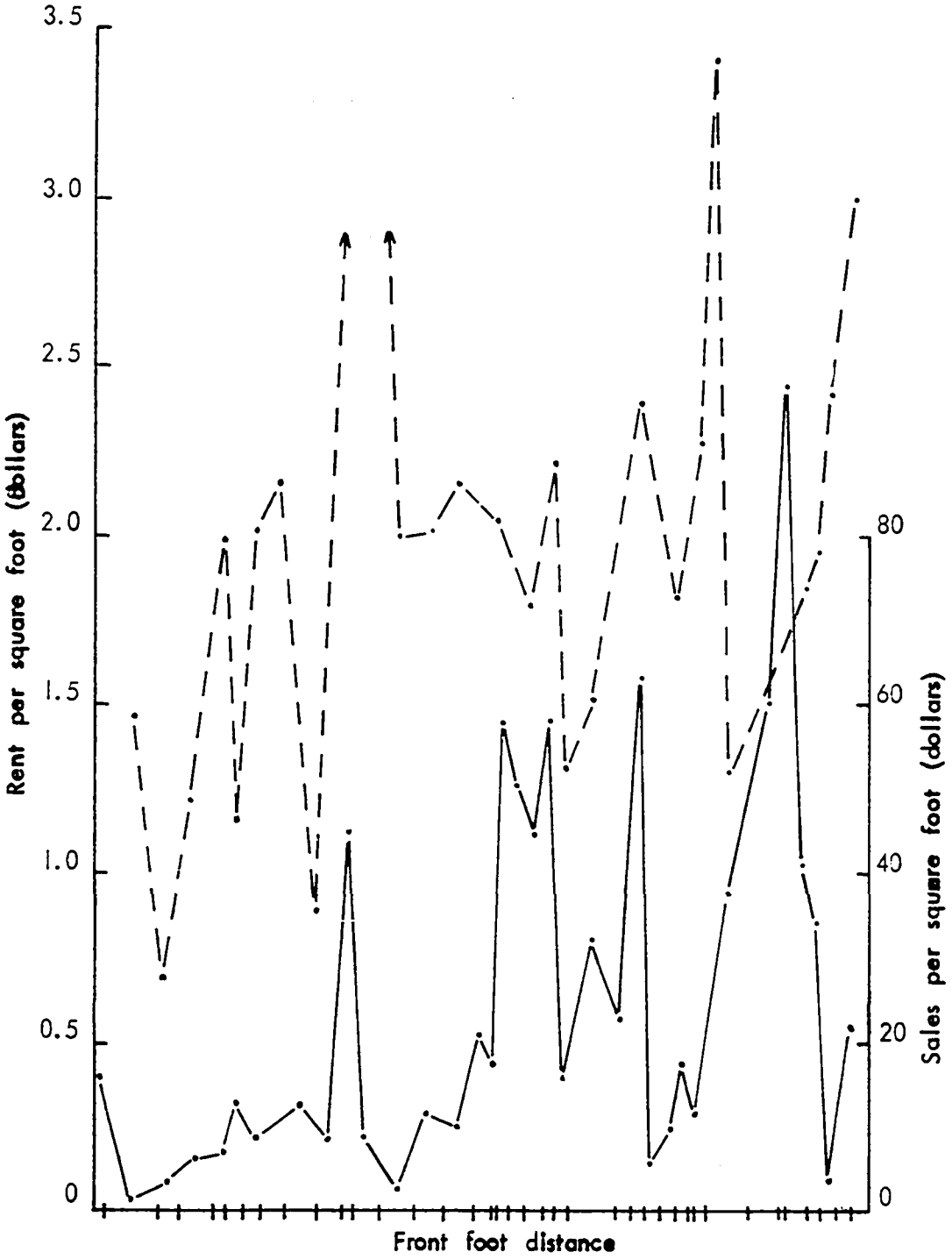


Figure 3.8c

DISTRICT C

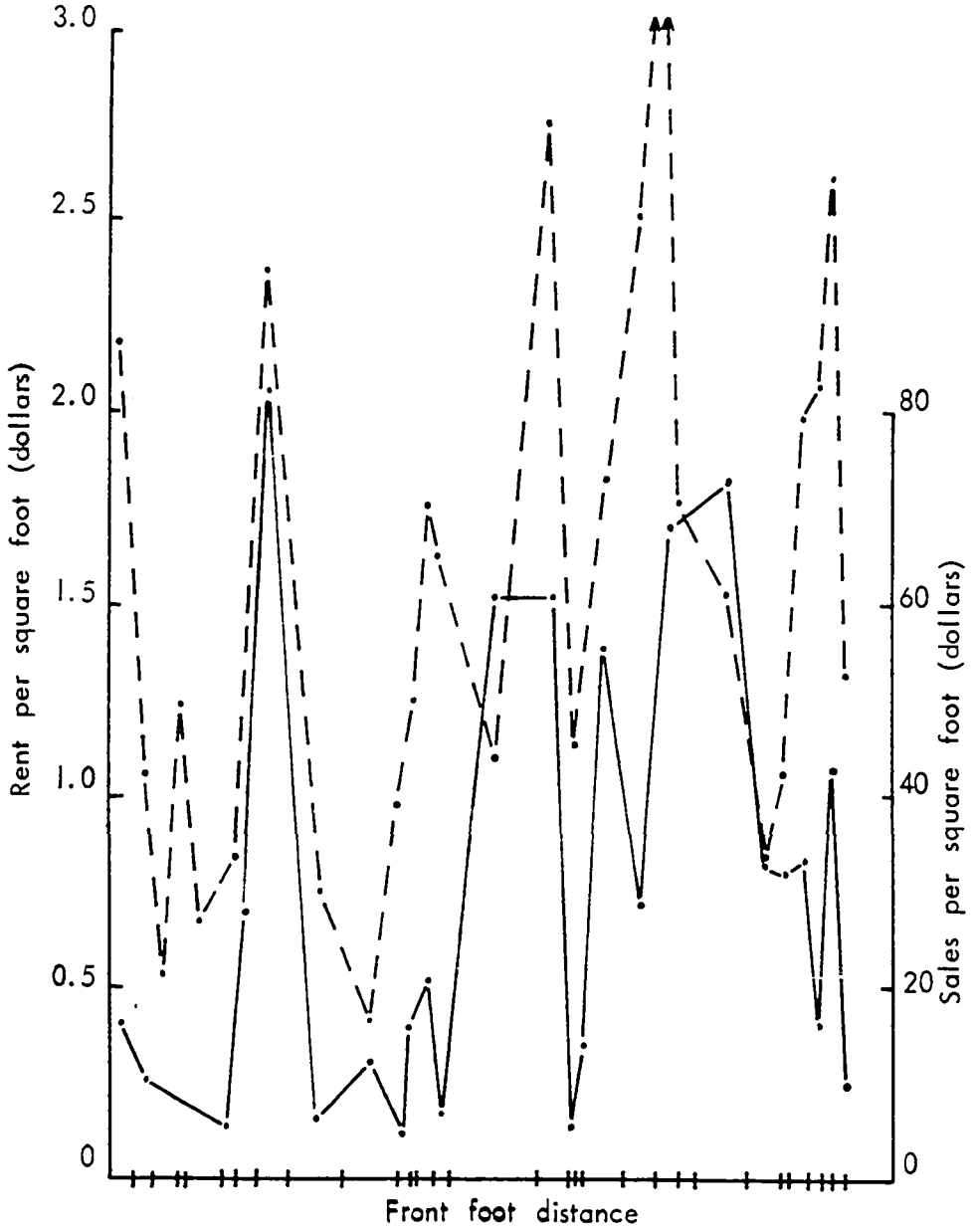


Figure 3.8d

THREE-STORE MOVING AVERAGE OF SALES AND RENT FOR RETAIL STORES BY BUSINESS DISTRICTS

DISTRICT A

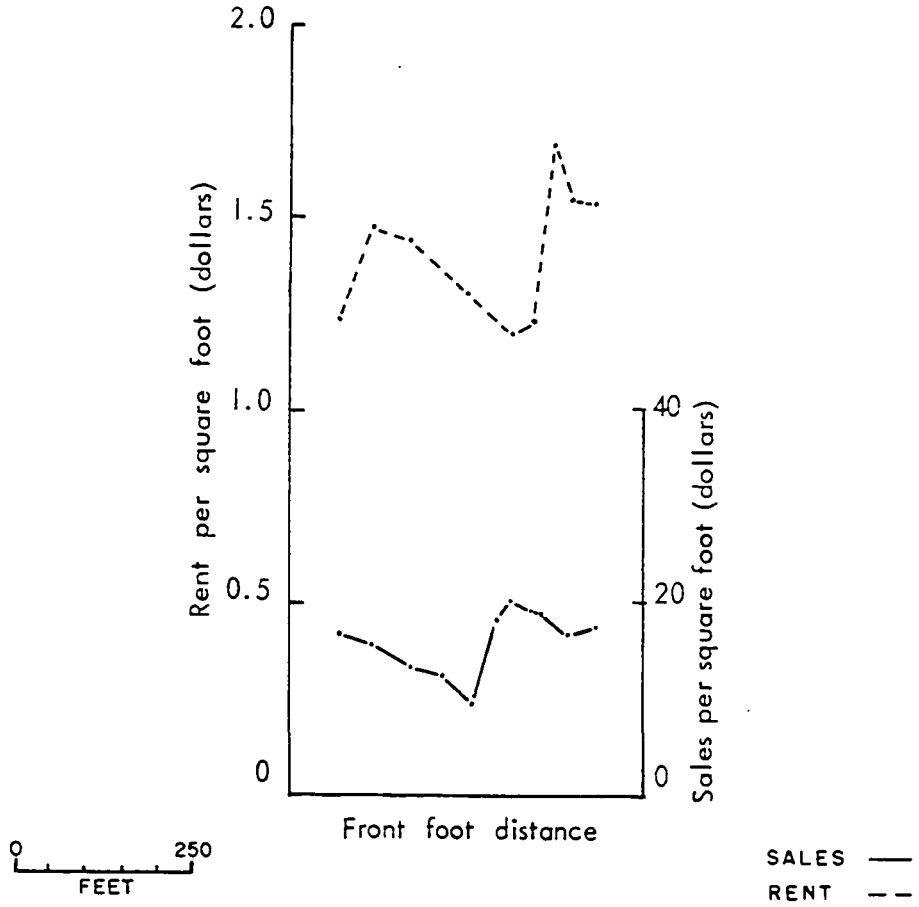


Figure 3.9a

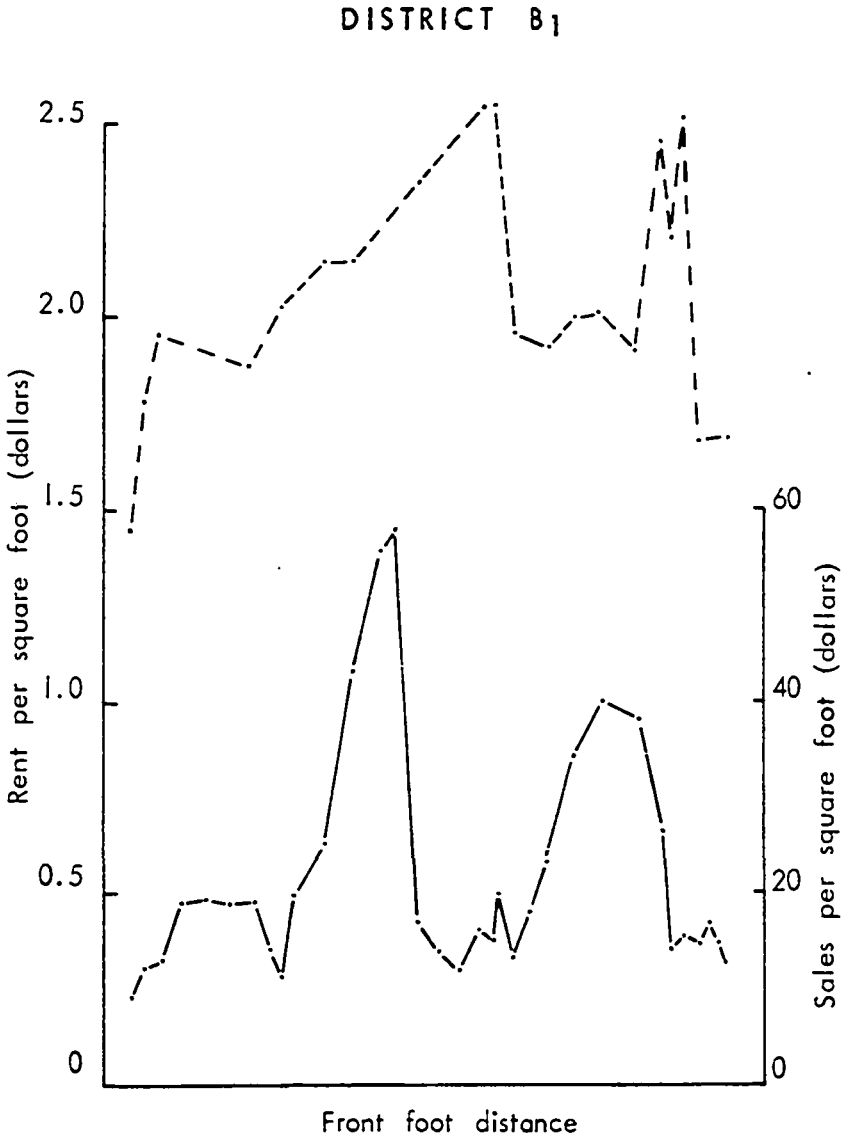

DISTRICT B1
2.5
2.0
1.5
1.0
0.5
0
Rent per square foot (dollars)
60
40
20
0
Sales per square foot (dollars)
Front foot distance

Figure 3.9b

DISTRICT B_2

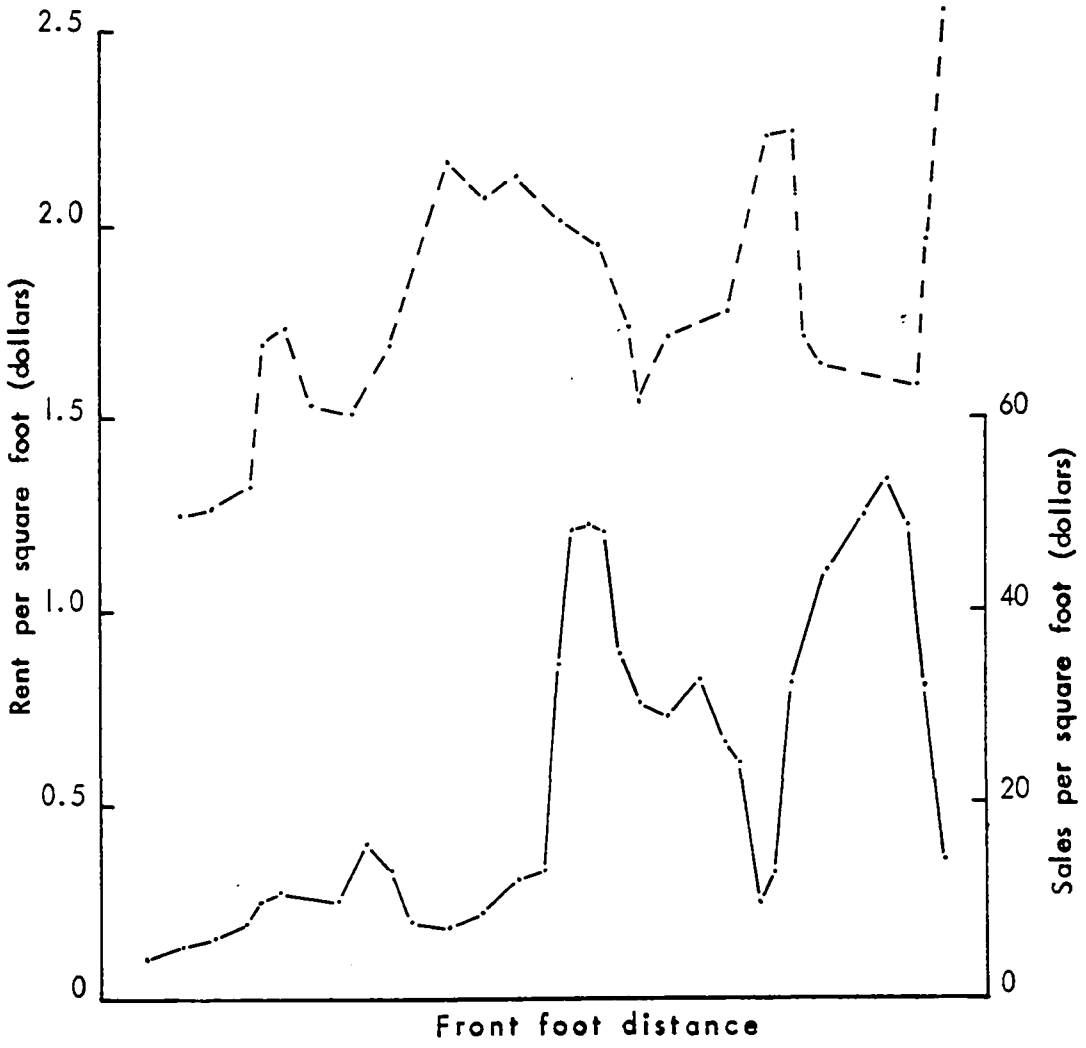


Figure 3.9c

DISTRICT C

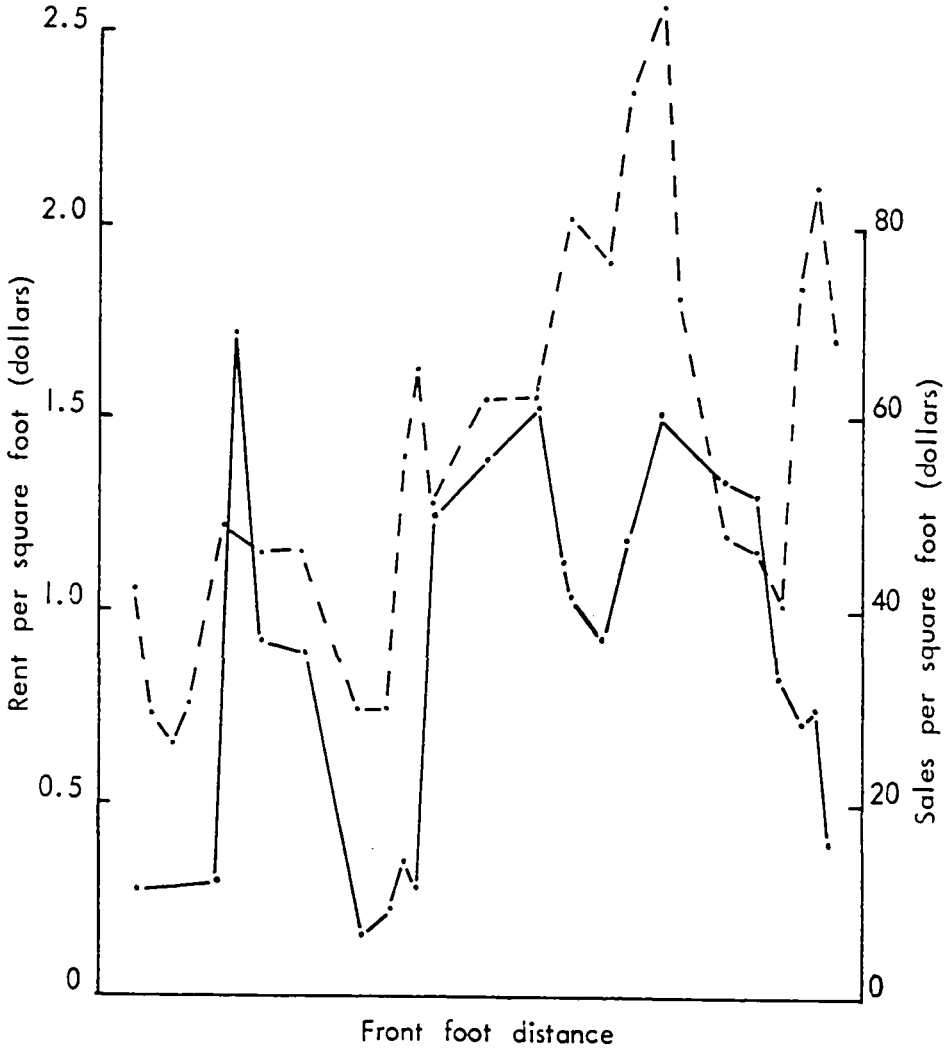
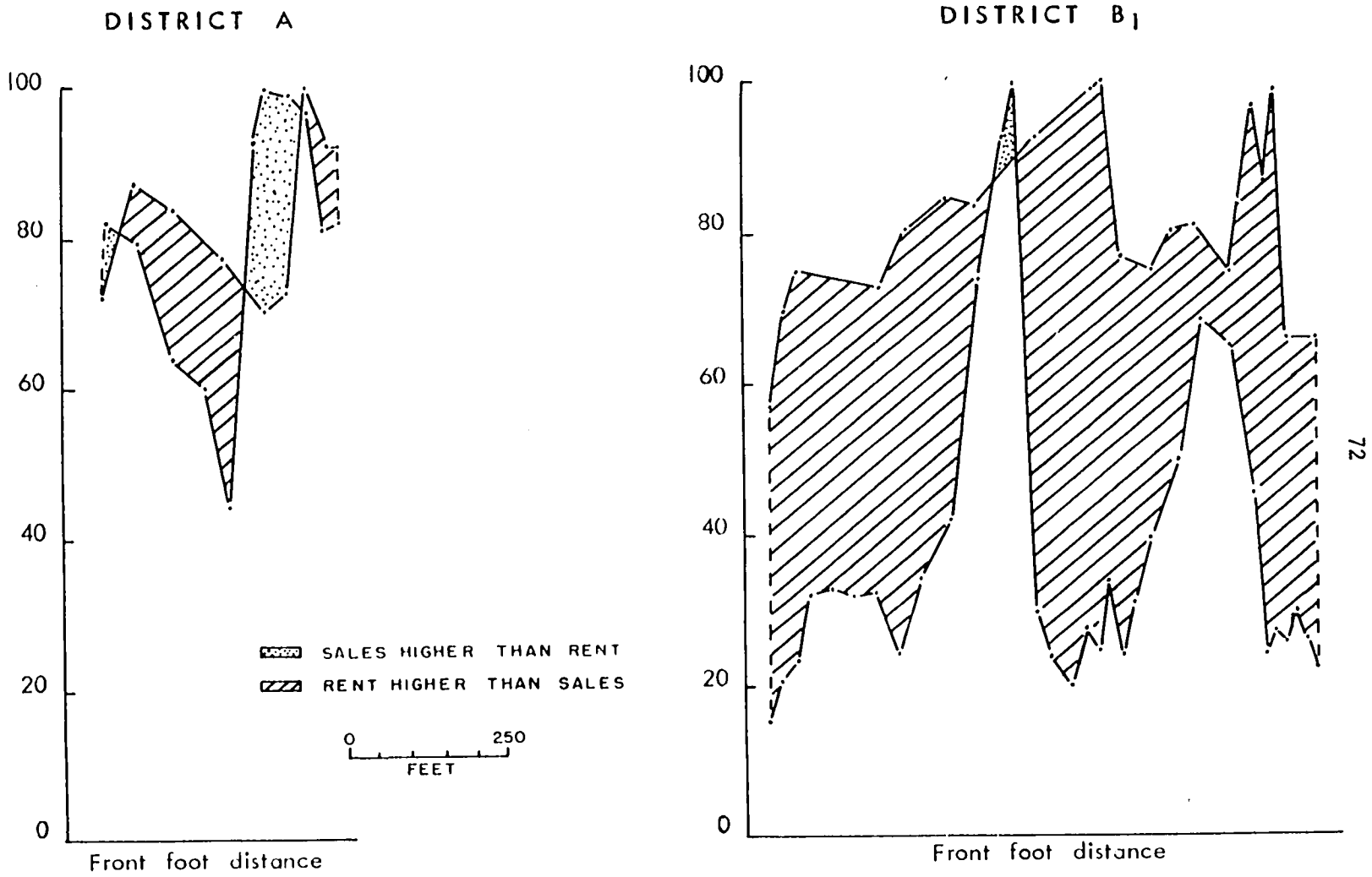


Figure 3.9d

Figures 3.10a,b-RELATIVE MAGNITUDE OF SALES AND RENT WITHIN BUSINESS DISTRICTS



DISTRICT B_2

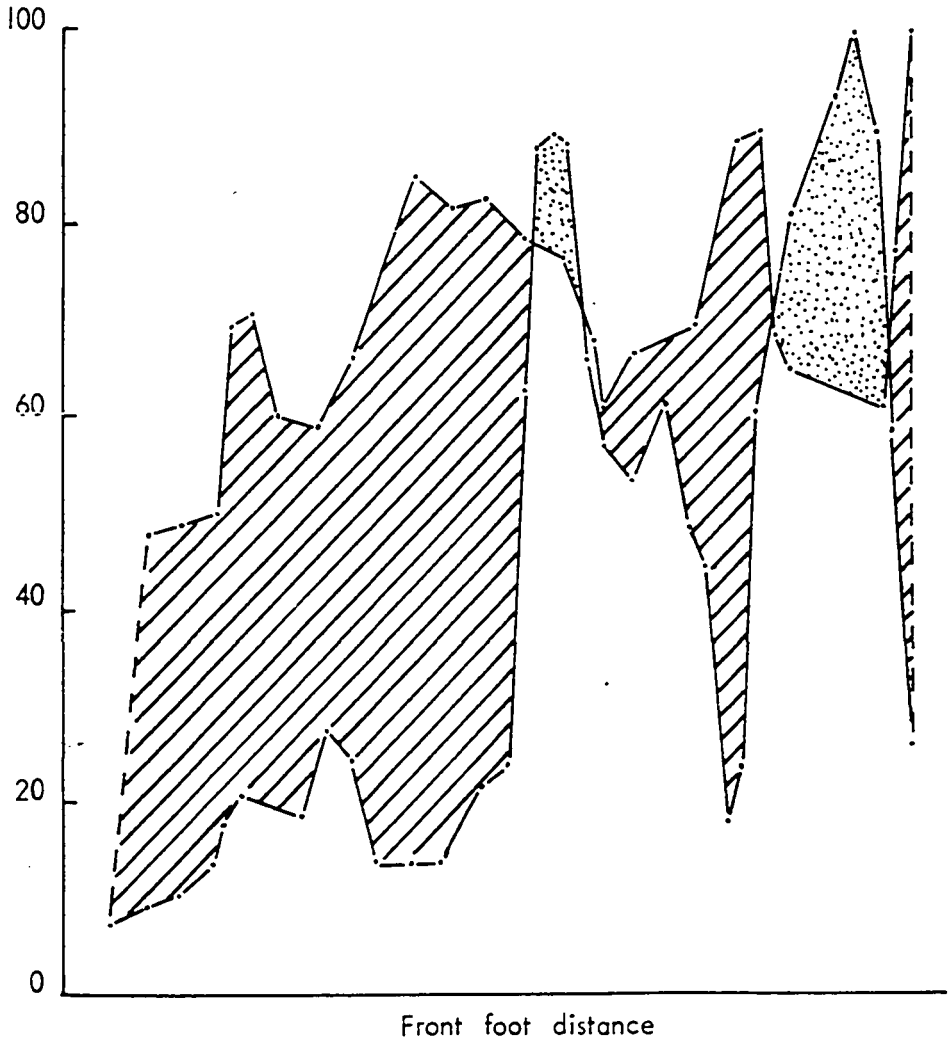


Figure 3.10c

DISTRICT C

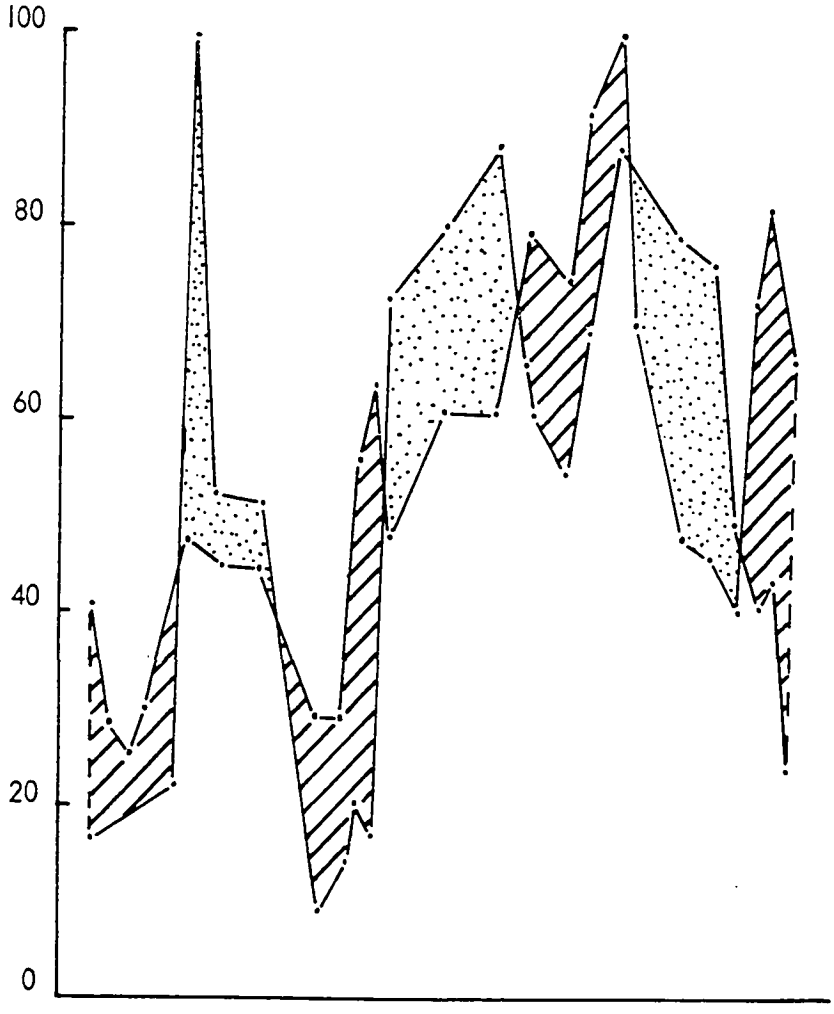


Figure 3.10d

Implications of Results on Related Hypotheses

The above results lead to further conclusions. First, if the central portion of a business district is considered as the center of disposable income in an area, then accessibility must be related to location of retail stores within business districts (hypothesis three).

Second, since in a general way rents fall off as distance increases from the center, then accessibility again must have some bearing on retail store location within business districts (hypothesis four).

However, since some of the stores included in the above tests showed no relation to distance from centers, then it may be accurately concluded that these stores do not reflect definitely the characteristics of convenience goods establishments. It then follows that these stores are not characterized by monopolistically competitive elements (hypothesis five).

The most important finding of this test, it is believed, is the fact that within shopping districts of the non-central business district type theoretically valid location forces are rather obscure. This is discussed more fully in the following section.

Summary and Conclusions

A number of statements extracted from the theory of the location of retail establishments were listed as hypotheses for empirical verification. Two of the hypotheses were tested in some detail, while three others, which might be considered corollaries

of the two, were tested simultaneously. Although the results were not necessarily negative, there was still considerable doubt as to the validity of that portion of the theory from which these hypotheses came. The tests were carried out using synthetic means in order to make the data conform to the demands of the analytical methods. It is felt that although these data manipulation procedures detract from the tests, there is suitable evidence presented to make researchers wary of the validity of the portions of the theory tested.

It was found that with the data used, surplus profits are not balanced by rent, thus revealing that if firms locating within shopping districts are considered as convenience goods establishments, then these are not monopolistically competitive, as the theory states. Further tests revealed that these stores do not reflect the characteristics of convenience goods firms, and therefore the above conclusion is checked and verified. The final chapter will discuss more fully economic differences between convenience and occasional goods establishments.

One test, the number of employees in retail firms does correlate well with revenue, revealed positive results, but did not have a direct bearing on the theory. The strongest correlations were on the national level, where grouped data were used. Nevertheless, with the use of store-by-store data on the local level, medium and high correlations were evidenced for most of the store types. It was hoped that the surpluses of sales, using

employment as a determinant, could be considered as surplus profits. There is no reason to believe that this is a false presumption, but the negative conclusion as to the hypothesis concerning surplus profits being balanced by rent leads researchers to attempt to refine the concept of surplus profits so that a more plausible testing procedure can be used.

If rents decrease more slowly from the centers of retail trade than sales, strength would be added to the theory of tertiary activity, and a goodly portion of the theory of retail store location would hold. However, the hypothesis was verified in only a very general way, and one must also consider that serious shortcomings in the theory of retail store location might become evident with an extension of the tests to central business districts. Many questions arise as to why this was the result. What other factors must be included in the theory? What form should these new variables take? What are their importance? What factors are operating in the non-central business district shopping areas which possibly give them a different economic flavor than in the central business district? How important is accessibility to the locations of these areas and the stores within the districts? How can the theory of imperfect competition be designed to satisfy the character of these establishments? The way in which the concept of monopolistic competition is used by land economists and geographers appears to be inadequate for empirical studies. It is apparent that a tremendous amount of research must be done before the theory can be modified

so that our understanding of the locations of stores within shopping districts will be increased appreciably. In Chapter V an attempt is made, using the results of the tests of this chapter and the results of the theoretical store location procedures of Chapter IV, to answer some of the questions posed above.

CHAPTER IV

TOWARD THE DETERMINATION OF RETAIL STORE LOCATION

In this chapter, theoretically based frameworks for analysis are developed which will, it is hoped, aid in more fully understanding the location of retail stores. Three methods for predicting retail store location are presented: (1) map transformations of disposable income data, (2) threshold determinants of business location, and (3) a measure of potential accessibility as an indicator of profitable urban sites for retail stores.

The first two of these methods are based on the theory of retail store location. They are presented for the purpose of furthering the analysis of the theory of retail store location where normal testing procedures are inadequate and new techniques of analysis may prove helpful. With the use of map transformations of disposable income data it is possible to evaluate the existence of market areas and indirectly to show the importance of the accessibility of retail sites to purchasing power for retail goods. Threshold determinants of business location test the existence of limitations on the ability of various types of retail establishments to locate in particular areas. The measure of potential accessibility must be set apart from the first two techniques, mainly

because of its independence from the theory of retail location. This technique is included here because, in common with the first two methods, it has the goal of theoretically predicting retail store location. However, this third method is an initial attempt to expand the theory of retail location by the development of a model based on the concept of intervening opportunity.

The three methods are discussed and some preliminary empirical tests presented. Emphasis is given to that part of the theory which shows the importance of the location of personal consumption expenditures available for retail goods and services. It should be emphasized at the outset that this work is presented in an introductory manner for further refinement in later urban studies.

The previous chapter contained tests of certain statements extracted from the theory of retail store location which bore, mainly, on the location of stores within shopping districts. This chapter is concerned primarily with statements bearing on the location of stores in the total urban economic landscape. To introduce the techniques cited above, mention will be made of certain theoretical aspects of personal consumption expenditures.

The Location of Personal Consumption Expenditures and Sales

Stores are spread unevenly in urban areas. Geographers in their quest for an explanation and understanding of store patterns have introduced implicitly in their analyses the effect of uneven

population densities. Certainly a more comprehensive indicator would be the distribution of the money that the population allocates for retail goods, rather than the distribution of the population itself. The problem, therefore, is what effect the distribution of consumer disposable income for retail goods has on the location of retail stores. In the following paragraphs an attempt is made to expand the notions presented in the theory of retail store location concerning the nature of the relations between income distribution and store location.

For decades economists have been plagued with the problem of determining the mechanism responsible for consumption expenditures. If it were possible to predict how each consumer will act in the market-place, the problem would be solved. Theories have been put forth and operational methods of analysis have been developed, but the problem of the psychology of individual consumer behavior has not been solved. Most analyses assume that man is a rational being, and that quantification is possible since maximization of satisfaction or utility lends itself to standard methods of economic analysis. Economists have isolated certain important variables, such as price and income, which influence consumer demand. As geographers interested in spatial relations, we are interested in how price and income act over space. The same problem of the psychology of consumer behavior, however, inhibits the geographer in understanding consumer movements and, also, store location. Nevertheless, if geographers also assume that man is an

economically rational being, it is possible to understand partially consumer movements and store locations.

Consumption expenditures are spread unevenly over space. In a figurative way we can think of consumption expenditures as moving to stores for the purchase of retail goods. If there are known limitations on the distances people will travel for goods, then it is possible to delimit areas where stores might locate. Table 4.1 presents general data as to how far people go or, more correctly, have gone for the purchase of some retail goods. Although distance alone does not determine where consumers purchase goods,[1] nevertheless most retail stores cannot successfully locate in an area if the consumption expenditures available in that area are not sufficient for the store to operate at or above the threshold level of the firm. Therefore, it may be concluded that distance from consumption expenditures can be a determinant of store location only if the total consumption expenditures available in a market area for a given type of retail store are the same or greater than the threshold requirement of that type of store.

The above discussion provides the necessary framework for the development of theoretical measures of market areas. Aggregates of consumer trip distances and consumption expenditures make it possible to delimit trade areas. At the same time, threshold levels of firms are distinctly related to consumption expenditures available

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[1] That is, distance is not the only factor--it is still an important factor.

TABLE 4.1

AVERAGE DISTANCE OF CONSUMER TRAVEL: SINGLE-PURPOSE TRIPS, MULTIPLE-PURPOSE TRIPS, AND TOTAL TRIPS IN CEDAR RAPIDS, IOWA, 1949

Destination or Purpose	Number of Single-Purpose Trips	Average Distance (Miles)	Number of Multiple-Purpose Trips[a]	Average Distance (Miles)	Total Trips	Average Distance (Miles)
Grocery	157	0.5	107	4.1	264	1.9
Bakery	5	0.9	29	3.6	34	3.3
Drug store	57	1.1	103	4.1	160	3.0
Hardware	7	1.4	18	3.8	25	3.1
Restaurant	16	1.6	132	3.2	148	4.2
Appliance store	2	1.7	10	5.6	12	4.9
Supermarket	44	1.8	100	3.4	144	2.9
Gas station	11	2.3	49	4.8	60	4.3
Tavern	4	2.4	12	5.2	16	4.8
Furniture	3	2.4	15	3.7	18	3.5
Clothing	2	2.5	46	4.7	52	4.6
Department store	11	3.0	151	4.1	162	3.6

[a]Multiple-purpose trips include multiple-purpose shopping trips, trips in which shopping is combined with work, and trips in which shopping purposes are combined with social-recreation purposes.

Source: John D. Nystuen in William L. Garrison et al., Studies of Highway Development and Geographic Change (Seattle: University of Washington Press, 1959).

for the particular goods they offer, thereby connecting firms with definite market areas.

Map Transformation of Disposable Income Data

The method of map transformation of disposable income data has as its purpose the allocation of income available for retail goods to places in urban areas where stores might profitably locate. It is based on the premises that: (1) market areas exist for retail stores, as indicated in the preceding theoretical statement; (2) there is a minimum or no overlap of market areas; (3) consumption expenditure location bears directly on the location of retail stores; (4) travel time or cost is the same for any unit distance from place to place; (5) rent or any other economic factor except consumption expenditures for goods supplied in retail stores has no bearing on the general location of the firm. A short description of the technique follows.

The Technique

On a population dot map of South Tacoma a number of square-shaped, equal-area grid cells were drawn. The consumption expenditures available for groceries (including produce and meat) were computed for each cell. The cells were then distorted following a specified set of rules so that the new cells would be rectangular and in areal proportion to the computed consumption expenditures available for groceries in each of the original cells.

It was decided to allocate twelve supermarkets to the area

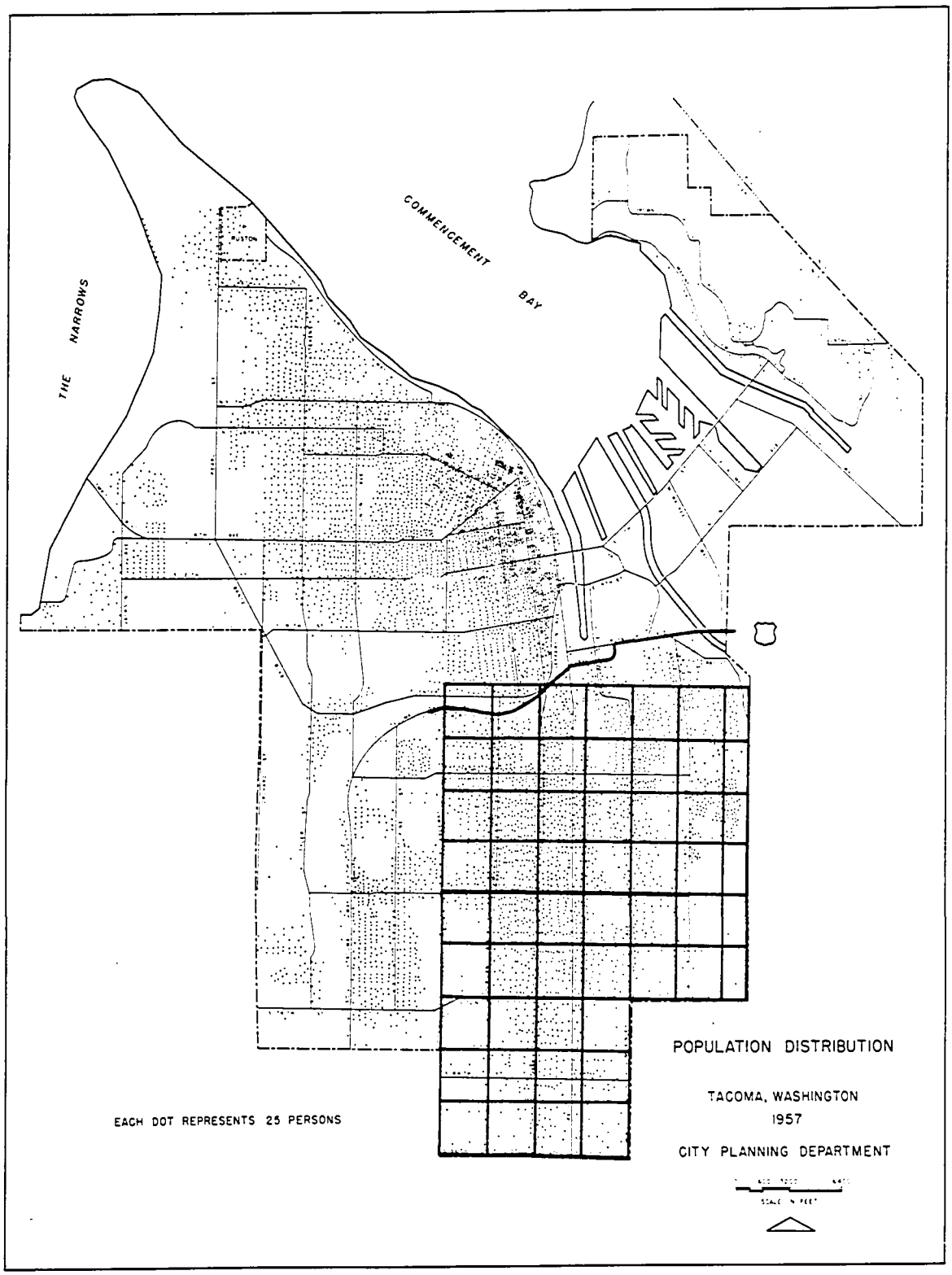
of South Tacoma. These stores were positioned by means of: (1) superimposing an hexagonal market area pattern consisting of twelve hexagons on the distorted cell diagram, (2) plotting the centers of the twelve hexagons on the distorted map, and (3) mapping the twelve centers of the distorted grid system to their proper positions on the original grid system.

Finally, the twelve largest actual supermarkets, and the twelve largest districts of grocery store sales (summation of grocery store sales where more than one store is located within a one block area) were plotted on separate but identical maps using the original grid and containing the theoretical store locations. The theoretical pattern was then compared to the real pattern. A discussion of the technique follows.

Delimitation of the Study Area

The area of South Tacoma that was delimited (Figure 4.1) has rather definite barriers to movement, especially for such short distance trips as those for groceries, on its edges. The north is bounded by a combination of a major United States highway, railroad right-of-ways, and industrial land. These three cover an area averaging a quarter of a mile in width. The eastern and southern boundaries are less well demarcated, but it is noted that the area becomes less and less densely populated in these two directions, with the population falling off considerably within the study area. The western boundary is well defined by a north-south freeway which

Figure 4.1 — STUDY AREA IN TEST CITY



has been hindering movement in an east-west direction for the last six years (an existing topographic depression impeded movement before that time).

The city of Tacoma uses the township-range system for land location identification, thereby making it easy to divide the study area into grid cells of one-quarter mile dimension on each side, totalling 48 cells. Information regarding the parts of cells in the north and east was included in the cells directly bordering them on the south and west respectively.

Determination of Income Available for Groceries

The population of each cell was determined by the use of a 1957 population dot map of the city (Figure 4.1). Income data for census tracts were taken from the 1950 census and adjusted to 1957 wage levels. For each census tract the consumption expenditures for groceries were computed by first dividing the population into income groups and then determining the amount of income allocated for groceries by each income group in each census tract. This income was then distributed to the grid cells, with housing data used to estimate the areas within a census tract where the various income groups resided (Figure 4.2). As a check on the validity of these calculations, the total sales of all grocery stores in the area were compared with the estimated consumption expenditures for groceries in the area. The results of this crude check were highly favorable.[2]

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[2]The estimated consumption expenditures for groceries in

LOCATION OF CONSUMPTION EXPENDITURES AVAILABLE FOR GROCERIES IN STUDY AREA

235	321	611	449	462	496
543	663	764	472	612	400
457	827	940	535	264	1023
345	827	823	420	288	162
194	515	680	265	298	46
24	397	508	336	153	99
35	312	300	31		
43	251	263	169		
87	147	175	88		

Figure 4.2

A more detailed explanation of the technique just outlined may be found in the Appendix.

The Map Distortion

The following rules were used in distorting the grid cells so that a unit of area anywhere on the distorted map would be equal to the consumption expenditures for groceries (Figure 4.3).

1. All cells must be rectangular.

2. All cells which are contiguous on the original map must also be contiguous on the distorted map.

3. The size and shape of the distorted map must be the same size and shape as the original map.

There are an infinite number of ways in which the map might have been distorted, but the method presented appears to be plausible. In effect what was done was to stretch or shrink the original cells within the rigid boundaries of the area to sizes approximating the consumption expenditures available for groceries in each of the cells.[3]

Determining Theoretical Market Areas

It is obvious that intra-urban market areas are not hexagonal in shape, but Isard suggests that market areas may be

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the study area are $18,356,151 for 1958. The actual sales in the area were $17,105,713. The difference is 5.2%.

[3]The general form of this technique is demonstrated and analyzed by Waldo R. Tobler in "Map Transformations of Geographic Space" (unpublished Ph.D. thesis, University of Washington, 1961), pp. 151-163.

MAP DISTORTION OF CONSUMPTION EXPENDITURES FOR GROCERIES IN STUDY AREA

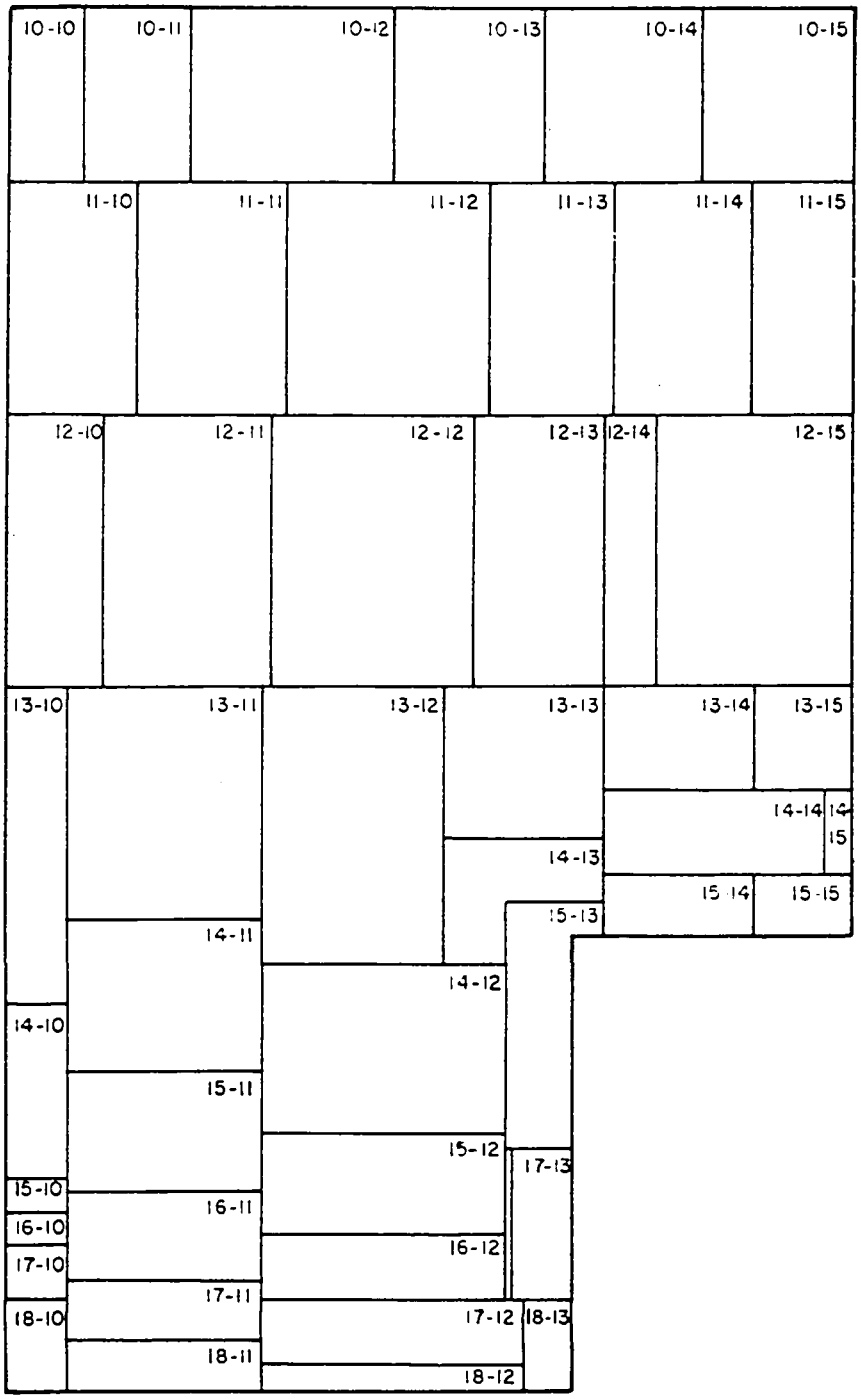

Figure 4.3

distorted six-sided polygons.[4] It is this suggestion, as well as the existence of well-defined market areas for grocery stores, that is being tested here. Starting at the geographical center of the study area (which is also the center of consumption expenditures available for groceries), hexagons were constructed so that as close to twelve hexagon centers could be included on the map as possible (Figure 4.4).[5] The number twelve was not binding, since any number of hexagons could have been drawn, but was based on the fact that if only supermarkets supplied the consumers of this area with groceries, then probably twelve or less would be needed (the average sales of a supermarket are a little over $1,500,000, and computed consumption expenditures for groceries in the area are approximately $18,000,000). The centers of the hexagons were positioned on the original map in the manner mentioned earlier. Distorted hexagons (six-sided polygons) were not drawn to represent the theoretical market areas. This was not necessary, for if twelve supermarkets are shown to exist in the study area at the

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[4]Walter Isard, Location and Space-Economy (New York: John Wiley and Sons, Inc., 1956), pp. 271-273.

[5]Figures 4.4 to 4.8 contain thirteen theoretical supermarket locations. This is the smallest number of centers that can be included within the study area given the size of the hexagon and the requirement that the first hexagon be constructed from the geographical center of the study area. The author rotated the hexagons with the geographic center as the vertex. After each roration of fifteen degrees of arc the number of hexagon centers falling within the study area was counted. Figure 4.4 shows the position of the hexagons when the smallest number (thirteen) of centers appears within the borders of the study area.

PRELIMINARY THEORETICAL MARKET AREAS
FOR SUPERMARKETS IN STUDY AREA

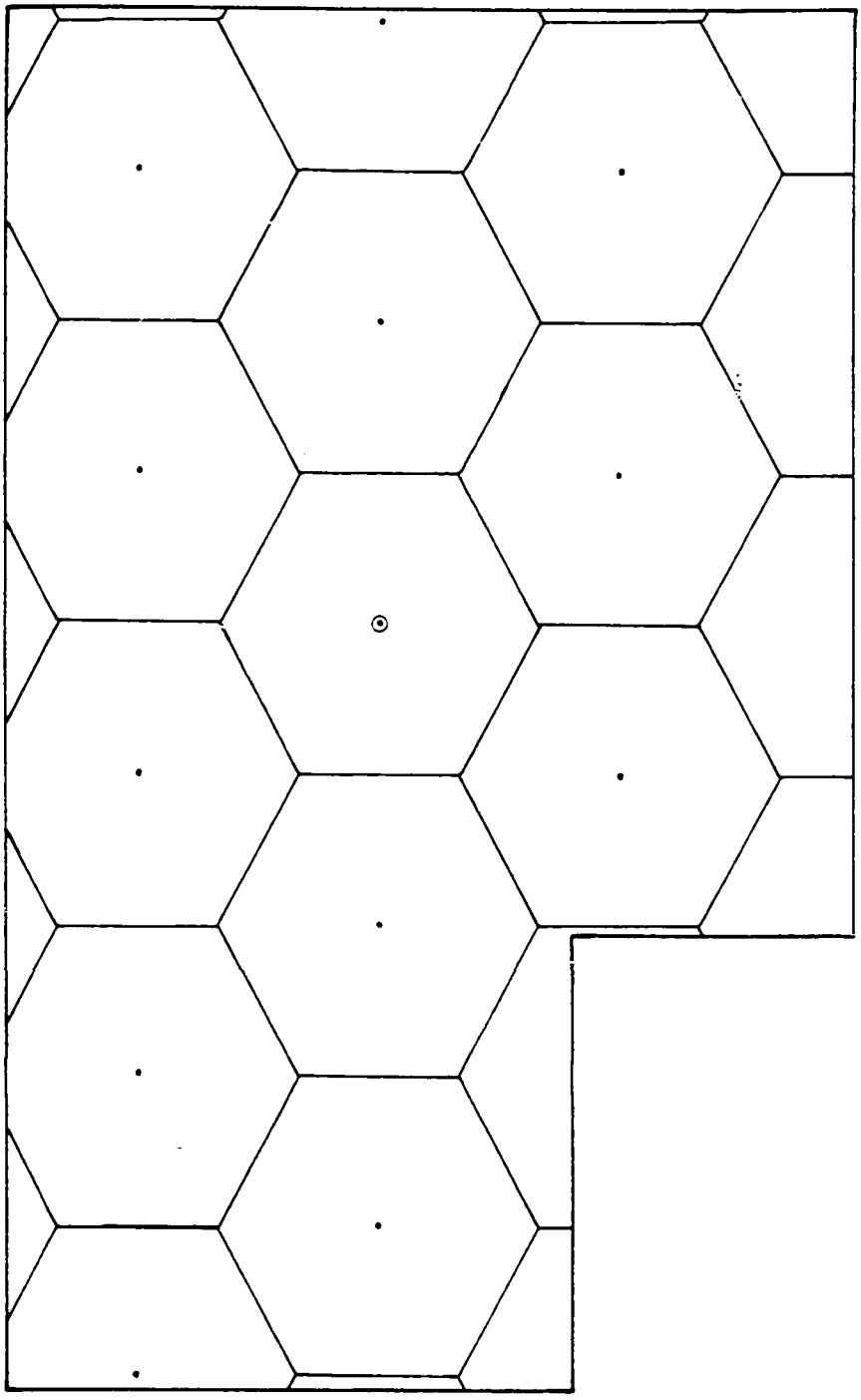

Figure 4.4

theoretically derived locations, then the existence of their market areas, represented by distorted hexagons, would be implied.

Theoretical Grocery Store Location and Actual Grocery Store Location

The following maps show the results of this method of theoretically determining grocery store locations. Figure 4.5 compares theoretical store locations with the locations of the twelve largest actual supermarkets, while Figure 4.6 compares theoretical store locations with the locations of the twelve largest actual centers of grocery store sales. On both maps the theoretical pattern and the actual patterns are rather similar. Measurements were made to determine the degree of similarity between the theoretical and actual patterns. The average distance of the theoretical locations from the actual locations is 345 yards for the case of the twelve largest supermarkets, and 328 yards for the case of the twelve largest centers of grocery store sales. These numbers were reduced to 282 and 249 yards when each theoretical location was adjusted to fall on the nearest commercially zoned land.[6] (Figures 4.7, 4.8)

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[6]These figures were arrived at in the following manner: (1) For Figures 4.5 and 4.6: the distance from each theoretical supermarket location to the nearest actual location was listed (thirteen readings). These distances were averaged. For each figure, seven of the thirteen readings were below the average. (2) For Figures 4.7 and 4.8: the distance from the adjusted theoretical supermarket location (arrowheads indicate the adjusted locations) to the nearest actual location was listed and averaged. For Figure 4.7, seven of the thirteen readings were below the average, and for Figure 4.8, eight of them were below the average.

THEORETICAL AND ACTUAL LOCATIONS OF SUPERMARKETS IN STUDY AREA

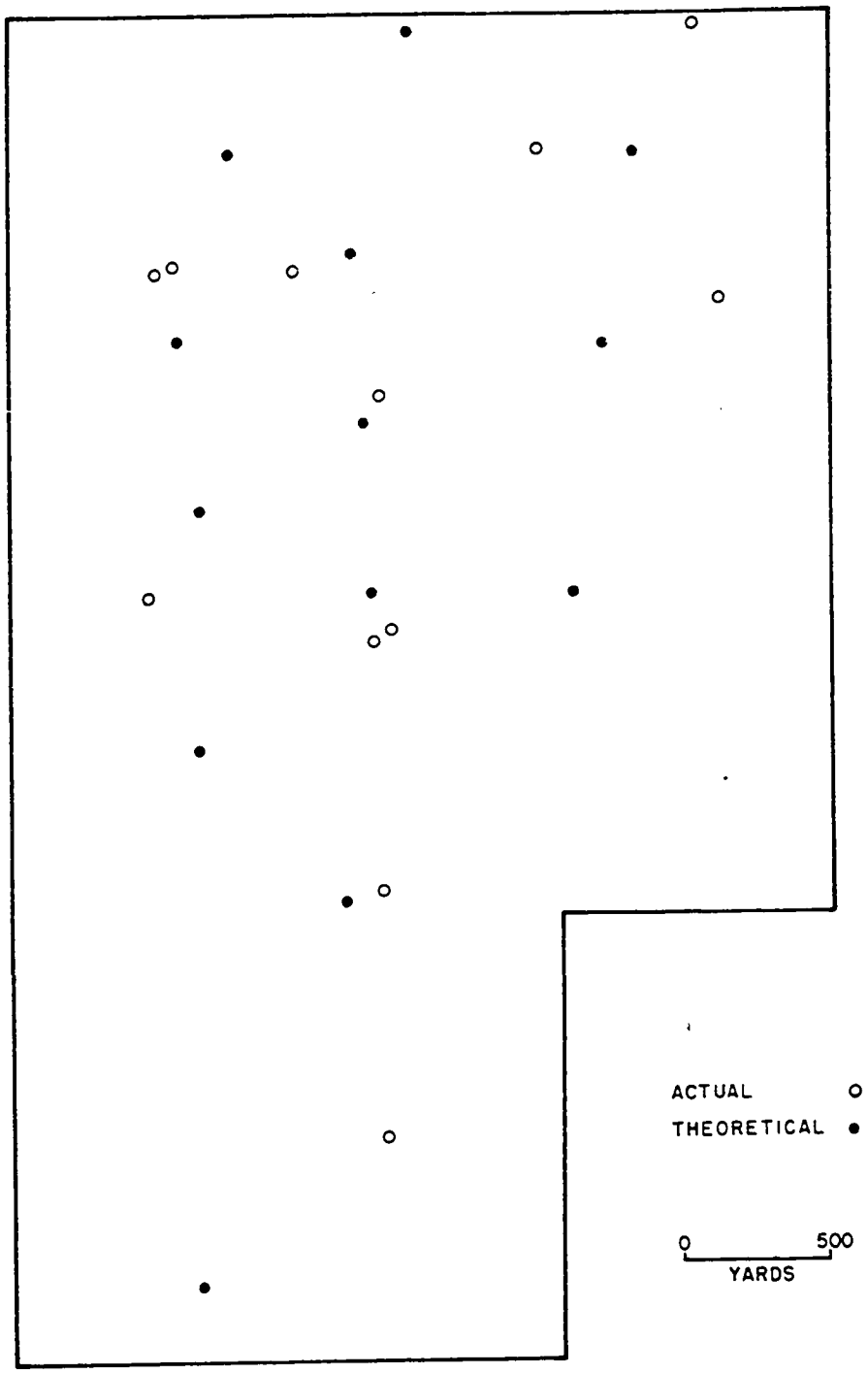

Figure 4.5

THEORETICAL AND ACTUAL LOCATIONS OF LARGEST CENTERS OF GROCERY STORE SALES IN STUDY AREA

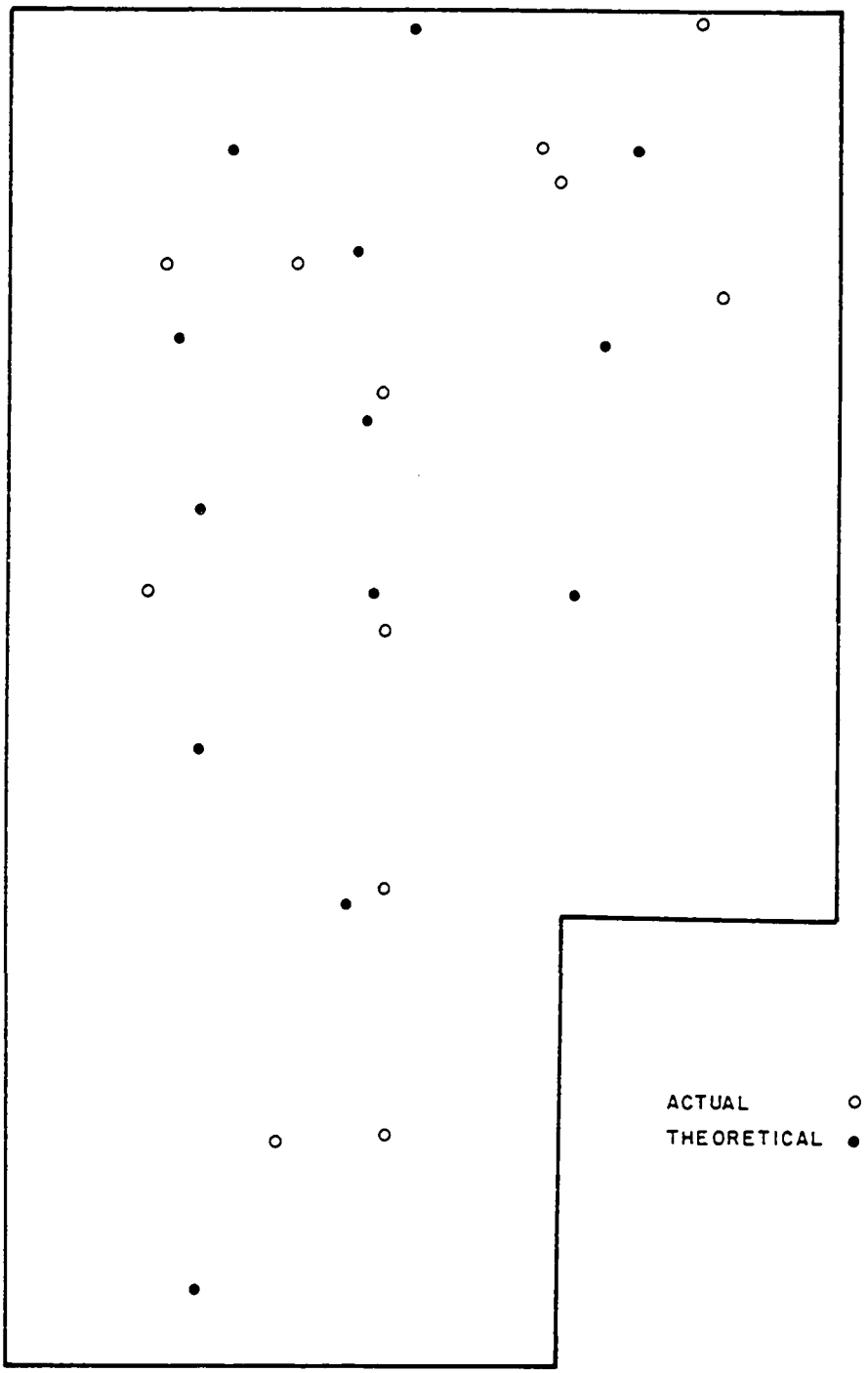

Figure 4.6

THEORETICAL LOCATIONS ADJUSTED TO NEAREST COMMERCIALLY-ZONED LAND AND ACTUAL LOCATIONS OF SUPERMARKETS IN STUDY AREA

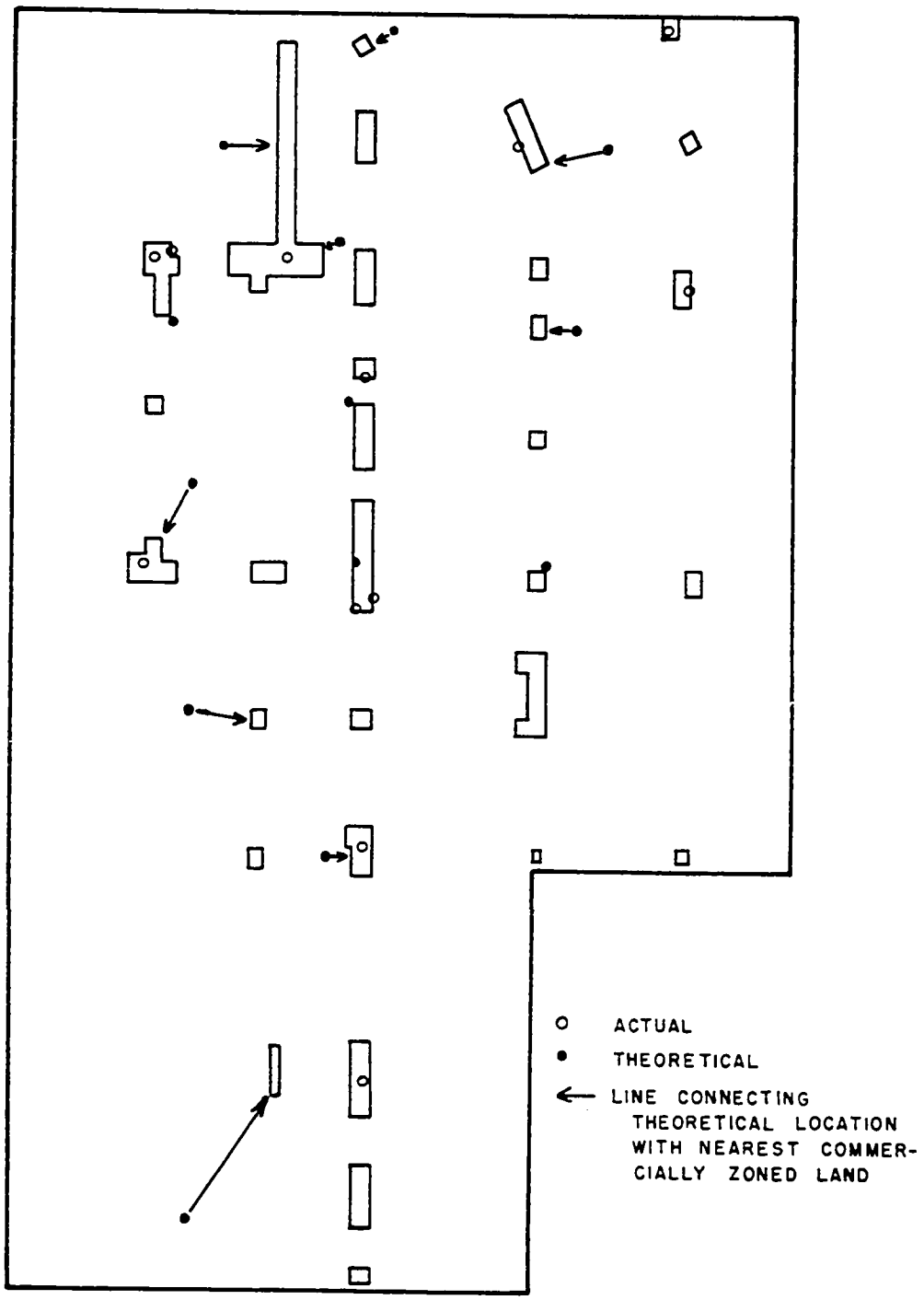

Figure 4.7

THEORETICAL LOCATIONS ADJUSTED TO NEAREST COMMERCIALLY-ZONED LAND AND ACTUAL LOCATIONS OF LARGEST CENTERS OF GROCERY STORE SALES IN STUDY AREA

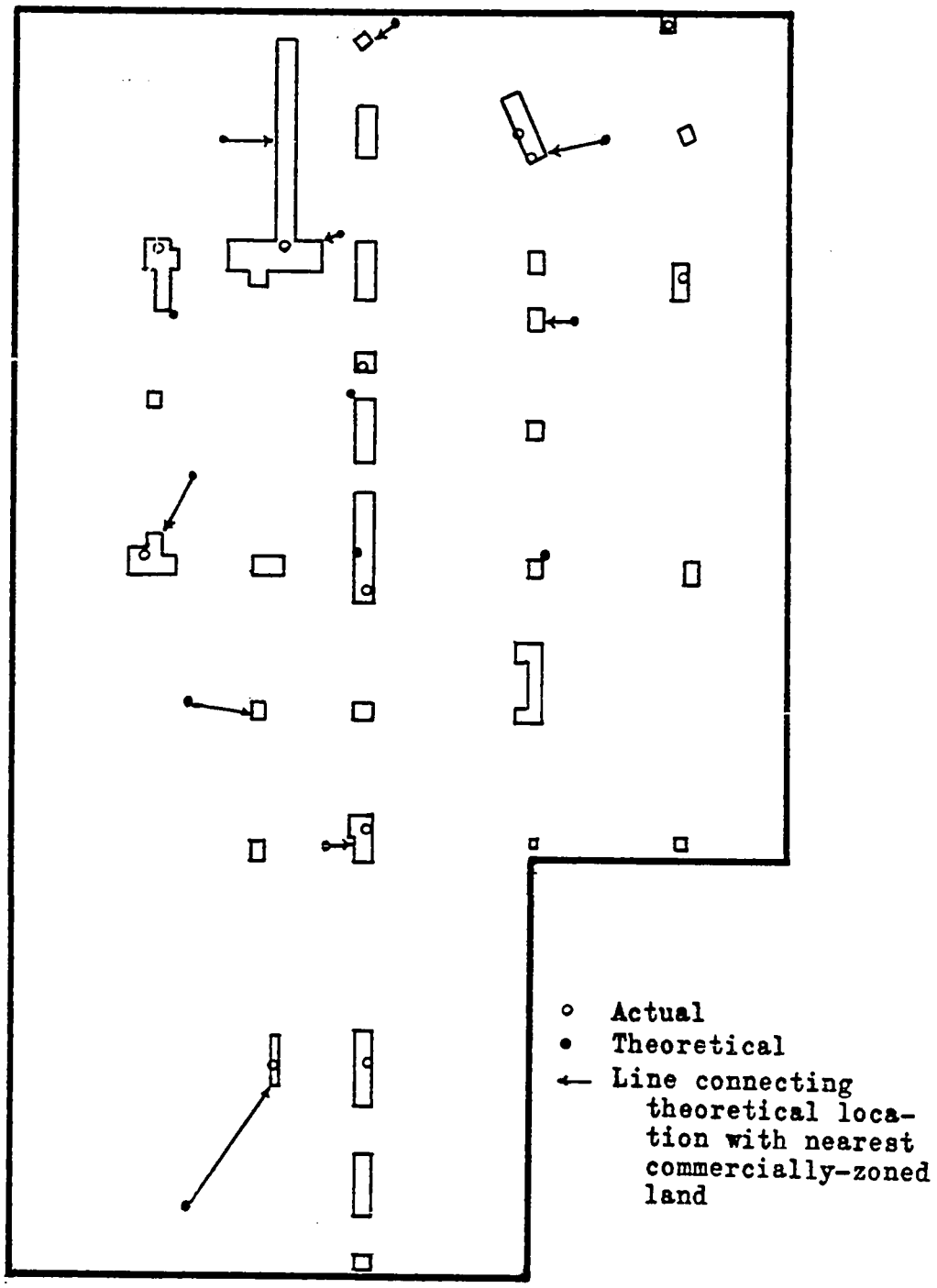

Figure 4.8

Limitations and Conclusions

It is possible to conclude from the foregoing that by using map transformations of disposable income data a feasible solution to store location problems is available--that well-defined market areas for retail stores exist. This would be a hasty conclusion. There are a number of limitations on the confidence one may have in the methodology and the apparent conclusions.

First, the procedure was carried out for grocery stores only. Although grocery stores command more expenditures for retail goods than any other type of retail firm, and have a strong bearing on the location of shopping centers, one must be aware that this procedure, followed in the manner outlined above, would not yield as favorable results for most other types of firms. Nystuen has shown that the shortest and most frequent shopping trips are those for groceries (Table 4.1). This fact leads one to believe that the market areas for grocery stores are rather definite and that monopolistic elements reflected in true convenience type retail firms are operating for this type of establishment. In the results of the tests of Chapter III it was found that it would be most difficult to conclude that retail stores of any kind are truly monopolistically competitive.[7] For this reason we should be wary of applying this technique to other types of stores. However, if it should prove possible to locate theoretically grocery stores by

[7]See pages 44-50, Chapter III.

use of this technique, then our knowledge of store linkages may be utilized to help explain the location of other types of retail firms.

A second limitation of the method is that a number of actual locations apparently are not "explained." "Excuses" such as the inability to interpret partial six-sided polygons are readily available for this shortcoming in the technique, but it is felt at this stage in the development of thought concerning retail store location that "excuses" are not called for. Certainly this is a shortcoming in the technique; nevertheless, present research should point to refining explanations, and not toward subjective notions of "explaining" the unexplained.

Thirdly, the theory of the location of retail store activity includes notions of the rent-paying ability of retail firms. The above analysis disregards rent. One might conclude from the above procedure that this factor may be omitted when attempting an understanding of retail patterns, but again this would be a hasty conclusion. In determining the general location of stores, rents may in fact be disregarded, but for a more refined, exacting study their inclusion would be necessary, since rents appear to have, as a result of the work of Chapter III, a direct bearing on the chosen site of the firm.

Fourthly, although there is a rather limited number of patterns made from the centers of twelve equal-sized hexagons that can be included on a map of the study area, still the hexagons

might have been rotated somewhat differently, with a better or worse theoretical explanation resulting.[8] Also, one might argue that the first hexagon constructed should have used some other originating point than the center of the map, which is, of course, the center of disposable income. If the theory were concerned directly with urban growth, then a starting point might be the location of the first grocery store established in the study area, or the first established supermarket of the twelve. The results obtained by using some other starting point than the one used might prove more favorable, but it is felt that the spirit of the theory would be violated since we are dealing with a static theory--a theory which is not concerned explicitly with change over time. In Chapter V mention will be made of the possibility of a dynamic retail store location theory.

Fifth, the question of whether the pattern of actual stores can be described statistically and then related to the theoretical pattern appears to be another problem. Dacey has shown how map patterns may be described by using "nearest neighbor" statistical analysis.[9] Rather than proceed with this time-consuming analysis, which did not appear necessary, a shortened version of the statistic was used.[10] When the actual store patterns are mapped onto the

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[8]See page 91, footnote 5, Chapter IV.

[9]Michael F. Dacey, "Analysis of Map Distributions by Nearest Neighbor Methods," Discussion Paper No. 1, Department of Geography, University of Washington, March 8, 1958.

[10]The first, second, and third nearest neighbor of each

distorted grid map, a uniform pattern would be expected if well-defined market areas exist. However, it appears from the limited analysis undertaken that in the individual twelve-store case the pattern is random, and that in the grocery store district case the pattern is more grouped than random. These results would lead one to conclude tentatively that market areas are in reality not well-defined.

Finally, and probably most important, is the advisability of using this technique of a map transformation. Tobler, who clearly indicates the usefulness of map transformations for studying economic geography phenomena, warns the researcher to use this type of technique as an approximation method.[11] He points out that there are an infinite number of solutions; in the case presented the distorted rectangles could have been drawn in an infinite number of ways. However, it is felt that using the rules presented above, any researcher attempting the map transformation would arrive at a map not significantly different, in its general make-up, from the one presented. Nevertheless, this is a shortcoming, and any results derived from this technique must be viewed in light of the shortcoming.

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actual store location was recorded. The number of reflexive pairs in each of the three categories was taken as ratios over the total possible number of reflexive pairs in each category. These ratios were compared to the statistic developed by Clark and applied to a linear array of points by Dacey in "The Spacing of River Towns," Annals, Association of American Geographers, Vol. L, No. 1 (March, 1960), pp. 59-61.

[11]Tobler, op. cit., pp. 155-159.

The Location of Retail Stores: Threshold Determinations

The concept of the range of a good is an integral part of central place theory. According to that theory, thresholds of goods correspond to the inner ranges of goods and are usually defined in terms of population. The original statement concerning thresholds assumed an isotropic surface and an hexagonal pattern of market areas was thus developed. However, in the expanded notions of that theory, this assumption was relaxed in order to more closely duplicate reality, with the result that the hexagons disappeared, but not the hierarchical arrangement of trade centers. When these results were tested in the real world, the hierarchical system was identified.[12] With these findings, it became evident that further research into the location of central functions might profitably follow the use of the modified central place theory, which implies a more incisive analysis of the threshold levels of firms.

In this section, thresholds will be defined operationally and a methodology for determining store locations presented. No attempt will be made to locate stores theoretically, mainly because of the difficulty of determining identifiable store market areas.

The Determination of Employee Thresholds

It was decided to select the point of marginal retail store operations as the threshold level for the establishment of a store.

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[12]Brian J. L. Berry, and William L. Garrison, "The Functional Bases of the Central Place Hierarchy," Economic Geography, Vol. XXXIV, No. 2 (April, 1958), pp. 145-154.

This means that for a retail store to establish it must have at the very least no profits.[13] The question is: What is that point below which no store can operate profitably? Since there is some correlation between sales and employees, as was shown in the preceding chapter, then the threshold levels can be estimated empirically from a distribution of the number of employees found in stores of the same type but in different gross income categories. The average sales per establishment cannot be the threshold, which must be at some level below the average. The problem arises as to what point below the average is most realistically the point of marginal operations. It was suggested to approximate this point as the "smallest one-sixth"--that is, the point where one minus the standard deviation from the mean would leave about one-sixth of the frequency of a normally distributed variate in the minus tail of a distribution curve.[14] The logic for this decision lies in facts concerning

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[13]Of course, many stores operate in the red for a short while before going out of business, or operate at a loss for competitive purposes or in hopes of increasing sales, but it is assumed that these stores constitute a very small portion of the total number of retail stores. An interesting study points out some of the problems of small businessmen in Kalamazoo, Michigan. See "Service Station Starts in Kalamazoo, 1957-1958," by Henry C. Thole (Kalamazoo, Michigan: The W. E. Upjohn Institute for Employment Research, August 1959). One conclusion of the study is that "the establishment of retail gasoline businesses by small businessmen is done in a most haphazard and unscientific manner." P. 17.

[14]In correspondence with the author, Professor William L. Garrison mentioned that it might be best to use the terminology "smallest one-sixth" rather than assume that the variates that were used are normally distributed. January 20, 1961.

the number of retail establishments going out of business. Goldstein and Mayer mention that twenty to twenty-five per cent of retail establishments of the convenience goods variety survived for less than two years in the period 1940-1950.[15] If we assume that the firms going out of business were less than marginal operations, then calculations will show that the point selected as the threshold has some validity, at least within the framework of the theory.

Table 4.2 summarizes the results of the threshold determinations for the city of Tacoma. Table 4.3 compares the average sales per employee for the Tacoma sample, the city of Tacoma, the state of Washington, and the United States. It is evident that the figures vary little within each type of retail store classification. Although the standard error about the least squares line is in some cases high, the compatibility of the sales per employee data for the different areas of the country adds much weight to the validity of the threshold values.

The Allocation of Stores to the Urban Economic Landscape

If we assumed that retail stores were all monopolistically competitive and had no overlapping trade areas, then firm threshold levels might be used as the major determinant of store location. The allocation procedure would be simple indeed. The solution

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[15] Sidney Goldstein and Kurt Mayer, "Patterns of Business Growth and Survival," The Journal of Economic History, 1957, pp. 193-206.

TABLE 4.2

RETAIL STORE THRESHOLDS, TACOMA, WASHINGTON

Store Type	Sample Size	Threshold (Gross annual income)
Hardware	8	$34,524
Grocery stores (no supermarkets)	10	125,581
Gasoline service stations	20	73,250
Women's clothes	6	66,150
Shoe stores	6	50,341
Furniture	8	168,219
Eating places	22	25,099
Drinking places (taverns)	31	24,167
Drug stores	20	47,304
Beauty shops	10	10,239
Barber shops	20	7,607

TABLE 4.3

SALES PER EMPLOYEE FOR SELECTED RETAIL ESTABLISHMENTS IN THE TACOMA SAMPLE, THE CITY OF TACOMA, WASHINGTON STATE, AND THE UNITED STATES

Store Type	Tacoma Sample (1958)	City of Tacoma (1954)	Washington State (1954)	United States (1954)
Hardware	$25,018	--	$25,300	$20,978
Gasoline service station	21,931	26,776	25,163	22,222
Women's clothes	19,571	19,221	18,125	16,780
Shoe stores	20,056	22,062	26,553	24,901
Furniture	23,827	22,135	23,578	20,757
Eating places	7,868	9,284	8,826	7,812
Eating and drinking places	12,144	10,240	12,925	11,575
Drug stores	15,113	25,021	24,516	18,882

would be to locate stores within areas where the consumption expenditures available for their goods were sufficient to support the stores. However, the earlier discussion has indicated that the location process is highly complex, especially within shopping centers. It would be very difficult to relate empirically the location of stores to the many variables acting both directly and indirectly on store location. For this reason, the following discussion might be considered as a verbal attempt to relate thresholds empirically to store location.

The threshold of a store is defined in terms of yearly gross sales and the number of employees. Since we would expect to find an employee only within an area where the disposable income available for his services was sufficiently large to support him, the allocation procedure could be one of "placing" workers within plausible market areas. Three major problems are evident in this regard: (1) the actual number of stores cannot be determined even though the number of employees needed in the area is known; (2) market overlap would cause appreciable differences between theoretical and empirically determined employee location; (3) the amount of goods purchased in central business districts would have to be considered. Other problems, such as rent considerations and store linkages, present further complications. The format needed to solve such a problem can best be illustrated by Figure 4.9.

The figure shows in simplified form the interrelationships between consumption expenditures for various retail goods,

SCHEMATIC REPRESENTATION OF FORMAT FOR STUDYING STORE LOCATIONS USING THRESHOLD DETERMINANTS

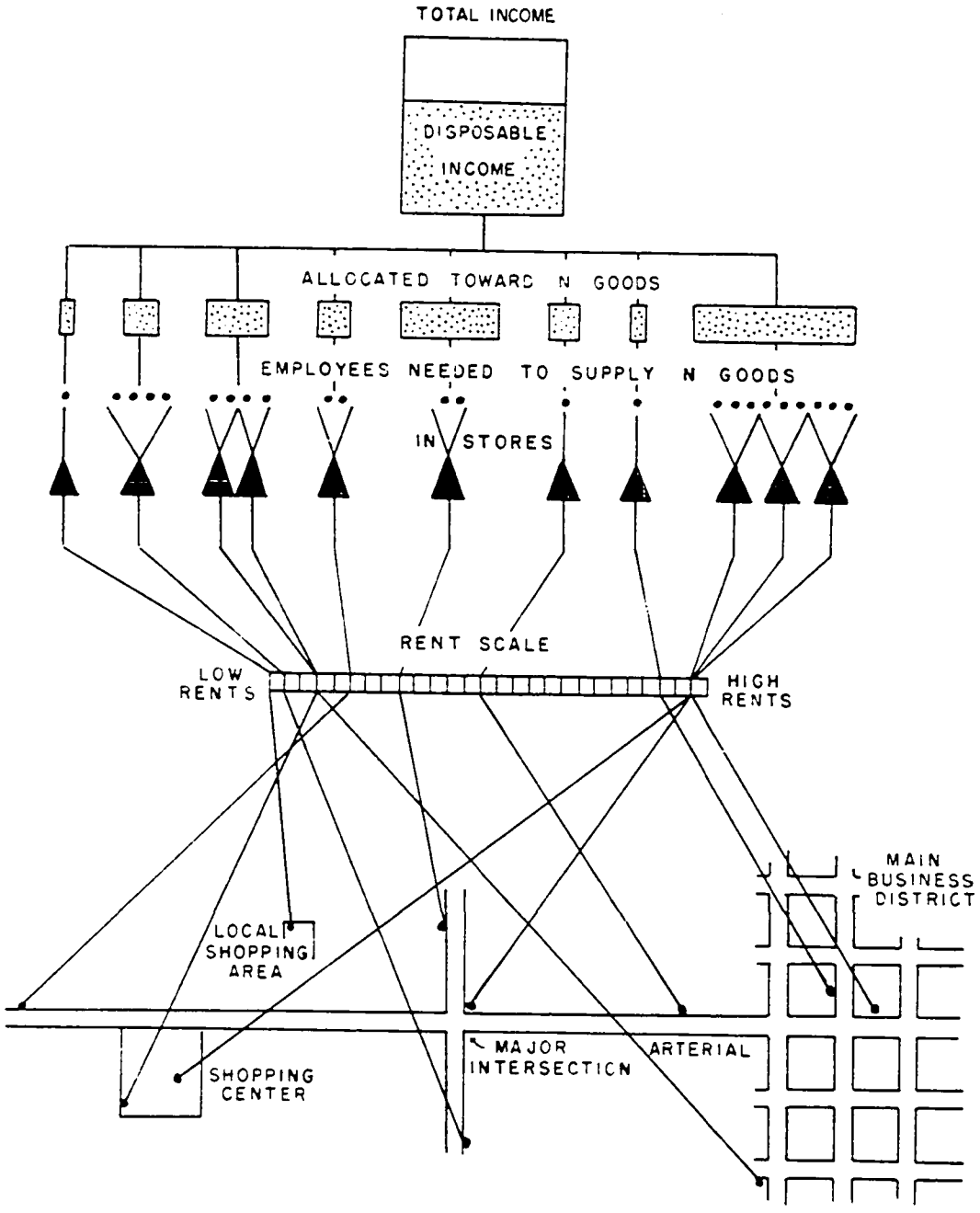

Figure 4.9

employees, stores, store rent, and store location. Unfortunately, store location cannot be determined by following the procedure suggested by the diagram. The problems of allocating employees to stores, stores to a rent level, and rent levels to particular urban locations, as well as problems relating to exogenous variables such as store linkages and distances from home, work or highway-based consumption expenditures to store locations have not been considered adequately in the theory in order to enable empirical verification of the relationships.

Potential Accessibility and the Location of Retail Establishments

Over the past few years geographers as well as planners, economists and business organizations have developed various measures of retail sales potential at urban sites.[16] Their formulations, whether developed from theory or from practical experience, have added greatly to the understanding of urban economic systems. The purpose of this section is to carry their work one step further by attempting to make more realistic the potential concepts by introducing a notion of "intervening opportunity."[17] In so doing,

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[16] For a review and bibliography of some of this material see Gerald A. P. Carrothers, "An Historical Review of the Gravity and Potential Concepts of Human Interaction," Journal of the American Institute of Planners, Vol XXII, No. 2, Spring 1956, pp. 94-102.

[17] "Intervening Opportunity" was introduced as a concept in 1940 by Samuel A. Stouffer: "Intervening Opportunities: A Theory Relating Mobility and Distance," American Sociological Review, Vol. V, No. 6, Dec. 1940, pp. 845-857. Edward L. Ullman included the concept when talking of "Geography as Spatial Interaction," in

progress toward a modified theory of retail location may become evident.

The term accessibility has been thought of as meaning the ease of movement to or from specific places on the economic landscape. For our purposes we will consider accessibility in a more limited way by thinking of possible consumer destinations as more or less accessible to home-based consumers. Specifically, accessibility is a measure of the transportation time[18] it takes for consumers' expenditures for retail goods to move from home bases (figuratively speaking) to real or possible locations of retail outlets.

It is felt that present measures of potential sales at a given urban location are deficient for practical use in one very important respect. Both the empirical and theoretical formulations fail to include the possibility of an intervening opportunity between the home base and the retail site in question as affecting the pattern of retail store locations. Potential and intervening

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Interregional Linkages, Proceedings of the Western Committee on Regional Economic Analysis of the Social Science Research Council, Berkeley, California, 1954, pp. 1-12. These thoughts were expanded in his article in Man's Role in Changing the Face of the Earth, edited by William L. Thomas, Jr., (University of Chicago Press, 1956), pp. 862-880, called "The Role of Transportation and the Bases for Interaction." Recently Swedish geographers and economists have used the concept to better understand migration and labor mobility patterns. Much of this work can be found in Lund Studies in Geography, Series B. Human Geography, The Royal University of Lund, Sweden, Department of Geography.

[18] Actually, any distance measure is applicable.

opportunity have been considered separately in the well-known gravity models, but a marriage of these two concepts would add greatly to an understanding and prediction of urban land use patterns. The empirical verification of the model might lead the way to a more viable and realistic theory of retail store location.

The Model

Gravity and potential concepts of human interaction were developed originally from analogy to Newtonian physics of matter. They are subject to criticism mainly because of the ability of individuals to make decisions, which may or may not conform to patterns indicated by physical laws.[19] Nevertheless, they have proved themselves to be good predictors of grouped human behavior.[20] These models, although not theoretically plausible, still work in many instances, and for this reason alone should not be cast aside until more plausible theoretical constructs are available. The model presented below is based on the conceptual

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[19]For an excellent discussion of gravity and potential models see "Gravity, Potential, and Spatial Interaction Models," by David F. Bramhall and Walter Isard in Walter Isard, Methods of Regional Analysis: An Introduction to Regional Science (Cambridge, Mass.: The Technology Press of the Massachusetts Institute of Technology, and New York: John Wiley and Sons, Inc., 1960).

[20]Some interesting results can be found in K. L. Heald, "Discussion of the Iowa Gravity Model Traffic Distribution Program" (Ames, Iowa: Iowa State Highway Commission, 1960). (Mimeographed.)

schemes of Isard and Freutel,[21] Harris,[22] and Stouffer.[23]

Potential accessibility indices for urban sites are developed for the purposes of evaluating sites for the location of retail establishments and for comparison with actual store locational patterns. The relationships may be described mathematically:

$$(1) \quad {}^{l}R_i = {}^{l}S_i + \sum_{\substack{j=1 \\ j \neq i}}^{n} \frac{S_j}{D_{ij}^{a}} \qquad \begin{matrix} j = 1,2,\ldots n \\ l = 1,2,\ldots m \end{matrix}$$

$$(2) \quad {}^{l}A_i = {}^{l}R_i - \sum_{\substack{j=1 \\ j \neq i}}^{n} \frac{R_j}{D_{ij}^{b}} \qquad \begin{matrix} j = 1,2,\ldots n \\ l = 1,2,\ldots m \end{matrix}$$

where A_i = potential accessibility in region i

S_i, S_j = volume of effective buying power available for particular type retail goods in region i, j (regions 1, 2, . . ., n)

R_i, R_j = retail potential in region i, j

D_{ij} = travel time from region i to region j

l = type of retail establishment (types 1,2, ..., n)

a, b = constant exponents which differ between equations and each type of retail establishment.

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[21]Walter Isard and Guy Freutel, "Regional and National Product Projections and Their Interrelations," in Long-Range Economic Projection, Studies in Income and Wealth, Vol. XVI (Princeton: Princeton University Press, 1954, for the National Bureau of Economic Research).

[22]Chauncy D. Harris, "The Market As a Factor in the Localization of Industry in the United States," Annals of the Association of American Geographers, Vol. XLIV, No. 4 (December 1954), pp. 315-348.

[23]Stouffer, op. cit., pp. 845-857.

Stated in this way, the model is based upon the reasoning that: (1) for any given site in an urban area there is a potential demand for the retail goods that could be supplied at that site, and (2) intervening opportunities between the consumer and the site in question detract from the potential at that site.

An Example

The following is a preliminary attempt to operate the model. Given: the area of South Tacoma where the consumption expenditures available for groceries are known. The area can be divided into small regions (cells), preferably of equal area and shape. This preference is based on the fact that (1) spatial bias is eliminated, (2) further research will be facilitated by such an efficient ordering of information, and (3) the ordered information may be stored conveniently on IBM cards and used easily for computer solution of large problems.[24] The S_i's for South Tacoma appear in Figure 4.10.

Since the regions are small, the driving time between any two cells may be computed or estimated, using the centers of the cells as the base point, or the centers of the consumption expenditures of the cells. In this case the centers of the cells were used. The potential for each cell can now be computed (this is the R_i). Using an a of 3.0 and assuming the driving time from any one cell to an adjacent cell is two minutes, and from any cell to a cell

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[24]Waldo Tobler, "Geographic Ordering of Information: An Exploratory Examination," (unpublished Discussion Paper, No. 38, Department of Geography, University of Washington, May 9, 1960).

LOCATION OF CONSUMPTION EXPENDITURES AVAILABLE FOR GROCERIES IN STUDY AREA

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345	827	823	420	288	162
194	515	680	265	298	46
24	397	508	336	153	99
35	312	300	31		
43	251	263	169		
87	147	175	88		

Figure 4.10

two cells away is three minutes, we have the R_i's as shown in Figure 4.11.[25]

The potential is reduced by the intervening opportunities when the A_i's are determined [the R_i's become the R_j's in the denominator of equation (2)] . For the purposes of illustration it was decided to continue using the same figures chosen arbitrarily for the new D_{ij}'s and exponent b as were used for the determination of the R_i's. The A_i's are presented in Figure 4.12.

A word must be said about the exponents a and b. There are empirical data available which show the average distance people will travel for various goods as well as the proportion of each of these goods purchased in the central business district as opposed to local shopping centers.[26] This information must be analyzed so that plausible exponents can be derived. The a's can be derived in this manner, but only by comparing the results of the A_i determinations with the real world pattern of store location will it be possible to estimate plausible b exponents. The same problem would appear in determining the driving times for equation (2),

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[25]These driving time figures were arrived at roughly by recording the driving time it took to go from centers of cells to the centers of adjacent cells.

[26]Data of this nature can be found in Studies of the Central Business District and Urban Freeway Development, by Edgar M. Horwood and Ronald R. Boyce (Seattle: University of Washington Press, 1960) and John Nysteum, "Geographical Analysis of Customer Movements and Retail Business Locations: (1) Theories, (2) Empirical Patterns in Cedar Rapids, Iowa and (3) A Simulation Model of Movement," (unpublished Ph.D. dissertation, Department of Geography, University of Washington, 1959).

LOCATION OF UNADJUSTED POTENTIAL FOR GROCERY STORE SALES IN STUDY AREA

	10	11	12	13	14	15
10	407	606	906	743	722	681
11	796	1100	1252	906	944	716
12	779	1331	1472	984	688	1199
13	641	1281	1331	806	559	387
14	395	892	1081	589	465	180
15	166	664	810	543	287	153
16	127	492	515	191		
17	118	390	417	256		
18	128	240	267	147		

Figure 4.11

POTENTIAL ACCESSIBILITY:
LOCATION OF POTENTIAL ABILITY OF CELLS
FOR GROCERY STORE SALES IN STUDY AREA
(in thousands)

	10	11	12	13	14	15
10	129	151	411	261	307	394
11	368	389	455	179	365	263
12	261	511	581	206	24	851
13	167	524	490	121	62	40
14	38	266	401	33	128	−43
15	-91	209	300	162	56	43
16	-47	175	153	-74		
17	-12	160	164	99		
18	54	99	118	51		

Figure 4.12

but, at this time, there seems to be no reason to believe that the D_{ij}'s of equation (2) should be different than those of equation (1).

Explanation of the Use of the Results

Potential accessibility represents the ability of a region to realize its retail potential. A high A_i does not necessarily indicate that a store should be located in that cell. If the retail potential in a high A_i is below the threshold level for the establishment of a retail outlet, then, of course, the entrepreneur must search out another A_i where the potential is sufficient to support his type of establishment. At this time in the development of the model, because of the difficulty of determining theoretically based exponents, it is impossible to relate directly potential accessibility and threshold levels.[27] However, the model can be used in its present form as a preliminary device, using plausible exponents, to determine potentially good sites for the location of retail establishments. For purposes of comparison the actual grocery store sales per cell are shown on Figure 4.13. It must be kept in mind that certain of the cells, because of zoning regulations, are unavailable for grocery store establishments.

Discussion Concerning the Technique

The question of just how well the model works will be

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[27]For an explicit definition of thresholds see Brian J. L. Berry and W. L. Garrison, "A Note on Central Place Theory and the Range of a Good," Economic Geography, Vol. XXXIV, No. 4 (October, 1958), pp. 304-311.

foremost in the minds of researchers. Can the model be tested? The model is formulated in such a way that it can eventually be tested more rigorously. The distances can be computed in terms of time by selecting various arterials within the urban area and establishing the driving time between key points (e.g., the centers, or close to the centers, of each of the cells) at regular shopping hours. For other transport media than automobiles new exponents would be required. Time-distances between cells not having arterials can be estimated from these data.

The determination of effective buying power can be estimated from census data and from charts showing how consumers in the different income classes allocate their disposable income.[28] Familiarity with the area in question would help in allocating the effective buying power of census tracts to the cells.

To some readers it may appear peculiar that what intervenes is retail potential, but if it was thought for the sake of clarity that retail establishments of the same type were located at all sites (cells) in the urban area then the model shows that what intervenes are retail establishments. Most of these retail establishments would find difficulty surviving because they would be located at sites where there is inadequate potential. When a further constraint, the effect of intervening retail establishments, is considered then many other possible sites should be eliminated

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[28]One such chart can be found in the Appendix.

LOCATION OF ACTUAL GROCERY STORE SALES
IN STUDY AREA IN 1957

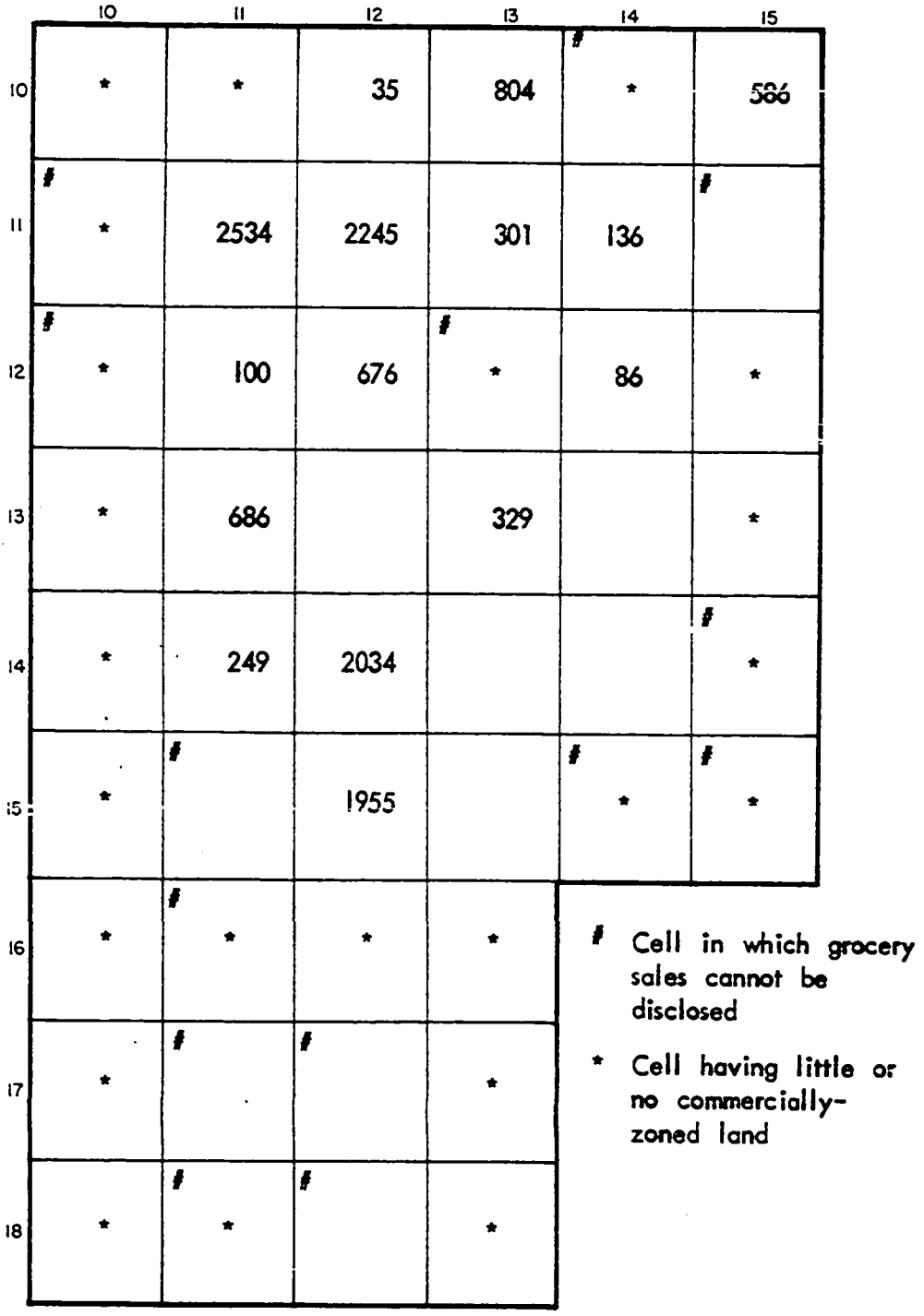

Figure 4.13

as being potentially profit-making locations.

The size of the cell chosen will have an effect on the potential value of the results. It would be desirable for the cell size to be small enough that only one of a type of retail establishment would find it profitable to locate within the cell.

An extension of the model would attempt linking thresholds explicitly with potential accessibility. Also, certain constraints such as retail spatial affinities, types of retail competition (the degree to which retail establishments are monopolistically competitive), zoning ordinances and city-planning considerations should be included.

Conclusions

A map transformation and a measure of threshold levels were used for the determination of store location. These two methods of analysis can be thought of as operational techniques suggested by the theory of retail store location for the testing of that theory. Neither of the techniques fully enabled the author to verify the statements extracted from the theory, but both did indicate shortcomings in the theory, especially those having to do with the existence of well-defined market areas. For example, can we say that threshold levels are well enough understood for their relationships with market areas to be clear? Do consumer trip movements follow a pattern which makes it possible to delimit trade areas?

Although one might have intuitively guessed at the outset of this study that answers to such questions would be negative, still light has now been shed upon the problems we encounter in trying to combine the various facets of the theory, thus indicating the need for a more realistic theory. A start was made in this direction by introducing the concept of potential accessibility. However, for a more complete evaluation of all of this work we must look at the theory again and appraise its merits and shortcomings. We are also obligated, as a result of the empirical work found in this and the previous chapter, to recommend and possibly develop new theoretical outlooks on this most perplexing problem.

CHAPTER V

PROSPECTS FOR A MODIFIED THEORY OF THE LOCATION OF RETAIL STORES

In this study a unified theory of the location of retail stores was presented. The theory is based on the work of economists and geographers, with the economists emphasizing the competition for sites in urban areas and the geographers concerned mainly with the spatial pattern of population (or in this case, of disposable income) and market areas for central goods. The theory links these two conceptual approaches by development of the idea that annual gross revenue for retail stores decreases with distance from the center of business activity much more quickly than the annual rent charged by the landowner. This notion is based on the expected and not the actual ability of land to return income to entrepreneurs. As a result, landlords are able to charge higher rents at off-center sites than actual income producing ability indicates. This concept permits a fuller understanding of the central tendency of stores than is possible with the use of the more general theory of tertiary activity.

The balance of the study was concerned with the testing of fundamental parts of the unified theory, since a theory which is to

be considered a viable tool for further research must be rigorously tested. Needless to say, it was hoped at the outset of the study that the theory would prove to be a powerful foundation for further urban land use research. Certain key statements were extracted from the theory and tested statistically, graphically, or by any other means available to the author. In some cases significant departures from normal testing procedures were required. In the following paragraphs an attempt is made to make clear the problems encountered in formulating testable hypotheses and in operationally testing the hypotheses.

The theory of retail store location makes use of such concepts as monopolistic competition, rent, and accessibility. It is rather perplexing to deal with these and other concepts in an empirical way. Although the theory can be transformed easily to statements in the form of hypotheses, the testing of the hypotheses presents some awkward problems. It is the author's firm conviction that a theory, to be of practical use, must be formulated in such a way that any hypothesis or model based on that theory can be tested. In this case the theory, as is the case with most general statements, deals with complex interrelationships in a simplified way. The ability of the theory to explain individual cases decreases with its level of generality. In this study, it was found that, in general, the theory was unable to deal with individual cases. Although it is recognized that the theory was not constructed in such a way that it could be used to predict the location of

particular stores, still, for the theory to be considered as a viable research tool it should go farther toward this objective than it does.

It might be possible to illustrate the above-mentioned difficulties by considering the concept of monopolistic competition. Insofar as the geographical element is concerned, Chamberlin explained that a monopoly can come about in a perfectly competitive market when one firm gains an advantage of location over some other firm (monopolistic competition). However, most economists who speak of the concept of monopolistic competition consider any imperfection in the market as monopolistic or rather, as imperfect competition. Geographers have tended to follow Chamberlin's approach and in this study we extended his analysis by considering any retail firm not directly dependent on its location as a firm possibly characterized by imperfect competition rather than monopolistic competition. Now the problem becomes clear. This study revealed very little of what we would call monopolistic elements for retail firms--that is, most retail firms appeared not to be dependent directly for success on location. This conclusion was reached when it was found that surplus profits are not balanced by rent. This hypothesis is theoretically dependent on the concept of monopolistic competition as presented and was rejected, with reservations, for retail firms. Before analyzing the techniques used to test the notion, we might pose questions which come to mind as a result of the rejection of this hypothesis. Are theorists

compounding the errors of their theories by deducing new concepts from the old without rigorously testing the old theories? Have we been searching for powerful general statements explaining human phenomena without due concern to the value of the theories for explaining individual cases? However, before the reader answers these questions affirmatively, a word must be said about the techniques used in this study to test the hypotheses. To round out our illustration, let us examine further the hypothesis mentioned above, surplus profits are balanced by rent.

It was found that there are operational difficulties in carrying out a test of the hypothesis. There is the problem of defining and quantifying surplus profits and the problem of evaluating results when synthetic statistical tests are used. Data inadequacies added to the problems and multiplied the possible error in the test. Furthermore, the concept of rent, with its varying meanings, was defined so that available data might be used. However, even with all of these uncertainties, the author felt justified, after an analytical test, in rejecting the hypothesis. It was noted that throughout the test there was a pervading tendency for many stores to display quantitative values of surplus profit and rent that were far in excess or far below what a casual observer would intuitively expect. Although this is not a firm rejection, one that future researchers can use in their analyses, the case does illustrate the point we are trying to make--that the base on which the theory of retail store location is founded cannot be tested

adequately directly or indirectly, and therefore the theory must be modified if it is to be useful for further research.

The above illustration does not imply that future tests would be pointless and that the theory must be reworked entirely. Rather, it was found that certain portions of the theory could explain, in general, real-world situations. The portions of the theory which have general validity might form the base for a modified theory. Before suggesting the form the new theory might take, let us look for a moment at some results of tests showing positive results.

It was shown that in Tacoma, in general, rents decrease more slowly than sales from centers of business districts. In the summary of Chapter III reservations were expressed as to the validity of the test which brought out the above conclusion. However, this may be a starting point in formulating a new theory. The fact that there is a tendency for many stores to establish at central locations may help us understand what are desirable locations. The modified theory, therefore, might profitably contain a more careful analysis of the character of desirable locations. This was further borne out in another relatively successful test. It was shown that supermarket locations could be predicted with reasonable accuracy given the constraint of limited available store sites. Again, this result might enable us to explore more carefully the character of desirable locations. The remainder of this chapter contains suggestions for a modified theory of retail store location,

based on findings such as those expressed above.

Components of a Modified Theory

In this section the factors governing retail store location which might be included in a modified theory are discussed. We attempt to put these various factors into perspective by subjectively evaluating their significance. In this manner we pave the way for the final section, which presents approaches that might be followed in developing a modified theory.

A recent issue of the Journal of the American Institute of Planners gave attention to the problem of predicting land use patterns.[1] Row and Jurkat suggested the bewildering variety of forces shaping land use patterns.[2] Knowledge of such factors as household income distribution, land and building supply, input-output patterns of each business type in terms of its labor requirements, its material and service requirements, and its market were all noted as necessary for development of a model of an urban area. The question arises: how should this model be organized--that is, what relationships are there between variables, and what weights should be given the variables? The theory of retail store location attempted to consider the variables in their proper perspective,

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[1] Journal of the American Institute of Planners, Vol. XXV, No. 2 (May, 1959).

[2] Arthur Row and Ernest Jurkat, "The Economic Forces Shaping Land Use Patterns," Journal of the American Institute of Planners, Vol. XXV, No. 2 (May, 1959), pp. 77-81.

but it was found wanting. The geographer must conclude that for a modified theory to be presented he must consider location forces from as many angles as possible. The variables that appear to have bearing on store location are discussed below.

Geographic Factors

Four factors have spatial meaning and for that reason can be considered as geographic. The first is the distribution of disposable income, which has been shown to have a bearing on the location of retail stores. The theory explained the relation between this distribution and other factors, such as employees and sales. Furthermore, in the section on map transformations, the distribution of disposable income played the only role in locating stores theoretically. Adding interrelated variables, such as employees and sales, we might find in an extension of that procedure (map transformation) a good predictive device. In another case, potential accessibility, based on the location of disposable income, was the major determinant of retail store location. Results of that test are inconclusive, but there are indications that further development of this technique would yield valuable results for the prediction of retail store location. There appears every reason, then, to include the factor of disposable income in a modified theory of retail store location.

A second factor is accessibility. This variable may be considered in three ways: in terms of transport time distance,

transport cost distance, and psychological distance. Notions of accessibility are an integral part of the theory of retail store location. Although accessibility as an important locational force seemed to be obscured when testing the hypotheses, still it played an important role in the prediction of store locations by the use of map transformations of disposable income data, and looked promising in the use of the potential accessibility index procedure. Studies by Nystuen, Berry and Garrison, and Marble have indicated that people will normally go to the nearest store which will satisfy their needs for goods and for services.[3] This suggests that accessibility may be a more important factor for retail store location than actual distance. However, since consumers do sometimes bypass nearby stores for stores with favorable locations in respect to their desires, accessibility cannot be considered as the lone variable, but must be used in conjunction with other variables for a realistic explanation of retail store location.

A third factor, the variable of retail store spatial affinities, was not considered in the theory of retail store location, but it has been considered explicitly by others. In fact, theories of retail store spatial patterns have been developed around this single variable.[4] The idea here is that stores can maximize their

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[3]See Garrison et al., Studies of Highway Development and Graphic Change (Seattle: University of Washington Press, 1959).

[4]John Rannells, The Core of the City (New York: Columbia University Press, 1956).

profits by locating near to one another in order to minimize inconvenience (or transport costs) to consumers. However, it is impossible to relate groups of stores with retail spatial affinities to the locations without considering the previous two factors. The fact that grocery stores locate in areas where the disposable income available for their goods is found suggests that the modified theory might accept grocery stores (in most areas grocery stores occur more often than any other type of retail establishment) as the generators of retail store activity, and that with an understanding of their location patterns will come an understanding of the location patterns of other types of stores having a spatial affinity for grocery stores.

The fourth geographic factor to be included in a modified theory concerns the availability of advantageous stites. It was shown in the study of map transformations of disposable income data that the inclusion of the restraint of the inability of stores to locate on other than commercially-zoned land yielded more accurate results. This fact indicates that the modified theory might relate the availability of commercial land to potentially advantageous sites in the urban area.

Economic Factors

The theory of retail store location assumes that each firm within a given retail store type operates at the same organizational level (can be thought of as the same level of efficiency) as all

other firms of the same type. This assumption, it is felt, fails to explain what appear in this study to be organizational differences within a retail store type. Possible errors arise when use is made of this assumption for differing store sizes and also for differing store locations. The use of rent in the theory and the analysis supposedly alleviates this difficulty, but it is felt from the results of the tests that rent does not explain enough. A more refined analysis of rent differences from place to place is certainly called for, but since empirical studies of rents for retail firms are, to the author's knowledge, non-existent, the modified theory might look to presently quantifiable economic variables to fill this gap in the literature.

The question of what economic variables can be included in the modified theory follows naturally from the above. It was shown in this study that the number of employees correlated closely with the annual gross sales of retail stores. Realizing that the economic character of stores sometimes varies markedly within a classification (grocery stores, for example, vary in the range of goods offered for sale) then we should be careful in the use of employees in a modified theory. One note of hope lies in the fact that for a number of types of retail stores the <u>average</u> sales per employee figures closely approximate one another. What meaning has this for a modified theory? Our discussion of threshold determinants provided a framework for analyzing retail store locations based in part on the number of employees needed for servicing

consumers. Although this analysis could not be completed, an empirical regularity was evident and use might be made of it at this time. This use will be made clear in the section dealing with suggested theoretical approaches.

The question of retail store competition raises another perplexing problem. There was an attempt to deal with this in the potential accessibility measurement, where spatial competition was presented in terms of intervening opportunities. Unfortunately, intervening opportunities as presented appear to be a useful method to get at spatial competition only when true convenience goods establishments are competing. Since it has been stated that most stores are not operating in the monopolistically competitive way that was used in the theory of retail store location, it might be necessary to exclude spatial competition from modified theories. In addition, ordinary, non-spatial competition further complicates an analysis of the effect of spatial competition. Is it possible to distinguish between spatial competition and other types of retail store competition in a realistic modified theory? Further tests on a potential accessibility model might show how much weight can be given to spatial competitive factors. But until that is done, it appears that inclusion of a monopolistically competitive variable in the modified theory might lead into further blind alleys.

Economists would not be satisfied with any analysis of retail stores which did not give due consideration to such factors as fixed and variable costs, overhead, and profit margins. Can

these factors be given spatial meaning? Alonso and Wingo have studied economic factors spatially by using the substitution principle, that is, substituting transportation costs for certain economic costs.[5] However, neither have shown empirically whether or not the substitution principle can be tested for urban land use problems. Again we come to a gap in our empirical knowledge. A modified theory should include those factors which have been shown empirically to be important in the determination of retail store location patterns. Further, the theory should make clear the relationships between the forces influencing retail land use and provide the empiricist with a means to test those relationships.

Another economic element of the theory of retail store location is that of thresholds. The fact that stores cannot establish if there is insufficient disposable income available for their establishment and ultimately their survival in an area, indicates that a meaningful theory should recognize their existence. However, it seems that thresholds as a constraint on firm establishment will have to be defined, or at least related explicitly, to other measurable variables also limiting establishment of firms. The realization that spatial competition limits stores from locating in what might seem, without thought of spatial competition, to

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[5]William Alonso, "A Model of the Urban Land Market: Locations and Densities of Dwellings and Businesses" (unpublished Ph.D. dissertation, University of Pennsylvania, 1960); and Lowdan Wingo, "Transportation and the Utilization of Urban Land: A Theoretical Exploration" (New York: Twentieth Century Fund), 193 pp. (Unpublished manuscript.)

be advantageous locations indicates that there are other variables that should be related to threshold values for firms. In addition there is the problem of measuring firm threshold levels. Constant values, such as those used in this study, are subject to criticism on grounds stemming mainly from the inconsistencies of economic character within a type of retail firm. The difficulty may be dealt with as it is in the original central place theory, if thresholds are considered in terms of the types of goods offered for sale, regardless of the type of store or stores from which these goods are supplied. This can be done as long as the modified theory can relate thresholds for goods to the location forces which produce potentially profitable sites in urban areas.

Psychological Factors

The final factors to be considered as possible elements of a modified theory are those related to psychological aspects of consumer behavior. A number of empirical studies have attempted to describe patterns of customer movement to retail stores, but they are so conflicting in results that very little can be said to have been determined.[6] In general, the studies show that locational variables do not seem to be any more important than socio-economic

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[6]See studies cited by Garrison et al., Studies of Highway Development and Geographic Change, pp. 166-168, and the studies of the authors themselves. Also, see David Huff, "Geographical Aspects of Consumer Behavior," University of Washington Business Review, Vol. XVIII, No.9((June, 1959), pp. 27-37, and studies cited by Huff.

characteristics in influencing consumer behavior. This is one area where interdisciplinary study would prove fruitful. If certain notions of, for example, consumer perception of trip distance, can be explicitly entered into the theory then the new theory will, of course, be more realistic. Does the consumer recognize quarter-of-a-mile differences or one or two minutes of driving time? Do these differences, if perceived, have an effect on his buying habits? Questions having to do with consumer reaction to the availability of parking spaces, multi-store shopping, advertising, and the like must be answered before a clear understanding of store location patterns can be achieved. On the other hand, looking at it from the entrepreneur's point of view, we want to know how the entrepreneur reacts, in terms of location, to consumer preferences. It appears that these attitudes bear greatly on store location patterns. Factors of this nature seem to be responsible for some of the evidently unexplained empirical results of this study. However, in attempting to evaluate consumer behavior our study designs and our tools for analysis must be sharpened so that conflicting results are reduced to a minimum.

Some Nonrelevant Factors

Certain elements of the theory, it is felt, should not be included in the modified theory. The fact that surplus profits, normal profits, and differentiations between convenience goods and occasional goods establishments all appeared too nebulous in

definition and meaning to be tested adequately leads the author to conclude that continued research along these lines would be wasteful in the short run and might prove fruitless in the long run. There is every reason to doubt the existence of what the economists call normal profits, mainly on the grounds that what one firm considers normal profits might differ strikingly from what another firm considers as normal profits. Subsequent research along the lines of economic classifications of firms into groups for further analysis may be of value, but this study failed to show any promise for the classification used, that of convenience goods and occasional goods firms. This ties in with our criticisms earlier in this chapter of the concepts of monopolistic and imperfect competition. It was shown that convenience goods establishments cannot be equated with the assumptions of monopolistic competition.

Suggestions for a Modified Theory of the Location of Retail Stores

The following discussion, based on the preceding theoretical and empirical study as well as work not mentioned previously, outlines possible approaches in formulating a modified theory of retail store location. The basic problem, mentioned earlier in this chapter, is the weakness of the theory of retail store location at the level of individual store location. The chief concern in this section is to try to make clear how this problem can be solved. We will introduce a number of concepts, some not mentioned in the theory, explain their potential role in a modified theory, and

attempt to show how these concepts might be studied.

The Concept of Store Linkages

A number of researchers have attempted to get at the problem of explaining retail store location patterns by considering the spatial affinities, which stores of various types have for one another. Notable among these studies is the work of Rannels, Nystuen, and Berry. Rannels emphasizes the symbiotic relationships that result from the operations of separate firms and from the business transactions taking place among the firms.[7] He notes four types of linkages: competitive, complementary, commensal (establishments using the same facilities or dependent upon the same supplier or the same market), and ancillary (services supplied by one establishment to others). Although Rannels fails to explain the spatial patterns which develop because of these linkages, he does provide a framework for spatial study.

Nystuen contends that the spatial arrangement of retail stores in shopping districts of different sizes reflects, in part, an adjustment to the tendency of consumers to make multi-purpose shopping trips.[8] He concludes that consumer travel behavior is a factor in the location of retail stores. Studies such as those by Berry have found empirical regularities in retail store spatial

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[7] Rannels, op. cit., pp. 19-33.

[8] John D. Nystuen, "Geographical Analysis of Customer Movements and Retail Business Locations" (unpublished Ph.D. thesis, University of Washington, 1959).

affinities. Berry discusses forms of retail patterns resulting from the spatial affinities, such as nucleated and arterial retail districts.[9]

This short review leads us to one of the drawbacks of the theory that might be compensated for by use of a linkage variable. For example, given the actual location of a grocery store, what are the probabilities of stores of different types locating close to it? If we know something of the location of disposable income, and have an idea of the ease of consumer movement to the grocery store, then we might be able to predict closely the location of other stores. By use of our knowledge of the spatial affinities of stores, we could determine which stores are mostly likely to locate near grocery stores. What is being suggested here, then, is that introduction of the concept of store linkages explicitly into the theory would give us a better predictive device than we now possess.

The Concept of Consumer Behavior

Although patterns of retail store location already in existence determine where consumers can shop, consumer travel habits have also acted to influence the extant pattern. For this reason, we are interested in consumer motivations and behavior. Katona concluded from his study of the relationship between psychological and economic behavior that "people act impulsively instead of

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[9]Garrison et al., op. cit., pp. 39-99.

rationally," and that consumers "do not plan."[10] Although the author does not feel that the situation is this extreme, he does agree with Katona that research "must be aimed toward discerning the patterns of motives entering into specific decision formations, not toward discovering the one motive of all behavior."[11] We are interested in why people shop where they do, and what influence their decisions have on store location.

A number of geographers have attacked this problem by attempting to discover patterns of customer movement to retail stores. It becomes evident from their studies that customer movement cannot be explained purely by reference to locational variables, and that much must be learned about motivations and individual group behavior. The problem of entering consumer behavior into a theory of retail store locations, however, is great. This is clearly a field where it will be necessary to use empirical findings related to regular or probabilistically predictable customer travel patterns. In this case, a refinement of technique rather than theory is called for. If game theoretic notions of consumer behavior can be built into simulation models for geographic use, a better understanding might result for the building of a more realistic theory. For the present, however, it appears too difficult to attempt to introduce non-rational economic behavior into a modified theory.

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[10] George Katona, Psychological Analysis of Economic Behavior (New York: McGraw-Hill, 1951), p. 63.

[11] Ibid., p. 71.

Evaluating Competitive Elements for Retail Store Location

It was suggested earlier that the "imperfectness" of competition might be measured, as the degree to which the rent of a particular store is lower than expected in a monopolistically competitive market. However, it is felt that product differentiation (all imperfections not due to location) has a marked effect on location and robs the concept of monopolistic competition of its definiteness and its serviceability. Moreover, theoretical constructs are definitely inadequate, at the present time, to explain the substitutability between products and the vulnerability of any firm to incursions from new rivals. Therefore, a monopolistic situation, rarely evidenced, could not form a tangible base on which to measure the degree of imperfectness.

With the introduction of the concept of potential accessibility there was an attempt to get at this problem. It is felt that further analysis of this intervening opportunity approach might help in an inductive way to build a theory of spatial competition which satisfies the character of retail store operations. A dynamic element might be combined with potential accessibility. For example, the establishment of stores over time, or changes in disposable income location might be built into a model having as its foundation the ability of sites to return profits to the entrepreneur. This would be a further modification of the theory, one that is necessary if we are to better understand the location of retail stores.

A Dynamic Retail Store Locational System

Researchers have often mentioned how urban change--for example, the introduction of a new highway--affects the spatial pattern of retail stores, but change has never, to the author's knowledge, been included explicitly in any theory of retail store location.

The theory of retail store location implicitly assumes that entry into retail business is relatively easy. Since it is known that many stores go out of business within a short period of time after their establishment, the theory assumes that the pattern of retail store location always approximates a static situation. However, the results of our tests suggest that such a situation does not exist, and we would intuitively expect that changes in the character of urban areas are going on much faster than are the compensating changes in retail store location. The following approach is a way to get at the adjustment of retail store location patterns to other changes in the urban environment.

Equilibrium locations can be determined by use of map transformations of disposable income data. This procedure could be used for different time periods, with the theoretical locations compared with actual store locations and changes noted from time period to time period. In this way an inductive approach might be best used to develop a theory which considers the time lag apparent in the store locational adjustment pattern. This is analogous to the cobweb type of analysis found in sequence models of economic phenomena.

Nonetheless, the suggested approach would still fall far short of a complete explanation of store location patterns. For example, both retail store spatial affinities and threshold levels for firms might change over time. However, a complete theory would relate these aspects of store location to dynamic processes.

Another equilibrium approach to a dynamic process is demonstrated by Morrill.[12] His spatial price equilibrium solution to a change in market areas as a result of a change in transportation facilities could be used to determine changes in retail store trading areas. A spatial equilibrium model would explain, normatively, the differential conditions resulting when there is imbalance of supply or demand for a retail good or service in an area and would predict the direction of movement for those goods. Urban changes would tend to bring about new trade areas and new patterns of consumer movements. A dynamic theory might evaluate these changes in urban areas in terms of monetary benefits or losses attributable to changes in accessibility in threshold levels for goods, in retail store spatial affinities, and so on. Although spatial equilibrium models would not provide explanations for location, they would help to explain changes in trade areas, which would certainly be helpful in explaining store location patterns.

In the following paragraphs, the simulation model is

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[12]Richard L. Morrill, "A Normative Model of Trade Areas and Transportation: With Special Reference to Highways and Physicians' Services" (unpublished Ph.D. thesis, University of Washington, 1960), pp. 11-12.

discussed. This technique of analysis might prove to be helpful as a testing device in giving direction to the suggested urban study approaches mentioned.

Simulation Models

A simulation model is used when a problem cannot be attacked by use of a simple model. Simulation models have been used to investigate the properties of a real system by introducing notions of the probability of occurrence of phenomena and then performing sampling experiments upon the model. Dacey suggests that a simulation model might be useful after reducing "a spatial pattern to a concise, probabilistic, descriptive statement."[13]

Hägerstrand[14] introduced the use of simulation models to American geography, and Nystuen, Garrison, and Dacey indicated their usefulness in urban research. Nystuen simulated multiple purpose shopping trips as a method of testing theoretical notions concerning these trips.[15] Garrison suggested that a simulation model might be used to study the internal pattern of urban growth and development.[16] It is Garrison's suggestion which might be

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[13]Michael F. Dacey, "Identification of Patterns on Maps with Special Reference to Data Reduction for Systems Analysis" (unpublished Ph.D. thesis, University of Washington, 1960), pp. 11-12.

[14]Torsten Hägerstrand, "Migration and Area," Migration in Sweden: A Symposium, edited by David Hannerberg, Torsten Hägerstrand, and Bruno Odeving (Lund, Sweden: C.W.K. Gleerup Publishers, 1957), pp. 27-158.

[15]Nystuen, op. cit., pp. 112-139.

used, in modified form, in the study of retail store location patterns as they change over time.

With advanced knowledge of the character of the geographic, economic, and psychological factors mentioned in the last section, it would be possible to simulate a pattern of retail store location. This could be done by considering the location of disposable income at a given time period in the growth of a city and the actual distribution of retail stores. By introducing changes in disposable income distribution, changes could be noted in the location of retail stores by simulating in a probabilistic way the effect the factors would have on the new retail store locations. Repetition of the process for each time period might reveal recognizable patterns which could be checked with real world situations. In this way the probabilities could be reworked and the modified model would be applied. This process would be repeated until reasonable "fits" can be made of the simulated patterns and the real patterns. Certainly this is a long and involved process, but it might prove to be efficient in the long run. With the use of this type of model it might be possible to gain an understanding of the importance of each of the variables in determining store location. Also, certain variables might be excluded from the model and introduced one by one until a diminishing return in the amount of "explanation" is

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[16]William L. Garrison, "Toward a Simulation Model of Urban Growth and Development," Paper given at the International Geographical Union Symposium on Urban Studies, Lund, Sweden, 1960.

noted. This technique might prove a valuable tool in building a modified theory.

Concluding Note

An attempt was made in this study to evaluate carefully the theory of the location of retail stores which was assembled from the work of geographers and economists. It is hoped that future urban research will benefit from the findings of the empirical tests made on that theory, from the introduction of new techniques of analysis, and from the suggestions for a modified theory developed in this study.

In summary, it should be stated that in our search for a more realistic theory of retail store location we did not expect to find an irrefutable set of relationships that completely explain the location of retail stores. In this study we were judging the appropriateness of an imperfectly realistic theory as a tool for further research and, in effect, we were re-examining the plausibility of some of the theory's basic assumptions. It is felt that it is necessary every so often to discard or modify theoretical postules which yield conclusions which are shown to be unworthy of further confidence. Theory can be more enlightening if it leads to the development of hypotheses which have practical applications and brings us closer to a greater understanding of reality.

APPENDIX

APPENDIX

THE DETERMINATION OF DISPOSABLE INCOME AVAILABLE FOR GROCERIES

In Chapter IV it was mentioned that the Appendix contains a more detailed description of the way in which the amount of disposable income available for groceries in Tacoma was determined. Cell 13-10 is used to illustrate the procedure. The cell falls partly within census tract 25 and partly within census tract 26. The first step was therefore to discover the disposable income available for groceries in those two census tracts.

The United States census for 1950 allocates the families in each census tract to one of fourteen income groups. For tracts 25 and 26 the mean income of each of these groups was multiplied by the number of families in each, and the results were totalled. In other words, the total incomes of people in tracts 25 and 26 have now been determined. In the case of those earning over $10,000, the figure $17,000 was used as the mean. It should be mentioned that population changes in the study area during the period 1950-1958 were rather small. However, whenever it was felt necessary to update the census data, the change in population was spread evenly throughout the fourteen census income group categories. To facilitate subsequent calculations the income groups were reduced to seven.

The next step was to determine the income available for groceries in census tracts 25 and 26 in 1958. (Table A.1) Multipliers were used to increase the 1950 gross income to realistic current dollar figures for 1958. The multipliers are derived after examination of tables which reveal the changes in income for various income groups over time in portions of the United States.[1]

Table A.2 is one of a number of tables which show how consumers allocate their income for retail goods. The percentage figures listed for "grocery and combination" goods were used to find that portion of 1958 gross income that was allocated for groceries in the two census tracts. Now it is possible to find the consumption expenditures available for groceries in cell 13-10. The population of the cell was determined by counting the dots falling within the cell on a population dot map of Tacoma (Figure 4.1). That portion of the population of census tract 25 and of 26 that is included in cell 13-10 was found. These percentage figures were applied to the total income available for groceries in the two tracts and then totalled. This figure represents the estimated income available for groceries in cell 13-10 for 1958. For census tract 25, $288,193 is the estimated amount available for groceries in one of the parts of cell 13-10. For census tract 26, the figure is $56,578.

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[1] U.S. Bureau of the Census, Statistical Abstract of the United States: 1960. (81st ed.; Washington, 1960), Table 409, p. 373, Personal Income--Changes in Total and Per Capita Personal Income, by States: 1929-1958; Table 418, p. 320, Families and Unattached Individuals and Family Personal Income by Income Level: 1944 to 1958.

TABLE A.1

GROSS INCOME AND INCOME AVAILABLE FOR GROCERIES IN CENSUS TRACTS 25 AND 26
BY INCOME GROUPS IN 1958

Census Tract 25	Families	1950 Gross Income	Per Cent Change Gross Income 1950-1958	1957 Gross Income	Per Cent of Gross Income Available for Groceries	Income Available for Groceries 1958
Census Tract 25						
$1,999 or less	625	$ 531,250	30%	$ 690,625	34.00%	$ 234,808
2,000 - 2,999	280	722,500	30	939,250	32.00	300,565
3,000 - 3,999	585	2,043,750	30	2,656,875	29.75	790,370
4,000 - 4,999	270	1,212,500	30	1,576,250	28.32	446,399
5,000 - 5,999	175	962,500	30	1,251,250	24.24	303,262
6,000 - 6,999	120	780,000	30	1,014,000	22.75	230,690
7,000 or more	135	1,402,500	25	1,753,125	18.20	315,536
						$2,621,630
Census Tract 26						
$1,999 or less	150	$ 157,500	30%	$ 204,750	34.00%	$ 69,613
2,000 - 2,999	165	418,750	30	544,375	32.00	174,203
3,000 - 3,999	310	1,048,750	30	1,363,375	29.75	405,578
4,000 - 4,999	160	710,000	30	923,000	28.32	261,397
5,000 - 5,999	60	330,000	30	429,000	24.24	103,975
6,000 - 6,999	35	227,500	30	295,750	22.75	67,285
7,000 or more	20	212,500	25	265,625	18.20	47,808
						$1,129,859

TABLE A.2

BREAKDOWN OF PERSONAL CONSUMPTION EXPENDITURES

Gross Family Income (100 per cent)	$1,999 or less	$2,000-2,999	$3,000-3,999	$4,000-4,999	$5,000-5,999	$6,000-6,999	$7,000-7,999	$8,000- or more
Percentage for taxes, savings & housing	23.70	24.28	26.64	26.67	30.55	30.72	32.33	33.18
Net percentage available for consumer	76.30	75.72	73.36	73.33	69.45	69.28	67.67	66.82
Type of Goods or Facility	Percentage of Gross Income Expended							
Convenience goods								
Drugs	2.35	2.35	2.35	2.38	2.32	2.32	2.25	2.25
Grocery & combination	34.00	32.00	29.75	28.32	24.24	22.75	20.60	19.39
Other food	4.10	4.00	4.25	4.20	4.15	4.20	4.00	4.00
Liquor	1.00	1.05	1.10	1.20	1.10	1.15	1.10	1.10
Hardware	0.65	0.65	0.70	0.92	0.97	1.10	1.15	1.38
Filling stations & accessories	3.25	3.35	3.52	4.65	4.65	4.40	4.10	4.00
Other stores	2.75	2.70	2.70	2.80	2.75	3.20	3.25	3.33
Total	48.10	46.10	44.37	44.47	40.18	39.12	36.45	35.45
Primary shoppers' goods								
Department stores	5.00	6.00	6.75	7.35	7.55	8.25	8.00	7.75
Family & other apparel	1.00	1.00	1.00	1.00	1.07	1.25	1.75	1.75
Men's clothing & furnishi furnishings	0.75	0.95	1.08	1.13	1.13	1.33	1.40	1.40
Shoes, men's & family	0.50	0.55	0.55	0.48	0.48	0.45	0.60	0.70
Shoes, women's	0.45	0.50	0.58	0.62	0.62	0.60	0.63	0.68
Women's apparel	2.85	2.80	3.00	3.18	3.33	3.50	3.50	3.30
Variety stores	1.33	1.40	1.50	1.45	1.45	1.35	1.35	1.35
Jewelry	0.20	0.20	0.20	0.35	0.34	0.33	0.40	0.50
Total	12.08	13.40	14.66	15.56	15.97	17.06	17.63	17.43

TABLE A.2--(CONTINUED)

Type of Goods or Facility	$1,999 or less	$2,000-2,999	$3,000-3,999	$4,000-4,999	$5,000-5,999	$6,000-6,999	$7,000-7,999	$8,000- or more
	Percentage of Gross Income Expended							
Secondary shoppers' goods								
Furniture & household furnishings	1.50	1.50	1.64	1.70	1.75	1.85	1.90	2.10
Household appliances & radio	1.48	1.48	1.60	1.65	1.60	1.55	1.75	1.80
Eating & drinking places	5.62	5.30	2.75	1.80	1.95	1.95	2.22	2.16
Total	8.60	8.28	5.99	5.15	5.30	5.35	5.87	6.06
General purchases								
Auto dealers	6.70	7.10	7.50	7.35	7.25	7.00	7.00	7.20
Auto parts & accessories	0.82	0.84	0.84	0.80	0.75	0.75	0.72	0.68
Total	7.52	7.94	8.34	8.15	8.00	7.75	7.72	7.88

Source: Richard L. Nelson, The Selection of Retail Locations, op. cit., p. 222.

The total is $344,771.

For many census tracts it was found necessary to determine the location of the residences of families in the higher income groups. This permitted a more realistic determination of expenditures for groceries in the cells. It was not necessary to determine these locations for census tracts 25 and 26 since it was noted that a very small portion of the population earned over $7,000 in 1958. Had it been necessary to locate the upper income level residences in cell 13-10, census of housing data would have been used. The block by block data shows the average value of home for cell blocks within the city. If it was found that one particular area within a census tract contained a number of blocks with houses valued $10,000 or more, then these areas would be marked on the dot population map and adjustments made accordingly in the grocery expenditure determinations.

Table A.3 compares the estimated consumption expenditures available for groceries as derived by the above procedure and the actual groceries sales in South Tacoma in 1958. There is a five per cent difference between the totals of the two columns.

TABLE A.3

COMPARISON OF ESTIMATED AND ACTUAL GROCERY STORE EXPENDITURES, 1958

Cell Number	Estimate of Income Available for Groceries	Actual Grocery Sales
10-11	$ 235,379	
10-11	321,164	
10-12	610,659	$ 34,645
10-13	449,119	803,997
10-14	462,213	*
10-15	496,137	586,227
11-10	542,882	*
11-11	662,539	2,533,963
11-12	764,217	2,245,430
11-13	471,692	300,806
11-14	612,489	136,403
11-15	440,163	*
12		
12-10	457,129	*
12-11	728,394	100,250
12-12	940,134	676,000
12-13	534,591	*
12-14	264,378	86,114
12-15	1,022,875	
13-10	344,771	
13-11	827,394	685,994
13-12	822,971	
13-13	420,224	329,267
13-14	287,706	
13-15	162,453	
14-10	193,773	
14-11	515,177	248,955
14-12	679,764	2,033,758
14-13	264,630	
14-14	298,328	
14-15	45,897	*

TABLE A.3 (CONTINUED)

Cell Number	Estimate of Income Available for Groceries	Actual Grocery Sales
15-10	$ 24,067	
15-11	396,988	*
15-12	508,468	$1,955,215
15-13	336,272	
15-14	152,989	*
15-15	99,443	*
16-10	34,613	
16-11	311,518	*
16-12	300,205	
16-13	31,271	
17-10	43,266	
17-11	250,945	*
17-12	262,680	*
17-13	168-865	
18-10	86,533	
18-11	147,106	*
18-12	175,120	*
18-13	87 ,560	
	18,356,151	17,105,713

*Disclosure precludes use of sales figure.

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