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Application of location theory and empirical data by area industrial development groups

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APPLICATION OF LOCATION THEORY AND EMPIRICAL DATA BY AREA INDUSTRIAL DEVELOPMENT GROUPS

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CHAPTER I

INTRODUCTION

Purpose

The objective of this paper is to determine if theories of industrial location and empirical data describing changes in manufacturing employment might suggest efficient approaches in attracting industry to a particular area. This is in sharp contrast to the usual application of location theory in which the optimum location of a firm or of a particular industry is selected.

While the area industrial development organization and the industrial firm seeking a new location have much in common, they approach the problem from opposite ends of the pole. Theoretically, the firm considers all of the land area in the world as a potential location and selects that site that will maximize profits over the long run. On the other hand, the area development organization is soliciting the firm, from all firms considering a new location, that will make a maximum economic contribution to the people within the area represented.

The objective of development groups is to locate within their area the largest amount of industry that can be sustained by the resources of the area. While the area is limited by resources, the effort to attract industry has more immediate limitations. These limitations may be economic or institutional.

Institutional limitations take many forms but are most frequently found in social attitudes and legislative action. For example, an area

rich in resources that might attract industry may be dominated by a group that wishes to preserve the status quo. In the case of legislative limitations the law of the land might prohibit tax forgiveness programs. Such limitations, while active considerations in day-to-day industrial development work, are considered to be outside the framework of this paper.

Economic limitations might take two forms. First, the development agency is faced with budgetary realities. It will have a given number of dollars to sustain its program over a given period of time. Secondly, there will be a limit to the financial concessions that may be granted in attracting a new industry. These concessions could be such things as gifts of land or low cost capital funds.

This paper will attempt to develop from existing location theory guidelines that might allow more efficient utilization of these limited financial resources.

Structure of Industrial Development Effort

Perhaps the most basic question to be answered is, Why encourage an industrial firm to move into an area? A recent study[1] prepared for the Chamber of Commerce of the United States reported areas undergoing substantial increases in manufacturing employment between 1950 and 1960 had witnessed dramatic economic changes. For every 100 factory jobs, this study found, the area's population increased 359 persons, personal income rose $710,000 per year, and additional job opportunities for 65 other

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[1]Chamber of Commerce of the United States, What New Industrial Jobs Mean to a Community (Washington: Chamber of Commerce of the United States, 1962), p. 6.

persons in non-manufacturing pursuit came into being.[2] Other secondary and tertiary results were the establishment of three more retail stores, an increase in annual retail sales of $331,000 with bank deposits going up $229,000, the registration of 97 additional passenger cars and the development of 100 more households. In summary, additional manufacturing jobs contributed substantially to those factors considered indices of economic growth.

The key to generation of income through manufacturing payrolls is found in value added in the manufacturing process. Fifty-three per cent[3] of the value added is in the form of wage payments. These wage payments circulate in the community with the total effect dependent upon the multiplier and leakage to other areas.

Considering the inter-area aspects of income flow, the sale of manufactured goods outside of the area of manufacture produces revenue which will support further wage payment in the area of manufacture. Conversely, the community without manufacturing firms tends to become an exporter of income. It does not compensate for the flow of payments to other areas by sales of locally manufactured goods in the competing areas.

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[2]These data are based on empirical observations in 11 counties located throughout the United States. Counties selected met the following criteria: (1) manufacturing employment at least doubled during the decade; (2) manufacturing employment constituted at least 15 per cent of total employment in 1960; (3) major employment change, excluding decreases in agriculture, was increased in manufacturing; and (4) county not part of or adjoining a metropolitan area.

[3]Bureau of the Census, Annual Survey of Manufactures; 1962. (General Statistics for Industry Groups and Selected Industries. Washington: Bureau of the Census, 1963), p. 4.

Other forms of economic activities create value added and thus add to a community's income. But the income generated is a relatively smaller proportion of total sales than that generated through manufacture. Agricultural production has a large value added ratio, but the decline in the price level of agricultural products, and consequent decline in over-all dollar sales, coupled with mechanization of farming activities have reduced the relative importance of farming in generating income. This decline has been quite marked in the south, and, as would logically follow, this region has become very aggressive in industry attracting activities.

There are about 11,000 industrial development agencies in the United States. In 1964 new plant locations will probably number about 4,050.[4] In terms of units employing 250 or more the number of new plants probably will be around 1,390--or one major factory for every eight industrial development agencies! Admitting the possibility of wide variations in these figures, it can be concluded that industrial development is a very competitive field.

Aside from the common objective of attracting new industry to a particular area, there is little cooperation among the groups supporting the effort. The revenue to sustain industrial development agencies comes from tax sources, membership payments to chambers of commerce and trade associations, and normal business operations.

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[4] Industrial Development Magazine reports each month location of plants costing $100,000 or more, having at least 10,000 square feet and employing not less than 25 persons. This source reported 3,716 locations in 1962. The U.S. Department of Commerce reports 1963 expenditure on new plant and equipment to be 4.7 per cent above 1962. The annual survey conducted by McGraw-Hill, Inc., revealed firms plan to increase plant and equipment expenditure by 4.0 per cent in 1964. Assuming a constant ratio between new plants and expenditures, 4,046 new plants (3,716 x 1.047 x 1.040) could potentially be established in 1964.

Federal and state governments, state and local chambers of commerce, banks, manufacturers' associations, utility companies and regional and local development organizations are typical groups active in the field.

Normally business firms exerting an effort in this field are interested in expanding markets and thus increasing profits. Railroads want to increase revenue by locating factories needing rail service along their roads. Power companies would like to have large power users locate within the limits of their distribution system.

Governmental units (federal, state, regional and local) and chambers of commerce are motivated by their desire to provide jobs and increase income within their sphere of responsibility. The broadening of the tax base by adding wealth, particularly in the form of buildings, is often a motivating factor.

These groups approach the problem from much the same way. They provide the prospect information on which the location decision is based.

The prospects are developed from a variety of sources including inquiries from firms planning expansion or relocation, scanning of financial news, word of mouth and personal visits with corporate officers. Most agencies budget a portion of their resources for advertising in financial and trade media. The salary and travel expense of agency representatives that present information to prospects is a major expense item.

Summary

From the viewpoint of the development agencies, the location of a new factory unit is quite competitive. At the same time the pay-off is

substantial. The purpose of this paper is to investigate the possibility of applying industrial location theory to the efforts of area industrial development organizations. The immediate objective would be to increase the efficiency of this effort.

In the chapters ahead various economic theories of location will be reviewed, empirical data describing changes in manufacturing employment will be presented, the data will be related to location theory, and conclusions will be drawn on the feasibility of applying location theory to the development effort.

CHAPTER II

REVIEW OF LOCATION THEORY

Material dealing with a general theory of industrial location is rather limited. Most of the writings in the field of industrial location deal in specifics. Numerous articles explaining the location of an industry are available as are articles dealing with the influence of a single location factor.

This phase of the investigation will be limited to an examination and evaluation of material that contributes to location theory from a general viewpoint. The objective will be to select one or two approaches which will be further developed by the application of empirical data.

Plant location theory is based upon the economic theory of substitution. Whether the immediate problem is the selection of one site from many possibilities or the substitution of "x" units of capital for "y" units of labor, there is a common objective.

To the economist the objective is allocation of scarce means among competing uses in an optimum manner. To the businessman the objective is selecting that combination of factors that will result in maximum long run profits. Obviously, the factors might influence either expenditures and/or revenue. The objective then becomes one of maximizing the difference--the net profit.

Von Thunen

Johann Heinrich von Thunen is the father of location theory. The original thoughts as stated in his Der Isolierte Staat in Beziehung auf

Landwirtschaft und Nationalokonomie, published in 1842, have provided all interested in this subject with a point of departure.

Von Thunen assumes an isolated state comprised of a uniformly fertile plane and void of navigable rivers or canals. Within the only city, located near the center of the state, are metal mines. The structure of the economy is such that workers within the city will produce manufactured products for the surrounding rural area while farmers will supply city dwellers with foodstuff.

Von Thunen states the problem, "How will agricultural production develop under these circumstances and how will . . . distance from the city affect . . . cultivation . . . ?"[1] Obviously von Thunen is concerned with a specialized location problem--the location of agricultural enterprises. His thoughts can be applied to the location of a factory by a change of purpose. Instead of thinking in terms of the optimum location of a crop, one raises the question in relation to the location of an industrial enterprise.

Based on his postulated state, von Thunen proceeds to answer his question:

> . . . it is clear that close to the town there will be produced such crops as, in relation to their value, have a considerable weight or take much space and such crops as require transportation cost so heavy that they cannot be brought to the town from the more distant areas. The greater the distance from the town, the more it will be found that land will be used for the production of goods which, in relation to their value, require lower costs of transportation. . . . There will be pretty definite and distinct concentric

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[1]J. H. von Thunen, Der Isolierte Staat in Beziehung auf Landwirtschaft und Nationalokonomie (translated in History of Economic Thought, ed. K. William Kapp and Lore L. Kapp, New York; Barnes & Noble, Inc., 1949), p. 300.

circles around the town in which either this or that crop will be the main crop.[2]

Later von Thunen defined land rent as the amount remaining after costs of production are deducted from sales. The location of particular crops (for the purposes of this paper the particular industry) was determined by the least-cost combination of transportation and land rent.[3] In effect, it became a problem in substitution.

Weber

While von Thunen provided the departure point in location theory, Alfred Weber was the first to attempt to construct a general location theory. In his book Uber den Standort der Industrien, published in 1909, Weber used an evolutionary approach in developing a general theory

He started with an undeveloped country and proceeded to develop an isolated economy The first development was an agricultural stratum which produced the means of subsistence This stratum served as the geographical foundation for subsequent developments. The second stratum was comprised of primary industry which produced for the agricultural stratum.

The primary industrial stratum in turn became the orientation plans for the third stratum, namely, the secondary industrial stratum. These three strata formed the core of the economic system--a system in which the relationship of producing units depended upon the location of consuming units in the supporting stratum. A fourth stratum,

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[2] Ibid. [3] Ibid., pp. 303-304.

consisting of general organizing and managing functions, and a fifth stratum, the central dependent stratum, were related to the organizing and managing function in much the same way as the secondary industrial stratum was related to the primary industrial stratum.[4] The forces of demand and supply playing back and forth among the five strata tied them into an economic unit and determined the locational structure.

Procedurally, the theory developed by Weber is in sharp contrast to von Thunen's work. The earlier writer determined the type of production at a given location while Weber sought the location of a given industry.

Weber's theory is based upon three general factors of location--transportation cost, labor cost, and agglomerating forces. Included in transportation cost are variations in raw material and fuel cost. Hence, a location producing a relatively high quality fuel commanding a relatively high price is considered more remote than competing areas producing a lower quality fuel.

Considering first the transportation variable, Webarian theory explains industrial location as determined by the character of the manufacturing process. If the process is one that results in a loss of weight in the conversion from raw materials to finished goods the plant is pulled toward the source of raw materials. A weight gaining process favors a location near the point of consumption. Where more than one source of raw materials exists and the process results in weight loss, the transportation

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[4]Walter Isard, Location and Space-Economy (New York; John Wiley & Sons, Inc., 1956) p. 29.

factor would dictate a location oriented to raw materials and resulting in a point of least transfer cost. The same concept would hold for a market oriented industry except that the pull would be toward the points of consumption.

Since Weber did not assume equal real wages and productivity, as did von Thunen, he could not ignore labor cost. Therefore, labor cost becomes the second variable exerting a locational pull. The relative importance of this factor is determined by the savings that might be effected through lower cost labor. Where savings are large enough, the labor variable might override the influence of transportation cost; i.e., where the savings in labor cost are larger than the additional transportation cost incurred because of location at a less than optimum point considering transportation alone.

The third variable in Weber's theory is the effect of agglomerating or deglomerating forces. This factor tends to draw industry closer together or to disperse it. Savings due to proximity to auxiliary industries, better marketing outlets, or economies of size tend to localize industry.[5] On the other hand, the higher land cost inherent in industrial concentration tends to disperse industry.

Weberian theory involves a rather close association between the labor and agglomerating factors. He held that only industries with a high value added could reduce expenses through agglomeration. In his analysis the necessary high value added had two main constituents--labor

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[5]Melvin L. Greenhut, Plant Location in Theory and In Practice (Chapel Hill: The University of North Carolina Press, 1956), pp. 9-10.

cost and machine cost Since a high degree of correlation exists between machine cost and fuel cost, and consequently between machine cost and transportation, this consideration fell under the influence of transportation Therefore, only when labor cost is the major contribution to value added does an agglomeration force exist.[6]

In further analysis, Weber determines that there exists no relationship between distance and pull of the labor factor. Proximity to an advantageous labor center yields little advantage. The labor factor either attracts a plant all the way to the labor center or leaves it unaffected.

In application Weber's theory of location involves substitution between transport cost and non-transport cost factors. Transport costs are defined to include the cost of shipping raw materials and finished products and also the different cost of fuel and raw materials at given sites. Also two agglomerating factors--proximity to auxiliary industries and marketing advantages--are included. Non-transport cost include labor and land cost In effect, non-transport cost are defined to include all Weberian variables which are non-transport in origin.

A curve of substitution connecting all points at which an equal number of units may be sold is constructed.[7] The locality represented by the point nearest the point of unitary elasticity on the substitution curve is selected as the optimum location since it represents the least cost location.

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[6] Ibid.

[7] This system does not take into consideration the influence of location on volume of sales. Cost of production and marketing are the sole considerations.

Predohl

Andreas Predohl's approach to location theory[8] was an application of the theory of interdependent prices and quantities. He contended the distribution of economic activity was the same problem as that involved in the distribution of groups of productive factors. He concluded that the general theory of interdependence explained the distribution of groups of production factors by means of the substitution principle. In his analysis transportation cost is generally abstracted and the factors and products possess perfect mobility.

In his development of a general equilibrium, Predohl started with an isolated state with all economic activities fixed save one. For purposes of substitution, costs were divided into land use outlay and all other outlay. Transfer costs were included in the second category. A shifting of the firm toward the periphery involves the substitution of labor and capital for land. Through this approach the minimum cost location for these two categories is located. However, within these two groups, i.e., land use outlay and labor and capital outlay, there will be other substitution possibilities. The individual firm in deciding where to process a product to reduce its weight is substituting transfer cost for local labor and capital. The firm has substitution possibilities within a given cost factor. For example, raw materials may be transported from various points. This inter-category and intra-category determine the location of any individual firm. Predohl held this approach

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[8]Predohl's thinking on location theory appeared in an article, "Das Standortsproblem in der Wirtschaftstheorie" published in 1925.

could be extended by use of general equilibrium analysis to cover the location of all economic activities.

Weigmann

Hans Weigmann introduced realism into the theory of location. He contended any theory purporting to explain the location of firms should take into account the fact of limited competition. The immobilities of factors and goods and the restrictions in markets are evidence of limited competition. Hence, the assumption of pure competition was not applicable in location theory.

Another contribution by Weigmann was his consideration of the influence of time on markets for land, labor and capital. While he introduced these important considerations, he did little to formulate a precise theory containing these variables. Weigmann sketched the space economy as an undulating unit composed of a basic core containing markets for land, labor and capital goods. Upon this basic core are superimposed numerous other markets, which not only influence the space economy upon which they are constructed, but extend temporarily into other economic spheres.[9]

Losch

August Losch approached location theory by postulating a broad, homogeneous plain with uniform transport features in all directions and with an even scatter of industrial raw materials in sufficient quantity

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[9]Isard, op. cit., pp. 37-42.

for production. The agricultural population of this plain are uniformly distributed, each individual having identical tastes, preferences, technical knowledge and production opportunities. These assumptions yielded a plain dotted with self-sufficient households.

From this point Losch moves into a dynamic situation with a farmer producing a product to sell his neighbors. The shape of the market area covered is that of a circle. Competition arises and the market area for the producer of the product is forced into the shape of a hexagon--this being the shape nearest to the circle that will completely cover an area without overlap. Other products are introduced and each results in the plain being divided into hexagons. The size of the hexagon varies by products but in each case completely covers the plain.

As these hexagon described plains are placed one upon the other, patterns of concentration will develop. These concentration points will determine the transportation system, introduce concentration of population and enhance consumer demand by enabling diverse purchases from many local producers. Losch maintains these are the reasons industry tends to agglomerate. The regions served by the concentrated industry will be determined by the product having the largest necessary shipping radius.[10]

Concentration of population destroys one of the assumptions necessary to the above condition. This change in the uniform scatter of population results in the destruction of the hexagional systems and conditions of competition.

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[10] Ibid., pp. 42-50.

Ohlin

A number of theorist stressed the interrelation of trade and location theories but Bertil Ohlin was the first to attempt to integrate the two. His objective was to develop a location theory that would encompass international trade theory. The influence of local differences in the supply of factors of production and transportation costs within each country were variables he considered.

For purposes of analysis his regions are defined as areas within which there is perfect mobility of factors and between which there is perfect immobility of factors All impediments of movement of commodities are assumed away. He then approaches reality by introducing interregional cost of transfer of commodities and interregional factor movement.

The cost of transfer and factor movement within the region, combined with local differences in labor and capital supply, subjected the interregional trade theory to a broadening process and produced his general localization theory.

Ohlin developed his theory within the framework of a mutual-interdependence theory of pricing. Varying spatial immobilities and indivisibilities of goods and factors produced a multitude of markets and local prices. His general localization theory, through the interactions of this system, would determine prices and markets in addition to the location of economic activity [11]

Hoover

Location theory as developed by Edgar M. Hoover continues as a problem of substitution with some variation in its application The

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[11] Ibid., pp. 51-53.

change is primarily one of classification of cost factors. In his analysis these factors are classified as transportation cost and production cost. While this represents the primary change, other important considerations are involved in the assignment of various cost to the appropriate category, i.e., transportation or production cost.[12]

Hoover observes that transportation cost cannot be considered to vary directly with distance and weight. Instead, cost of transportation for raw materials and products on a ton-mile basis will decrease with an increase in the length of haul. Therefore, these charges should not be considered as a linear function of quantity and space.[13]

For purposes of application, transportation cost as defined by Hoover include only the transit expenses on raw material and finished products. Production cost includes all other outlays involved in producing goods at a given site. Into the production cost category he places not only direct production outlays such as labor cost, but also cost associated with agglomerative forces and institutional factors.[14] With such a rigorous definition transportation cost becomes much more implicit as a location factor.

The introduction of institutional cost into locational analysis places Hoover's contribution within the capitalistic framework. He considers taxes and cost incidental to air conditioning and heating as an element of land cost.

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[12]Greenhut, op. cit., pp. 17-18.

[13]Edgar M. Hoover, The Location of Economic Activity (New York; McGraw Hill Book Company, Inc., 1948), pp. 15-26.

[14]Ibid., pp. 67-89.

While Hoover's writing has added considerable breadth to location and analysis, it is still limited to cost of producing goods. He alludes to the influence of supply and market areas, but does not develop or include the effect of these factors in location determination.

Isard

In the preface to his exhaustive analysis of location theory Walter Isard observes "a comprehensive theory of society or economy should embrace both time and space . . . (and) unravel interplay of forces not only currently but also over the long past."[15] With the admission that his contribution will be of "little direct utility for handling specific problems," Isard proceeds to develop a general location theory.

This theory, eclectic by nature, is presented as a general theory designed to explain past, present and future location of economic activities. The broader purpose of maximizing benefits for society, as contrasted with maximizing profits, becomes his guide in selecting the optimum location.

Isard distinguishes between two types of substitution: (1) that between transport inputs; and (2) that between outlays, between revenues, and between outlays and revenues. He justifies this approach when he states that without some relationship between distance and variations of costs and prices there would be no logic to the explanation of economic activities.[16]

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[15]Isard, op. cit., p. vii. [16]Ibid., p. 35.

Transport inputs become the heart of Isard's analysis. Distance and weight are the two basic factors and transport rates are the price of the input. When integrated with production theory, the problem becomes a problem of choosing the right combination of the various types of capital, labor, land and transport inputs.

For purposes of analysis, Isard classifies location factors into three groups. In the first group he includes transport costs and certain other transfer costs. These costs have a distinguishing feature: regular variability with distance. Since terminal cost is relatively more important for a short haul, the relationship between transport cost and distance is not likely to be linear. Also, tariffs and transfer of goods from one form of transportation to another tend to reduce, but not destroy, the regularity of the distance-cost relationship.

The second group of location factors is comprised of cost for which no variability with distance can be established. This would include costs associated with labor, power, water, taxes, insurance, interest, climate, topography and many others.

Agglomeration and deglomeration economies are covered by the third group of location factors. Agglomeration economies are defined to include (1) economies of scale; (2) localization economies; and (3) urbanization economies. Deglomerative forces embrace (1) diseconomies occurring when scale of operation becomes too large; (2) increased rents associated with increase in intensity of land use; and (3) increased food cost occasioned by lengthening agricultural supply lines.

After grouping factors involved in location selection into a form that can be handled, Isard used substitution to select the optimum site.

As stated earlier, transport inputs are the foundation upon which his theory is constructed. Transport inputs are defined as the movement of a unit weight over a unit distance and transport rate is the price of the input. The problem of finding the transport optimal point reduces to a problem of finding the correct substitution points between pairs of inputs.

Where more than two transport inputs are factors in the problem, as would be the case where three or more sources of raw materials are under consideration, transport inputs generated from one source are compared with the sum of inputs originating from all other sources. Through application of the substitution principle Isard constructs price-ratio lines using the transport input concept as the price of the two variables. A transformation line describing the distance-weight relationship of raw material sources and the market point to be served is compared with the price-ratio lines. The optimal location is the point of tangency between the two curves.[17]

Where an area market, rather than a market located at a point, is to be served the analysis developed above is reversed. The point requiring the least transport inputs to serve a market area in relation to a single raw material source is located.

Other location factors as suggested in group two above are integrated with transport inputs as a substitution of one outlay for another. A cheap labor point within the area under study is considered as a sub-

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[17] Ibid., pp. 95-104.

stitution of transport outlay for labor outlay. The transport outlay will increase because less than the optimal point is considered but the lower labor cost will more than offset this increase. The net result is a decrease in outlay. Other factors, such as power, rent, and taxes can be handled in the same manner.

The third group of location factors--agglomerative and deglomerative forces--are also considered by Isard as substitutions for transport outlays. As an example, should a firm decide to locate one large plant rather than three smaller plants, the primary factors considered are the increase in transport outlay occasioned by longer supply lines to raw materials and/or distribution lines to markets versus the economies afforded by the larger scale operation.[18]

Revenue that might be expected from various locations is interjected into this approach with the construction of iso-revenue-less-outlay lines. These are predicated upon the assumption that a firm has little, if any, influence upon the pattern of market prices. The location yielding the maximum difference between product revenue and transport outlay is considered as the site that will result in the greatest profit.

Greenhut

In contrast to other location theorist who set about to formulate general theories explaining the location of economic activities, Melvin L. Greenhut's announced objective is to devise a theory explaining industrial location within a capitalistic economy.[19] His major work in this

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[18] Ibid., pp. 173-178. [19] Greenhut, op. cit., p. v.

field was published in 1956, the same year as Isard's book. While Isard used theoretical approach, Greenhut reviews previous theory, presents empirical data on the location of small firms, and attempts to integrate the empirical findings with existing theory. Failure to find accord between general theory and experience of the small firms studied is the basis for Greenhut's contribution to location theory.

The findings that failed to fit into the general theory are described by Greenhut as "personal factors." These include such considerations as availability of loan capital because of personal contact of the owner or sales due to personal relationship between owner and customer. These factors stand outside of earlier theory since previous writers assumed the system would attempt to distribute scarce goods in such a manner as to maximize the output. Such factors cannot be included in a capitalistic system since this system carries a basic assumption that decisions are based on the desire to maximize profits.

After examining the approaches that might allow inclusion of personal factors,[20] Greenhut concludes that the general maximum profit objective must be retained in order to retain the basic assumption of economic man motivated to rational action by pecuniary returns.

This excursion completed, Greenhut summarizes his theoretical concept as:

> . . . each firm entering the competitive scene will seek that site from which its sales to a given number of buyers

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[20]The possibilities considered are (1) a maximum profit and a maximum satisfaction theory; (2) a maximum profit theory including imputed values for psychic income; and (3) a maximum satisfaction theory in which profits and nonpecuniary returns are equated with satisfaction.

> (whose purchases are required for the greatest possible profits) can be served at the lowest total cost.[21]

This statement emphasizes to a greater extent than earlier writings the importance of demand. The influence of demand on location is underlined by observations that successful attempts of competitors to locate at a point of maximum profits reduce relative demand and thereby cut profits. This will result in a state of equilibrium which might be disturbed by shifts in demand or changes in cost.

Greenhut also observes an interrelation between competing firms. This might be in the form of market area served or demand for labor. Due to this interrelationship a change by a competitor can influence both demand and cost of the firm and disturb the state of equilibrium.

Greenhut finds that demand and cost are not sole determinants of equilibrium and that personal factors are to be reckoned with. Variations in psychic income cause "different ascriptions to cost data and encourage relocation and subsequent distortions of all existing relationships."[22]

The factors influencing industrial location are divided into three categories. The first category consists of demand factors and includes shape of the demand curve, location of competitors, significance of proximity to market, influence of personal contact on sales, and extent of the market area.

Cost factors are divided in cost of land, cost of labor and management, cost of materials and equipment and the cost of transportation. Interestingly, this breakdown is virtually synonymous with Isard's production cost classification of land, labor, capital and transport inputs.

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[21] Ibid., p. 285. [22] Ibid., p. 286.

The third factor entails the extent to which psychic income outweighs the maximum profit motivation.[23]

Observations

The economic theory involved in explaining industrial location has changed very little since its earliest statement. Von Thunen's contribution to this body of theory is based on location determined by minimum cost. The principles embodied in this work are the same concepts used by today's theorist. The difference lies in the expansion of theory to give proper consideration to changes in economic society.

In von Thunen's day the consideration of a spatial market was not important. Production of foodstuff was for the purpose of sustaining the producer or for sale or barter in the nearby village. Neither the market system as known today nor the transportation necessary to sustain such a system were considered within the realm of possibility and understandably were not important in theory formulation.

The continued advance of specialization and the hand-in-hand growth of distribution facilities have focused attention on revenue and marketing cost. During the period that location theory has been under consideration, distributive cost have changed from a relatively minor role to a prime consideration in the effort to satisfy human wants. It is only natural that this aspect of total cost be given more attention in explaining industrial location.

The principles involved in location theory have not changed. Substitution of factors continues to be the technique used. But with the

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[23] Ibid., pp. 279-281.

relative change in importance of factors the emphasis has changed. Therefore, when Greenhut and Isard write in terms of a location that will maximize profits or the comparable objective in a general theory it becomes a substitution problem of broader scope whereby various revenue possibilities are weighed against varying combinations of cost. It is still, however, a substitution problem.

At this point it might be well to recognize the problem exposed by Greenhut in his study of small firms locating in Alabama.[24] The personal factor is a real consideration in business decision making but defies quantification. With the growing awareness of the social responsibilities of business, it is reasonable to expect that personal considerations will continue to be a weight in location decisions. It is likely to be more important in the single-unit firm but is not to be completely discounted in the location of branch operations. The influence of this source when applied to cost or demand factors is indirectly reflected in profits. But personal factors that affect psychic income cannot be expressed numerically and, therefore, cannot be used in economic models. For this reason, Greenhut excluded from further consideration purely personal considerations that influence site locations.

With the field thus narrowed, the objective of the location decision becomes one of choosing the site that will yield maximum profits. Profits are that portion of revenue remaining with the firm after payment of operating cost. It is the function of two variables--revenue and outlay.

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[24] Ibid., pp. 181-242.

Therefore, the substitutions to select the site of maximum profits must consider both variables.

While demand factors have been recognized by the more recent theorist as an important element in location decision, it is doubtful that the full impact of these forces has yet been recognized. The primary mission of any industrial operation is the production of goods of the quality desired, delivered to a customer when and where desired, at a price the customer is willing to pay. The profit is derived from the ability of a firm to perform this activity with an outlay below the revenue generated by this function.

In this context, the place of marketing in the overall operation of an industrial firm becomes much more apparent. And the impact of the demand factors in location decision takes on a new dimension not yet fully recognized by the economic theorist or the pragmatic agency responsible for industrial development effort in an area.

CHAPTER III

EMPIRICAL DATA DESCRIBING MANUFACTURING EMPLOYMENT

Changes that have taken place in manufacturing employment, the relative importance of new industries to changes in manufacturing employment, and a review of empirical data related to location selection will be covered in this chapter.

The first topic, changes in manufacturing employment, will be examined in relation to space and time. The year 1950 will be used as the base with changes measured at four-year intervals. The United States, North Carolina, and Virginia will provide the spatial dimension. These comparisons will provide the basis for judgment on the industrial development efforts in affecting industrial employment.

Data on industries located in Virginia since 1950 will be used to determine the relative importance of new industries to changes in manufacturing employment. This section will contain an industry-by-industry comparison of employment changes. The proportion of such changes due to new industry will be determined.

Changes in Manufacturing Employment

As pointed out earlier, 1950 will be used as the base year with changes measured at four-year intervals. Use of 1950, 1954, 1958 and 1962 is dictated by expediency. Data showing employment by industry for many important industries are not available prior to 1950. From the viewpoint of freedom from abnormalities 1950 has a good rating. Major

readjustments following World War II had been accomplished and the Korean Incident had not begun to influence the economic system.

The years 1954 and 1958 are unique in that they are the years in which Census of Manufacturers were conducted. By 1954 the Korean influence had waned.

Finally, 1962 is the most recent year for which complete data are available. Another reason for the selection of these particular years is the consideration of uniform time periods. It allows comparisons of three periods with each period consisting of four years.

Changes between the states of North Carolina and Virginia will be considered. Comparisons of these areas will minimize the influence of certain location factors. For example, transportation cost differential for the two areas should be at a minimum. North Carolina will have some advantage on movement to the south and southwest but this will be offset by the proximity of Virginia sites to northern and mid-western markets. Each has facilities to serve ocean-going and coastwise shipping.

Both states have a history of dependence on an agricultural economy and the problems associated with the decline in this important segment of the economy. Labor cost and supply, while not identical, are not considered to be substantially different.

Climatological and topographical features of the two areas are quite similar. Both are in the temperate zone. The eastern boundary of each is the Atlantic Ocean and the land areas rise in elevation to the western boundary of the Appalachian Mountains. A wide variety of low cost sites can be had in either state.

Virginia has a locational advantage for coal supplies but North Carolina's proximity to southwestern and gulf petroleum deposits would likely neutralize this advantage for some industries. Each has available unlimited electrical power from hydro and steam sources and in some instances are served by the same power company.

In summary, each state likely has minor cost and market advantages but neither state has a major natural advantage in increasing its proportion of manufacturing employment.

One of the major questions under consideration in this paper, the influence of regional industrial development efforts, can be pinpointed with the data under consideration. Although both states have been active since 1950 in encouraging industry to locate within their boundaries, North Carolina effort was substantially larger in magnitude and stepped up sharply in 1956. While comparable figures on expenditures are not available, observations of persons active in the field support this statement.[1] The increased North Carolina effort continued through the period under study while Virginia's program remained on a much lower level.

Changes in employment within industries during the three time periods under consideration should allow evaluation of the influence of this effort. Those changes not explained by the theoretical concepts examined earlier should be evaluated.

For purposes of this paper, the United States will be considered as the universe and North Carolina and Virginia as regions within the

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[1]Interviews with Joseph G. Hamrick, Director, and Robert O. Gill, Assistant Director, Division of Industrial Development and Planning, Commonwealth of Virginia.

universe. Changes in manufacturing employment for the two states can occur because of overall change in employment within the universe with a portion of this change taking place within the regions, a shift to or from the regions under consideration, or a combination of the two influences.

Table I presents data that describe changes in manufacturing employment for North Carolina and Virginia over the twelve-year period, 1950 to 1962. In order to exclude the influence of change in manufacturing employment for the United States, the ratio of North Carolina and Virginia manufacturing employment to the comparable United States figure is computed.

TABLE I

COMPARISON OF MANUFACTURING EMPLOYMENT IN THE UNITED STATES, NORTH CAROLINA AND VIRGINIA

Year	United States (thousands of persons)	North Carolina (thousands of persons)	North Carolina Ratio to U.S.	Virginia (thousands of persons)	Virginia Ratio to U.S.
1950	15,241	418.3	.0274	229.5	.0151
1954	16,314	436 8	.0268	247.0	.0151
1958	15,945	469.6	.0295	257.8	.0162
1962	16,859	527.6	.0313	291.3	.0173

Source: U.S. Department of Labor, Employment and Earning Statistics for States and Areas, 1932-1962.

The percentage change in this ratio is then computed and presented in Table II. No change in the ratio would indicate the state change was in the same proportion as the national change. This technique will allow

an evaluation of changes in manufacturing employment following an assumption that changes within a state will follow national changes in the short run unless some exogenous force is interjected.

TABLE II

PERCENTAGE CHANGE IN RATIO OF STATE TO NATIONAL MANUFACTURING EMPLOYMENT

Time Period	North Carolina	Virginia
1950-54	-2.19%	0.00%
1954-58	10.07%	7.28%
1958-62	6.10%	6.79%

Source: Table I, p. 30.

The data reveal that while North Carolina's manufacturing employment grew in each of the three periods the changes, relative to national employment, were very uneven. From 1950 to 1954 North Carolina's manufacturing employment actually declined relative to United States manufacturing employment. This tendency was reversed during the next four-year period and manufacturing employment showed a substantial increase relative to the United States change. From 1958 to 1962 this improvement continued.

While North Carolina's ratio dropped from 1950 to 1954 Virginia's ratio was unchanged. This indicated the change in Virginia was in the same proportion as the national change. During the next two periods, 1954 to 1962, Virginia's ratio moved upward. Over the twelve-year

period, 1950 to 1962, the North Carolina ratio of state to national manufacturing employment increased 14.2% and Virginia's ratio increased 14.6%.

Summarizing the changes, both states have grown substantially relative to national growth. North Carolina's growth has been more erratic than Virginia growth.

The technique used above will exclude overall national changes but one major influence to be considered is changes within industries and the relative importance of a given industry to manufacturing employment for a state. The next section will delve into this matter.

Employment Changes Within Industry Groups

Following the same objectives outlined above it is desirable to exclude the influence of changes in the universe and the region from employment within industry groups. This can be accomplished by use of the location quotient. This analytical tool is described by Isard as "a device for comparing a region's share of a particular activity with its percentage share of some basic aggregate."[2]

A location quotient of 1.00 would indicate a region had its proportion of an industry. A figure of less than unity would indicate less than its share and, conversely, a figure greater than unity would indicate a greater than proportionate share. In effect the influence of change in the base is "washed out" by using regional and national data describing the variable to be neutralized as the base.

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[2]Walter Isard, Methods of Regional Analysis. (New York: John Wiley & Sons, Inc., 1960), p. 124.

If it is assumed employment by industry groups within a region will change as the universe changes, the location quotient developed for each regional industry group can be used to point out changes that cannot be accounted for by overall changes in manufacturing employment.

The computation of the location quotient describing 1950 employment in the Virginia food processing industry is used here to illustrate the mechanics involved. In 1950 Virginia's food processing industry employed 21,100 persons. Employment in the United States for this industry was 1,790,000. The numerator of the location quotient is determined by dividing the former by the latter (21,000/1,790,000) and is .012. The denominator is computed by dividing manufacturing employment in Virginia during 1950 (229,500 persons) by the comparable United States figure (15,241,000). This computation yields the figure .015. Expressing the numerator and denominator as a single figure (.012/.015) the location quotient becomes .80. In effect this ratio says Virginia does not have its share of national employment in food processing if national employment in manufacturing is considered as the criterion.

The primary criticism of use of the location quotient is the assumption that industry should be distributed over an area, in this case within a region, in the same manner as it is distributed over the universe. It is inherently assumed that the factors affecting industrial location do not vary in value in spite of spatial differences or that differences in locational factors are neutralized or offset from region to region. Neither assumption could be supported by empirical data.

To accomplish the objectives of this paper, however, it is not necessary to measure the relative development of an area. The immediate objective can be served by observing changes through time in the location quotient.

Assuming a condition of locational equilibrium existed in 1950, changes in the state of equilibrium should be accountable for by theoretical concepts or by factors outside of the economic system, in the immediate case the industrial development effort.

The location quotient for basic industrial groups (two digit SIC code) relating Virginia employment to United States employment is presented in Table III.

These data show in 1962 Virginia had a larger than proportionate share of the tobacco, textile, lumber, furniture and chemical industries if a location quotient of .75 to 1.25 is accepted as describing a "fair share" of an industry. Nine industries, printing, petroleum, rubber, primary metals, fabricated metals, nonelectrical machinery, electrical machinery, scientific instruments and miscellaneous manufactures, fail to meet this arbitrary standard. Six manufacturing industries, food, apparel, paper, leather, stone, clay and glass, and transportation equipment, have employment comparable to national employment.

Table IV presents similar data for North Carolina. Using the same arbitrary standard with .75 to 1.25 location quotient as acceptable, North Carolina has four industries, tobacco, textiles, lumber and furniture, rated above the national performance. Only one industry, apparel, falls within the range and the remaining 15 are below the standard.

TABLE III

LOCATION QUOTIENT FOR VIRGINIA INDUSTRY GROUPS

	1950	1954	1958	1962
Food and kindred products	.80	.93	1.17	1.06
Tobacco manufactures	9.50	9.94	9.14	8.88
Textile mill products	2.48	2.40	2.34	2.41
Apparel and related products	1.06	1.00	1.11	1.24
Lumber and wood products	2.40	2.40	2.34	2.24
Furniture and fixtures	2.73	2.67	2.59	2.88
Paper and allied products	1.40	1.33	1.27	1.12
Printing and allied industries	.60	.67	.67	.71
Chemicals and allied products	3.53	3.20	2.47	2.47
Petroleum and rubber		.13	.31	.47
Leather	1.06	.93	.93	.82
Stone, clay and glass products	.72	.80	.86	.94
Primary metal industries	.20	.20	.31	.35
Fabricated metal products	.40	.47	.49	.47
Nonelectrical machinery			.19	.24
Electrical machinery			.31	.41
Transportation equipment	.60	.73	.67	.94
Scientific instruments			.31	.24
Miscellaneous manufacturing industries			.49	.47

Source: Tables VIII-XI, pp. 68-71.

Quite interestingly, Virginia and North Carolina are in accord on four industries rated above standard. The fifth Virginia industry with the high rating, chemicals, performed below standard in North Carolina. Virginia had six industries within the acceptable range while North Carolina had one. One industry, apparel, is found acceptable in both states. Of the remaining five, three had fairly high ratings in North Carolina (.58-.74) and two, transportation equipment and leather, rated below standard. The two regions are in accord on the industries rated below standard except for the deviations noted above.

The high degree of correlation obtained when applying non-subjective standards to the location quotient support the assumption that the difference in value of location factors for the two states must be relatively small. Major differences would have resulted in a greater degree of divergence from the established pattern.

As noted earlier, the primary concern of this paper is with changes in the location quotient through the twelve-year period, 1950-1962. Tables V and VI present the change in location quotient for three periods of four years, for the twelve years as a single period, and on an annual basis. Table V is derived from Virginia data and Table VI from North Carolina data.

Data allow computation of change in location quotient for eighteen Virginia industries and are presented in Table V. Fourteen of these cover the twelve-year period, 1950 to 1962. Available employment figures allow a comparison for 1958 and 1962 on the remaining four industries. Comparable data describing employment in North Carolina industries are

TABLE IV

LOCATION QUOTIENT FOR NORTH CAROLINA INDUSTRY GROUPS

	1950	1954	1958	1962
Food and kindred products	.41	.45	.61	.65
Tobacco manufactures	10.11	10.50	10.90	12.13
Textile mill products	6.82	8.40	8.07	8.06
Apparel and related products	.41	.60	.78	1.10
Lumber and wood products	1.94	1.88	1.84	1.68
Furniture and fixtures	3.05	3.59	3.71	4.00
Paper and allied products	.58	.67	.71	.74
Printing and allied industries	.34	.33	.34	.35
Chemicals and allied products	.55	.59	.51	.58
Petroleum, rubber and leather			.10	.19
Stone, clay and glass products	.44	.45	.51	.58
Primary metal industries	.07	.07	.07	.06
Fabricated metal products	.11	.15	.24	.25
Nonelectrical machinery			.24	.29
Electrical machinery			.58	.52
Transportation equipment			.07	.10
Instruments and miscellaneous manufacturing			.10	.19

Source: Tables VIII-XI, pp. 68-71.

not as complete as Virginia data. Only twelve industries are described by a complete set of data while employment data for three industrial groups are available for 1958 and 1962.

Two Virginia industries, tobacco and chemicals, show major declines in their location quotient. The location quotient for tobacco manufactures was down 62 points for the twelve-year period in spite of an upward movement during 1950-54. Chemicals were down during each of the first two periods and were unchanged during the final period. The only Virginia industry to show a major upward movement in location quotient was transportation equipment. Annual changes in the remaining fifteen industries averaged two points or less with ten increasing and five declining.

Referring to absolute figures, employment in Virginia's chemical industry has increased from 1950 to 1962. The decrease in the location quotient is due to the sharp increase in United States employment for this industry. In other words, while chemical employment in Virginia increased, the increase did not keep pace with national gains. In the other two major movements noted above, tobacco and transportation equipment, the absolute figures moved in the same direction as the location quotient. National and Virginia employment in tobacco has declined since 1950 but Virginia's reduction has been relatively greater than the United States reduction. The same holds true for transportation equipment except the movement was in the opposite direction.

Changes in location quotient for North Carolina industries as shown in Table VI reveal four groups with major increases and no industries with significant declines. In contrast to Virginia's decline of

TABLE V

CHANGE IN VIRGINIA'S LOCATION QUOTIENT

	1950 to 1954	1954 to 1958	1958 to 1962	1950 to 1962	Annual Average
Food and kindred products	.13	.24	-.11	.26	.02
Tobacco manufactures	.44	-.80	-.26	-.62	-.05
Textile mill products	-.08	-.06	.07	.07	.01
Apparel and related products	-.06	.11	.13	.18	.02
Lumber and wood products	.00	-.06	-.10	-.16	-.01
Furniture and fixtures	-.06	-.08	.29	.15	.01
Paper and allied products	-.07	-.06	-.15	-.28	-.02
Printing and allied industries	.07	.00	.04	.11	.01
Chemicals and allied products	-.33	-.73	.00	-1.06	-.09
Petroleum and rubber		.18	.16		.04
Leather	-.13	.00	-.11	-.24	-.02
Stone, clay and glass products	.08	.06	.08	.20	.02
Primary metal industries	.00	.11	.04	.15	.01
Fabricated metal products	.07	.02	-.02	.07	.01
Nonelectrical machinery			.05		.01
Electrical machinery			.10		.02
Transportation equipment	.13	-.06	.27	.34	.03
Scientific instruments			-.07		-.02
Miscellaneous manufacturing industries			-.02		-.01

Source: Tables VIII-XI, pp. 68-71.

62 points, North Carolina's tobacco location quotient gained 202 points. Textile employment moved sharply higher during the first four-year period and then recorded slight declines in location quotient the last eight years.

Apparel and furniture steadily forged ahead in each period. Of the remaining 11 industries, eight had location quotients that were slightly higher and three were slightly lower.

Absolute figures for categories showing major changes moved in the same direction with one exception. Total employment in North Carolina's textile industry declined two per cent from 1950 to 1962. The increase of 124 points in the location quotient resulted from a sharp decline in United States employment for the industry.

In summary, location quotients for ten of the industries moved in the same direction while five took divergent courses. Three of these, paper, primary metals and electrical machinery were not involved in moves of major magnitudes. However, the tobacco and chemical industries followed sharply different paths in North Carolina and Virginia. The reason for this difference will be examined later in this paper.

Changes in Virginia, 1950-1962

Having presented data on changes in manufacturing employment and changes in employment within industry groups, the next step is to look at the influence of new manufacturing plants on employment. Figures relating to these changes are presented in Table VII.

For the period 1950 to 1962, manufacturing employment in Virginia increased by 70,900 persons. New manufacturing operations established

TABLE VI

CHANGE IN NORTH CAROLINA'S LOCATION QUOTIENT

	1950 to 1954	1954 to 1958	1958 to 1962	1950 to 1962	Annual Average
Food and kindred products	.04	.16	.04	.24	.02
Tobacco manufactures	.39	.40	1.23	2.02	.17
Textile mill products	1.58	-.33	-.01	1.24	.13
Apparel and related products	.19	.18	.32	.69	.06
Lumber and wood products	-.06	-.04	-.16	-.26	-.02
Furniture and fixtures	.54	.12	.29	.95	.08
Paper and allied products	.09	.04	.03	.16	.01
Printing and allied industries	-.01	.01	.01	.01	.001
Chemicals and allied products	.04	-.08	.07	.03	.002
Stone, clay and glass products	.01	.06	.07	.14	.01
Primary metal industries	.00	.00	-.01	-.01	-.001
Fabricated metal products	.04	.09	.01	.14	.01
Nonelectrical machinery			.05		.01
Electrical machinery			-.06		-.02
Transportation equipment			.03		.01

Source: Tables VIII-XI, pp. 68-71.

in Virginia since 1950 employed 51,900 persons during 1962.[3] These new operations account for 73 per cent of the increase.

In terms of absolute figures, new firms in the apparel and electrical machinery field have made the major contribution to expanding the employment base. Chemicals and food are important contributors but are substantially below apparel and electrical machinery. On the other end of the scale, tobacco, paper, petroleum, leather, and scientific instruments have made little contribution to employment through new Virginia firms.

Considering new employment relative to total employment in the industry, electrical machinery and apparel again stand out. The combined categories of petroleum and rubber show sharp gains with the latter apparently the major gainer. Industries in which new firms provide a relative insignificant portion of total employment generally coincides with the absolute figures. The one exception, transportation equipment, provided 1,000 jobs but this accounted for only 4 per cent of 1962 employment in this category. Overall, producing units established during the twelve-year period accounted for one of every six jobs existing in 1962.

An interesting corollary of these statistics is the relative importance of plant size. During the period 1950 to 1962, 25 per cent of the new Virginia plants employed 100 or more persons in 1962. Yet this group of plants accounted for 82 per cent of the new manufacturing employees. An even more dramatic result is obtained if plants employing

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[3]John L. Knapp, "New Plants in Virginia," Virginia Economic Review. (XV, September, 1963), p. 5.

TABLE VII

CHANGE IN EMPLOYMENT AND EMPLOYMENT IN NEW FIRMS FOR VIRGINIA INDUSTRIES

	Change in Employment 1950 to 1962	1962[1] Employment in New Firms	New Firms as Per Cent of Total
Food and kindred products	11.2	4.3	13.3
Tobacco manufactures	-.6	.1	.7
Textile mill products	-3.6	2.5	6.8
Apparel and related products	10.2	11.7	44.2
Lumber and wood products	-7.2	1.5	6.8
Furniture and fixtures	4.2	2.6	13.7
Paper and allied products	1.6	.6	5.2
Printing and allied industries	4.0	1.0	9.2
Chemicals and allied products	1.1	4.6	13.1
Petroleum	(	.3	(
Rubber and plastics	(4.7 (	1.9	(46.7 (
Leather	-1.1	.3	5.8
Stone, clay and glass products	3.2	2.0	21.5
Primary metal industries	3.6	.7	10.1
Fabricated metal products	3.2	2.8	29.8
Nonelectrical machinery	5.6	1.9	33.9
Electrical machinery	11,8	11.5	97.6
Transportation equipment	14.2	1.0	4.0
Scientific instruments	1.5	.2	13.3
Miscellaneous manufacturing industries	3.3	.4	12.1
Total	70.9	51.9	17.8

[1]Plants beginning operations since 1950.

Source: John L. Knapp, "New Plants in Virginia," Virginia Economic Review, XV, (September, 1963), pp. 1, 4 and 7.

more than 200 persons are considered. These account for only one-eighth of the new operations but employ two-thirds of the newly created jobs.[4]

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[4] Ibid. p. 1.

CHAPTER IV

ANALYSIS OF CHANGE IN MANUFACTURING EMPLOYMENT

In the preceding chapter empirical data describing changes in manufacturing employment and changes within industrial groups were presented. The purpose of this chapter is to analyze these data in relation to the industrial development effort and relate the conclusions to location theory.

Manufacturing Employment and Development Effort

To measure quantitatively the results of government programs is quite difficult. The difficulty of the task is compounded when the attempt is made to measure results of programs that contain many intangibles. Such is the case with industrial development.

Assuming the purpose of industrial development efforts is to increase employment in manufacturing jobs, the change in the number of manufacturing jobs within a region can be considered as a program measurement device. However, it can be argued that absolute figures within a region should change in relation to universe figures. For this reason it is desirable to exclude the influence of change in the universe and this has been done in Tables I and II.

These figures reveal that manufacturing employment in North Carolina and Virginia has grown much more rapidly than has manufacturing employment in the United States. In 1950 Virginians constituted 1.51 per cent of the employees of all manufacturing firms in the United States. Twelve

years later this had grown to 1.73 per cent. Although of greater magnitude, figures for North Carolina show the same general trend.

Table II provides some insight into the twelve-year period by expressing in percentage form the change in the ratio over a four-year period. North Carolina figures show a modest decline during the first four-year period, a sharp rebound during the second and a substantial gain during the last period. Virginia figures were unchanged during the first period and marked up substantial gains during the second and third.

Relating these changes to the industrial development effort of the two states, it must be remembered that North Carolina's program was considered to be on a higher level than Virginia's program for the entire twelve-year period. Also, the magnitude of the North Carolina effort was stepped up in 1956 through 1962.

What conclusions can be drawn from these data? First, the absolute figures show manufacturing employment in North Carolina has grown by about 110,000 jobs from 1950 to 1962. During the same time Virginia manufacturing employment has grown by 62,000 jobs. If the industrial development effort has a payoff in jobs it would be reasonable to expect the results to be in rough proportion to the effort. While the effort cannot be quantified, there is apparently some relationship between the scale of the effort and the increase in manufacturing jobs in Virginia and North Carolina.

The second conclusion to be reached is based on the timing of the industrial development effort. North Carolina's effort was on a

higher level during the last half of the period. The greatest portion of the gain in manufacturing employment for that state came during the last six years. Virginia's growth also came in the latter part of the twelve-year period, but the difference in the first half and the second half is not as significant as is the case with North Carolina figures. Since North Carolina's industrial development effort was at a higher level during the second half, while Virginia's effort continued at a relatively constant level, these data tend to support the effectiveness of industrial development programs from a timing standpoint.

Income and Development Effort

The analysis above is concerned with the relationship of manufacturing employment and industrial development effort. Industrial development programs have a second objective which should be considered in measuring the effectiveness of the program. This objective is increasing the income of the region and this is most effectively attained by providing high income employment opportunities. If the greater part of the increase in manufacturing employment is in high wage industries, industrial development programs could be considered as effective factors in industrial location decisions.

Earlier it was noted that Virginia tobacco and chemical industries had registered major declines in location quotient. Chemicals are considered a high wage industry. If the criterion of program effectiveness is increased income, this downward movement can be considered as being in contrast to the industrial development objectives.

The only Virginia industry to show a major upward movement in location quotient was transportation equipment. This is likewise a high wage industry. But the growth in this industry did not come from new operations in the state. Table VII reveals only four per cent of the increase came in this form and the remaining 96 per cent was in the form of expansion of employment in existing producing units. Virginia data point to the conclusion that the industrial development program has not been instrumental in upgrading the wage level of manufacturing employees.

What has been the case in North Carolina? Four industry groups were considered to have had major growth in their location quotient. These were tobacco, textile, apparel, and furniture. With the exception of tobacco, the average wage in each of these is below the state average for manufacturing employees. The experience in this region supports the observations on changes in Virginia.

While this analysis has been concerned with growth in high wage industries as a contribution to regional income, there is one consideration that should not be overlooked. The earnings of a person not previously employed in a wage earning capacity represent a net addition to area income. Such would be the case of the housewife leaving the duties of her home to work in an apparel industry. Although the wages paid by this industry might be comparatively low, all of the earnings of the housewife would be considered additional income and thus contribute significantly to the objective of increasing regional income.

Changes by Industry Groups

Examining changes within industries and relating these changes to the industrial development effort, Table VI shows relatively substantial gains in the location quotient during 1950 to 1954 for North Carolina based tobacco, textile, apparel and furniture. For the same period, comparable Virginia figures showed gains in tobacco and transportation equipment and a decline in chemicals. The most striking contrast here is the increase in textile and apparel in North Carolina and the decrease in chemicals in Virginia.

The next time period to be considered is 1958 to 1962. During this four-year period North Carolina's industrial development effort was in full swing and Virginia's continued on a relatively lower level. The significant changes in the North Carolina location quotient were increases in the tobacco, apparel and furniture industries. Comparable Virginia figures show increases in apparel, furniture and transportation equipment and a decline in tobacco.

To narrow the industries under consideration tobacco and transportation equipment will be eliminated. Changes in employment and the consequent change in location quotient for these two industries within the two states have a common feature that justifies this action. Virtually all of Virginia's change in the transportation equipment industry has been in existing plants and not in new plants influenced by the development effort. Most of the tobacco employment gain in North Carolina has been in one firm that apparently has a policy of placing all additional producing units in North Carolina. In neither instance would it be

reasonable to consider the development program as an influence in employment growth.

What do these shifting figures reveal to assist in evaluating industrial development programs? The textile growth in North Carolina during 1950-1954 was apparently a carry over of the transfer of the industry from New England to the South that had been interrupted by World War II. So this gain would likely have come about on the basis of competition forcing the move out of the high cost area into the relative low cost southern area. This, in effect, was a case of follow-the-leader to North Carolina. But apparel and furniture made substantial gains during both periods in North Carolina and only during the later periods in Virginia.

Both of these industries are labor intensive and have average hourly wages below the average of all manufacturing industries. Therefore, low labor rates would be attractive. In addition, the apparel industry is highly mobile. The raw materials for the apparels industry is produced by textile industries and these are well established in the area. The lone disadvantage to an apparel producer in the South is transportation to market. But this has been overcome to some extent by growth of the southern market and improvement in truck transportation to the north which allows overnight delivery into New York.

So it would appear quite natural that apparel employment would grow in North Carolina and Virginia. The earlier growth in North Carolina is hard to justify. It could not be explained by the wage differential since as late as 1962 Virginia's average wage was only $.05 per hour

than that paid in North Carolina. The proximity of a Virginia site to northern markets will be consequent savings in freight cost and savings resulting from the time element would offset the North Carolina wage advantage. Considering all factors, the conclusion is that the development program in North Carolina was effective in attracting apparel operations to that state.

Can furniture growth, which has the same time and spatial change as apparel, be explained on the same basis? It has much the same factor cost pattern as the apparel industry and it would seem logical that its earlier development in North Carolina can be attributed to the concerted effort to encourage industrial growth.

Probably one of the most remarkable changes reflected by developing location quotients for the different time periods is that of the chemical industry in Virginia. During the first two periods the quotient dropped drastically but from 1958 to 1962 steadied to reflect no change. The question is, could this change be accounted for by the Virginia development effort?

The chemical industry is oriented to the industrial market. Virtually all of its output is subjected to additional processing before being consumed. It is capital intensive and the mobility of capital removes any restriction on this account. Transportation is a major factor in considering location.

Man-made fibers account for about two-thirds of Virginia's chemical employment. The continued transfer of the textile industry from New England to the South removed Virginia's locational advantage whereby

Virginia producers were able to serve both markets. Growth in the fiber industry took place in the more southern states. Industrial and agricultural chemicals did not grow in employment. Consequently, the location quotient dropped while employment measured in absolute figures remained relatively unchanged. During the last four-year period, 1958-1962, the quotient was unchanged due to a slowing of United States growth in chemical employment and slight improvement in Virginia's employment picture.

The relative decline of this industry in Virginia likely would have taken place without regard to the intensity of any effort to promote its growth. The market it served had shifted its center southward and mobility of capital gave the industry freedom to follow. The area possessed no advantage to override the transportation factor.

Industry Changes Related to Theory

In summarizing Chapter II the conclusion was reached that industry would most often locate where the difference between cost and revenue would be the greatest. Do the data on Virginia location quotient presented in Chapter III bear this out?

Before examining this material, consideration should be given a basic problem involved in the data. As noted earlier the location quotient was computed for industry groups, i.e., for the two digit S.I.C. groups. This classification of industries does not necessarily join together operations with common cost and revenue considerations. For example, fabricated metal products include such diverse products as fabricated structural metal products and engraving services. Chemicals

include industrial chemicals and pharmaceutical drugs. Any analysis involving such broad definitions must be cushioned with many reservations.

The Virginia industry with the highest location quotient is tobacco manufactures. The relative importance has declined since 1950 because the reduction in the number of workers has been more marked in Virginia than in the United States. This decrease in number of employees is the result of increased application of mechanization. Since 1950 output per employee increased by 47 per cent while overall production rose by 25 per cent.

In its earlier years tobacco manufacture, especially cigarette manufacture, was much more influenced by labor cost than is the current case. The availability of raw materials was another factor explaining the development of the industry in Virginia. The theories of industrial location support the location of such a substantial part of the industry in Virginia and the same theories explain the rise in importance of this industry in Kentucky.

The growth in population on the West Coast favors a more inland location. Shifts in consumer taste has allowed use of more Burley type tobacco in filter cigarettes. The center of production for this type of tobacco is in Kentucky. Taxes on this industry have been lower in Kentucky than in Virginia and a labor cost differential of $.05 per hour favors Kentucky over Virginia. This industry appears to hold little potential as a producer of additional jobs for Virginians.

Lumber and wood products, relative to national employment, is an important Virginia industry. A majority of these workers are involved in harvesting of timber--typically a low skill and low wage job. The abundance of this type labor and growing reserves of this resource would suggest the continuing importance of this industry. However, the substitution of machinery for human labor has begun to take its toll in jobs and if it follows the lead of farming, it will make further inroads. This is a case of reducing cost with the hope of increasing profits.

Two industries that location theory would point to as potential job growth industries are textiles and furniture. The rising cost of labor in northern textile operations make Virginia labor very attractive. The availability of raw materials and a growing regional market in the apparel industry would help to reduce cost by minimizing transportation cost.

The furniture industry is controlled by much the same factors. Virginia production workers receive 22 per cent less hourly wage than the national average. Local supplies of fabricated board and dimensional stock are readily available. Transportation cost of the finished product are a major factor and in the long run may inhibit growth similar to the tobacco industry.

Location theory sustains further Virginia growth in textiles and furniture. A Virginia locality with the particular factors required by one of these would likely get a greater return on effort directed specifically to furniture or textiles than would be the case of a vague, general program.

Another industry of growing local importance is apparel. This industry is highly mobile and is dependent upon availability of low cost labor and overnight transportation to marketplace. A large pool of low cost labor is available in Virginia. Many producers have found housewives on farms anxious to supplement declining family income. This source of labor is virtually untapped and growing with the decline of agricultural income. Again, location theory points to this as a potentially fertile field to till.

Other industry groups hold less promise from an aggregrative viewpoint. Most of these require a reasonably high skill level of labor. Pools of this type of labor are not readily available in Virginia. A long term effort in education, both vocational and social, will remedy this shortcoming.

Some industries are so controlled by transportation cost as to be dependent upon the development of a market within an area to justify a production unit. With deference to the dangers of generalities, the industrial group of stone, clay and glass would be an example of such an industry. The cost of transporting the finished products and the wide geographic distribution of raw materials limit production units to a relatively small market area.

The limitations of skilled labor supply and developed markets in the immediate vicinity of the production unit suggest such industries are not likely candidates for development groups.

Summary

Measured from the standpoint of manufacturing employment, empirical data tend to support industrial development programs as contributions to the economic growth of an area. Growth for the Virginia-North Carolina region since 1950 has largely been in low wage industries. Examination of the changes in location quotient for industry groups located in Virginia points out the dynamic nature of industrial location. Relating the theory of location to the controlling cost and demand factors suggest textiles, furniture and apparel industries offer the most likely prospects for further Virginia industrial growth.

CHAPTER V

SUMMARY AND CONCLUSIONS

This chapter will consist of a summary of the material presented earlier. Conclusions relating to the original problem and based on this summarized material will then be drawn.

Summary

The objective of this paper is to determine if theories of industrial location and empirical data describing changes in manufacturing employment might suggest more efficient approaches in attracting industry to a particular area.

The location of a factory in a community contributes materially to its economic development. For this reason numerous agencies--governmental, quasi-governmental and profit motivated firms--are activately engaged in programs to increase manufacturing employment within their sphere of responsibility. Limited resources and the competitive nature of the effort dictate the application of innovations in approaching the problem.

Contemporary location theory has an evolutionary background reflecting a changing economic environment. The earliest theorist were concerned with minimizing cost. The substitution of location factors in order to select the site of lowest production cost was the objective.

Development of the market system dictated that revenue be considered in site selection. Location theory then became a problem of substitution to find the optimum location considering both cost and demand.

The final development has been the introduction of personal factors into the theory. Personal considerations might influence the cost and/or the demand side of the problem. To the extent that they influence either of these, personal factors can be integrated into theoretical economic concepts. When personal considerations are not reflected in cost or demand, i.e., are not involved in the determination of the firm's profit, they lie outside of the economic framework of a capitalistic society.

One of the first steps in studying this problem is determining how much influence, if any, industrial development programs might have in expanding manufacturing employment. Comparative data for North Carolina and Virginia for the time period 1950-1962 indicate some positive correlation exist between effort and manufacturing employment. When data are examined from the standpoint of growth in higher wage industries, the conclusion is reached that development programs are not instrumental in expansion of these industries.

In summary, industrial development programs appeared to attain their objective of expanding employment opportunities in manufacturing but the efforts were most effective in low wage industries.

Conclusions

What approaches are suggested by location theory and empirical data that might benefit development groups?

Since the objective of business in the capitalistic society is to operate at a maximum profit, any successful industrial development program will have to be oriented to this objective. The problem for those operating

industrial development programs is to determine that industry, or those industries, which will attain maximum benefit by location in their area.

This involves three steps. The first step is a complete inventory of location factors. The vastness of the geographical area will determine the preciseness with which this is to be undertaken. It would be reasonable to expect a community to obtain detail data on wages paid in local industries. An agency working with an area as large as a state would gather more general information, such as average wages paid by industry groups. In the case of transportation cost, a community should be familiar with rates on typical commodities to centers of population. The program for the larger geographic area would be concerned with distances to potential markets.

The most important factors to be considered in the inventory taking are related to markets for new industries. Certainly one of the most attractive features of an area to a company making a location decision would be some locational advantage from the standpoint of proximity or convenience to markets.

This type of information is most difficult for the agency to develop. In order to estimate with any degree of certainty the revenue to be expected from a factory at a given location it would be essential to know the quantity of goods to be produced, the price at which they will be sold and costs, including transportation cost, incidental to the marketing procedure. This problem is compounded by the multitude of products produced within the broad industrial classifications.

The prime function that the development agency can perform is supplying information upon which the business decision can be based. It then develops that the agency that supplies the most useful information will receive the most consideration in area selection. While detailed quantification of the demand factors might prove impractical without an intimate knowledge of the individual firm, the scope and potential of markets for certain general classifications of products might prove feasible.

As an example, the market potential for air conditioners within a radius dictated by transportation cost could be developed by relating income growth to unit sales. Or, in a less sophisticated example, the need for support industries to serve existing industry might be apparent to the local development agency. Such market information, whether related to industrial or consumer markets, will prove helpful and, no doubt, enhance consideration of that area as a potential location.

The second phase of applying location theory and empirical data would be the selection of those industries that would profit most by locating in the area. This involves an analysis of the cost and revenue factors for many industries and the selection of those that appear to fit best the local conditions. In an area having an abundance of unskilled persons willing to work for low wages the development agency should concentrate on labor intensive industries. Should the area promise income or population growth that would open new markets, industries producing a product that requires large transportation cost would be logical candidates for a new factory.

After making an inventory of area location factors and selecting those industries that would benefit most under local conditions, the problem becomes one of communicating with individual firms in the industry group. This may be done through trade media advertising or personal contact using letter or visit. The object of this communication is to provide the businessman with information so that he can consider the potentialities of this location in his decision making.

Location theory rests on maximizing profits but in practical application the decision to locate a plant is limited to those sites on which the decision maker has information. Therefore, a development agency representing an area with particular advantages to certain industries must effectively convey this information to the decision maker.

Since many areas offer practically the same factors for consideration, the sophistication with which the development agency approaches the inventory function and the familiarity with industry problems exhibited by the agency might well be key considerations of the decision maker. These two points will add credence to the data developed by an obviously biased source. In order to better serve the interest of all concerned, the development agency could assign personnel to specialize in working with certain industries. Another contribution to the desirable sophisticated image would be a strong research staff.

Returning to the objective of this paper, what does location theory and empirical datum offer to those responsible for area development?

An understanding of location theory, i.e., an understanding of the objective of maximizing profits through substitution of cost and revenue factors, is essential for personnel working in this field. This will involve cross-matching local factors required in an industrial enterprise with the needs of a wide variety of possible industrial firms. The ability or feasibility of quantifying these two sides of the question are very doubtful.

While cost factors might be measured with some degree of success, estimating revenue that can be generated by the area market would be impossible without knowing precisely the product to be produced, the size of the producing unit, and the relation of this producing unit to competitive and non-competitive units. Therefore, location theory could be considered a foundation upon which a development program could be built but not a precise implement which could be used in the construction.

Empirical data are historical in nature. Using such data one may point out what has taken place in the past and consequently can be used to select those industries that have grown and been profitable in the past. By using the location quotient industries can be selected for which a larger than proportionate share of employment is located in the area under consideration. In effect, empirical data can be used to select those industries whose cost and demand factors have proven to coincide with factors supplied by the area. These data merely reflect what has taken place in the past and do not necessarily reflect the current or future situation.

But an understanding of what has happened in the past, combined with an understanding of why it happened, would give a development agency a technique to select those industries that are likely to be successful and to eliminate those that would likely prove unsuccessful.

This preliminary selection process will narrow the field to workable proportions. From here a complete inventory of cost and revenue factors could be cross-matched with industry needs to further pinpoint the agency efforts.

At this point it is questionable as to whether quantification of factors is feasible. Even with detailed industry breakdowns the requirements of individual firms within the industry will vary considerably. Therefore, the application of local conditions to industry needs is likely to be a subjective rather than an objective evaluation.

In conclusion, location theory and empirical data are tools, albeit not precision implements, which can be used in constructing an industrial development program.

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APPENDIX

TABLE VIII

COMPUTATION OF 1950 LOCATION QUOTIENT FOR NORTH CAROLINA AND VIRGINIA INDUSTRY GROUPS

	Employment (000)			Location Quotient (Columns 6 and 8)			
				Virginia		North Carolina	
	U. S. (2)	Virginia (3)	North Carolina (4)	(5) (3)/(2)	(6) (5)/.015[1]	(7) (4)/(2)	(8) (5)/.027[1]
Food and kindred products	1,790	21.1	19.8	.012	.80	.011	.41
Tobacco manufactures	103	14.3	27.3	.143	9.50	.274	10.11
Textile mill products	1,256	40.6	230.7	.037	2.48	.184	6.82
Apparel and related products	1,202	16.3	13.3	.016	1.06	.011	.41
Lumber and wood products	808	29.4	42.6	.036	2.40	.053	1.94
Furniture and fixtures	364	14.8	32.8	.041	2.73	.090	3.05
Paper and allied products	485	10.0	8.0	.021	1.40	.016	.58
Printing and allied industries	748	6.9	6.3	.009	.60	.008	.34
Chemicals and allied products	640	34.1	9.7	.053	3.53	.015	.55
Petroleum and rubber	529						
Leather	395	6.3		.016	1.06		
Stone, clay and glass products	547	6.1	6.8	.011	.72	.012	.44
Primary metal industries	1,247	3.3	2.4	.003	.20	.002	.07
Fabricated metal products	982	6.2	2.8	.006	.40	.003	.11
Nonelectrical machinery	1,210		6.0			.005	.18
Electrical machinery	991						
Transportation equipment	1,265	11.0		.009	.60		
Scientific instruments	250						
Miscellaneous manufacturing industries	400						
All manufacturing	15,241	229.5	418.3	.015	1.00	.027	1.00

[1]Constants used in computing location quotient in columns 6 and 8 are derived by dividing total manufacturing employment in the state by total manufacturing employment in the United States.

Source: Column 2 - U. S. Department of Labor's Employment and Earning Statistics for the United States, 1909-62.
Columns 3 and 4 - U. S. Department of Labor's Employment and Earning Statistics for States and Areas, 1932-62.

TABLE IX

COMPUTATION OF 1954 LOCATION QUOTIENT FOR NORTH CAROLINA AND VIRGINIA INDUSTRY GROUPS

	Employment (000)			Location Quotient (Columns 6 and 8)			
	U. S.	Virginia	North Carolina	Virginia		North Carolina	
	(2)	(3)	(4)	(5) (3)/(2)	(6) (5)/.015[1]	(7) (4)/(2)	(8) (5)/.027[1]
Food and kindred products	1,818	25.6	22.2	.014	.93	.012	.45
Tobacco manufactures	103	15.4	29.2	.149	9.94	.282	10.50
Textile mill products	1,042	37.8	225.7	.036	2.40	.226	8.40
Apparel and related products	1,184	19.5	19.8	.015	1.00	.016	.60
Lumber and wood products	708	25.5	36.2	.036	2.40	.051	1.88
Furniture and fixtures	342	13.5	33.1	.040	2.67	.097	3.59
Paper and allied products	531	10.5	9.4	.020	1.33	.018	.67
Printing and allied industries	814	8.0	7.7	.010	.67	.009	.33
Chemicals and allied products	753	36.5	12.3	.048	3.20	.016	.59
Petroleum and rubber	567	1.2					
Leather	373	5.3		.014	.93		
Stone, clay and glass products	553	6.8	6.5	.012	.80	.012	.45
Primary metal industries	1,219	3.6	2.3	.003	.20	.002	.07
Fabricated metal products	1,070	7.4	4.5	.007	.47	.004	.15
Nonelectrical machinery	1,418						
Electrical machinery	1,190						
Transportation equipment	1,754	18.6		.011	.73		
Scientific instruments	321	1.8		.006	.40		
Miscellaneous manufacturing industries	391	3.0		.008	.53		
All manufacturing	16,314	247.0	436.8	.015	1.00	.027	1.00

[1]Constants used in computing location quotient in columns 6 and 8 are derived by dividing total manufacturing employment in the state by total manufacturing employment in the United States.

Source: Column 2 - U. S. Department of Labor's Employment and Earning Statistics for the United States, 1909-62.
Columns 3 and 4 - U. S. Department of Labor's Employment and Earning Statistics for States and Areas, 1932-62.

TABLE X

COMPUTATION OF 1958 LOCATION QUOTIENT FOR NORTH CAROLINA AND VIRGINIA INDUSTRY GROUPS

	Employment (000)			Location Quotient (Columns 6 and 8)			
				Virginia		North Carolina	
	U. S. (2)	Virginia (3)	North Carolina (4)	(5) (3)/(2)	(6) (5)/.016[1]	(7) (4)/(2)	(8) (5)/.029[1]
Food and kindred products	1,773	33.8	31.5	.019	1.17	.018	.61
Tobacco manufactures	94	14.2	30.4	.148	9.14	.322	10.90
Textile mill products	919	35.2	218.6	.038	2.34	.237	8.07
Apparel and related products	1,172	21.5	27.1	.018	1.11	.023	.78
Lumber and wood products	615	23.3	33.0	.038	2.34	.054	1.84
Furniture and fixtures	361	15.2	39.4	.042	2.59	.109	3.71
Paper and allied products	564	11.1	12.0	.020	1.27	.021	.71
Printing and allied industries	873	9.3	8.7	.011	.67	.010	.34
Chemicals and allied products	794	32.0	11.9	.040	2.47	.015	.51
Petroleum and rubber	568	2.8		.005	.31		
Leather	359	5.5		.015	.93		
Stone, clay and glass products	562	8.0	8.3	.014	.86	.015	.51
Primary metal industries	1,154	6.2	2.1	.005	.31	.002	.07
Fabricated metal products	1,077	8.4	7.0	.008	.49	.007	.24
Nonelectrical machinery	1,362	3.7	9.7	.003	.19	.007	.24
Electrical machinery	1,249	5.8	20.8	.005	.31	.017	.58
Transportation equipment	1,607	16.9	3.6	.011	.67	.002	.07
Scientific instruments	324	1.6		.005	.31		
Miscellaneous manufacturing industries	373	3.3		.008	.49		
All manufacturing	15,945	257.8	469.6	.016	1.00	.029	1.00

[1]Constants used in computing location quotient in columns 6 and 8 are derived by dividing total manufacturing employment in the state by total manufacturing employment in the United States.

Source: Column 2 - U. S. Department of Labor's Employment and Earning Statistics for the United States, 1909-62.
Columns 3 and 4 - U. S. Department of Labor's Employment and Earning Statistics for States and Areas, 1932-62.

TABLE XI

COMPUTATION OF 1962 LOCATION QUOTIENT FOR NORTH CAROLINA AND VIRGINIA INDUSTRY GROUPS

	U. S.	Virginia	North Carolina	Virginia		North Carolina	
	(2)	(3)	(4)	(5) (3)/(2)	(6) (5)/.017[1]	(7) (4)/(2)	(8) (5)/.031[1]
Food and kindred products	1,760	32.3	34.4	.018	1.06	.020	.65
Tobacco manufactures	91	13.7	34.2	.151	8.88	.376	12.13
Textile mill products	903	37.0	226.5	.041	2.41	.250	8.06
Apparel and related products	1,267	26.5	43.6	.021	1.24	.034	1.10
Lumber and wood products	589	22.2	30.4	.038	2.24	.052	1.68
Furniture and fixtures	385	19.0	46.9	.049	2.88	.124	4.00
Paper and allied products	614	11.6	13.9	.019	1.12	.023	.74
Printing and allied industries	925	10.9	10.3	.012	.71	.011	.35
Chemicals and allied products	846	35.2	15.0	.042	2.47	.018	.58
Petroleum and rubber	501	4.7		.008	.47		
Leather	360	5.2		.014	.82		
Stone, clay and glass products	594	9.3	10.8	.016	.94	.018	.58
Primary metal industries	1,164	6.9	2.7	.006	.35	.002	.06
Fabricated metal products	1,127	9.4	8.9	.008	.47	.008	.25
Nonelectrical machinery	1,490	5.6	13.5	.004	.24	.009	.29
Electrical machinery	1,579	11.8	24.9	.007	.41	.016	.52
Transportation equipment	1,542	25.2	3.9	.016	.94	.003	.10
Scientific instruments	360	1.5		.004	.24		
Miscellaneous manufacturing industries	391	3.3		.008	.47		
All manufacturing	16,859	291.3	527.6	.017	1.00	.031	1.00

[1]Constants used in computing location quotient in columns 6 and 8 are derived by dividing total manufacturing employment in the state by total manufacturing employment in the United States.

Source: Column 2 - U. S. Department of Labor's Employment and Earning Statistics for the United States, 1909-62.
Columns 3 and 4 - U. S. Department of Labor's Employment and Earning Statistics for States and Areas, 1932-62.