AN EXAMINATION OF THE EXTENT AND IMPACT OF THE DISPERSION OF MANUFACTURING EMPLOYMENT

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PREFACE

This paper is concerned with examining and predicting the impact of manufacturing on small Oklahoma towns. This is accomplished directly through case studies and indirectly through studies of the towns' entire economic bases of which manufacturing is a part. These base studies are combined with single sector model multipliers and multisector model multipliers to generate forecasts which are compared with observed changes.

I especially wish to thank my professor and major advisor, Dr. Ron Moomaw, for giving me a clear understanding of markets and for his continued advice and assistance throughout this project. Dr. Gerald Doeksen also deserves special thanks for helping me with the assorted technical problems encountered in preparing this paper. The other committee members, Dr. Gerald Lage, Dr. Mike Applegate, and Dr. Jim Nelson were also of great help each time it was required.

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TABLE OF CONTENTS

Chapter Page

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

THE PROCESS OF ECONOMIC DEVELOPMENT

Introduction

Economic development is defined as a secular increase in real per capita income. This dissertation examines this process at the community level as it relates to industrialization. Although the avenues to economic development are disputed, regional economists agree that the development of the manufacturing sector is important, if not crucial.

On the one side is the "fairly well-accepted body of theory regarding the normal sequence of development stages in a region" as presented by Hoover and Fisher.[1] The sequence may be outlined as follows:

1. The first stage in the economic history is one of a self-sufficient subsistence economy in which there is little investment or trade. The basic agricultural stratum of population is simply located according to the distribution of natural resources.

2. With improvements in transport, the region develops some trade and local specialization. A second stratum of population comes into being, carrying on simple village industries for the farmers . . .

3. With the increase of interregional trade, a region tends to move through a succession of agricultural crops from

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[1]E. M. Hoover and Joeseph Fisher, "Research in Regional Economic Growth," Problems in the Study of Economic Growth, Chapter V, quoted in Douglas C. North, "Location Theory and Regional Economic Growth," Regional Economics: Theory and Practice, ed. David L. McKee, Robert D. Dean, and William H. Leahy, (New York: The Free Press, 1970), p. 30.

extensive grazing to cereal production to fruit-growing, dairy farming, and truck gardening.

4. With increased population and diminishing returns in agriculture and other extractive industries, a region is forced to industrialize . . . Typically, if the early stage of industrialization is to continue, mineral and energy resources become critical . . .

5. A final stage of regional growth is reached when a region specializes in tertiary industries producing for export. Such a region export capital, skilled personnel, and special services to less advanced regions.[2]

Advancement through these stages is dependent upon reduced transport rates which have tended to

> . . . transform a scattered, ubiquitous pattern of production into an increasingly concentrated one, and to effect progressive differentiation and selection between sites with superior and inferior resources and trade routes.[3]

The development process described by Hoover then is one accomplished by regional internal reorganization and eventual specialization finally resulting in interregional trade. The goods traded are first agricultural goods and goods from extractive processes such as mining. Then manufactured goods are traded among regions as diminishing returns occur in agricultural and extraction, and finally some regions grow past the manufacturing stage and become capital exporters to less developed regions.

North notes that this sequence of stages bears "little resemblance to the actual development of regions" in America.[4] This discrepancy

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[2]Douglas C. North, "Location Theory and Regional Economic Growth," Regional Economics: Theory and Practice, ed. David L. McKee, Robert D. Dean, and William H. Leahy (New York: The Free Press, 1970), pp. 30-31.

[3]Walter Isard, "Distance Inputs and The Space Economy, Part I, The Conceptional Framework," Quarterly Journal of Economics, LXV (May, 1951), pp. 188-198.

[4]North, p. 32.

arises because "America was exploited in large part as a capitalist venture" where the market-oriented economy of Europe "emerged only gradually from the predominantly local economies of the manorial system."[5]

In short, development in America was accomplished, according to North, by initial exploitation of the various region's natural resources. North cites the economic history of the Pacific Northwest as a counter example to the stages model. Upon settlement the region's wheat, lumber, and flour industries developed almost entirely for export to distant markets. Canada is also cited by North as a counter example to Hoover's stages theory. Manufacturing growth has resulted from the growth of exporting agricultural or extractive activity, rather than from the diminishing returns in those sectors.

North distinguishes four types of manufacturing which will develop. These are listed as follows:

1. Materials-oriented industries which because of marked transfer advantages of the manufactured product over the raw material, locate at the source of the latter. Among the industries in this category are sugar-beet refining, flour-milling, and lumbering. Such industries may develop further stages of vertical integration until transfer cost advantages become equalized. Such industry is typically part of the export base.

2. Service industries to the export industry. Foundaries and establishments that make machine tools, specialized agricultural implements, and logging and lumbering equipment are illustrations.

3. Residentiary industry produced for local consumption.

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[5] Ibid., p. 32.

4. Foot-loose industries, where transfer costs are not of significant importance in location. A great many such industries develop purely by chance in some location.[6]

He recognizes that the outputs of these manufacturing industries, given appropriate changes in transportation technology, may themselves become exports and thus part of the regional economy's economic base. North's position then might be summarized as 'Manufacturing growth is sufficient but not necessary for the attainment of economic growth.'

A synthesis of Hoover's stages approach and North's base approach is presented by Stabler. He presents a scenario of business firms choosing locations in order to minimize costs given various constraints. Some of these plants will produce for the export market given sufficient export demand. According to Stabler:

> It is readily observable that various combinations of the above criteria may be grouped in such a manner as to insure a continuous expansion in the volume of regional activity, population and per capita income. There is little evidence to indicate that evolution to a manufacturing base is necessary for continued progress in every case. However, it must be recognized that regions that do develop such a base have several advantages becuase of the number of output-oriented and interindustry-oriented activities that are attracted to the region widen the base and enhance the possibility of continuous expansion . . .[7]

Thus while controversy exists concerning the necessity of manufacturing in a regional economy, general agreement on the positive economic impacts on per capita income and other economic variables also exists among professional economists. As is shown below, there may be more divergency of purpose and less agreement at the level where

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[6]Ibid., p. 42.

[7]J. C. Stabler, "Exports and Evolution: The Process of Regional Change," Land Economics, XLIV, No. 1 (February, 1968), p. 20.

decisions to pursue or not pursue a policy of industrialization is actually made.

The Political Economy of Industrialization

Industrialization shall hereafter be defined as the process of including manufacturing in the economic base of an economy which was formerly agrarian or extractive. Industrialization is accomplished by privately owned business firms whose managements are primarily interested in making profits. These profits are made by combining inputs such as land, labor, capital, raw materials and transportation services in such a manner that an output results whose value to society exceeds the social value of the inputs.

The interaction between the owners of these resources and the potential resource users sets a market clearing price. In that the potential users continue to find new ways to use the resources, and consumers tire of some of the uses of the resources while resource owners continuously change their reservation prices, resource prices are constantly fluctuating. Should business firms perceive that resource price increases in their current market result in profits lower than those available in other locations, the firms will search for new resource sources and new manufacturing sites. This plant site search is an extension of the firm's day to day business into another market. The product which the firm will buy in this market is a parcel of real estate, but the characteristics of the community in which the physical site is located will also weigh heavily in the decision maker's site selection choice. Those characteristics most commonly noted are labor force characteristics and access characteristics.

The person who disseminates information to these firms with potentially mobile capital is the community leader. The community leader may be a profit seeking individual with immobile resources such as land or good will which he expects to increase in value with industrialization. These localized expected gains are great enough to allow this leader to devote a significant amount of his valuable effort to the promotion of his community. A larger proportion of the community's electorate anticipate that the gain from industrialization accruing to them will be positive but not sufficiently large to compensate them for additional effort or decreased leisure. These people will vote to elect a leader to promote the community for them. A third group of a community's electorate will likely view their share of any benefits from industrialization to be so small that they will expend their efforts to avoid their tax dollars being spent on community promotion. The interaction of these three groups in a perfectly functioning political system could result in a correct level of promotion. There are, however, two problems.

The first involves a breakdown of workings of the political system caused by the free rider problem. Each voter has the incentive to understate the intensity of his true preferences allowing his fellow voters to pay for those services. When each voter behaves in this manner, however, the resultant level of expenditure is one which may be different than that which would have been chosen by a perfect political system.

The second problem is the lack of information regarding the impact of industrialization. This lack of information results from the fact that each decision maker must not only predict the impact of industrialization but must also develop a methodology for estimating that impact.

The intent of this study is to reduce the cost of obtaining good information about the extent and impact of industrialization to community leaders and potential community leaders.

The specific objectives of the study are to:

1. Examine the process of the dispersal of manufacturing to allow community decision makers to assess the probability of receiving a new manufacturing plant.
2. Determine the impact of an increase in manufacturing employment on selected economic variables by use of case studies to allow the community decision maker to estimate the general impact of increased manufacturing activity.
3. Determine the applicability of using a simple economic base model to predict total employment change given an exogenous change in basic employment.
4. Determine the applicability of using a location quotient input-output model to predict total employment change given an exogenous increase in basic employment.

Organization of the Study

The following chapter presents a model for understanding the economic rationale for industrial dispersion and a summary of the results of national dispersion. Chapter III contains a description of industrial dispersion in Oklahoma over recent years and presents the development of a summary index which allows the trend in dispersion to be discerned. Chapter IV develops the methodology for the community case studies.

Chapter V presents the formal development of the economic base model and compares the employment change predicted by this model with those actually observed. Chapter VI formally develops the location quotient input-output model and compares the employment changes predicted by this model with those actually observed. Chapter VII provides a summary of the results and their implication.

CHAPTER II

THE PROCESS AND OUTCOME OF DISPERSION OF MANUFACTURING IN THE UNITED STATES

Introduction

This chapter will present a summary of the economic models explaining industrial location and will also present an examination of the change in the distribution of manufacturing across city sizes. A review of the literature describing the dispersion of manufacturing employment in the United States is also presented in this chapter. The evidence suggests that small communities outside of the traditional industrial areas of the United States have received and might be expected to continue to receive substantial increases in manufacturing employment.

A Cost Minimizing Model

As was shown in the preceding chapter, the various regions of the United States were developed largely through the capitalistic exploitation of the regions' various resources. Isard and Moses, among others, have developed rigorous models using graphics and mathematics to show the implications of individual plants locating in such a manner that the total cost of transforming resources and raw materials into finished goods is minimized.[1] This total cost includes not only production costs but also those costs incurred by the transportation of the raw materials to the site of assembly plus the transportation of the assembled goods to the site of consumption.

Stabler has classified the outcomes of the locational decision into four distinct classes. His first class is composed of those activities where input access is the major consideration. The classic example here is the mineral extractive industry where the process is physically tied to mineral deposits which are distributed at disperse points in space. Agriculture and recreational activities such as skiing, fishing and sport hunting are similarly closely tied to their inputs. As input oriented location preference may also result when some other input, say, labor, constitutes the major proportion of production costs. This would give a least cost site at the location of the labor force. A similar input oriented location preference occurs when the cost of moving the major input

> . . . exceed the sum of any processing costs differential that may exist at alternative sites plus transfer costs on the product, because the input may be perishable, or because a substantial savings is realized when technologically separate operations are carried out at the same time and place.[2]

Examples of this orientation include the classic weight-losing processes such as smelting and sawmilling.

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[1] Walter Isard, "Distance Inputs and the Space Economy: The Locational Equilibrium of the Firm," The Quarterly Journal of Economics, 65 (1951), pp. 373-397; Leon N. Moses, "Location and the Theory of Production," The Quarterly Journal of Economics, 72 (1958), pp. 259-272.

[2] Stabler, p. 56.

A second location orientation is at the market for the product rather than the location of an input. This may occur when "the transfer costs on the output exceed the sum of differential processing costs plus transfer costs on inputs that are not locally available."[3] Other industries which will be located at the final market for their product are those which require face-to-face contact with customers.

A third locational preference as described by Stabler is one where both input and output access exert strong influence. This generally occurs in "the production of intermediate goods whose inputs are received from industry and whose output is sold to industry."[4] Stabler suggests that the least cost location for such plants is in an industrial complex. These plants may be pulled away from the complex to large markets if scale economies are important in the production of their products. Alternatively, these plants may be optimally located at the site of some scarce resource.

A fourth class of industry is that where input and output access exert little influence on location. These industries generally "produce a profit whose output is valuable but not fragile, bulky, or perishable."[5]

In a competitive static economy which satisfied generalized convexity conditions and where all actors operate with full knowledge to maximize their satisfaction, a single distribution of economic activity will be generated. This distribution will be one which results in the fewest resources being used to create the greatest value of output, and since the entire economy is assumed unchanging, the

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[3]Ibid., p. 58.

[4]Ibid., p. 59.

[5]Ibid., p. 60.

distribution of activity will also remain unchanged. If, however, households are allowed to change their tastes, and knowledge is allowed to be imperfect but expanding, relative prices will constantly be changing. These changing prices reflect the changing scarcities of stocks of resources relative to the uses to which the resources may be put. The optimal distribution of economic activity is thus constantly changing.

A Model of Other Factor Costs

A body of literature has developed to examine the change in the location of manufacturing employment by the type of location. An expectation of the direction of this change is given by Evans in "The Pure Theory of City Size." Evans shows that input prices for labor and land rise with city size, and that the price of business services should decrease at a decreasing rate as city size increases.[6] As cities grow then a firm could be thrown into locational disequilibrium. That is, even if it were located so as to minimize its transportation costs, its total profit may not be maximized. If a firm were an extensive user of land or labor relative to business services, given a normal rate of growth for every city, the firm would find it advantageous over time to relocate in cities nearer the bottom of the size distribution of cities.

Hoch in "Income and City Size" found per capita income to rise significantly with city size. This is pointed out most sharply by the fact that average per capita income in the New York Standard Metropolitan Statistical Area was 35 percent above the national average. Hoch finds

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[6] A. W. Evans, "The Pure Theory of City Size," Urban Studies, Vol. 9, No. 1 (1972), p. 63.

this income difference to be the sum of the effects of differences in population composition, differences in living costs, and differences in the level of payments required to compensate citizens for exposure to non-priced negative externalities.[7] The population composition differences result in higher wages in larger cities because the larger cities, perhaps by chance, have citizens and jobs with higher productivity than do the smaller cities. This greater productivity would not be incentive for a firm to choose a larger city over a smaller if higher wages offset the greater productivity in larger cities. But larger cities have higher costs of living stemming from increased housing and intraurban transport costs which are an increasing function of density which is itself a function of city size. Consequently labor must be paid a higher and perhaps an offsetting wage to compensate for these higher costs.

The production of intraurban transportation is a process with abundant possibilities for externalities. Congestion results from decision makers' failure to recognize that each of their presences impose costs on everyone else, including themselves. Air pollution is similarly produced by commuters, urban home heating, and business production. Because of the increased travel associated with increased city size, the pollution and congestion levels are likely to increase with the population. Because of their very nature these effects escape direct pricing at their source. If decision makers do notice the congestion and pollution and recognize that its effects could be somewhat avoided by locating in a smaller city, then they will demand

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[7]Irving Hoch, "Income and City Size," Urban Studies, Vol. 9, No. 1 (1972), p. 315.

a wage premium to allow them to attain the same level of satisfaction that would be achieved without the negative externality. Thus, wages again rise with city size.

Will a firm, holding the labor to business services ratio constant, be tempted to migrate from a growing large city to a growing smaller city? If the firm's output is a normal good produced with entirely locally produced inputs and is also sold only within the city's boundaries, it will not. In this instance its costs will rise, but so will the demand for its product enabling the firm to receive normal profits.

If the firm uses locally purchased factors of production to produce a normal good which is sold on the national market the firm may be tempted to relocate. If a smaller city exists which affords the same transportation costs, the firm will be incurring economic losses by foregoing the purchasing of labor and land at the lower price available in the smaller city. The process of the search for maximum profits through economizing on the use of scarce and valuable resources such as urban labor and land will likely result in a constantly changing distribution of manufacturing employment with respect to city size. The remainder of this chapter and the whole of the following chapter are devoted to the examination of the outcome of the above process.

The Change in the Demographic Distribution of Manufacturing in the United States

Creamer has chronicled this changing distribution of manufacturing employment by type of location. His locational categories follows:

A. The principal city of an industrial area
B. A satellite city with 100,000 or more population in an industrial area

C. Remainder of industrial area
D. A city of 100,000 or more population outside industrial areas
E. Remainder of county in which D is located
F. Important industrial county outside industrial areas with 10,000 manufacturing employees but no city
G. Remainder of the United States.[8]

Creamer uses the concept of the industrial area and industrial counties found in the 1929 Census of Manufacture. The industrial area

> . . . signified an area having as its nucleus an important manufacturing city and comprising the county in which the city is located, together with any adjoining county or counties in which there is great concentration of manufacturing industry. The number of wage earners employed in each area is at least 40,000. Selected industrial counties outside industrial areas are those having some degree of industrial importance, at least 10,000 wage earners were employed.[9]

Reviewing further Creamer's terminology, he states ". . . Shifts from A and B categories to C are characterized as primary diffusion, shifts to D, E, and F, as secondary diffusion; while shifts to G are referred to as dispersion."[10] He also divides the county between the "old manufacturing belt" composed of the New England region, the Upper Middle Atlantic region, the Lower Middle Atlantic region and the Midwest region and "all other" regions.[11]

Creamer reports that from 1899 to 1929 the share of manufacturing employment of the principal cities and their satellites, the A and B cities fell by 5.2 percentage points. This was nearly offset by the

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[8]Daniel Creamer, Manufacturing Employment by Type of Location: An Examination of Recent Trends (1969), p. 3.

[9]Daniel Creamer, Changing Location of Manufacturing Employment, Part I: Changes by Type of Location, 1947-1961 (1963), p. 10.

[10]Creamer, Manufacturing Employment, pp. 4-5.

[11]Ibid.

rise in the share of the C cities which comprise the remainder of the industrialized areas. The areas outside the industrialized areas which were deemed industrially important, the D, E, and F areas, gained in share, but the areas of the industrial hinterland, the G counties which had less than 10,000 manufacturing employees, lost in share.

The distribution of manufacturing in the "old manufacturing belt" in 1929 left 70 percent of the employment in the A and B cities, 13 percent in the C, D, E, and F areas, and 16 percent in the G areas. This distribution was essentially inverted for "all other regions" with 60 percent of these regions manufacturing employment in the G areas, 27 percent in the C, D, E, and F areas, and 13 percent in the A and B cities.

From 1929 to 1947 the shares of the A and B areas continued to decline while the shares of the C, D, E, and F areas continued to rise. The G areas' share continued its fall. From 1947 to 1955 the principal cities' share fell by some ten percentage points, but this was just offset by a rise in the share of their suburbs, the B cities. There was no significant change in the shares of those areas of secondary diffusion, the C, D, E, and F area, or the share of the area of dispersion, the G areas.

From 1958 to 1961 Creamer, using data from the Annual Survey of Manufactures, finds a small decrease in the share of the A counties.[12] These counties contain both the A cities and B cities. The other industrialized areas experienced a small increase in their share. The G counties, for the first time in Creamer's time period, experienced

[12] Ibid.

an increase in their share of manufacturing employment. This increase was 1.3 percentage points.

The question of whether there exists s trend towards an increasing share of the G counties is answered obliquely by Creamer. He notes that the number of G counties has been steadily on the decline since 1929, and that

> . . . if all localities had retained their 1929 classification, the declining share of the principal cities would have been accentuated, and the gain of the suburban areas, diminished. The increasing share of the important industrial counties without a large city (F) would have registered a small relative loss, while the unimportant counties (G) would show an increasing share instead of a decreasing one over the time period from 1929 to 1947.[13]

Since there was no change in the share of the G counties from 1947 to 1958 while their number declined, those counties remaining in the G group on the average must have experienced an increase in the share of national manufacturing employment. Given this trend it is not surprising that from 1958 to 1961 the G counties increased their share of manufacturing employment. This 1.3 percentage point increase in share must not be viewed as an outlier, but as a true representative of a trend.

This change in the grographic distribution of manufacturing employment, connected with the continued exploitation of resources found in diverse parts of the nation has resulted in a geographic dispersion of manufacturing employment which parallels the demographic dispersion.

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[13]Creamer, Changing Location of Manufacturing, p. 16.

The Change in the Geographic Distribution of Manufacturing Employment in the United States

That this geographic change truly results from firms' search for locations in communities of optimal size has been recognized in the popular business press. In Business Week, as early as 1970, it was stated that

> . . . the real problem is not the shifts among regions . . . Instead it is the persistent movement away from established urban centers and out to satellites . . . by firms with little need for specialized business service.[14]

Other writers have examined the changes in the geographic distribution of manufacturing employment in the United States. Table I presents an updated summary of the information reported by Perloff, Dunn, Lampard and Muth regarding the geographic distribution of manufacturing employment. The distribution differs slightly from that presented in census publications because of their use of adjusted census data and regional delineations which differ from those presented by the various censuses.[15]

The adjustments to the data on the labor force are those suggested by Brainerd in Agricultural and Non-Agricultural Workers by States, 1870-1950 and Miller in Statistics on the Labor Force by Sex and Age, 1870-1950. These adjustments are to correct for inappropriate reporting

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[14]"Northeast Cuts Its Losses," Business Week, June 6, 1970, p. 82.

[15]Harvey Perloff, et al., Regions, Resources, and Economic Growth, (Lincoln, Nebraska: University of Nebraska Press, 1960), p. 6.

TABLE I

REGIONAL DISTRIBUTION OF THE MANUFACTURING LABOR FORCE, 1870-1970

Region	Percent						
	1870+	1890+	1910+	1930++	1950++	1970*	1975**
New England	21.65	17.38	13.42	10.48	9.59	7.48	7.19
Middle Atlantic	38.35	35.84	33.55	30.31	29.11	23.34	20.77
Great Lakes	20.36	21.24	22.61	25.59	28.94	26.02	25.24
South East	9.94	10.42	12.69	14.38	15.43	20.05	21.39
Plains	6.52	8.88	8.35	7.11	5.68	6.31	6.71
Southwest	0.72	1.31	2.74	4.13	3.28	5.10	5.89
Mountain	0.35	1.44	1.64	1.34	0.87	1.26	1.53
Far West	2.11	3.50	5.00	6.66	7.10	10.43	11.26

Sources: +Perloff, et al., Regions, Resources and Economic Growth (1960); p. 152, Table 44.
++Perloff, et al., p. 252, Table 102.
*U.S. Department of Commerce, Bureau of the Census, Statistical Abstract of the United States: 1971, (Government Printing Office, Washington, D.C., 1971), p. 215, Table 344.
**U.S. Department of Commerce, Bureau of the Census, Statistical Abstract of the United States: 1976, (Government Printing Office, Washington, D.C., 1976), p. 367, Table 596.

of the agricultural labor force. No adjustments are made to reconcile differences in the minimum age for entry into the labor force even though the minimum age for labor force entry from 1870-1930 was ten years of age, from 1930-1960 was 14 years of age, and in 1970 the minimum age for labor force entry was set at 16. The authors claim this to be a very minor defect since the number of children employed in manufacturing after 1930 is quite small.

Their regional delineation, which differs from that of the census, follows:

NEW ENGLAND: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut.

MIDDLE ATLANTIC: New York, New Jersey, Pennsylvania, Delaware, Maryland, District of Columbia.

GREAT LAKES: Ohio, Indiana, Illinois, Michigan, Wisconsin.

SOUTHEAST: Virginia, West Virginia, Kentucky, Tennessee, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Arkansas, Louisiana

PLAINS: Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, Kansas.

SOUTHWEST: Oklahoma, Texas, Arizona, New Mexico.

MOUNTAIN: Montana, Idaho, Wyoming, Utah, Colorado.

FAR WEST: Washington, Oregon, California, Nevada.[16]

The observations for 1980 and 1975 differ slightly from Perloff's in source and content. These observations are based upon the

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[16] Ibid.

distribution of actual manufacturing employment as reported in the Statistical Abstract of the United States for 1971 and 1976.[17]

An examination of the change in regional shares of manufacturing activity from 1870 through 1970 gives insight into the change in the geographic distribution of manufacturing. New England's 1970 share of national manufacturing fell to 33.21 percent of its 1870 share. The Middle Atlantic region's 1970 share fell to 54.15 percent of its 1870 share. The Great Lakes region's share rose by 27.80 percent over those 100 years. The Southeast regional share of manufacturing increased by 101.71 percent over this time period. The Plains states' regional share declined to 96.78 percent of its 1870 level. The greatest change in shares was experienced by the Southwest region. Its 1970 share was 608.33 percent larger than its 1870 share. The Mountains region experienced an increase in its share of the nation's manufacturing activity by 394.31 percent.

Comparing endpoints of this 100 year time series might bias the conclusions one would draw about the change in the geographic distribution of manufacturing activity. The Great Lakes region, the Plains region, and the Mountain region attained their maximum shares at neither the beginning of the time period nor at its end. The Great Lakes share increased until 1950 but decreased in 1970. The share of the Plains region reached its maximum in 1910 and has since declined. The share of the Mountain region has fluctuated between 0.35 percent and 1.64

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[17] U.S. Department of Commerce, Bureau of the Census, Statistical Abstract of the United States 1976, (97th Edition, Washington, D.C., 1976), p. 367; U.S. Department of Commerce, Bureau of the Census, Statistical Abstract of the United States 1971, (92nd Edition, Washington, D.C., 1971), p. 218.

percent showing no clear trend with respect to time. The trend in each of the other regions has been either monotonically increasing or decreasing so that the use of endpoints does in fact convey the correct information about the direction and magnitude of the change.

Summary

An analysis of the plant location decision under conditions of profit maximization through cost minimization suggests that the distribution of employment will be continuously changing if consumer tastes are changing or if relative scarcities are changing. Systematic movement of land or labor intensive firms into less populous areas from growing areas is predicted. The Creamer data suggest that those places with less than 100,000 people and less than 10,000 manufacturing employees in 1929 have been increasing their share of the nation's manufacturing employment. These places, in 1929, accounted for about one-sixth of all manufacturing belt, and they accounted for nearly two-thirds of total manufacturing employment in the rest of the nation.

The Perloff data suggest that over the last 100 years, the share of manufacturing employment in the old manufacturing belt has decreased by about a third, while the share of manufacturing employment in the rest of the nation has more than doubled. Taken together then Creamer and Perloff suggest that many of those towns which were classified as industrially unimportant in 1929 must have experienced substantial increases in manufacturing employment. The following chapter will examine in detail the dispersion of manufacturing employment in Oklahoma in order to provide information for community leaders.

CHAPTER III

THE EVIDENCE ON THE RECENT DISPERSION OF MANUFACTURING IN OKLAHOMA

Introduction

One of the objectives of this work is to provide information to decision makers regarding the locational preferences of various types of manufacturing. This chapter does this by examining in detail the revealed preferences of manufacturing firms expanding their employment in Oklahoma from 1963 through 1975. The demographic dispersion is also measured by a summary index developed in this chapter.

The data available for the recent past in Oklahoma allow specific conclusions to be drawn about the distribution of new manufacturing employment. Starting in 1963 the Oklahoma Department of Industrial Development has published its _Oklahoma Industrialization_.[1] This publication presents verified observations of jobs created by new and expanded manufacturing plants. Each plant is listed by the appropriate Standard Industrial Classification for its major product. The data presented in the forthcoming analysis has been adjusted to conform to the 1972 SIC industry groups.

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[1]Neil J. Diekman, Jr. and Paula D. Muel, _Oklahoma Industrialization_, (Oklahoma City: Oklahoma Department of Industrial Development, 1963), p. 2.

From 1963 to 1975, 91,820 new jobs were created in Oklahoma by manufacturing plants. There were fewer new manufacturing plants than expanded plants, but the new plants were responsible for creating more jobs in Oklahoma. In fact, the 680 new plants created 47,380 new jobs for an average of 69.7 jobs per plant while the 938 plant expansions created 44,440 new jobs for an average of 47.4 jobs per plant. In total, the new plants created 51.7 percent of all the new manufacturing jobs in Oklahoma over this time period, and the expanded plants created 48.3 percent of the new jobs.

The Geographic Distribution of Manufacturing Employment in Oklahoma

The geographic area of study in this section is the sub-state planning district. There are 11 such districts in the state. They were created in 1971 by Executive Order of the Governor to provide a means for coordinating functional planning and for delivering federal and state services to the cooperating governmental units which compose them.[2]

A delineation of the sub-state districts is found in Figure 1. Detailed information on the number of new plants locating in each district is found in Table II. Table III presents the number of jobs created in each district by the various industries from 1963 through 1975. The number of plant expansions and of jobs created by expanded plants is found in Tables IV and V, respectively.

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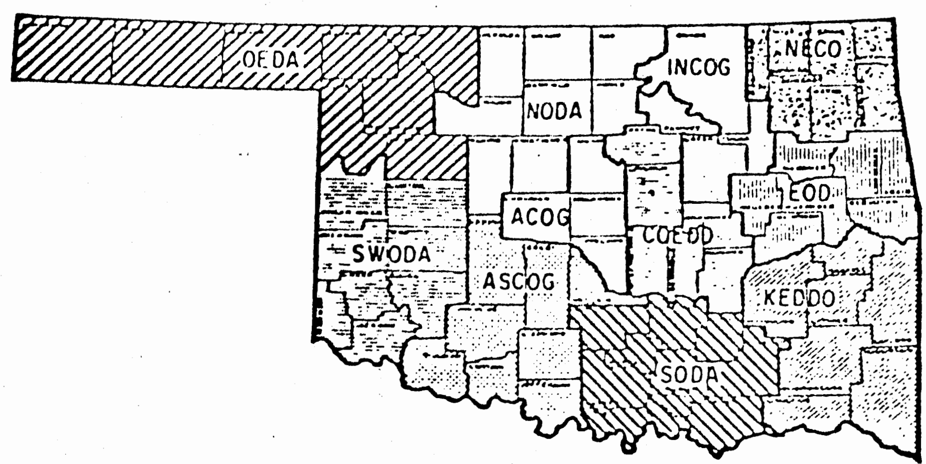
[2]Gale Blalock and Gerald A. Doeksen, Job Creation in Oklahoma by New and Expanded Manufacturing Plants, (Stillwater, OK: Agricultural Experiment Station, 1978), p. 15.



NECO-Northeast Counties of Oklahoma Economic Development Association
EODD-Eastern Oklahoma Development District
KEDDO - Kiamichi Economic Development District of Oklahoma
SODA - Southern Oklahoma Development Association
COEDD - Central Oklahoma Economic Development District
INCOG - Indian Nations Council of Governments
NODA - Northern Oklahoma Development Association
ACOG - Association of Central Oklahoma Governments
ASCOG - Association of South Central Oklahoma Governments
SWODA - South Western Oklahoma Development Authority
OEDA - Oklahoma Economic Development Association

Source: M. Gale Blalock and Gerald A. Doeksen, Job Creation in Oklahoma by New and Expanded Manufacturing Plants, 1963 Through 1975, p. 15.

Figure 1. Sub-State Planning Districts in Oklahoma

TABLE II

NUMBER OF NEW PLANTS CLASSIFIED BY SUB-STATE PLANNING DISTRICTS

Industry Group	NECO	EODD	KEDDO	SODA	COEDD	INCOG	NODA
Food and Kindred Products	5	4	3	6	3	3	2
Tobacco Manufacturers	0	0	0	0	0	0	0
Textile Mill Products	4	0	2	0	2	8	2
Apparel	3	3	5	9	5	3	1
Lumber & Wood Prod. except Furn.	5	2	7	2	3	7	3
Furniture & Fixtures	2	3	3	4	0	1	4
Paper & Allied Products	4	1	2	1	1	1	0
Printing, Publishing	0	0	0	0	0	4	0
Chemicals & Allied Products	6	2	2	1	2	4	5
Petroleum Refining & Related Industries	1	1	0	2	2	1	4
Rubber & Misc. Plastic Prod.	1	2	1	4	2	6	2
Leather & Leather Products	1	0	0	2	1	2	1
Stone, Clay, Glass & Concrete Products	3	9	4	6	8	5	1
Primary Metal Ind.	7	5	1	0	4	5	2
Fabricated Metal Prod. except Mach.	9	2	3	1	3	26	5
Machinery, except Elec. & Trans.	10	3	4	6	5	10	9
Electrical & Elec. Mach. & Equip.	3	4	4	3	3	6	2
Transportation Equip.	4	2	2	7	4	9	3
Instruments & Related Products	0	0	1	3	0	2	0
Misc. Manu. Ind.	0	5	0	6	1	0	1
Total	68	48	44	63	49	103	47
% of Total	10.0	7.1	6.5	9.3	7.2	15.1	6.9

Source: Neil J. Dikeman, Jr. and Paula D. Muel, Oklahoma Industrialization, Oklahoma Department of Industrial Development, 1963 through 1975.

TABLE II (Continued)

	ACOG	ASCOG	SWODA	OEDA	Total	% of Total
Food and Kindred Products	6	3	4	3	42	6.2
Tobacco Manufacturers	0	0	0	0	0	0.0
Textile Mill Products	1	2	1	0	22	3.2
Apparel	4	7	8	2	50	7.4
Lumber & Wood Prod. except Furn.	7	7	2	0	45	6.6
Furniture & Fixtures	0	7	3	2	35	5.2
Paper & Allied Products	4	0	1	0	15	2.2
Printing, Publishing	5	1	0	0	10	1.5
Chemicals & Allied Products	9	6	2	5	44	6.5
Petroleum Refining & Related Ind.	3	0	0	1	15	2.2
Rubber & Misc. Plastic Products	9	1	2	0	30	4.4
Leather & Leather Products	0	0	0	0	7	1.0
Stone, Clay, Glass & Concrete Products	8	1	3	0	48	7.1
Primary Metal Ind.	7	2	2	0	35	5.2
Fabricated Metal Prod. except Mach.	15	6	1	0	71	10.4
Machinery, except Elec. & Trans.	15	4	5	3	74	10.8
Electrical & Elec. Mach. & Equip.	9	6	3	0	43	6.3
Transportation Equip.	10	8	7	2	58	8.5
Instruments & Related Products	3	1	3	0	13	1.9
Misc. Manu. Ind.	4	2	2	2	23	3.4
Total	125	64	49	20	680	100.0
% of Total	18.4	9.4	7.2	2.9	100.0	

TABLE III

JOBS CREATED BY NEW MANUFACTURING PLANTS IN OKLAHOMA 1963-1975 CLASSIFIED BY SUB-STATE PLANNING DISTRICT

Industry Group	NECO	EODD	KEDDO	SODA	COEDD	INCOG	NODA
Food and Kindred Products	182	301	268	178	41	93	17
Tobacco Manufacturers							
Textile Mill Products	410	0	675	0	375	865	222
Apparel	92	272	550	1,143	448	395	35
Lumber & Wood Prod. except Furn.	272	260	350	225	123	292	57
Furniture & Fixtures	300	180	280	460	0	30	134
Paper & Allied Products	210	800	600	7	13	200	0
Printing, Publishing	0	0	0	0	0	71	0
Chemicals & Allied Products	544	133	8	5	13	50	127
Petroleum Refining & Related Ind.	20	20	0	3	28	4	38
Rubber & Misc. Plastic Products	7	75	65	1,334	475	184	20
Leather & Leather Products	11	0	0	23	25	27	40
Stone, Clay, Glass & Concrete Prod.	23	333	49	418	347	532	8
Primary Metal Ind.	1,027	266	300	0	453	265	405
Fabricated Metal Prod. except Mach.	568	122	75	50	105	1,073	317
Machinery, except Elec. & Trans.	354	59	61	230	820	551	91
Electrical & Elec. Mach. & Equip.	302	373	260	166	170	1,839	79
Transportation Equip.	190	310	93	255	102	324	400
Instruments & Related Products	0	0	6	43	0	7	0
Misc. Manu. Ind.	0	53	0	197	100	0	0
Total	4,512	3,557	3,640	4,737	3,638	6,802	1,990
% of Total	9.5	7.5	7.7	10.0	7.7	14.3	4.2

Source: See Table II.

TABLE III (Continued)

Industry Group	ACOG	ASCOG	SWODA	OEDA	Total	% of Total
Food and Kindred Products	216	34	16	145	1,491	3.1
Tobacco Manufacturers						0.0
Textile Mill Products	75	585	200	0	3,407	7.2
Apparel	1,078	869	992	527	6,401	13.5
Lumber & Wood Prod., except Furn.	119	244	108	0	2,050	4.3
Furniture & Fixtures	61	121	1,300	123	2,989	6.3
Paper & Allied Products	93	0	213	0	2,136	4.5
Printing, Publishing	213	10	0	0	294	0.6
Chemicals & Allied Products	237	30	122	197	1,466	3.1
Petroleum Refining & Related Ind.	265	0	0	4	382	0.8
Rubber & Misc. Plastic Prod.	1,235	25	80	0	3,500	7.4
Leather & Leather Products	0	0	0	0	126	0.3
Stone, Clay, Glass & Concrete Prod.	229	1	32	0	1,972	4.2
Primary Metal Ind.	67	68	43	0	2,894	6.1
Fabricated Metal Prod. except Mach.	300	433	4	0	3,047	6.4
Machinery, except Elec. & Trans.	1,069	128	82	41	3,486	7.4
Electrical & Elec. Mach. & Equip.	1,070	329	59	0	4,647	9.8
Transportation Equip.	2,818	939	179	23	5,633	11.9
Instruments & Related Products	622	100	194	0	972	2.1
Misc. Manu. Ind.	88	17	18	14	487	1.0
Total	9,855	3,933	3,642	1,074	47,380	100.0
% of Total	20.8	8.3	7.7	2.3	100.0	

TABLE IV

PLANT EXPANSIONS CLASSIFIED BY SUB-STATE PLANNING DISTRICTS

Industry Group	NECO	EODD	KEDDO	SODA	COEDD	INCOG	NODA
Food and Kindred Products	2	7	3	7	2	12	2
Tobacco Manufacturers	0	0	0	0	0	0	0
Textile Mill Products	4	0	1	0	0	2	1
Apparel	5	2	12	12	15	6	0
Lumber & Wood Prod. except Furn.	3	0	9	3	1	4	1
Furniture & Fixtures	0	3	2	2	0	2	0
Paper & Allied Products	0	0	1	0	1	7	0
Printing, Publishing	1	1	0	0	2	7	0
Chemicals & Allied Products	7	0	1	0	1	12	1
Petroleum Refining & Related Ind.	1	2	0	5	3	7	7
Rubber & Misc. Plastic Prod.	9	0	3	5	6	10	0
Leather & Leather Products	1	1	3	0	0	0	0
Stone, Clay, Glass & Concrete Prod.	3	6	1	8	3	19	0
Primary Metal Ind.	6	3	0	0	1	17	1
Fabricated Metal Prod. except Mach.	8	7	2	1	0	77	0
Machinery except Elec. & Trans.	8	3	1	7	4	52	19
Electrical & Elec. Mach. & Equip.	6	4	3	7	3	15	1
Transportation Equip.	5	1	2	6	2	29	6
Instruments & Related Products	0	2	1	2	0	4	0
Misc. Manu. Ind.	0	4	0	3	0	8	0
Total	69	46	45	68	44	290	39
% of Total	7.4	4.9	4.8	7.2	4.7	30.9	4.2

Source: See Table II.

TABLE IV (Continued)

Industry Group	ACOG	ASCOG	SWODA	OEDA	Total	% of Total
Food and Kindred Products	36	7	2	3	83	8.8
Tobacco Manufacturers	0	0	0	0	0	0.0
Textile Mill Products	4	4	0	0	16	1.7
Apparel	10	6	7	1	76	8.1
Lumber & Wood Prod. except Furn.	4	6	1	0	32	3.4
Furniture & Fixtures	5	1	0	1	16	1.7
Paper & Applied Prod.	2	0	0	0	11	1.2
Printing, Publishing	21	0	2	1	35	3.7
Chemicals & Allied Prod.	9	0	2	0	33	3.5
Petroleum Refining & Related Ind.	3	2	0	0	30	3.2
Rubber & Misc. Plastic Products	11	0	0	0	44	4.7
Leather & Leather Products	1	2	0	0	8	0.9
Stone, Clay, Glass & Concrete Prod.	14	3	1	1	59	6.3
Primary Metal Ind.	5	0	0	0	33	3.5
Fabricated Metal Prod. except Mach.	36	3	1	0	135	14.4
Machinery, except Elec. & Trans.	40	8	2	6	150	16.0
Electrical & Elec. Mach. & Equip.	13	4	0	0	56	6.0
Transportation Equipment	26	4	1	2	84	9.0
Instruments & Related Products	6	1	1	0	17	1.8
Misc. Manu. Ind.	5	0	0	0	20	2.1
Total	251	51	20	15	938	100.0
% of Total	26.8	5.9	2.1	1.6	100.0	

TABLE V

JOBS CREATED BY MANUFACTURING PLANT EXPANSIONS IN OKLAHOMA 1963-1975
CLASSIFIED BY INDUSTRY AND SUB-STATE PLANNING DISTRICT

Industry Group	NECO	EODD	KEDDO	SODA	COEDD	INCOG	NODA
Food and Kindred Products	88	68	185	24	20	178	1
Tobacco Manufacturers	0	0	0	0	0	0	0
Textile Mill Products	340	0	200	0	0	140	80
Apparel	197	40	748	1,010	1,352	365	0
Lumber & Wood Prod. except Furn.	106	0	384	98	60	44	50
Furniture & Fixtures	0	50	50	225	0	50	0
Paper & Allied Products	0	0	30	0	11	67	0
Printing, Publishing	20	0	0	0	2	27	0
Chemicals & Allied Products	40	0	0	0	6	113	2
Petroleum Refining & Related Ind.	50	0	0	25	80	98	223
Rubber & Misc. Plastic Products	482	0	195	235	119	237	0
Leather & Leather Products	25	10	145	0	0	0	0
Stone, Clay, Glass & Concrete Prod.	75	50	3	145	50	458	0
Primary Metal Industries	242	135	0	0	3	535	4
Fabricated Metal Prod. except Mach.	143	83	471	50	0	2,896	0
Machinery, except Elec. & Trans.	264	241	123	163	44	2,202	630
Electrical and Elec. Mach. & Equip.	718	266	308	1,166	75	876	6
Transportation Equipment	85	25	70	401	320	7,722	251
Instruments & Related Products	0	2	100	90	0	125	0
Misc. Manu. Ind.	0	86	0	89	0	125	0
Total	2,875	1,056	3,012	3,121	2,142	16,258	1,247
% of Total	6.4	2.4	6.8	8.4	4.8	36.6	2.8

Source: See Table II.

TABLE V (Continued)

Industry Group	ACOG	ASCOG	SWODA	OEDA	Total	% of Total
Food and Kindred Products	498	99	3	15	1,179	2.7
Tobacco Manufacturing	0	0	0	0	0	0.0
Textile Mill Products	102	525	0	0	1,387	3.1
Apparel	1,191	489	471	100	5,963	13.4
Lumber & Wood Prod. except Furn.	45	273	0	0	1,060	2.4
Furniture & Fixtures	70	6	0	50	501	1.1
Paper & Allied Products	26	0	0	0	134	0.3
Printing, Publishing	147	0	7	2	205	0.5
Chemicals & Allied Products	49	0	50	0	260	0.6
Petroleum Refining & Related Ind.	32	6	0	0	514	1.2
Rubber & Misc. Plastic Products	1,056	0	0	0	2,324	5.2
Leather & Leather Products	10	325	0	0	515	1.2
Stone, Clay, Glass & Concrete Prod.	136	28	4	0	949	2.1
Primary Metal Ind.	204	0	0	0	1,123	2.5
Fabricated Metal Prod. except Mach.	698	80	10	0	4,431	10.0
Machinery, except Elec. & Trans.	2,215	117	6	223	6,228	14.0
Electrical & Elec. Mach. & Equip.	1,751	285	0	0	5,451	12.3
Transportation Equipment	2,491	95	8	7	11,475	25.8
Instruments & Related Products	105	15	0	0	437	1.0
Misc. Manu. Ind.	4	0	0	0	304	3.6
Total	10,830	2,343	559	397	44,440	100.0
% of Total	24.4	5.3	1.2	0.9	100.0	

A Brief Description of the Important Industries for Each District

District 1--NECO

The Northeast Counties of Oklahoma Economic Development Association (NECO) is composed of Ottawa, Delaware, Mayes, Craig, Nowata, Rogers, and Washington Counties. This district received 7,387 new jobs from the manufacturing sector, 4,512 of these jobs were created by the 68 new plants, and 2,875 were created by the 69 plants which expanded their operations in this district.

The primary metal industry accounted for 1,027 jobs created at new plants in this district, while the fabricated metal products except machinery industry created 568 jobs at its new plants. The chemicals and allied products industry opened six new plants in this district to create 544 new jobs.

Those existing firms which generated the greatest amount of new jobs by expanding their plants were in the electrical and electronic machinery and equipment industry, the rubber and miscellaneous plastic products industry, and the textile mill products industry.

District 2--EODD

The Eastern Oklahoma Development District (EODD) is made up of Adair, Sequoyah, Muskogee, Cherokee, Wagoner, McIntosh, and Okmulgee Counties. The manufacturing sector created 4,613 new jobs in this district from 1963 through 1975. Forty-eight new plants located here to create 3,557 jobs, and 46 existing plants expanded over this time period to create 1,056 jobs.

Firms in the paper and allied products industry created 800 new jobs by locating new plants in EODD to make them the single most important source of jobs from new firms for this district. Firms in the electrical and electronics equipment industry, the stone, clay, glass and concrete products industry, and the food and kindred products industry were also important to EODD in that they created 373, 333 and 301 jobs, respectively. These four industries created slightly over half of the jobs from new plants in this district. Firms in the electrical and electronic equipment industry were responsible for creating over half of the jobs that were created by expanding manufacturing plants.

District 3--KEDDO

The Kiamichi Economic Development District of Oklahoma (KEDDO) is made up of LeFlore, McCurtain, Choctaw, Pushmataha, Latimer, Haskell, and Pittsburg Counties. Of the 6,652 new jobs, 3,640 were from 44 new plants, and 3,012 were from 45 expanded plants.

The textile mill products industry created 675 jobs at its two new plants to make it the most important source of jobs at new plants in this district. The paper and allied products industry created 600 new jobs at its two plants, and the apparel industry created 550 new jobs at its five new plants. Firms in these three industries were responsible for creating more than half of the jobs created by new plants in this district over the last 13 years.

The most important firms expanding in this district were firms in the apparel industry, the fabricated metal product except machinery industry, and the lumber and wood products except furniture industry.

Respectively, these industries created 748, 471, and 384 new jobs and together they accounted for 53.2 percent of the jobs created by expanding manufacturing plants.

District 4--SODA

The Southern Oklahoma Development Association (SODA) is made up of Atoka, Coal, Bryan, Marshall, Johnston, Pontotoc, Murray, Love, Carter, and Garvin Counties.

Sixty-three new plants were opened in this district to create 4,737 jobs and 68 plants expanded to create 3,121 new jobs. The rubber and miscellaneous plastic products industry was the largest single source of jobs from new plants, and the apparel manufacturers followed by creating 1,143 jobs in five new plants in this district. These two industries account for more than half of the jobs created by new plants in SODA.

Producers in the electrical and electronic machinery and equipment industry expanded their plants to create 1,166 new jobs, and the apparel producers created 1,010 new jobs here by expanding their plants. These two industries account for more than two thirds of the jobs created by expanded plants.

District 5--COEDD

This district, the Central Oklahoma Economic Development District (COEDD), is composed of Pottawatomie, Seminole, Hughes, Okfuskee, Lincoln, Payne, and Pawnee Counties.

This district received 3,638 jobs from 49 new plants and 2,142 jobs from 44 expanded plants. The machinery, except electrical and transportation equipment machinery, industry created 820 jobs at its five new plants, the rubber and miscellaneous plastic products industry created 475 jobs in two new plants, and the apparel industry opened five new plants to create 448 jobs.

Of the 2,142 jobs created by 44 expanding manufacturing plants, more than half, 1,352, were created by the expanding apparel industry. Other expanding industries which were important in COEDD were the electrical and electronic equipment producers and the rubber and miscellaneous plastics products producers.

District 6--INCOG

The Indian Nations Council of Governments (INCOG) is made up of Osage, Tulsa, and Creek Counties. INCOG received more jobs over this time period than any other sub-state planning district in Oklahoma. Plant expansions were a more important source of jobs in INCOG than were new plant openings. Two-hundred-ninety plants expanded to create 16,802 jobs, and 103 new plants opened to create 6,802 jobs.

Of the new firms locating here, those in the electrical and electronic machinery and equipment industry were most important in that they created 1,839 new jobs. Firms in the fabricated metal products, except machinery industry created 1,073 new jobs by locating here, and textile mill products producers created 865 new jobs.

The single most important source of jobs was the expansion of the transportation equipment industry in INCOG. The expansion of firms in this single industry created 7,722 jobs. This exceeds the total number of jobs created by all new manufacturing over this time period. Other expanding industry groups which were important in this district were the fabricated metal products, except machinery, industry with 2,897 jobs, and the machinery, except electrical and transportation equipment, industry which created 2,202 jobs.

District 7--NODA

The counties of Alfalfa, Grant, Kay, Noble, Garfield, Major, Blaine, and Kingfisher comprise the Northern Oklahoma Development Association (NODA). This sub-state plannint district received 3,237 jobs over this 13 year period. 1,990 of these were created by 47 new plants, and 1,247 were created by 39 expanded plants.

The primary metal industry created 405 new jobs at its two new plants to make it the most important source of new jobs. The transportation equipment industry was also important since it created 400 jobs at its three new plants. The fabricated metal products, except machinery, industry created 317 new jobs at five new plants.

Expanded plants in the machinery, except electrical and transportation equipment, industry created 630 jobs. Plants in the transportation equipment industry exapnded their operations to produce 251 new jobs, and plants in the petroleum refining industry expanded to create 223 new jobs.

District 8--ACOG

The Association of Central Oklahoma Governments (ACOG) is made up of Logan, Canadian, Cleveland, and Oklahoma Counties. This district was the second largest recipient of manufacturing jobs. Of the 20,685 jobs created here, 9,855 were created by 125 new plants and 10,830 were created by 251 plant expansions.

The transportation equipment industry created 2,818 jobs at its new plants in this district. The rubber and miscellaneous plastics products industry created 1,235 jobs, and the apparel industry created 1,078 new jobs. These three groups of manufacturers were responsible for 52 percent of the jobs created by new plants in this district.

The transportation equipment industry was also responsible for creating the largest number of jobs by plant expansion. Firms in the transportation equipment industry created 2,491 jobs by enlarging their plants. Other industries whose firms expanded to create new jobs were the machinery, except electrical, industry and the electrical machinery and equipment industry. They created 2,215 and 1,751 jobs respectively.

District 9--ASCOG

The Association of South Central Oklahoma Governments (ASCOG) contains Caddo, Grady, Stephens, Jefferson, Cotton, Tillman and Comanche Counties. This district received 6.8 percent of the new jobs created by manufacturing in Oklahoma. Fifty-four new plants created 3,933 jobs and 51 expanding manufacturing plants created 2,343 jobs.

The transportation equipment industry created 939 jobs in this district by locating eight new plants here. The apparel industry opened seven new plants to create 869 new jobs, and the textile mill products industry opened two new plants to create 585 new jobs. These three industries accounted for over half of the jobs created by new plants in this district. The lumber and wood products, except furniture, industry and the furniture and fixtures industry were also important to this district in that they each located seven of their new plants in ASCOG.

The textile mill products industry and the apparel industry were also quite important to this district as a source of new employment from manufacturing plant expansions. They created 525 new jobs and 489 new jobs respectively. The leather and leather products industry expanded in ASCOG to create 325 jobs. These three industries account for more than half of the jobs created by expanded manufacturing plants in this district.

District 10--SWODA

Roger Mills, Custer, Beckam, Washita, Greer, Kiowa, Harmon, and Jackson Counties make up the South Western Oklahoma Development Authority (SWODA). This district was the recipient of four percent of the state's manufacturing jobs.

Forty-nine new plants located in SWODA to create 3,642 new jobs, and 20 plants expanded to create 559 new jobs. The most important source of new jobs was the furniture and fixtures industry which created 1,300 jobs at three new plants. The industry group creating the second largest number of jobs was the apparel industry with 992 jobs. The apparel industry expanded seven of its plants to create 471 of the 559 jobs created by plant expansions in this district.

District 11--OEDA

This development district, the Oklahoma Economic Development Association (OEDA) is composed of Cimarron, Texas, Beaver, Harper, Woods, Ellis, and Woodward Counties. OEDA received the smallest proportion of the state's industrial development. Only 1,471 or 1.6 percent of the state's total new manufacturing jobs were created here over the 13 years of this study. 1,074 jobs were brought into existence by new plants and 397 jobs were generated by plant expansion.

The apparel industry was the largest source of new jobs for this district. Two new apparel plants located here to create 527 jobs. The second largest source of jobs was the chemical and allied products industry which opened five plants in OEDA to create 197 new jobs. The food and kindred products industry opened three new plants to create 40 new jobs. This industry was also the most important source of jobs from plant expansion in this district since it expanded six plants and created 223 of the 397 total jobs from plant expansion.

The Demographic Distribution of New Manufacturing Employment in Oklahoma

Jobs Created by New Manufacturing Plants

An examination of the temporal distribution of the 47,380 jobs created by new plants reveals that there has been more activity in recent years than in the earlier years of the 13 year time period covered by this study as is shown in Table VI. Omitting the preliminary figures for 1975, the data may be divided into quarters. The first quarter provided 12.4 percent of the state's total jobs from these plants, the second quarter provided 19.7 percent, the third quarter accounted for 29.1 percent and the last quarter accounted for 35.0 percent.

A more understandable picture of industrialization may be presented by comparing three broader size classes of communities. The size class composed of cities in excess of 100,000 population contained 698,100

TABLE VI

JOBS CREATED IN OKLAHOMA BY NEW MANUFACTURING PLANTS CLASSIFIED BY CITY SIZE

City Size	1963	1964	1965	1966	1967	1968	1969
0 - 2,499	282	288	11	307	613	682	1,007
2,500 - 4,999	80	16	109	86	362	498	620
5,000 - 9,999	248	29	343	1,286	998	687	1,219
10,000 - 24,999	176	59	318	530	557	682	1,960
25,000 - 49,999	26	164	98	134	0	417	478
50,000 - 99,999	0	0	60	47	8	35	65
100,000 +	2,809	386	372	410	773	250	1,337
Total	3,621	942	1,311	2,800	3,311	3,251	6,686
% of Total	7.6	2.0	2.8	5.9	7.0	6.9	14.1

Source: See Table II.

TABLE VI (Continued)

City Size	1970	1971	1972	1973	1974	1975	Total	% of Total
0 - 2,499	791	437	1,142	624	162	272	6,618	14.0
2,500 - 4,999	537	105	322	1,230	391	108	4,464	9.4
5,000 - 9,999	826	1,336	1,072	1,238	1,452	605	11,339	23.9
10,000 - 24,999	160	695	550	326	555	675	7,243	15.3
25,000 - 49,999	140	32	631	1,440	1,001	0	4,561	9.6
50,000 - 99,999	500	26	0	305	57	60	1,163	2.5
100,000 +	432	1,005	350	2,934	822	50	11,992	25.3
Total	3,386	3,696	4,067	8,099	4,440	1,770	47,380	100.0
% of Total	7.1	7.8	8.6	17.1	9.4	3.7	100.0	100.0

people or 34.7 percent of the population and received 25.3 percent of the jobs created by new manufacturers. Those cities of population between 10,000 and 99,999 had a combined population of 692,000 or 34.4 percent of the state's total and received 27.4 percent of the new manufacturing jobs. The cities in the smallest interval of 0 - 9,999 people accounted for the smallest proportion of the state's population with 39.0 percent or 624,500 people, but received the largest share of the jobs created by new manufacturing plants, 47.3 percent. This suggests that manufacturing plants in general were more attracted to communities in the lower end of the size distribution of cities than those large metropolitan centers which compose the upper end of this distribution.

Jobs Created by Plant Expansion

A total of 44,440 jobs were created by manufacturing plant expansions in Oklahoma from 1963 to 1975 as is shown in Table VII. Examination of the four three-year time periods mentioned above does not show job creation by plant expansion to be either steadily increasing or decreasing. The first quarter accounted for 18.8 percent of the total jobs from plant expansions, the second quarter gave 29.1 percent of those jobs, the third quarter gave 24.1 percent, and the fourth quarter accounted for 28.0 percent of the jobs from expansions.

The very largest cities, Oklahoma City and Tulsa, accounted for more than half of all jobs created by plant expansions. They received 23,039 new jobs or 51.8 percent of the total. The small and medium sized cities shared the remaining 48.2 percent almost equally. Those cities of less than 10,000 population received 10,518 jobs or 23.6

TABLE VII

JOBS CREATED IN OKLAHOMA BY EXPANDED MANUFACTURING PLANTS CLASSIFIED BY CITY SIZE

City Size	1963	1964	1965	1966	1967	1968	1969
0 - 2,499	103	3	34	186	224	200	154
2,500 - 4,999		35	88	92	80	60	233
5,000 - 9,999	315	529	190	515	751	723	195
10,000 - 24,999	720	230	762	956	687	428	582
25,000 - 49,999	3	86	224	187	456	177	50
50,000 - 99,999			27	12	65		250
100,000 +	188	4,461	232	2,963	1,406	2,455	2,562
Total	1,329	5,344	1,557	4,911	3,669	4,043	4,026
% of Total	3.0	12.0	3.5	11.1	8.3	9.1	9.1

Source: See Table II.

TABLE VII (Continued)

City Size	1970	1971	1972	1973	1974	1975	Total	% of Total
0 - 2,499	411	294	138	466	274	22	2,509	5.6
2,500 - 4,999	105	76	420	185	483	75	1,932	4.3
5,000 - 9,999	634	561	426	697	478	63	6,077	13.7
10,000 - 24,999	1,020	475	575	761	528		7,724	17.4
25,000 - 49,999	184	7	11	838	291	195	2,709	6.1
50,000 - 99,999	5	60	6			25	450	1.0
100,000 +	2,202	441	2,072	2,779	767	511	23,039	51.8
Total	4,561	1,914	3,648	5,726	2,821	891	44,440	100.0
% of Total	10.2	4.3	8.2	12.9	6.3	2.0	100.0	100.0

percent of the total while those cities between 10,000 and 99,999 received 10,883 jobs or 24.5 percent of the total. This heavy concentration of jobs created in the metropolitan areas by plant expansions is to be expected since these cities contained most of the manufacturing plants at the beginning of the study period.

Jobs Created by New Manufacturing Plants Classified by Industry and Community Size

This section of the chapter will examine the types of manufacturing plants which have located in Oklahoma over the years 1963 through 1975 and the community sizes which have been most popular with the various industries. The industry types used are those delineated in the 1972 Standard Industrial Classification Manual published by the U.S. Department of Commerce. All manufacturing enterprises are systematically grouped into 20 broad industry groups, each composed of producers of similar products.

The industrial growth of Oklahoma over the last 13 years has come from a very wide base. All but one of the 20 industries which comprise the Standard Industrial Classification's manufacturing sector had at least one new plant locate in Oklahoma. Only the tobacco manufacturers group was not represented. The number of jobs created by new plants locating in communities is presented in Table VIII, and the number of new plants locating in those communities is presented in Table IX.

TABLE VIII

JOB CREATION BY NEW PLANTS LOCATING IN OKALHOMA CLASSIFIED BY INDUSTRY GROUP AND CITY SIZE

Industry Group	0- 2,499	2,500- 4,999	5,000- 9,999	10,000- 24,999	25,000- 49,999
Food and Kindred Products	65	42	574	283	224
Tobacco Manufacturers	0	0	0	0	0
Textile Mill Products	680	920	1,220	430	157
Apparel	867	1,007	2,684	758	0
Lumber & Wood Prod. except Furn.	619	162	536	510	175
Furniture & Fixtures	585	225	1,609	470	25
Paper & Allied Products	701	0	185	357	800
Printing, Publishing	0	0	0	10	3
Chemicals & Allied Prod.	627	109	368	25	115
Petroleum Refining & Related Ind.	76	10	198	0	29
Rubber & Misc. Plastic Products	80	75	17	1,399	498
Leather & Leather Products	51	0	25	23	0
Stone, Clay, Glass & Concrete Prod.	432	108	428	69	192
Primary Metal Ind.	422	378	1,208	88	555
Fabricated Metal Prod. except Mach.	317	342	390	890	420
Machinery, except Elec. & Trans.	245	33	723	689	385
Electrical & Elec. Mach. & Equip.	318	387	478	242	13
Transportation Equipment	373	493	488	769	670
Instruments & Related Products	94	100	100	69	0
Misc. Manu. Ind.	66	73	108	162	0
Total	6,618	4,464	11,339	7,243	4,561
% of Total	14.0	9.4	23.9	15.3	9.6

Source: See Table II.

TABLE VIII (Continued)

Industry Group	50,000-99,999	100,000 +	Total	% of Total
Food and Kindred Products	8	295	1,491	3.1
Tobacco Manufacturers	0	0	0	0.0
Textile Mill Products	0	0	3,407	7.2
Apparel	12	1,073	6,401	13.5
Lumber & Wood Prod. except Furn.	0	48	2,050	4.3
Furniture & Fixtures	0	75	2,989	6.3
Paper & Allied Products	0	93	2,136	4.5
Printing, Publishing	0	281	294	0.6
Chemicals & Allied Prod.	0	222	1,466	3.1
Petroleum Refining & Related Ind.	0	69	382	0.8
Rubber & Misc. Plastic Products	25	1,406	3,500	7.4
Leather & Leather Products	0	27	126	0.3
Stone, Clay, Glass & Concrete Prod.	10	733	1,972	4.2
Primary Metal Ind.	0	243	2,894	6.1
Fabricated Metal Prod. except Mach.	90	598	3,047	6.4
Machinery, except Elec. & Trans.	610	501	3,486	7.4
Electrical & Elec. Mach. & Equip.	300	2,909	4,647	9.8
Transportation Equipment	103	2,737	5,633	11.0
Instruments & Related Products	0	609	972	2.1
Misc. Manu. Ind.	5	73	487	1.0
Total	1,163	11,992	47,380	100.0
% of Total	2.5	25.3	100.0	

TABLE IX

NEW PLANTS IN OKLAHOMA CLASSIFIED BY CITY SIZE AND INDUSTRY GROUP 1963-1975

Industry Group	0- 2,499	2,500- 4,999	5,000- 9,999	10,000- 24,999	25,000- 49,999	50,000- 99,999	100,000+	Total	% of Total
Food and Kindred Products	9	4	10	6	5	1	7	42	6.2
Tobacco Manufacturers	-	-	-	-	-	-	-	0	0.0
Textile Mill Products	3	6	7	4	2	-	-	22	3.2
Apparel	11	14	15	5	-	1	4	50	7.4
Lumber & Wood Prod. except Furn.	10	6	10	12	3	-	4	45	6.6
Furniture & Fixtures	11	2	10	5	2	-	5	35	5.2
Paper & Allied Products	5	-	2	3	1	-	4	15	2.2
Printing, Publishing	-	-	-	1	1	-	8	10	1.5
Chemicals & Allied Prod.	10	6	10	4	3	-	11	44	6.5
Petroleum Refining & Related Ind.	5	1	4	1	2	-	2	15	2.2
Rubber & Misc. Plastic Products	2	2	2	5	5	1	13	30	4.4
Leather & Leather Products	3	-	1	2	-	-	1	7	1.0
Stone, Clay, Glass & Concrete Prod.	10	10	6	4	6	1	11	48	7.1
Primary Metal Ind.	5	7	8	2	4	-	9	35	5.2
Fabricated Metal Prod. except Mach.	9	8	8	15	6	2	23	71	10.4
Machinery, except Elec. & Trans.	17	6	21	10	3	3	14	74	10.8
Electrical & Elec. Mach. & Equip.	9	6	7	4	1	1	15	43	6.3
Transportation Equipment	14	7	5	12	3	4	13	58	8.5
Instruments & Related Products	2	1	2	4	-	-	4	13	1.9
Misc. Manu. Ind.	9	5	3	3	-	1	2	23	3.4
Total	144	91	131	102	47	15	150	680	100.0
% of Total	21.1	13.4	19.3	15.0	6.9	2.2	22.1	100.0	

Source: See Table II.

Industries Exhibiting Specialized Demographic Locational Preference

The locational patterns of these industries with respect to community size will now be examined. For this part of the analysis, three population intervals are delineated, small communities of less than 10,000, medium sized communities of 10,000 to 100,000, and metropolitan areas in excess of 100,000 population. This classification divides the state's population approximately into thirds. An industry is hereafter said to exhibit specialized locational preference if the firms comprising it choose one of the above population intervals for more than half of their new employment.

Less than 10,000. Firms in seven industries specialized in locating in small communities. The textile mill products firms created 82.7 percent of their employment and located 72.7 percent of their plants in communities of less than 10,000. The chemical and allied products industry located 59.1 percent of its plants and created 75.3 percent of its total jobs in this population interval. The petroleum refining firms located 66.6 percent of their new plants and 74.3 percent of their new jobs in small towns. The apparel manufacturing firms located 90.0 percent of their new plants and 71.2 percent of their new jobs in communities of less than 10,000. Firms processing primary metals has 69.4 percent of their new jobs and 57.1 percent of their new plants in these cities, the lumber and wood products, except furniture, manufacturers located 57.8 percent of their new plants here to create 64.2 percent of their new jobs, and firms in the leather and leather products industry located 60.3 percent of their new jobs and 57.1

percent of their new plants in these small cities. These seven industries created 65.0 percent of the jobs created at new plants in these smaller communities.

10,000 through 100,000. Firms in the machinery, except electrical and transportation equipment, industry specialized in locating in medium sized communities by locating 56.9 percent of their jobs at 21.6 percent of their new plants in this class. The rubber and miscellaneous plastic producers located 36.7 percent of their new plants and 54.9 percent of their new jobs in these communities of 10,000 to 100,000. The paper and allied producers created 54.2 percent of their jobs in this interval by locating 26.7 percent of their plants in these communities. The firms of these industries created 5,063 jobs in this population interval. This was 39.0 percent of the jobs created by new plants in these mid-sized communities over the 13 years covered by this study.

100,000 and Over. The strongest locational specialization was exhibited by the printing and publishing firms which located 95.6 percent of their jobs and 80.0 percent of their new plants in metropolitan centers with population in excess of 100,000. The only other industries whose firms specialized in metropolitan centers were the instrument makers with 62.6 percent of their new jobs and 30.8 percent of their plants in this size interval and the electrical and electronic machinery and equipment producers with 62.6 percent of their jobs and 34.9 percent of their new plants in those largest cities. These three industries accounted for 3,799 jobs or 31.6 percent of the total jobs created by new plants in these metropolitan areas.

Five industries were not specialized. These include the transportation equipment industry, the fabricated metal products industry, the stone, clay, glass and concrete products industry, the food and kindred products industry, and miscellaneous manufacturing industries. It is interesting to note that of those industries which exhibit specialized locational patterns, the ones that specialize in communities of less than 10,000 were most important in Oklahoma in terms of manufacturing employment creation. They created 19,715 new jobs or 41.6 percent of all the jobs created by new plants.

Jobs Created by Expanded Manufacturing Plants Classified by Industry and City Size

The increase in employment from expanded manufacturing plants came from all manufacturing industries except tobacco manufacturing. The number of jobs created by expanding manufacturing plants is presented in Table X, and the number of plants expanding in the various community sizes is presented in Table XI.

The most important source of new jobs from plant expansion was the transportation equipment industry which provided 11,475 new jobs at its 84 expanded plants to create 25.8 percent of these jobs. Firms in this industry also created more new jobs at each expanded plant than any other industry, an average of 137. The second largest increase in employment from plant expansion occurred in the machinery, except electrical and transportation equipment, industry. The 150 expanded

TABLE X

JOB CREATION BY MANUFACTURING PLANT EXPANSIONS IN OKLAHOMA 1963-1975
CLASSIFIED BY CITY SIZE AND INDUSTRY GROUP

Industry Group	0- 2,499	2,500- 4,999	5,000- 9,999	10,000- 24,999	25,000- 49,999
Food and Kindred Products	57	145	177	145	10
Tobacco Manufacturers	0	0	0	0	0
Textile Mill Products	225	220	590	320	0
Apparel	405	699	2,175	1,263	660
Lumber & Wood Prod. except Furn.	303	151	401	145	0
Furniture & Fixtures	65	210	80	0	40
Paper & Allied Products	41	0	0	27	0
Printing, Publishing	0	27	4	0	0
Chemicals & Allied Prod.	2	50	46	0	6
Petroleum Refining & Related Ind.	38	80	0	27	261
Rubber & Misc. Plastic Products	0	2	144	925	10
Leather & Leather Products	10	0	470	25	0
Stone, Clay, Glass & Concrete Prod.	111	26	15	186	90
Primary Metal Ind.	4	122	110	430	148
Fabricated Metal Prod. except Mach.	72	22	180	1,062	73
Machinery, except Elec. & Trans.	478	61	529	604	588
Electrical & Elec. Mach. & Equip.	368	35	531	1,364	563
Transportation Equipment	330	62	372	1,107	245
Instruments & Related Products	0	0	180	25	2
Misc. Manu. Ind.	0	20	73	69	13
Total	2,509	1,932	6,077	7,724	2,709
% of Total	5.6	4.3	13.7	17.4	6.1

Source: See Table II.

TABLE X (Continued)

Industry Group	50,000-99,999	100,000 +	Total	% of Total
Food and Kindred Products	32	613	1,179	2.7
Tobacco Manufacturers	0	0	0	0.0
Textile Mill Products	0	32	1,387	3.1
Apparel	60	701	5,963	13.4
Lumber & Wood Prod. except Furn.	0	60	1,060	2.4
Furniture & Fixtures	6	100	501	1.1
Paper & Allied Products	0	66	134	0.3
Printing, Publishing	0	174	205	0.5
Chemicals & Allied Prod.	0	156	260	0.6
Petroleum Refining & Related Ind.	0	108	514	1.2
Rubber & Misc. Plastic Products	0	1,243	2,324	5.2
Leather & Leather Products	0	10	515	1.2
Stone, Clay, Glass & Concrete Prod.	0	521	949	2.1
Primary Metal Ind.	0	309	1,123	2.5
Fabricated Metal Prod. except Mach.	0	3,022	4,431	10.0
Machinery, except Elec. & Trans.	12	3,956	6,228	14.0
Electrical & Elec. Mach. & Equip.	90	2,500	5,451	12.3
Transportation Equipment	250	9,109	11,475	25.8
Instruments & Related Products	0	230	437	1.0
Misc. Manu. Ind.	0	129	304	0.6
Total	450	23,039	44,440	100.0
% of Total	1.0	51.8	100.0	

TABLE XI

PLANT EXPANSIONS IN OKLAHOMA CLASSIFIED BY CITY SIZE AND INDUSTRY GROUP 1963-1975

Industry Group	0- 2,499	2,500- 4,999	5,000- 9,999	10,000- 24,999	25,000- 49,999	50,000- 99,999	100,000+	Total	% of Total
Food and Kindred Products	7	2	12	15	3	2	42	83	8.9
Tobacco Manufacturers	-	-	-	-	-	-	-	0	0.0
Textile Mill Products	2	3	6	4	0	0	1	16	1.7
Apparel	6	17	24	14	4	1	10	76	8.1
Lumber & Wood Prod. except Furn.	5	6	10	6	-	-	5	32	3.4
Furniture & Fixtures	2	2	4	0	2	1	5	16	1.7
Paper & Allied Products	2	0	0	3	0	0	6	11	1.2
Printing, Publishing	0	3	2	1	2	1	26	35	3.7
Chemicals & Allied Prod.	1	3	8	2	1	0	18	33	3.5
Petroleum Refining & Related Ind.	6	3	1	6	7	0	7	30	3.2
Rubber & Misc. Plastic Products	-	1	9	14	1	0	19	44	4.7
Leather & Leather Products	1	0	5	1	0	0	1	8	0.9
Stone, Clay, Glass & Concrete Prod.	6	1	8	11	5	0	28	59	6.3
Primary Metal Ind.	2	3	3	5	4	0	16	33	3.5
Fabricated Metal Prod. except Mach.	3	2	10	18	5	0	97	135	14.4
Machinery, except Elec. & Trans.	13	5	19	19	15	1	78	150	16.0
Electrical & Elec. Mach. & Equip.	6	1	6	10	5	2	26	56	6.0
Transportation Equipment	7	6	7	12	3	1	48	84	8.9
Instruments & Related Products	1	0	3	2	1	0	10	17	1.8
Misc. Manu. Ind.	0	1	3	3	1	0	12	20	2.1
Total	70	59	140	146	59	9	455	938	100.0
% of Total	7.5	6.3	14.9	15.5	6.3	1.0	48.5	100.0	

Source: See Table II.

plants in this industry, the largest number of plant expansions observed, each created an average of 41.5 new jobs. This gives a total increase in employment of 6,228 or 14.0 percent of the new jobs from plant expansion. The apparel industry supplied 13.4 percent of the state's new jobs from plant exapnsion. The electrical and electronic machinery and equipment industry created 12.3 percent of the state's new jobs from plant expansion by creating 5,451 jobs at its 56 expanded plants for an average of 97.3 jobs per plant. The fifth most important industry for job creation was the fabricated metal products, except machinery, industry. An average of 32.8 jobs per plant were created in its 135 expanded plants to give a total of 4,431 jobs or 10.0 percent of the state's total. These five industries together created 33,546 jobs from their firms expanding their plants in Oklahoma over the past 13 years. This accounts for 75.5 percent of the jobs created by manufacturing plant expansions.

Other industries that have made substantial impact on employment by their plant expansions include: the rubber and miscellaneous plastic products industry with 2,324 jobs; the textile mill products industry with 1,387 jobs; the food and kindred products industry with 1,179 jobs; the primary metal industry with 1,123 new jobs; and the lumber and wood products, except furniture, industry with 1,060 jobs created. These five industries combined accounted for 7,073 new jobs and 15.9 percent of the total jobs created by plant expansion in the state.

Industries Exhibiting Specialized Demographic Locational Preference

100,000 and Over. As mentioned earlier, most of the jobs created by plant expansion were located in the metropolitan areas in excess of 100,000 population. Nine industries created more than half of their jobs by plant expansions in these cities. The food and kindred producers located 52.0 percent of their jobs from expansion in these cities, the printers and publishers created 84.9 percent of their jobs there, and the chemicals and allied products producers located 60.0 percent of their jobs from plant expansion in these cities. These largest cities also received 53.4 percent of the jobs created by expanded plants in the rubber and miscellaneous plastics producers, 54.9 percent of the jobs from expansion of the stone, clay, glass and concrete producers, 68.2 percent of the jobs from expansion of plants owned by firms in the fabricated metal products except machinery industry, and 63.5 percent of these jobs from firms in the machinery, except electrical and transportation equipment, industry. The transportation equipment producers expanded their plants in these cities to create 79.4 percent of its jobs there, and the instruments and related products industry expanded its plants in these cities to create 52.6 percent of its jobs from expansions.

10,000 through 100,000. The medium sized cities of 10,000 to 100,000 received more than half the jobs created by plant expansion in only two industries. These industries were the petroleum refining industry with 56.0 percent and the primary metal industry with 51.5 percent.

Less than 10,000. The communities of less than 10,000 population received more than half of the jobs created by plant expansion in four industries. The textile mill products producers created 74.6 percent of their jobs in these communities, the apparel manufacturers created 55.0 percent of their jobs from plant expansion here, and firms in the lumber and wood products, except furniture, industry created 80.6 percent of its jobs from expansion here. These communities also received 70.9 percent of the jobs created by expansion of plants in the leather and leather products industry.

Only the paper and related products producers, the electrical and electronic equipment producers, and miscellaneous manufacturing firms did not concentrate more than 50 percent of their increases in employment from plant expansions in one of the three broad size classifications in cities.

The data show that plant expansion are concentrated in large cities with nine industries specialized in large cities. Small cities, on the other hand, received a more than proportional amount of employees in new plants with seven industries specializing in small cities. Consequently, for the small cities, which are the major concern of this study, new plants and their associated employees are of major importance.

An Examination of the Trend in Industrial Dispersion in Oklahoma from 1963 through 1974

Descriptive data have been used to show that industrial job creation at new plants is growing faster in nonmetropolitan areas than in metropolitan areas and that job creation from this source is more important for small cities than large and vice verse. Furthermore, for purposes of providing information for decision makers in small cities an understanding of the locational patterns of new plants rather than expanding plants is more important. Such information also gives an understanding of current locational forces, since new plants locate without any concern for existing structural capital. Consequently, the objective of this section is to examine statistically the dispersion of new manufacturing jobs with respect to size of community in Oklahoma from 1963 through 1974. Previous studies have either been descriptive or have used some measure of dispersion, such as entropy, without statistically testing the restuls. Garrison, for example, used entropy to describe distribution of manufacturing employment among counties classified by the largest city in the county within the Tennessee Valley.[3] His study indicates a slight increase in the equality of manufacturing employment among his designated county types, which range from entirely rural to metropolitan. Till examines the manufacturing employment growth rates of three types of counties, those within a Standard Metropolitan Statistical Area (SMSA), those within 50 miles of an SMSA, and those more than 50 miles from an SMSA, where the counties

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[3]Charles B. Garrison, "Industrial Growth in the Tennessee Valley Region, 1959 to 1968," American Journal of Agricultural Economics, 56 (February, 1974), p. 52.

within each distance zone are subclassified "by size of main city".[4] He concludes that in no case were growth rates in manufacturing employment of the distant non-metropolitan counties dwarted by employment growth rates of either less distant non-SMSA counties or growth rates of the SMSAs themselves.

This study differs from previous ones in that dispersion of job creation from new manufacturing plants is tested and the community is used as the unit of measurement. Regression is combined with entropy to test dispersion statistically. Before presenting and discussing data and empirical results, entropy as a measure of dispersion is discussed.

The Use of Entropy as an Analytical Tool

The entropy concept had its beginning in thermodynamics where it was and is used to describe the disorder or randomness of a system.[5] Theil appears to have been the first economist to apply entropy to quantitative economics. He used entropy and related measures to examine income inequality, industrial concentration and geographic dispersion of demand.[6] Horowitz suggested that entropy can measure the degree of

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[4]Thomas Till, "The Extent of Industrialization in Southern Nonmetro Labor Markets in the 1960's," Journal of Regional Science, Vol. 13, No. 3 (1973), p. 454.

[5]Gale Blalock and Gerald Doeksen, "An Examination of the Trend in Industrial Dispersion," Southern Journal of Agricultural Economics is the source for the entropy discussion.

[6]Henry Theil, Economics and Information Theory, (Amsterdam: North-Holland, 1967), p. 19.

competition in an industry by quantifying the degree of uncertainty as to which firm might be frequented by a customer chosen at random.[7] Garrison extended the use of this concept to measure the degree of randomness in a regional system. He suggested that the greater the entropy of industrial employment within a regional system, the greater the equality among counties in that system in attracting industry.[8]

The task is to examine the entropy of new jobs created by new manufacturing plants with respect to community size intervals. The entropy measure is comprehensive in that the new employment share of each town is considered in its computation rather than the share of a major group, such as an entire population interval. The entropy of job creation by new plants within this distribution of cities in year t can be written as

$$H(y)_t = \sum_{i=1}^{n} y_{it} \quad \log \frac{1}{y_{it}}$$

where

$$y_i \geq 0, \; i = 1, 2, \ldots, n; \quad \sum_{i=1}^{n} y_i = 1$$

and t = 1963, ..., 1974.

Given that

y_{it} = i^{th} community's share of the jobs created by new plants in the state in year t and

log = common logarithm.[9]

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[7] Ira Horowitz, "Numbers-Equivalents in U.S. Manufacturing Industries: 1954, 1958, and 1963," Southern Economic Journal, 37 (April, 1971), p. 397.

[8] Garrison, p. 54.

[9] Theil, p. 290.

This index will take on its minimum value of zero when all jobs are created in one city.[10] Entropy will take on its maximum value of log n when each city received an equal share of the jobs.

Because entropy considers the number of jobs received by each community, the measure has some very useful disaggregational properties. Once a number of sets, such as population intervals, are delineated, the total amount of dispersion in the system can be classified as dispersion among sets and dispersion within each set as shown in equation (2).

$$H(y)_t = \sum_{g=1}^{G} Yg_t \log \frac{1}{Y_{gt}} + \sum_{g=1}^{G} Yg_t \, Hg(y)_t \qquad (2)$$

where

$$Yg_t = \sum_{i \varepsilon Sg} y_{it} \qquad g = 1, \ldots, G$$

and

$$Hg(y)_t = \sum_{i \varepsilon Sg} \frac{Y_{it}}{Yg_t} \log \frac{Yg_t}{y_{it}} \qquad g = 1, \ldots, G$$

The first term on the right in equation (2) is the between set entropy, which measures degree of equality among sets in year t where Yg_t is the share of new jobs received by set Sg in year t. The second term on the right is the weighted sum of within set entropies. The within set entropies, $(Hg(y)_t)$, measure equality of new job shares of the cities within each set in year t. These within set entropies are

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[10] In that cities with very small shares make very small contributions to the entropy, it is assumed that a city receiving no jobs in one year would make a zero contribution to entropy.

weighted by respective sets' share of jobs created by new plants in year t in the computation of total entropy.[11]

Data and Empirical Results

The major data source of this study is Oklahoma Industrialization by the Oklahoma Department of Industrial Development. This publication presents verified observations of jobs created by new manufacturing plants from 1963 through 1974.[12] Sets used are constructed by combining Oklahoma's 560 communities into seven population groups based on 1970 Census of Population data. These population intervals are: 460 communities with less that 2,500 population; 43 with population from 2,500 to 4,999; 27 with population from 5,000 to 9,999; 18 with population from 10,000 to 24,999; eight with population from 25,000 to 49,999; two with population from 50,000 to 99,999; and two with 100,000 and over.

Precise distribution of the jobs created by new manufacturing plants among the seven population intervals is given in the last two columns of Table XII. It will be recalled that communities of less than 10,000 population had 31.2 percent of the state's non-farm population and received 47.0 percent of new manufacturing jobs. The mid-sized communities from 10,000 to 99,999 and the metropolitan areas of 100,000 and over each had 34.4 percent of the non-farm population. Mid-sized communities, though, received 26.8 percent of the new jobs while metropolitan areas received 26.2 percent. This illustrates the viability

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[11] Ibid., p. 292.

[12] Dikeman, p. 2.

TABLE XII

TOTAL, BETWEEN SET, AND WITHIN SET ENTROPY OF JOBS CREATED BY NEW PLANTS IN OKLAHOMA, 1963-1974

			Within Set Entropy*						
Year Col. 1	Total Entropy Col. 2	Between Set Entropy Col. 3	Less than 2,500 Col. 4	2,500-4,999 Col. 5	5.000-9,999 Col. 6	10,000-24,999 Col. 7	25,000-49,999 Col. 8	50,000-99,999 Col. 9	100,000 and over Col. 10
1963	0.687669	0.367438	0.254096	0.701855	0.369636	0.643320	0.000000	0.000000	0.294361
1964	0.844783	0.598211	0.358340	0.427383	0.617871	0.598663	0.159750	0.000000	0.113954
1965	1.074550	0.709529	0.463431	0.302471	0.447580	0.529690	0.208367	0.000000	0.263693
1966	1.051358	0.661631	0.532248	0.588707	0.367384	0.574026	0.125507	0.224790	0.198419
1967	1.157557	0.681875	0.515354	0.072978	0.742040	0.467771	0.000000	0.000000	0.299090
1968	1.334325	0.773285	0.610187	0.611596	0.678275	0.690140	0.224227	0.000000	0.292285
1969	1.288488	0.751843	0.904449	0.884401	0.763044	0.355998	0.456221	0.000000	0.211620
1970	1.266039	0.780422	0.669301	0.826885	0.614762	0.101534	0.259825	0.000000	0.255633
1971	0.995612	0.638496	0.574931	0.315732	0.535651	0.420314	0.228144	0.000000	0.019207
1972	1.372284	0.729462	0.920701	0.589115	0.668357	0.652029	0.419728	0.000000	0.095124
1973	1.246855	0.733934	0.938737	0.777611	0.795084	0.788205	0.521932	0.036328	0.214010
1974	1.258213	0.722769	0.746505	0.588009	0.747306	0.862175	0.322110	0.000000	0.170931

*Unweighted within set entropies are reported here.

of the small community in attracting manufacturing plants. An index is needed which will examine dispersion of new manufacturing employment precisely.

Results of the entropy computation from equation (2) are presented in Table XII. Total entropy for a given year measures the equality of job shares of all communities in general and is given in column two. Between set entropy, which measures dispersion of jobs among the seven population intervals, is given in column three. Columns four through ten contain within set entropies for each of the individual population intervals. It is interesting to note that in all 12 years, between set entropy has accounted for over half of total entropy. That is, job creation by new plants is more dispersed among the seven population intervals than within them. This is pointed out more strongly in Table XIII.

Table XIII presents the relative entropies for each of the 108 entries in Table XII. Relative entropy measures the extent to which observed level of dispersion equals the maximum level. This index is calculated by dividing the observed entropy index by its upper bound, log n. For instance, total entropy in 1974 was 1.258213. If each of the 560 communities in Oklahoma had received an equal share of the jobs created by new plants, then total entropy would have taken on its maximum value of $H(y)_{1974}$ = log 560 = 2.748188. Relative total entropy for 1974 is then 1.258312 ÷ 2.748188 or 45.8 percent. Relative between set entropy, given in column three of Table XIII, measures the extent to which the seven population intervals shared equally in receipt of jobs created by new manufacturing plants. This index is calculated by dividing the observed between set entropy for any year by its maximum,

TABLE XIII

RELATIVE ENTROPY: OBSERVED ENTROPY AS A PERCENTAGE OF ITS MAXIMUM

			Relative Within Set Entropy						
Year Col. 1	Relative Total Entropy Col. 2	Relative Between Set Entropy Col. 3	Less than 2,500 Col. 4	2,500-4,999 Col. 5	5,000-9,999 Col. 6	10,000-24,999 Col. 7	25,000-49,999 Col. 8	50,000 99,999 Col. 9	100,000 and over Col. 10
1963	25.0	43.5	9.5	43.3	25.8	51.2	0.0	0.0	97.8
1964	30.7	70.8	13.5	26.2	43.2	47.7	17.7	0.0	37.9
1965	39.1	84.0	17.4	18.5	31.3	42.2	23.1	0.0	87.6
1966	36.4	78.3	20.0	36.0	25.7	45.7	13.9	74.7	65.9
1967	42.1	80.7	19.4	4.5	51.8	37.3	0.0	0.0	99.4
1968	48.6	91.5	22.9	37.4	47.4	55.0	24.8	0.0	97.0
1969	46.9	89.0	34.0	54.1	53.3	28.4	50.5	0.0	70.3
1970	46.0	92.3	25.1	50.6	42.9	8.1	28.8	0.0	84.9
1971	36.4	75.6	21.6	19.3	37.4	33.7	25.3	0.0	6.4
1972	49.9	86.3	34.6	36.1	46.7	51.9	46.5	0.0	31.6
1973	45.4	86.8	35.3	47.6	55.5	62.8	57.8	12.1	71.1
1974	45.8	85.5	28.0	36.0	52.2	68.7	35.7	0.0	56.8
Mean	41.0	80.4	23.4	34.1	42.8	44.4	27.0	7.2	67.2

log 7. For example, in 1974 between set entropy was 0.722769. If each of the seven sets had received an equal share that year, between set entropy would have taken on its maximum value of log 7 = 0.722769 ÷ 0.845098 = 85.5 percent. That is, dispersion of jobs among the seven population intervals was 85.5 percent of its maximum in 1974.

Relative within set entropy is computed by dividing the unweighted within set entropy for a given year, $Hg(y)_t$, by its maximum value, log ng, where ng is the number of communities within population interval g. For example, in 1974 the observed within set entropy for the 10,000 to 24,999 population interval was 0.862175. Had the 18 cities in this class each received an equal share of jobs created by new plants therein, within set entropy would have taken on its maximum of log 18 = 1.255272. The relative entropy index is then 68.7 percent for this population interval for 1974.

The last row of Table XIII contains means of the relative entropy series. While total entropy averaged 41.0 percent of its maximum over the 12 years examined, between set entropy averaged 80.4 percent. Average relative between set entropy also exceeded average relative within set entropy for each population interval. That is, while the degree of equality in receipt of jobs among the seven population intervals was quite high, 80.4 percent of its maximum, degree of equality among all communities was rather low, 41.0 percent of its maximum. This may imply that there are a few communities in each population interval which are experiencing a more rapid growth in manufacturing employment that the rest, and that these growing communities are sharing, more or less equally, increases in the state's employment created by new plants.

Some support for this hypothesis is given by rather low levels of observed relative within set entropy in some intervals.

Information presented in Tables XII and XIII does not readily convey whether dispersion as measured by entropy has increased, remained constant, or decreased over the 12 years covered by this study. To test for the existence of statistically significant changes in dispersion of jobs created by new plants, each of the nine entropy series presented in Table XII was regressed on time.

General dispersion of jobs created by new plants among all Oklahoma communities as measured by total entropy exhibited a significant trend to increase over time. This is shown by the positive time coefficient estimated for total entropy in Table XIV. Between set entropy has exhibited a positive trend with respect to time which is significant at the .05 level.

Three of the seven population intervals experienced significant increases in dispersion of jobs among their cities with respect to time. Those experiencing increasing interval dispersion were the less than 2,500 interval, the 5,000 through 9,999 and the 25,000 through 49,999 intervals. In each of these cases, the coefficient of dispersion with respect to time exceeded that relating between set entropy to time. That is, equality within each of the sets has been increasing more rapidly than equality among sets.

Dispersion of these jobs created by new plants within the other four intervals did not exhibit trends which were statistically significant at the .05 level. Coefficients of dispersion over time within the 2,500 to 4,999 interval and the 10,000 to 24,999 interval were positive but were not significant. The dispersion of jobs created by new plants

TABLE XIV

REGRESSION RESULTS

Entropy	Intercept	Time Coefficient t-statistic, 11 d.f.
Total	0.8744564	0.0400839
	9.59***	3.24**
Between Set	0.5557879	0.0189301
	9.68***	2.43*
Within Set		
0-2,499	0.2861667	0.0511539
	3.77***	4.96***
2,500-4,999	0.441727	0.1777273
	2.97*	0.88
5,000-9,999	0.3064546	0.0413147
	3.70***	3.67***
10,000-24,999	0.4942273	0.0096573
	3.81**	0.55
25,000-49,999	0.0209697	0.0342867
	0.29	3.55**
50,000-99,999	0.0399545	-0.0028007
	0.97	-0.50
100,000 +	0.2681363	-0.0099056
	5.12***	-1.39

*Significant at .05.

**Significant at .01.

***Significant at .005.

within the 50,000 to 99,999 population interval and the over 100,000 population interval has exhibited a small negative but insignificant trend.

Summary

The objectives of this chapter were to examine the locational preferences of manufacturing firms expanding their hiring in Oklahoma and to measure the dispersion of jobs created by new plants with the entropy index.

Of particular interest to leaders in smaller communities is the fact that firms in seven industries exhibited a locational preference by locating more than half of their employment in new plants in Oklahoma towns of less than 10,000. These industries were: textile mill products; chemical and allied products; petroleum refining; apparel manufacturing; primary metals processors; lumber and wood products, except furniture, manufacturers; and leather and leather products manufacturers. These towns also received more than half the jobs created by plant expansions in four industries. These important industries were: the textile mill products industry; the apparel industry; the lumber and wood products, except furniture, industry; and the leather and leather products industry.

The Oklahoma towns of 10,000 to 100,000 received more than half the jobs created by new plants in three industries. These industries were: the machinery, except electrical and transportation equipment, industry; the rubber and miscellaneous plastics products industry; and the paper and allied products industry. These towns also received more than half the jobs created by manufacturing plants in the petroleum refining industry and in the primary metal industry.

Three other industries chose Oklahoma cities in excess of 100,000 for more than half of the jobs created at new plants. These were: the printing and publishing industry; the instrument industry; and the electrical and electronic machinery and equipment industry. The Oklahoma cities also received more than half of the jobs created by expanding plants in nine industries. These industries were: the food and kindred products industry; the printing and publishing industry; the chemicals and allied products industry; the rubber and miscellaneous plastics products industry; the stone, clay, glass and concrete industry; the fabricated metals industry; the machinery, except electrical and transportation equipment, industry; the transportation equipment industry; and instrument industry.

A summary index to measure the dispersion of jobs created by new plants in Oklahoma, the entropy index, was also developed in this chapter. The entropy index and simple regression were used to discern trends in industrial dispersion. The results were:

(1) On the average, equality of new manufacturing job shares as measured by between set entropy for the seven population intervals has been 80.4 percent of its maximum for the years covered.

(2) Dispersion of jobs created by new manufacturing plants among all communities, as measured by total entropy, has increased over time. This positive trend is significant at the .01 level.

(3) The equality of job shares of the seven broad population intervals, as measured by between set entropy, has also

exhibited an increasing trend over the years 1963 through 1974. This trend is significant at the .05 level.

(4) Increases of within set entropy were found in the less than 2,500 population interval, the 5,000 to 9,999 interval, and the 25,000 to 49,999 interval which were significant at better than the .05 level.

Conclusion

In general, industry has shown a market preference for the community of less than 10,000 in its locational decision. Industry has become more dispersed across population intervals as well as within three of these intervals. In no case has there been a significant negative trend in dispersion over the 12 years of this study.

CHAPTER IV

THE ECONOMIC IMPACT OF AN INCREASE IN MANUFACTURING EMPLOYMENT

Introduction

Previous chapters have shown manufacturing to be dispersing both geographically and demographically. In Oklahoma even those communities of less than 10,000 population have proved to be suitable locations for manufacturing plant location. The question about the impact of an increase of manufacturing employment upon an economy remains unanswered because the effort involved in accumulating the required information exceeds the probable benefits to any single decision maker in a given community. In this chapter an experiment to identify change associated with changes in manufacturing activity is described with respect to methodology and statistical decision criteria. The results of the experiment are presented, and conclusions are drawn from the experiment's results.

The Experiment

An experiment must be designed which will separate the changes in an economy associated with a change in manufacturing activity from the changes which are associated with change in other variables. This experiment involves selecting two closely related groups of small communities. The group receiving treatment one is a control group composed of communities of less than 10,000 which experienced a change in manufacturing employment of less than 30 jobs from the 1960 census to the 1970 census. The group receiving treatment two is composed of communities of less than 10,000 which received more than 75 new manufacturing jobs.

The Grouping Criteria

To account for differential impacts of changes in agriculture, communities are classified by their geographic location. Three areas of the state which have distinct agricultural production techniques exist.[1] The northeast quarter of the state bounded by Interstate Highway 35 to the west and Interstate Highway 40 to the south, is agriculturally specialized in livestock grazing activity. The southeast quarter of the state bounded by Interstate 35 to the west and Interstate 40 to the north is specialized in forestry. The area of the state west of Interstate Highway 35 is specialized in wheat and cotton farming. The communities within any one of these regions are assumed to have been subject to the same forces from changing agricultural technology, all other things equal, but are assumed to have faced forces different from the communities in the other two regions. This grouping by regional agricultural specialization also adjusts for the economic bases of the three regions. For example, a change in the price of wheat is assumed to affect all the western communities equally and not affect the communities in the eastern part of the state.

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[1]John Goodwin, Interview held in his office at Oklahoma State University, Spring 1977.

All communities are assumed to have the same rate of natural population increase. This assumption gives credence to the grouping of communities with respect to their initial population in that communities of equal size and equal growth rates will have an equal number of additions to their population from births and deaths.

To standardize the communities with respect to distance from a standard metropolitan statistical area a distance variable is created for each community in each of the three geographic regions of the state. In the western region, the distance variable for each community is constructed by dividing the distance of that community from Oklahoma City by the distance from Oklahoma City to the community in the western region which is most distant from Oklahoma City. This process gives a standardized distance variable which can vary between 0 and 100. For the distance variables in the eastern two regions of the state, the distance from the community to the nearest standard metropolitan area is used. The three SMSAs which are possible choices are Oklahoma City, Tulsa and Fort Smith, Arkansas. The denominator of the distance variable is the distance between the most distant community in each region and each SMSA in the region.

The Case Studies

To determine the impact of an increase in manufacturing employment on a community of less than 10,000 population, a number of case studies are performed. In these case studies, a community which experienced an increase in excess of 75 manufacturing jobs is matched with a similar community which experienced a change in manufacturing employment of less than 30 jobs. The ideal match would be one composed of two communities which were carbon copies of each other in 1960 with one receiving a large expansion of manufacturing employment and the other receiving no change in its manufacturing employment and with the nonmanufacturing basic sector of the two economies expanding at exactly the same rate. This would allow one to determine the impact of the increase in manufacturing activity by comparing the economies of the two communities in the terminal year, 1970. That is, the difference in the observed changes in the economies of the two communities would be considered to be the impact of the increased manufacturing activity. Unfortunately, it is not possible to find economies which were identical in the base year of this study, 1960. Thus, some criteria for matching economies must be developed.

The Matching Criteria. The matching method selected is quite straightforward. The sample communities are classified with respect to their geographic location in the regions discussed above. Within each region the communities are placed into two groups; Group A which is composed of communities which experienced a change of less than 30 manufacturing jobs from 1960 through 1970, and Group B which is composed of communities which received an increase of manufacturing jobs in excess of 75. Each of the communities is evaluated with respect to its characteristics as reported in the 1960 census. The first characteristics compared are population, labor force, employment and distance to the nearest SMSA. These four observations make up the list of characteristics for each community.

Each community in Group A is then compared to every community in Group B within the same region of the state. This comparison is performed by subtracting the elements of the list of characteristics of the Group B communities from the corresponding elements of the list for the Group A community. This produces a list of differences for each possible set of matched communities for each region. Each element is then squared to generate a column of squared differences for each pair. The elements of this column are then summed to calculate a sum of squared differences and the pair with the smallest sum is chosen.

Sixteen matched pairs were selected for the case studies. This sample size was chosen because the 17th smallest sum of squared differences was substantially larger than the 16th smallest. This matching procedure does not guarantee that each community will be matched with only one other community. For example, the group A community, Hobart, was more closely matched to the group B community of Frederick and Perry than was the group A community of Hollis matched to the group B community of Tonkawa.

The Decision Criteria. To determine whether the difference between the change in the Group B community and the change in the Group A community is significant, Wilcoxson's matched-pairs signed-ranks test is used. This test is particularly well suited to the problem at hand because it is designed for use with ordered-metric scales where normality cannot be assumed.[2] The data in the case studies, people, dollars, houses, and jobs, are all measured at the interval and ratio scale thus meeting the measurement requirement. The sample size of 16 would likely invalidate an assumption of normality which would be required for a t test.

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[3]Hubert M. Blalock, Jr., Social Statistics, (Second Edition, New York, New York: McGraw-Hill, 1972), p. 244.

The null hypothesis for the Wilcoxson test is that there are no differences between the scores of the two groups. This is tested by ranking the differences in the changes in the variables of interest for each pair by absolute value from smallest absolute difference to largest. If there are no differences between the two groups, there will likely be equal numbers of positive and negative differences of similar absolute magnitude. If there are great differences between the sum of the positive ranks and the sum of the negative ranks, the null hypothesis is to be rejected.[3]

The Wilcoxson test statistics, T, is obtained by summing those ranks associated with negative differences. According to Blalock, "For larger samples, T is approximately normally distributed with Mean = $\frac{N(N+1)}{4}$ and Standard Deviation = $\sqrt{\frac{N(N+1)(2N+1)}{24}}$."[4] If there are in fact equal numbers of positive and negative ranks of similar magnitude when a sample of 16 pairs is examined, the Wilcoxson statistic, T, will take on its expectation of 68. The approximate standard deviation of T when the sample size is 16 is 19.34. The value of T which results in the rejection of the hypothesis that no differences between the two groups exist is 30. That is, if a T of 30 is observed, this T is some 1.96 standard deviations less than its expectation. The null hypothesis can thus be rejected at the .05 level. Should a T of 24 be observed, the null hypothesis is rejected at the .01 level for such a T is 2.27 standard deviations below its expectation. The population

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[3]Ibid., p. 267.

[4]Ibid., p. 268.

case studies in Table XV are used for illustrative purposes. In this table the differences between the pair members are presented in column one. These differences are ranked from smallest absolute value to largest absolute value in column two. Those ranks associated with negative differences are repeated in column three. The sum of these negative ranks is the Wilcoxson T. The remaining tables concerning the case studies present differences between the pair members. Percentage differences alluded to in the text are not included in these tables.

The Data. In the population case study, two topics are examined. The first is population growth associated with increased manufacturing employment. Total population for each community is obtained from the 1960 and 1970 Census of Population. These case studies are presented in Table XV.

The second group of case studies examine the rate of immigration. A point estimate of this flow is given in the 1970 Census of Population under the heading "Residence in 1965." The data of interest under this heading are those which record the number of people now living in a particular community over five years of age who were living in a different house in a different county in Oklahoma and those people in the community who were living in a different state in 1965. These two variables give an estimate of intrastate and interstate immigration. These case studies are presented in Table XVI.

The income case studies determine the impact of increased manufacturing employment on median family income and on the median income of all families and unrelated individuals. Again, data from 1960 and 1970 census of population are used. Using unadjsted income presented

TABLE XV

POPULATION CASE STUDIES

Base Year 1960		Terminal Year 1970		
The Pairs		Difference in Change in Population ($\Delta B - \Delta A$)	Rank of Change	Negative Ranks
A City*	B City**			
Hobart	Frederick	982	10	
Hobart	Perry	827	9	
Hollis	Tonkawa	-312	3	-3
Lindsay	Marlow	545	7	
Madill	Tonkawa	126	1	
Sayre	Marlow	388	5	
Watonga	Tonkawa	-334	4	-4
Pauls Valley	Anadarko	1,592	13	
Pauls Valley	Wewoka	1,829	14	
Pauls Valley	Holdenville	1,872	12	
Atoka	Okemah	-561	8	-8
Checotah	Okemah	428	6	
Madill	Okemah	-198	2	-2
Pawhuska	Perry	1,545	11	
Alva	Tahlequah	2,164	15	
Alva	Weatherford	2,230	16	
Total				-17

*Change in manufacturing employment was less than 30 jobs.

**Increase in manufacturing employment was more than 75 jobs.

Source: 1970 Census of Population, U.S. Department of Commerce, Bureau of the Census, 1973, Fourth count tapes; 1960 Census of Population, U.S. Department of Commerce, Bureau of the Census.

in current dollars presents no inflationary bias to the observation because it is assumed in the case study methodology that each community experienced the same aggregate price level changes over the years covered by this study. These case studies are presented in Table XVII.

TABLE XVI

INMIGRATION CASE STUDIES, BASE YEAR 1970, NUMBER OF RESIDENTS OF FIVE YEARS AGE AND OLDER WHO LIVED IN A DIFFERENT HOUSE IN 1965

The Pairs		Difference in Number of People Whose Former House was in Another County
A City*	B City**	
Hobart	Frederick	125
Hobart	Perry	571
Hollis	Tonkawa	392
Lindsay	Marlow	-84
Madill	Tonkawa	209
Sayre	Marlow	559
Watonga	Tonkawa	183
Pauls Valley	Anadarko	131
Pauls Valley	Wewoka	-11
Pauls Valley	Holdenville	-133
Atoka	Okemah	-256
Checotah	Okemah	-136
Madill	Okemah	-267
Pawkuska	Perry	496
Alva	Tahlequah	1,851
Alva	Weatherford	1,900

*Change in manufacturing employment was less than 30 jobs.

**Increase in manufacturing employment was more than 75 jobs.

TABLE XVII

INCOME CASE STUDIES

Base Year 1960		Terminal Year 1970	
The Pairs		Difference in Change in Median Family Income	Difference in Change in Median Income of Families and Unrelated Individuals
A City*	B City**	(ΔB - ΔA)	(ΔB - ΔA)
Hobart	Frederick	456	1,278
Hobart	Perry	670	1,882
Hollis	Tonkawa	1,453	-466
Lindsay	Marlow	-698	-1,265
Madill	Tonkawa	1,598	42
Sayre	Marlow	622	152
Watonga	Tonkawa	-150	-1,357
Pauls Valley	Anadarko	171	793
Pauls Valley	Wewoka	-608	59
Pauls Valley	Holdenville	342	596
Atoka	Okemah	-865	-86
Checotah	Okemah	-717	-173
Madill	Okemah	287	477
Pawhuska	Perry	424	1,072
Alva	Tahlequah	-916	373
Alva	Weatherford	348	-390

*Change in manufacturing employment was less than 30 jobs.

**Increase in manufacturing employment was more than 75 jobs.

Source: See Table XV.

The housing case studies use data from the 1960 Census of Housing and the 1970 Census of Housing. Characteristics of the housing stock associated with increased manufacturing employment examined by case studies are changes in the number of housing units, changes in the owner occupancy rate, changes in the number of owner occupied units, change in the median value of owner occupied units, changes in the number of renter occupied units, changes in the number of units in multi-unit structures, and change in contract rent. These studies are presented in Table XVIII.

The labor market case studies also rely upon data presented in the 1960 and 1970 Census of Population. The 1970 fourth count Census Tapes present data using the 1960 labor force definition. The impact of increased manufacturing employment on total employment, male and female, labor force participation rates and on unemployment rates is estimated. These labor market case studies make up Table XIX.

The examination of manufacturing's impact on retail sales presents a slight problem in that the data on retail sales in these communities of 2,500 to 10,000 population are not for the years reported 1960 and 1970. These data are presented, however, in the 1963 Census of Business and in the 1972 Census of Retail Trade. While this lagged information is not strictly comparable to the census information of 1960 and 1970, it is better than no information. The subjects addressed by the retail trade case study are changes in the number of retail establishments, changes in total retail sales, changes in retail payroll, and changes in employment. Again, it is assumed that comparing dollar magnitudes of ten year intervals introduces no bias because both community groups are expected to have experienced similar rates of change in their

TABLE XVIII

HOUSING CASE STUDIES, BASE YEAR 1960, TERMINAL YEAR 1970

The Pairs		Difference in Change in:					
A City*	B City**	Number of Housing Units (ΔB − ΔA)	Owner Occupied Units (ΔB − ΔA)	Median Value of Owner Occupied Units (ΔB − ΔA)	Renter Occupied Units (ΔB − ΔA)	Number of Units in Multi-Unit Structures (ΔB − ΔA)	Contract Rent (ΔB − ΔA)
Hobart	Frederick	311	-7	400	252	647	3
Hobart	Perry	220	94	1,900	107	624	-1
Hollis	Tonkawa	160	-52	500	80	292	8
Lindsay	Marlow	302	78	-300	167	42	-5
Madill	Tonkawa	-5	-15	2,100	81	-7	8
Sayre	Marlow	160	73	1,200	34	-3	-2
Watonga	Tonkawa	-196	-175	-600	83	23	0
Pauls Valley	Anadarko	820	451	600	290	77	-1
Pauls Valley	Wewoka	637	431	800	148	32	-6
Pauls Valley	Holdenville	615	307	-600	297	65	-6
Atoka	Okemah	-171	-66	-700	-58	7	-1
Checotah	Okemah	-182	-95	0	-34	-27	6
Madill	Okemah	-7	-5	200	27	10	6
Pawhuska	Perry	347	213	900	134	72	-2
Alva	Tahlequah	875	493	300	275	223	-1
Alva	Weatherford	1,110	577	3,400	386	446	7
Total		4,996	2,302	10,100	2,269	2,523	13

*Change in manufacturing employment less than 30.

**Increase in manufacturing employment greater than 75.

Source: 1970 Census of Housing, U.S. Department of Commerce, Bureau of the Census; 1960 Census of Housing, U.S. Department of Commerce, Bureau of the Census.

TABLE XIX

LABOR MARKET CASE STUDIES, 1960 BASE YEAR, 1970 TERMINAL YEAR

The Pairs: A City*	The Pairs: B City**	Manufacturing Employment (ΔB - ΔA)	Total Employment (ΔB - ΔA)	Male Labor Force Participation Rates (ΔB - ΔA)	Female Labor Force Participation Rates (ΔB - ΔA)	Unemployment Rate (ΔB - ΔA)
Hobart	Frederick	252	414	7.4	-0.4	-.010
Hobart	Perry	151	404	5.2	2.5	-.001
Hollis	Tonkawa	78	51	5.9	0.0	-.009
Lindsay	Marlow	75	133	10.9	-5.5	-.013
Madill	Tonkawa	75	1,370	7.4	8.6	.009
Sayre	Marlow	72	138	6.7	2.0	.028
Watonga	Tonkawa	97	17	-9.7	1.1	.005
Pauls Valley	Anadarko	190	287	3.5	-6.3	-.003
Pauls Valley	Wewoka	61	304	7.2	-2.8	-.028
Pauls Valley	Holdenville	86	293	11.3	-0.6	-.003
Atoka	Okemah	63	-14	9.0	12.8	0.0
Checotah	Okemah	62	-168	0.3	0.7	.045
Madill	Okemah	88	225	8.7	11.3	.008
Pawhuska	Perry	116	577	9.0	8.1	-.019
Alva	Tahlequah	126	889	22.5	1.4	.013
Alva	Weatherford	122	957	11.1	2.9	.006

*Change in manufacturing employment was less than 30.

**Increase in manufacturing employment was greater than 75.

Source: See Table XV.

aggregate price indices. The retail trade case studies are presented in Table XX.

Examining the service providing sector of these communities' economies presents the same data problems as does examining their retail sectors. Data from the 1963 and 1972 Selected Service Industries--Area Statistics are used to perform the case studies. The variables examined are again the change in total establishments, change in receipts of these establishments, change in their payroll, and the change in employment in these selected service industries. A slight difficulty is introduced by census disclosure rules omitting two of the previous 16 observations. This study of the service sector is presented in Table XXI.

Empirical Results

Population. Those cities which were net recipients of manufacturing employment grew more than those cities which experienced little change in manufacturing employment. The former group's increase in manufacturing employment exceeded the latter's by an average of 107.13 jobs per unit. The average population growth of the first group was 760.44 people greater than the population growth of the second. Subjecting these results to the Wilcoxson test procedure gives a T value of 17, as is shown in Table XXII. This allows the hypothesis that no difference between the two groups exists to be rejected at the .01 level. A T of this magnitude is -2.637 standard deviations from its expectation. If normality could be assumed, rejection of the null hypothesis would be possible at the .005 level.

TABLE XX

RETAIL TRADE CASE STUDIES, DIFFERENCE IN CHANGE FROM 1963 THROUGH 1972

The Pairs		Number of Retail Establishments	Sales in $1,000	Payroll in $1,000	Employment
A City*	B City**	(ΔB - ΔA)	(ΔB - ΔA)	(ΔB - ΔA)	(ΔB - ΔA)
Hobart	Frederick	-11	-332	-1	3
Hobart	Perry	8	3,501	324	136
Hollis	Tonkawa	27	4,897	495	-60
Lindsay	Marlow	4	-513	564	-16
Madill	Tonkawa	-8	88	-25	19
Sayre	Marlow	13	1,162	104	48
Watonga	Tonkawa	-4	310	96	41
Pauls Valley	Anadarko	11	3,115	206	53
Pauls Valley	Wewoka	2	-2,615	-331	-50
Pauls Valley	Holdenville	-4	-1,956	-101	0
Atoka	Okemah	22	-2,440	-282	-51
Checotah	Okemah	10	70	-159	-77
Madill	Okemah	8	177	-117	49
Pawhuska	Perry	8	7,123	385	50
Alva	Tahlequah	20	7,889	705	67
Alva	Weatherford	34	7,120	681	135

*Change in manufacturing employment was less than 30.

**Increase in manufacturing employment was greater than 75.

Source: 1972 Census of Retail Trade, U.S. Department of Commerce, Bureau of the Census; 1963 Census of Retail Trade, U.S. Department of Commerce, Bureau of the Census.

TABLE XXI

SERVICE INDUSTRY CASE STUDIES, DIFFERENCE IN CHANGE FROM 1963 THROUGH 1972

The Pairs		Number of Establishments	Receipts in $1,000	Payroll in $1,000	Number of Paid Employees
A City*	B City**	(ΔB - ΔA)	(ΔB - ΔA)	(ΔB - ΔA)	(ΔB - ΔA)
Hobart	Frederick	2	318	33	18
Hobart	Perry	-14	-146	36	29
Hollis	Tonkawa	-6	D	D	D
Lindsay	Marlow	9	-259	-14	3
Madill	Tonkawa	42	-389	-13	-4
Sayre	Marlow	-23	-129	18	15
Watonga	Tonkawa	28	176	87	18
Pauls Valley	Anadarko	11	-80	-414	-24
Pauls Valley	Wewoka	7	-573	589	43
Pauls Valley	Holdenville	13	-227	-506	51
Atoka	Okemah	14	D	D	D
Checotah	Okemah	15	-227	-95	-11
Madill	Okemah	-3	-525	-116	-2
Pawhuska	Perry	-17	-826	87	45
Alva	Tahlequah	28	670	41	15
Alva	Weatherford	18	2,926	472	106

*Change in manufacturing employment was less than 30.

**Increase in manufacturing employment was greater than 75.

Source: 1972 Census of Selected Service Industries, U.S. Department of Commerce, Bureau of the Census; 1963 Census of Selected Service Industries, U.S. Department of Commerce, Bureau of the Census.

TABLE XXII

SUMMARY OF STATISTICAL RESULTS OF THE CASE STUDIES

Case Study	Average Difference Between B Cities & A Cities	Wilcoxson T-Statistic	Standard Deviations from T's Expectation
Population	760.40	17.0*	-2.64*
Percentage Change in Population	13.67	37.0	-1.60
Gross Immigrants from Out of the County	345.63	33.0**	1.8**
Median Family Income	$151.57	58.0	-0.51
Median Income for Families and Unrelated Individuals	$186.69	52.0	-0.82
Number of Housing Units	312.25	21.0*	-2.43*
Percentage Change in Housing Units	18.27	40.0	-1.45
Ratio of Owner Occupied to Total Housing Units	-0.15	90.0	1.14
Median Value of Owner Occupied Units	63.25	29.5*	-1.991*
Renter Occupied Units	141.81	6.5*	-3.18*
Units in Multiunit Structures	157.69	9.5*	-3.03*
Contract Rent	0.81	59.0	-0.465
Total Employment	367.31	7.0*	-3.154*
Percentage Change in Total Employment	19.38	15.0*	-2.74*
Male Labor Force Participation Rate	7.27	12.0*	-2.895*
Female Labor Force Participation Rate	2.49	47.0	-1.086
Unemployment Rate	0.18	67.0	-0.051
Number of Retail Establishments	8.75	23.0*	-2.326*
Retail Sales in $1,000	1,745.50	38.0	-1.551
Retail Payroll in $1,000	159.00	13.0*	-2.844*
Retail Employment	21.69	48.0	-1.034
Number of Service Establishments	8.86	38.5	-1.034
Receipts of Service Establishments in $1,000	50.64	56.0	-0.220
Service Payroll in $1,000	14.57	46.0	-0.408
Service Employees	21.57	17.0*	-2.229*

*Significant at .05 level.

**Significant at .10 level.

Comparing the difference in percentage change in population from 1960 through 1970 for the two groups gives a slightly different impression of the impact of manufacturing on population. The average percentage change in population for the communities with little manufacturing growth was slightly less than zero, and the average percentage change in the communities with substantial growth exceeded 13 percent. The matching procedure combined the communities in such a way that the observed Wilcoxson T of 37 resulted. The critical value for rejection of the hypothesis that no difference between the two groups exists is 36. Thus if is not possible to reject the above hypothesis at commonly accepted levels of significance. It must be noted however that the direction of the difference is of the expected sign and that substantive significance exists.

The Level of Immigration. Results from the immigration studies are similar to those found in the population study. Comparing numbers of gross immigrants from outside the county results in a T of 33, one small enough to reject the null hypothesis at the .10 level in favor of an alternative hypothesis suggesting that the towns with actively growing manufacturing sectors were attracting larger numbers of people from the rest of the world. This difference becomes less strong when immigrants as a proportion of 1960 total population is examined.

Income. The case studies show that in total the citizens of the communities which received manufacturing jobs experienced greater growth in median income than did those members who received very few manufacturing jobs. The average difference in change in median family income was $151 per pair in favor of the cities with growing manufacturing sectors. For median income of families and unrelated individuals, the difference across all cases was an average of $187 per pair.

These dollar differences are not, however, distributed in such a manner to allow one to conclude that there are any significant differences in income growth between the two groups. In neither case is the T value generated by the observed data greater than one standard deviation away from its value when no difference between the two groups exists. For this reason, the case studies on income and manufacturing employment do not allow the hypothesis that the two are not related to be rejected at commonly accepted levels of significance. Again, it is noted that the difference is of the expected sign.

The Housing Market. The case studies examining the housing market bear results similar to the population, migration, and income case studies. The pair members of group B, i.e., those communities which experienced significant growth in manufacturing employment, had an increase in the number of housing units of 4,996 in excess of the members of group A. This translates to an average difference of 312.25 housing units per pair. This is associated with a Wilcoxson T of 21. This is small enough to reject the null hypothesis at the .01 level.

The average difference in increase in owner occupied units is 143.88 per pair. The average difference in the increase in the median value of owner occupied housing is $631.25 per pair, again in favor of the towns with the larger manufacturing employment increases. The only variable which grew less rapidly in the group B cities than in the group A cities was the ratio of owner occupied units to total housing units. This ratio, which is not reported directly in Table XVIII, fell by an average of 0.15 percentage points in each of the pairs.

This decrease is reflected in the difference in the change in rented occupied units. The average difference between the group B city and the group A city for each pair was 141.81 additional renter occupied units for the group B city. Many of these units were in multiunit structures as evidenced by the fact that the average difference in the change in housing units in multiunit structures per pair is 157.69 units larger for the cities receiving the larger increases in manufacturing employment. The average change in median contract rent was only $0.81 per month per pair with the group B cities again receiving the larger increase.

Subjecting the empirical information of the housing market case studies to the scrutiny of the Wilcoxson test again points up significant differences between the housing markets of those towns receiving increases in manufacturing employment and those which received no such increase. Wilcoxson's T for the differences in the change in housing units, the number of rented occupied units and the number of housing units in multiunit structures were large enough to reject the hypothesis that no differences in the changes between these two groups existed. Each of these studies show the towns receiving the larger increase in manufacturing employment to have grown more with respect to the variables listed above than those towns which received no such increase in employment. The change in the median value of owner occupied units is significantly greater for the manufacturing towns than for the nonmanufacturing towns. As shown in Table XXI the null hypothesis can easily be rejected in the value study.

Study of the owner occupancy characteristics indicate weakly significant difference in the change between the two groups. The T value for the difference in the change in owner occupied units is 1.758 standard deviations less than that when no difference exists. This T would allow rejection of the null hypothesis at the .10 level, but not the .05 level. The difference in the change in owner occupancy ratios is not large enough to reject the hypothesis that no difference exists between the two groups. It is interesting to note, however, that the ratio fell in the towns with growing manufacturing sectors relative to the towns without growing manufacturing sectors. The difference in the change in contract rents is also too small to reject this null hypothesis at the .05 level as shown in Table XXII.

The Labor Market. The average difference in the change in total employment per pair is 367.31 jobs in favor of the towns receiving the increased manufacturing jobs. The percentage increase in these towns exceeded the percentage increase in the other towns by an average of 19.38 percentage points. The average difference in the change in male labor force participation rates is 7.27 percentage points in favor of the group B towns. An interesting sidelight is that the male labor force participation rate generally declined for the cities in this sample. The average difference in the change in the female labor force participation rate is 2.49 percentage points per pair in favor of the group B towns. The unemployment rate went up by an average of 0.18 percentage points per pair in those towns receiving substantial increases in manufacturing employment compared to those towns which experienced little change in manufacturing jobs.

Statistically, the differences in change in total employment, percentage change in total employment, and male labor force participation rates are shown to be significantly different from zero by the Wilcoxson test. The difference in change in total employment generates a T value 3.15 standard deviations less than its expectation, the difference in percentage change in total employment generates a T value of 2.74 standard deviations less than its expectation, and the difference in the change in male labor force participation rates generates a T value 2.90 standard deviations less than its expected value when no difference between the two groups actually exists.

While female labor force participation rates were slightly higher for the group B towns than the group A towns, the differences were only large enough to generate a T value 1.09 standard deviations less than its expectation. Differences in the change in the rate of unemployment were so slight that the observed T was only 0.05 standard deviations less than its expectation. It seems, then, that the manufacturing growth was not that which employed mainly women.

The Retail Trade Sector. The average difference in the change in the number of retail establishments per pair is 8.75 establishments in favor of the towns receiving the significantly increased manufacturing employment. These same towns increased their sales by an average of $1,745,500 over those towns not receiving increases in manufacturing employment. These towns experiencing manufacturing growth also increased their retail payrolls by $159,000 on the average over those towns not experiencing manufacturing growth, and they increased their retail employment by an average of 21.69 jobs more than the towns not experiencing growth in manufacturing jobs.

Significant differences between the groups with respect to the number of retail establishments and retail payrolls are shown by the Wilcoxson test. The increase in the number of retail establishments in the group B towns over the change in the group A towns is sufficiently large to generate a T value of 2.33 standard deviations less than its expectation. The T generated by comparing ranks of the change in payrolls is 2.84 standard deviations less than its expectation. The differences in sales change and employment change are distributed in such a manner that no difference can be shown between the change in the two groups.

The Service Sector. The average difference between the change in the number of services establishments in group B cities and the changes in the number of establishments in the group A cities is 8.86 establishments per pair with the group B city receiving the increase. The average difference in the change per pair in receipts is $50,640 with the group B city again receiving the net increase. The average payroll difference is $14,570 per pair with the net increase going again to the B city and the increase in service employment per pair is 21.57 additional jobs being held in the cities receiving the increase in manufacturing employment.

The distribution of the differences was such that only with respect to the difference in the change in service employment could the two groups of cities be distinguished as statistically different by the Wilcoxson test.

Conclusion

Methodology

To draw conclusions about the impact of a change in manufacturing employment on a city's economy a hypothetical town is imagined. This hypothetical town is that town which after having reached equilibrium in all markets and having this equilibrium remain undistributed for some years, experiences a sudden change in its manufacturing employment.

This increase in employment and income will then spread to the other sectors of the town's economy causing changes to be observed there as well. The exogenous change in manufacturing for this town is the average change in manufacturing employment across each pair of 107 jobs. The endogenous changes are given by the average difference in change for those variables where the difference was found to be significant.

A Scenario Consistent with the Case Studies

At the beginning of the period a manufacturing plant announces its opening in the town of Micropolis. The plant employs 107 people full time. These people are hired away from an existing job and out of the pool of workers seeking better jobs.

The news of these job vacancies is disseminated throughout the state and relevant parts of the county by letters and phone calls to persons who have migrated from Micropolis by their relatives who remained. The number of immigrants during the last five years of the decade amounts to 311 who moved from other towns within the state and 67 who have moved from towns outside the state. At this rate, the entire population change of 767 could be explained largely by gross immigration.

This influx of people must, at some point, cause excess demand in the market for residential housing. To attain a new market clearing price, the median price of owner occupied hosuing rises by $631. This, along with a monetary increase in rents, attracts resources into the construction of residential housing. By the end of the decade the total number of housing units has increase by 312. Of these, 158 are in multiunit structures, and 142 units are occupied by renters. This marked increase in the competitively supplied number of rental housing units drives the monthly rent back down to its original level.

Total employment in Micropolis increased by 367 jobs over the decade. That is about 2.43 jobs outside manufacturing for every job created in the manufacturing plant. The male labor force participation rate has increased by 7.27 percentage points, but there has been no change in the rate of unemployment.

The increase in the male labor force participation rate may suggest that some potential workers who were discouraged and forsook job search at the decade's beginning have re-evaluated their opportunities and have re-entered the labor force. It might alternatively suggest that the pool of population delivered by the immigration contained a disproportionately large number of work seeking males. Whichever explanation is correct, the constancy of the rate of unemployment implies that the labor market has returned to equilibrium from the shock of the increase manufacturing activity, and that unemployment is at its natural rate.

Nine new retail establishments have opened, and payrolls have increased by $159,000. While the number of service establishments remained unchanged, employment in the service sector increase by 22 jobs.

Summary

A decision maker in a town similar to the ones of this sample could then expect increased manufacturing employment to result in increased population, employment, housing values, and housing units. Similarly, that decision maker could expect increased male labor force participation rates and increased activity in the service and retail trade sectors.

CHAPTER V

THE ONE SECTOR MODEL

Introduction

A model which allows before the fact prediction of economic impacts from expected exogenous changes would be of great use to decision makers evaluating alternative development projects for a municipality. Such a model exists in the economic base model. This chapter is devoted to examination of the theoretical framework of this model and the empirical veracity of its predictions.

More specifically, this chapter will consist of a chronological development of the theory, an algebraic description of a city's economy, and a description of prior empirical studies. The actual empirical section of this chapter includes a description of the data, descriptions of the methodology for the identification of a community's economic base and changes in the size of the base after the fact, the multiplier and a statistical comparison of the actual and predicted changes in employment.

The Chronological Development of the Theory

Those analysts who have dealt with urban problems, both geographers and economists, have long believed that the internal structure of a community's economy was of great importance in the determination of that community's rate of growth. One of the first presentations to specifically delineate a framework for analyzing urban growth was that of Aurousseau in 1921. He stated that towns could be classified by their function or economic specialization and delineated six classes of towns. The classes were "administration, defense, culture, production, communication, and recreation."[1] He then hypothesizes that the growth of a city "appears to be due to the relation between the primary occupations and secondary occupations of the townfolk."[2] Where the primary occupations are those directly concerned with the function of the town, and the secondary occupations are those concerned with the maintenance of the well-being of those people engaged in primary occupations. Aurousseau's simple growth model was the "more primary citizens there are, the more secondary are required in a relation something like compound interest."[3]

The Regional Survey of New York and Its Environs of 1938 recognized that the economic activity taking place within the city could be classified as "primary" if it was involved in the production of goods "not confined to use within the community itself", and auxiliary" if it was devoted "to the service and convenience of the people engaged in the primary occupations."[4] No attempt was actually made to estimate the magnitudes of these two classes of activity.

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[1]M. Aurousseau, "The Distribution of Population: A Constructive Problem," The Geographical Review, Vol. XI, No. 4 (October, 1921), p. 569.

[2]Ibid., p. 574.

[3]Ibid., p. 574.

[4]Regional Survey of New York and Its Environs, quoted in Theodore Lane, "The Urban Base Multiplier: An Evaluation of the State of the Art," Land Economics, Vol. 42, No. 3 (August, 1966), p. 340.

The theory of the economic base model is further clarified by Tiebout in The Community Economic Base Study. In this paper, he develops a short run model and a long run model for examining changes within the community's economy. In the short run, only local consumption can be considered endogenous, while local investment and exports are considered exogenous.[5] Investment here is the sum of local business investment, local housing construction, and government investment. Tiebout states that on a short run basis these types of investment are determined by many factors in addition to local income. Housing construction depends upon "interest rates, downpayment requirements, and occupancy ratios"; business investment depends upon expectations which themselves depend on much more than local income; and the decisions to invest in social overhead capital are made politically and are also not dependent upon the level of local income in the short run.[6] Exports are also not dependent upon local income. Changes in any of these exogenous sectors will produce a multiplied change in the community's level of income.

Tiebout suggests that in a short run model, income data will be more applicable than employment data. He states,

> Income changes affect spending rather rapidly and, in turn, the ramifications are likely to be felt quickly. Effects on employment, on the other hand, are likely to register only over a longer-run.[7]

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[5]Charles M. Tiebout, <u>The Community Economic Base Study</u>, (New York, New York: Committee for Economic Development, 1962), p. 58.

[6]Tiebout, p. 58.

[7]Ibid., p. 67.

[8]Ibid., p. 61.

In his long run model local consumption remains endogenous, and local investment also becomes endogenous. This leaves the export sector as the only exogenous sector. According to Tiebout,

> Over the longer time span only the export sectors appear as basic. The locally oriented industries will grow or decline along with the growth or decline of the export sectors.[8]

In International and Interregional Payments Adjustment: A Synthetic View, Whitman presents a most precise explanation of the process of "export-led growth and export-led decline" for open economies.[9] She defines an open economy to be one which is "heavily dependent on the foreign trade sector."[10] Her argument rests upon the observed high mobility of factors of production among the "open" regions of a national economy.

In the Whitman framework, an increase in the demand for a region's exports results in an increased amount of economic activity in the region and an increased marginal efficiency of capital in the region's export sector. Foreign investors are more sensitive to changes in the region's export sector than the local sector because it is the export sector with which they routinely deal. They then invest their capital in the region's export sector to reap these higher returns. As this new financial capital is converted into real physical capita, the region's capital/labor ratio is increased which increases the productivity and wage of the region's labor force. With labor mobility between regions

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[9] Marina Whitman, International and Interregional Payments Adjustment: A Synthetic View, (Princeton, New Jersey: Princeton Studies in International Finance, February, 1967), p. 2.

[10] Ibid., p. 4.

also high, a complementary flow of labor is forthcoming to match the flow of new capital.

The region described above will initially experience an increase in its current account. That is, exports initially rise more rapidly than do imports. As local income or employment increases via the short run base multiplier, imports also increase. Simultaneously, the marginal efficiency of capital in the export industry will have increased, and capital goods will be imported from abroad. These two increases in imports will shift the current account toward deficit in the short run, but the "capacity effects" of the inflow of labor will have generated secondary increases in consumption and imports. This process will continue until the increased rate of investment diminishes the region's export sector's marginal efficiency of capital so that it is equal to the marginal efficient of capital in the rest of the nation.

North, as already noted, presents a slightly different scenario for export-led growth in "Location Theory and Regional Economic Growth." Here, increased governmental investment in transportation resources makes interregional specialization and trade possible.[12] For a single region, this process results in an increased level of exports which leads to an increased income for the region. This expanding income attracts "footloose" industries which eventually become exporting industries in their own right.[13]

Thus a rich body of thought concerning the importance of a region's internal structure exists. The general relation implied by this model

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[12] North, p. 36.

[13] Ibid., p. 45.

is that the level of activity in the export sector of the economy is exogenous while the level of activity in the remainder of the economy is endogenous. This proposition is stated with precision in the following section.

An Algebraic Description of a City's Economy

To proceed further with the development of a model for predicting employment change, the economy of a city must be presented in a simplified form.

An algebraic specification of the economic base model is developed by Sirkin in "The Theory of the Regional Economic Base." The important variables in the Sirkin specification are:

Y = the income of an area,
H = the part of the area's output which is absorbed by the area,
X = the part of the area's output which is exported,
F = net factor payments from 'abroad', and
T = net transfer payments to the area from abroad.[14]

Additionally, he defines

M = the value of imports to the area, and
B = external balance on current account where $B = X + F + T - M$,
h = H/Y = average propensity to absorb local production,
m = M/Y = average propensity to import, and
b = B/Y = average propensity to lend.[15]

Then the area's income can be defined as the sum of the area's receipts:

$$Y = H + X + F + T \qquad (5.1)$$

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[14] Gerald Sirkin, "The Theory of the Regional Economic Base," Review of Economics and Statistics (November, 1959), p. 426.

[15] Ibid.

These receipts must, in equilibrium, be equal to the area's expenditures so that

$$Y = H + M + B \qquad (5.2)$$

That is, the total receipts of the region generated from local consumption, exports, factor payments from abroad, and transfer payments from abroad can be allocated among three alternatives. They may be absorbed at home, H, they may be exchanged for imports, M, or they may be lent aborad, B.[16] Combining equations 5.1 and 5.2 into the equilibrium conditions gives

$$X + F + T = M + B \qquad (5.3)$$

where X, F, and T are determined exogenously and M and B are endogenously determined, in that they depend upon the level of income. Equation 5.3 can be rewritten as

$$X + F + T = iY + sY \qquad (5.4)$$

where i is the marginal propensity to spend on imports, $\frac{dM}{dY}$, and s is the marginal propensity to lend abroad, $\frac{dB}{dY}$. The equilibrium condition derived from 5.4 is

$$Y = \frac{X + F + T}{i + s} \qquad (5.5)$$

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[16] Ibid.

The impact of a change of any of the exogenous variables, X, F, or T is

$$\frac{dY}{dX} = \frac{1}{i + s} \tag{5.6}$$

The levels of the endogenous variables will change in response to the changes in exogenous variables, but their structural specification is assumed to remain constant. While Sirkin's multiplier takes on an unusual form, a more recognizable form exists. Income was initially allocated to three uses, domestic consumption, imports, and foreign lending. Their respective marginal propensities then must sum to one. This allows equation 5.6 to be restated as

$$\frac{dY}{dX} = \frac{1}{i + s} = \frac{1}{i - c} \tag{5.7}$$

where c is the marginal propensity to consume locally. This, of course, is the familiar simple Keynesian multiplier with permissive monetary policy.

Internal changes such as import substitution will provide changes in both the level of income and the value of the multiplier for an economy. That is, if some good which had been imported was not produced locally, i, the marginal propensity to import, would decrease and increase the equilibrium level of income. This import substitution would also increase the multiplier which would be applicable to any future exogenous changes in demand.

The Empirical Studies

It is necessary to develop empirical methods which can be used in conjunction with the theoretical framework developed above to predict changes in the level of economic activity. The first task any empirical methodology must accomplish is to identify the exogenous and endogenous sectors of the subject economy.

The first of these attempts was at best crude in its empirical estimation. Hartshorne in 1936 attempted to measure basic and non-basic manufacturing employment for urban areas in 1936 by simply assuming the shares to be 90 percent basic and 10 percent non-basic.[17]

A far more sophisticated analysis of a single urban economy was conducted by Fortune magazine in 1938 in a study of the Oskaloosa, Iowa economy. This study used income data rather than employment data, and employed concepts from the theory of international trade to measure the payments between Oskaloosa and the rest of the United States. The basic sector was identified as those industries which received payment from the rest of the United States, the import sector was identified as those industries making payments to the rest of the world, and the non-basic sector, those industries involved in intra-city transactions, was calculated as a residual.[18] While the precision of this analysis can certainly be appreciated, its reliance upon primary data makes it costly to reproduce.

During the mid 1930's, Hoyt in an effort to forecast urban housing demand developed a technique for estimating primary or basic employment from secondary data which is, with some modification, still is use today. Hoyt started his analysis by classifying urban employment with respect to industry. He then estimated the number of workers engaged in

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[17]Lane, p. 340.

[18]"Oskaloosa vs. The United States," Fortune (April, 1938), p. 55.

non-locally consumed production in the manufacturing, extractive, transportation, communication, tourist, and non-local government sectors of the urban economy.[19] The number of urban workers employed in the production of services and trade consumed in the local market was then estimated. This was done by assuming that the ratio of employment in locally consumed trade and services in the city to total national employment in trade and services would be identical to the ratio of urban to national income. This calculation estimated the level of employment in trade and services which would be required to sustain the city's observed level of income. The number of workers employed in the production of non-local trade and services could then be calculated as the residual of the observed employment less the estimated required employment in trade and services.

After estimating the city's economic base, Hoyt went on to specify the relationship between non-basic and basic employment. Initially, this was done by assuming the basic:non-basic ratio to be 1:1. Hoyt later concluded that the ratio would vary from city to city.

This approach of comparing the subject economy to a "benchmark" economy was extended by Hildebrand and Mace.[20] They broke down the Los Angeles County economy in "export" and "home production" categories using location quotients. The location quotient is a measure of the

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[19]Homer Hoyt, Principles of Urban Real Estate, Cited in Lane, p. 340.

[20]George H. Hildebrand and Arthur Mace, Jr., "The Employment Multiplier in an Expanding Industrial Market: Los Angeles County, 1940-47," The Review of Economics and Statistics, (August, 1950), p. 243.

relative concentration of employment in a given industry in one area compared with another area.[21] Formally the location quotient, L, is given by:

$$L_i = \frac{(ni/n)}{(Ni/N)}$$

where the subscript i denotes industry i, the lower case letters denote the employment values of industry i in the subject economy and total employment in the subject economy. The upper case letters of the denominator represent the level of employment in industry i in the benchmark economy and the total employment in the benchmark economy.

To use this concept for classifying industries as to exporting or home producing one must assume that the residents of the subject economy and benchmark economy have identical demand functions, and one must also assume that there are no differences in the methods of production for each industry between the subject and benchmark economies. A location quotient of one for some industry means that the subject economy and the benchmark economy are equally specialized in the production of that industry's product. A location quotient in excess of one shows the subject economy to be relatively more specialized in the production of that good, and a location quotient of less than one shows the subject economy to be less specialized in that production than the benchmark economy. Assuming the benchmark economy to be a closed system allows the following conclusions about the above three states to be drawn.

If the location quotient for some industry is equal to one, the subject economy is concluded to be just self sufficient in the production of that good. If the location quotient is greater than one, it is

[21] Ibid.

concluded that the good is exported by the subject economy, and if the location quotient is less than one, the good is concluded to be imported.

Hildebrand and Mace, after delineating the primary, that is, export, sector of the Los Angeles county economy using location quotients, went on to construct an employment multiplier using regression analysis. Localized employment or non-basic employment, was regressed on non-localized, or basic, employment. The resulting equation of $X_1 = 222{,}000 + 1{,}248\ X_2$ gave their employment multiplier of 1.248. T statistics were not reported, but a correlation coefficient in excess of .95 was given.[22] While their approach to delineating or identifying the basic sector was basically correct, their use of the regression coefficient was a proxy for the multiplier rather than using a multiplier derived from the reduced form of the income-expenditure model precludes making any conclusion about the validity of such a theoretical model. An empirical examination of the applicability of the reduced form multipliers follows below.

The Oklahoma Studies

The Data

The sample of cities chosen to test the applicability of the economic base model in predicting employment changes was composed of all the communities with a 1960 and 1970 population between 2,500 and 10,000 which were also in excess of 50 miles from Oklahoma City, Tulsa, and Fort Smith, Arkansas. These were, it will be recalled, the communities examined by the case studies presented in the preceding chapter.

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[22]Hildebrand and Mace, p. 247.

The empirical models developed for each community follow along the lines suggested by Tiebout and are theoretically related to the income expenditure model developed above. The data used were reported in the Census of Population for 1960 and 1970.

The 1960 Census of Population reports employment in communities of 2,500 to 10,000 in the following industrial classifications:

Agriculture, Forestry, and Fisheries
Mining
Construction
Durable Goods Manufacturing
Nondurable Goods Manufacturing
Transportation, Communications and Other Public Utilities
Wholesale and Retail Trade
Finance, Insurance and Real Estate
Business and Repair Services
Personal Services
Entertainment and Recreation Services
Professional and Related Services
Public Administration
Industry Not Reported[23]

The 1970 Census of Population Fourth Count Tapes report employment in these communities by a more disaggregate set of industry classifications. These are:

Agriculture, Forestry and Fisheries
Mining
Construction
Furniture and Lumber and Wood Products
Primary Metal Industry
Fabricated Metal Industries
Machinery
Electrical Machinery
Transportation and Equipment
Other Durable Goods
Food and Kindred Products
Textile Mill Products
Printing and Publishing
Chemical Products
Other Nondurables

[23] U.S. Department of Commerce, Census of Population 1960, Washington, D.C.

Railroads
Trucking and Warehousing
Other Transportation
Communication
Utilities and Sanitary Services
Wholesale Trade
Food Stores
Eating and Drinking Places
General Merchandise Retailing
Motoe Vehicle Retailing and Service Stations
Other Retail Trade
Banking and Credit Agencies
Insurance, Real Estate, and Other Finance
Business Service
Repair Service
Private Households
Other Personal Service
Entertainment and Recreation
Hospitals
Other Health Services
Elementary and Secondary Schools and Colleges
Other Education Services
Nonprofit Membership Organizations
Legal, Engineering, and Miscellaneous Professional Services
Public Administration[24]

These industrial classifications were aggregated to form industries which correspond to those of the 1960 census, and the industries of the input-output model developed in Chapter VI, but the data must be further adjusted to remove two problems. The first obstacle to be overcome was the "industry not reported" category of the 1960 census. Each industry's share of these "industry not reported" category workers was assumed to be equal to that industry's share of total local employment reported by industry.

The other obstacle to comparability arises from the fact that the 1960 census reports employment for persons 14 years old and older while the 1970 census gives detailed industry employment for only those workers 16 years old and over. The census tapes do provide employment data for

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[24] U.S. Department of Commerce, Census of Population 1970, Washington, D.C.

14 and 15 year olds employed classified as farm workers and nonfarm workers. The young nonfarm workers were assumed to be distributed throughout the various industries of the local economy exactly as their older counterparts were distributed excluding the mining and manufacturing sectors where those workers of less than 16 years of age were assumed to not work.

The Model

As developed above, the only truly exogenous injection to a community's income stream is that income derived from its exports. The income-expenditure data needed to estimate this base are, unfortunately, not available. Employment data which are readily available are for this reason substituted for the income data.

To identify a community's export sector, the local economy is compared to the national economy. The assumption that the nation is a closed economy and that demand and production functions are the same throughout the nation are made to simplify the analysis.

The local basic employment in industry i, b_i, is defined to be the number of workers in industry i in excess of that required to make the town self sufficient in the production of that industry's output. Self sufficiency is assumed to occur in industry i when the proportion of total local employment accounted for by industry i is just equal to the proportion of national employment accounted for by industry i.

Algebraically this may be stated as

$$b_i = a_i - \frac{A_i}{T} t$$

where

b_i = local basic employment in industry i,

a_i = total local employment in industry i,

A_i = national employment in industry i,

T = total national employment, and

t = total local employment.[25]

It will be noted that the above definitional equation is identical to

$$b_i = a_i \left(1 - \frac{A_i}{T} \frac{t}{a}\right)$$

or

$$b_i = \left(1 - \frac{1}{LQ_i}\right) a_i$$

where LQ_i is the location quotient for industry i.

Two Qualifications. The 1960 Census reports manufacturing employment in communities of 2,500 through 10,000 only as durable goods and non-durable goods manufacturing. Comparing the specialized manufacturing sector of a single town to the diversified manufacturing sector of the nation, composed of many specialized local manufacturing sectors, will grossly understate the importance of manufacturing in the local economy's export sector. Consequently, all manufacturing employment will be taken to be basic.

The agricultural and mining sectors may also suffer systematic understatement in that the agricultural goods and minerals produced by workers in these cities are not goods ready for consumption by their

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[25]Tiebout, p. 47.

final consumers, but are raw goods, such as wheat, cattle and crude petroleum, which are exported to nonlocal processors who prepare the goods for final consumption. So, in one version that follows, agricultural and mining employment will also be taken to be basic in one specification. While this scenario is most probable, it is possible, that a portion of the agricultural goods and minerals produced locally are also consumed locally in their raw state. For this reason a second specification is used which attributes only that portion of agricultural employment and mining employment in excess of that required for self sufficiency to the community's economic base.

The remainder of the economy is composed of sectors which do not, a priori, appear to be characterized by plants of large minimum efficient scale relative to the local labor force and thus do not deserve the special treatment afforded manufacturing. These remaining sectors' outputs are finished goods and services easily consumed in their locally available states, thus these sectors do not deserve the special treatments given agriculture and mining.

The actual computation on the economic base of a community is accomplished by quantitatively comparing that community's economy to the national economy as discussed above. The 1960 Economic Base of Tonkawa is calculated in Table XXIII.

The Economic Base Multiplier

As developed in the text above, the long run multiplier for a community should be constructed so that all variables but exports are endogenous. This is accomplished by using the marginal propensity to consume locally in the denominator of the multiplier.

TABLE XXIII

ECONOMIC BASE, TONKAWA, OKLAHOMA, 1960

Industry	1960 Local Employment	Percent of Total Local Employment	Industry National	Location Quotient	Basic Share	Economic Base (Method 1)	Economic Base (Method 2)
Agriculture, Forestry and Fisheries	35	0.0291	0.019	1.532	0.347	35.0	12.1
Mining	32	0.0266	0.005	5.320	0.812	32.0	26.0
Manufacturing	253	0.2103	0.290	0.725	0.000	253.0	253.0
Construction	99	0.0823	0.056	1.470	0.320	31.7	31.7
Transportation, Communications and Other Public Utilities	71	0.0590	0.074	0.797	0.000	0.0	0.0
Wholesale and Retail Trade	262	0.2178	0.188	1.159	0.137	35.9	35.9
Finance, Insurance, Real Estate	28	0.0233	0.047	0.495	0.000	0.0	0.0
Business Repair and Personal Services	163	0.1355	0.146	0.928	0.000	0.0	0.0
Professional and Related Services	213	0.1771	0.120	1.476	0.322	68.7	68.7
Public Administration	21	0.0175	0.055	0.318	0.000	0.0	0.0
Total[1]	1,203					456.3	427.4
Base Multiplier						2.636	2.815

[1]Includes Industry Not Reported.

Source: See Table XV.

Assuming that local income is proportional to employment, the ratio of local consumption to total income would be identical to the ratio of nonbasic to total employment. Assuming that the average and marginal propensities to consume are equal, the multiplier, K, is derived as follows:

$$K = 1/(1 - MPC_L) = 1/(1 - APC_L)$$

$$K = 1/1 - \frac{\text{Nonbasic Employment}}{\text{Total Employment}}$$

$$K = 1/ \frac{\text{Basic Employment}}{\text{Total Employment}}$$

$$K = \frac{\text{Total Employment}}{\text{Basic Employment}}.$$ [26]

For example in Tonkawa, basic employment was calculated to be 456.3 using method one and 427.4 using method two. Total employment in 1960 in Tonkawa was 1,203. This gives a method one multiplier of $K_1 = \frac{1,203}{456.3} = 2.636$ and a method two multiplier of $K_2 = \frac{1,203}{427.4} = 2.815$.

The Exogenous Changes in Employment

Employment in all sectors changed from 1960 to 1970. Some of this change was determined exogenously through changes in the demand for the community's exports. The remainder of the changes in employment were determined endogenously in that they changed in response to the changes in the export sector.

In identifying the economic base, those sectors were chosen which devoted at least some of their employees to producing for foreign markets.

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[26] Hugh O. Nourse, Regional Economics, (New York, New York: McGraw-Hill, 1968), p. 162.

The remaining employees, however, were assigned to produce for the local market. In any industry some employment is endogenously determined, and some is exogenously determined. In construction for example it is easy to develop a scenario where those employees living in town A export labor to town B to build roads or houses. This could easily result in an increased demand for local housing and cause an increase in employment in the local nonbasic construction industry. The total change in employment in the construction industry must be broken down into the change in the basic sector and the change in the nonbasic sector. The derivative of equation 5.8 must be taken and evaluated to allow these changes to be separated out.

$$b = (1 - \frac{1}{LQ})\ a \qquad (5.8)$$

$$\frac{db}{da} = (1 - \frac{1}{LQ})\ \frac{da}{da} + a\ \frac{d(1 - \frac{1}{LQ})}{da} \qquad (5.9)$$

$$db = (1 - \frac{1}{LQ})\ da + [\frac{t}{T} \cdot \frac{A}{T}(\frac{dT}{da} - \frac{dt}{da}) + \frac{A}{a}\ (1 - \frac{dA}{da})] \qquad (5.10)$$

Thus, of the total change in employment in a basic industry, da, the proportion which is basic or exogenously changed is given by the two terms on the right side of equation 5.10. The first term is the familiar expression which measures the extent to which the industry's location quotient exceeds one, or the extent by which the community exceeds self sufficiency.

The bracketed second term most likely approaches zero for the communities of this study. The first term of the bracketed expression, $\frac{t}{T}$, is small since t is local employment and T is national employment. The second term, $\frac{A}{T}$, measures the importance of industry i as a percent of total national employment and is also less than one. The third term, $\frac{dT}{da} - \frac{dt}{da}$, measures the extent to which an increase in employment in a particular community spills over into the rest of the nation. It is not likely that this term is large. The fourth term, $\frac{A}{a}$, is very large in that it is national industry employment divided by local employment in that industry. The final term, $\frac{dA}{da}$, will differ from one only to the extent that local expansion causes greater expansion in the national industry. For the remainder of this analysis this second term is treated as zero, resulting in equation 5.11

$$db_i = (1 - \frac{1}{LQ})\ da_i \tag{5.11}$$

In method one, since the location quotient was assumed to be inapplicable for agriculture, mining, and manufacturing, equation 5.11 is also inapplicable. In these industries the entire change in employment was classified as exogenous to parallel the classification of their total work forces as basic. The exogenous employment changes in the remaining industries with employees contributing to the economic base were calculated using equation 5.11. Method two uses equation 5.11 to separate out exogenous employment changes in all industries with basic employment except manufacturing where the entire change is assigned to the exogenous category. Examples of the results each method follow in Table XXIV using Tonkawa as the sample city.

Column three of Table XXIV shows the estimated change in basic employment assuming all changes in agriculture, mining and manufacturing to be of exogenous origin to be 81.36 jobs reported in man years. Column four shows the exogenous change in employment assuming employment in agriculture and mining to be at least partly endogenously determined to be 102.79 jobs. The total change in employment in Tonkawa from 1960 to 1970 was 195 jobs as shown in column one.

TABLE XXIV

CHANGES IN EMPLOYMENT IN TONKAWA, OKLAHOMA, 1960 THROUGH 1970

Industry	Change in Employment	Location Quotients	Exogenous Change (Method 1)	Exogenous Change (Method 2)
Agriculture, Forestry and Fisheries	-9	1.532	-9	-3.13
Mining	-8	5.320	-8	-6.50
Manufacturing	78	0.725	78	78.00
Construction	-22	1.470	-7.03	-7.03
Transportation, Communications, and Other Public Utilities	-16	0.797	0.00	0.00
Wholesale and Retail Trade	68	1.159	9.33	9.33
Finance, Insurance, Real Estate	5	0.928	0.00	0.00
Business Repair and Personal Services	56	1.476	18.06	18.06
Professional and Related Services	43	0.318	0.00	0.00
Public Administration	195		81.36	102.79

Source: See Table XV.

The Predicted Changes in Total Employment

The estimated multipliers for Tonkawa will be recalled to be $K_1 = 2.636$ for method one which corresponds to column six of the above table and $K_2 = 2.815$ for method two which corresponds to column seven of the Table XXIII. The predicted employment change, N_i, is obtained by multiplying the estimated exogenous employment change, b_i, by the calculated economic base multiplier, K_i. For the example town of Tonkawa the predicted change in total employment using method one is (81.36)(2.636) = 214.46 jobs. Method two predicts an employment change of (102.79)(2.815) = 289.4 jobs. Total employment change, the method one multiplier, the method one estimated exogenous employment change, and the predicted change in total employment using method one are presented for each of the 24 communities in the sample in Table XXV. The comparable information derived from the use of method two is presented in Table XXVI.

Conclusions Concerning the Applicability of the Single Sector Model

While the predicted employment changes obviously differ from the observed changes, either definition of the base yields predictions which are closely related to the observed changes as is shown in Figure 2 and Figure 3. In these figures, predicted employment change is plotted against actual employment change. The heavy broken line is a line of equality between actual and predicted and is presented for reference.

The solid line on each of the figures is the regression line generated when predicted employment change is regressed on actual

TABLE XXV

PREDICTED AND ACTUAL CHANGES IN EMPLOYMENT (METHOD 1)

Town	Change in Basic Employment (Method 1)	Multiplier (Method 1)	Predicted Change in Employment	Actual Change in Employment
Alva	381.87	2.90	1,110.60	748
Anadarko	-48.82	2.73	-133.28	-75
Atoka	-3.22	2.49	-8.04	111
Checotah	109.18	2.89	316.05	267
Clinton	-76.01	2.75	-209.03	-195
Frederick	212.87	2.97	632.22	283
Hobart	-131.18	3.02	-396.16	-123
Holdenville	19.03	2.88	54.81	-59
Hollis	18.31	2.57	47.06	-20
Lindsay	40.97	2.31	94.68	267
Madill	-123.098	2.51	-310.13	-128
Marlow	-26.26	2.75	-72.22	112
New Cordell	62.81	2.74	172.10	206
Okemah	76.06	2.74	208.40	97
Pauls Valley	-333.663	2.65	-995.35	-363
Pawhuska	-145.99	2.99	-437.03	-297
Perry	-15.24	2.91	-44.35	283
Sayre	1.78	3.12	5.55	-26
Tahlequah	860.71	2.85	2,451.33	1,662
Tonkawa	94.43	1.96	185.08	140
Walters	5.56	3.14	17.46	74
Watonga	44.60	2.65	117.41	125
Weatherford	712.97	2.59	1,842.59	1,732
Wewoka	-101.52	2.94	-298.47	-59

TABLE XXVI

PREDICTED AND ACTUAL CHANGES IN EMPLOYMENT (METHOD 2)

Town	Change in Basic Employment (Method 2)	Multiplier (Method 2)	Predicted Change in Employment	Actual Change in Employment
Alva	426.85	2.71	1,158.35	748
Anadarko	-84.21	2.53	-213.05	-75
Atoka	2.18	2.35	5.13	111
Checotah	113.57	2.70	360.66	267
Clinton	-148.94	2.57	-382.78	-195
Frederick	212.89	2.77	589.71	283
Hobart	-148.21	2.81	-416.47	-123
Holdenville	18.00	2.73	49.14	-59
Hollis	18.43	2.41	44.43	-20
Lindsay	30.64	2.26	69.30	267
Madill	-120.91	2.38	-287.17	-128
Marlow	-42.53	2.57	-109.30	112
New Cordell	55.84	2.57	143.51	206
Okemah	63.95	2.57	164.35	97
Pauls Valley	-327.84	2.49	-816.32	-363
Pawhuska	-118.76	2.81	-334.06	-297
Perry	-10.45	2.71	-28.32	283
Sayre	-26.00	2.89	-89.57	-26
Tahlequah	893.85	2.69	2,399.64	1,662
Tonkawa	85.37	1.87	159.64	140
Walters	6.99	2.92	20.40	74
Watonga	54.26	2.47	134.12	125
Weatherford	777.97	2.47	1,921.58	1,732
Wewoka	-87.39	2.82	-246.43	-59

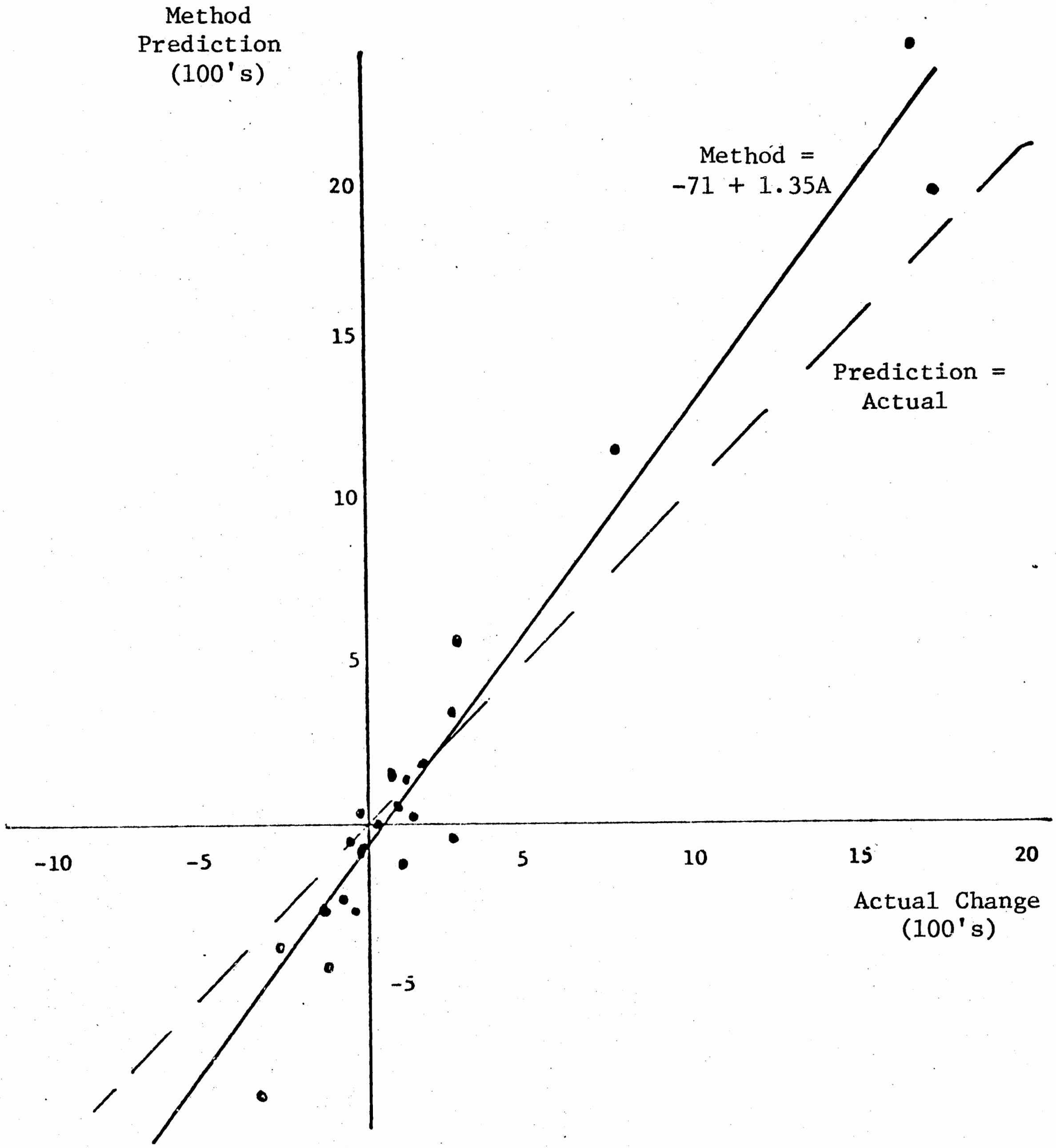

Figure 2. Predicted Change Regressed on Actual Change, Economic Base Method One

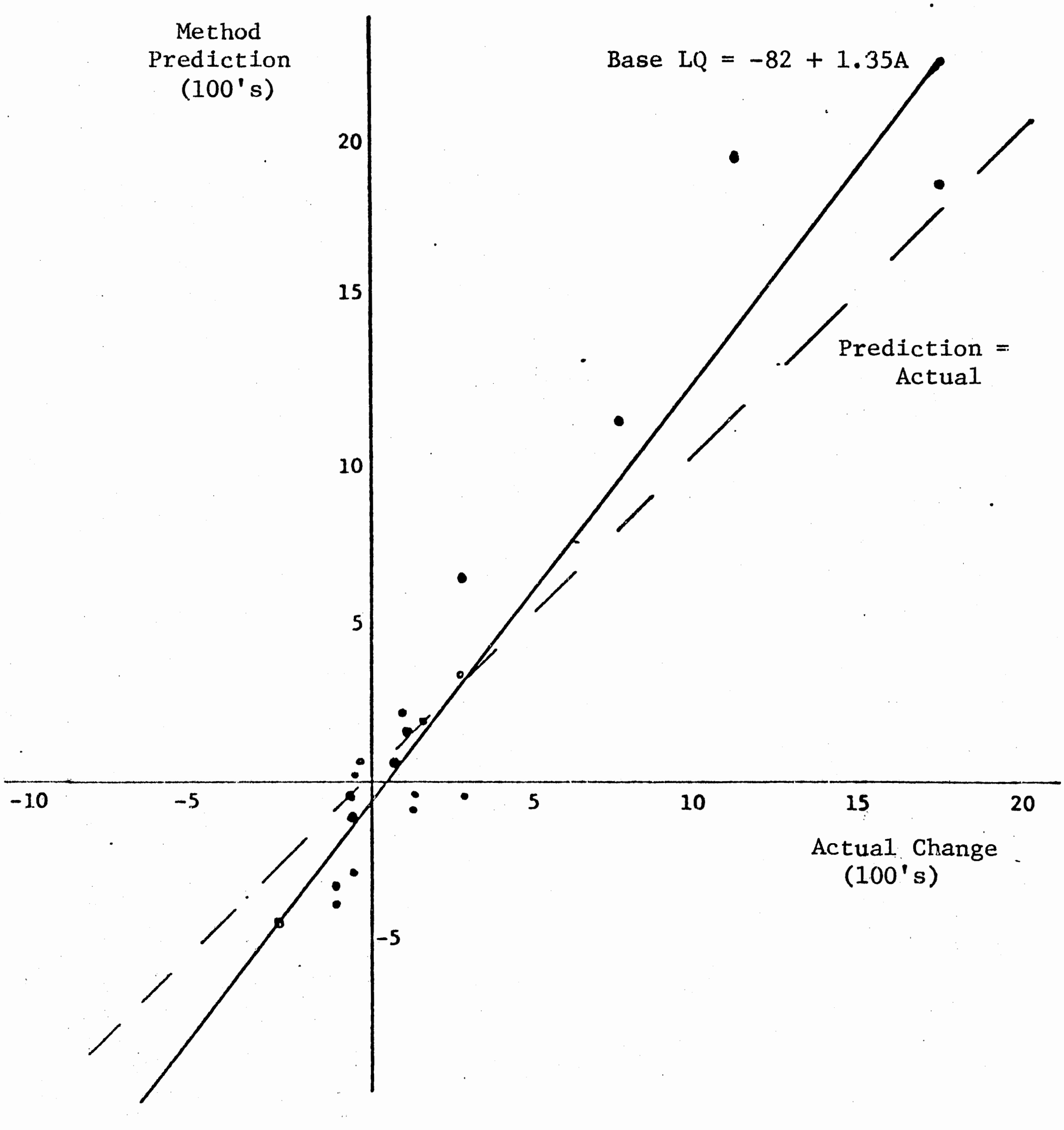

Figure 3. Predicted Change Regressed on Actual Change, Economic Base Method Two

employment change. The estimated coefficients, standard errors, t-statistics, and r^2's are presented in Table XXVII. In neither case can the hypothesis that $B_0 = 0$ be rejected at the .05 level, but in both cases the hypothesis that $B_1 = 1$ is rejected easily using the t test. An F test used to test the hypothesis that B_0 and B_1 were simultaneously equal to zero and one also resulted in rejection in both cases. Failure to reject $B_0 = 0$ might suggest that base is identified pretty well. $B_1 > 1$ might suggest that multipliers are overestimated. One would thus conclude that this procedure gives good, but less than perfect forecasts.

TABLE XXVII

REGRESSION OF PREDICTED EMPLOYMENT CHANGE ON ACTUAL EMPLOYMENT CHANGE

	Constant	Actual Employment Change
	Method One	
Coefficient	-71.10504	1.35135
Standard Error	44.36630	0.07741
t	-1.60268	4.53882
r^2	0.94131	
	Method Two	
Coefficient	-82.22142	1.35564
Standard Error	47.92972	0.08362
t	-1.71546	4.25305
r^2	0.93259	

A more straightforward and commonly used method of comparison of the predictions of forecasting models is the mean absolute percentage error (MAPE). This is calculated by taking the average of the sum of all the percentage errors for a given data set without regard to sign.[27] The predictions of the model calculated with the agriculture and mining to be totally exogenous (method one) were slightly inferior to the predictions of the model calculated treating agriculture and mining the same as all other manufacturing industries (method two). The MAPE statistic for the method two model was 1.2052 while the MAPE statistic for the method one model was 1.2755.

Summary

In this chapter a historical description of the various attempts to analytically describe an urban economy was presented. Using expected theoretical correctness and simplicity of method as criteria for choice, the economic base model as estimated by location quotients and employment data was chosen as the first forecasting tool to be applied to explaining the impact of a change in basic employment.

A methodology was developed to distinguish changes in basic employment from changes in nonbasic employment. These estimated basic changes were used in conjunction with the economic base multipliers to give predictions of total employment change.

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[27] Spysos Makridakis and S. C. Wheelwright, Forecasting Methods and Application, (Somerset, New Jersey: Wiley and Sons, 1978), p. 688.

CHAPTER VI

THE MULTISECTOR MODEL

Introduction

In the preceding chapter exogenous changes in employment were identified. It is of interest to determine whether the origin of these changes makes a quantitative difference in the total change in employment. For example, if a worker were freed from agriculture by technological change and obtained a job in manufacturing, would the change induced by the increase in manufacturing just offset the total change induced by the decrease in agricultural employment, or would one induced change more than offset the other? To answer this question a multisector model with distinct sector multipliers is required. The input-output model is such a model, and this model is discussed in this chapter.

Included in this chapter are general discussions of social accounting systems using input-output models and of multipliers developed from input-output models.

Given that such a model has been estimated, the information presented within it can be added to other information to develop a similar model for some other area. Various techniques of alteration are also discussed with particular emphasis placed on the location quotient technique. This technique is used to alter existing tables to conform to those communities already examined. These models are used to predict employment change. The last part of this chapter is devoted to an examination of the predictive power of the input-output model.

The Makeup of the Model

The interindustry transactions table is the base of an input-output study. This table shows the purchases of each producing sector, the purchases of each consuming sector, and the destination of each sector's output. The format of the transactions table used in this study is presented in Figure 4.

Quadrant I of the transactions table is made up of the final uses of each good or service classified by each major type of use. The vector F_{i1} is the investment or capital formation vector. The i^{th} element of this vector shows the dollar amount of industry i's output which was purchased as a final capital good by all of the producing sectors of the economy.

The vector F_{i2} is the government purchases vector. The i^{th} element of this vector shows the dollar amount of industry i's output which was purchased by federal, state and local governments to be used as final goods.

The vector F_{i3} is the export vector. The i^{th} element of this vector shows the dollar amount of industry i's output which was purchased by users outside the boundaries of the area for which the transactions table is constructed.

Quadrant II of the transactions table presents the interindustry purchases of goods to be further processed. The elements X_{ij} of this matrix represent a purchase of the output of industry i by industry j which uses i's output as an input in j's product. An examination of

To / From	Purchasing Sectors: 1	. . . j . . .	n	H.H.	Final Demand: Private Investment	Government	Exports	Total Gross Output
Producing Sectors: 1	X_{11}	X_{1j}	X_{1n}	C_1	I_1	G_1	E_1	X_1
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
		QUADRANT II				QUADRANT I		
i	X_{i1}	X_{ij}	X_{in}	C_i	I_i	G_i	E_i	X_i
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
n	X_{n1}	X_{nj}	X_{nn}	C_n	I_n	G_n	E_n	X_n
H.H.	L_1 . . .	L_j . . .	L_n	L_C	L_I	L_G	L_E	L
		QUADRANT III				QUADRANT IV		
Value Added	V_1 . . .	V_j . . .	V_n	V_C	V_I	V_G	V_E	V
Imports	M_1 . . .	M_j . . .	M_n	M_C	M_I	M_G	--	M
Total Gross Outlay	X_1 . . .	X_j . . .	X_n	C	I	G	E	X

Source: Harry W. Richardson, Input-Output and Regional Economics, London, p. 19.

Figure 4. Simplified Input-Output Transactions Table

each row of this quadrant allows one to see the usage of an industry's output as an intermediate input in the production of all the processing sectors. An examination of any column of this quadrant reveals the origins of an industry's inputs. That is, each column shows the purchases of each domestic industry i's output to be as an input by industry j.

Two sectors presented in this quadrant deserve special discussion. Since all goods must be processed by the wholesale and retail trade sectors, the use of the value of all transactions would greatly overstate the importance of this sector. The output of the wholesale and retail trade sector is instead presented as the gross margin or mark up on the goods handled by these establishments.[1]

In this analysis, the household sector is also included inside the intermediate transactions quadrant. The households row is composed of the factor payments made to the households by each of the j purchasing sectors. The households column represents the household sector's purchases of goods and services produced by the i producing sectors.

Quadrant III of the transactions table contains imports and value added and is referred to as the payments quadrant. The elements of the row vector M_j show the dollar amounts of inputs purchased outside the economic system described by the interindustry transactions table by industry j. The vector V_j shows payments to primary factor of production excluding those sold by the household. This includes payments of indirect business taxes, depreciation, and business saving.

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[1]William H. Miernyk, The Elements of Intput-Output Analysis, (New York, New York: Random House, 1969), p. 10.

Quadrant IV shows the direct usage of imports and primary inputs to satisfy the final demands of investment, government and exports.

The Solution of the Model

A Dollar Value System

By making certain assumptions about the nature of production, the above social accounting system may be transformed into an analytic macroeconomic model which is similar to the Keynesian model described in the preceding chapter. Each commodity is assumed to be produced by a single producing sector. This assumption is alternatively stated by requiring each good to be produced by only one method of production and that there be no firms producing outputs of two productive sectors. The second assumption requires the inputs purchased by each sector to be a stable and linear function only of the level of output of that sector. The final assumption requires that there are no external economies or diseconomies.[2] These assumptions, taken together, allow one to conclude that a firm producing a good or service buys inputs from other producing sectors which it combines in fixed proportions to make its final output.

For equilibrium to exist in an economic system the quantity of each good and service produced must equal the quantity of each good and service which consumers are willing and able to purchase. These consumers may be the final consumer of a good, or they may purchase the good, process it, and resell it to another consumer. These two types

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[2] Hollis B. Chenery and Paul G. Clark, Interindustry Economics, (New York, New York: John Wiley and Sons, Inc., 1967), pp. 33-34.

of purchasers are referred to as final and intermediate. Equilibrium for all markets may then be written as

$$X_i = X_{i1} + X_{i2} + \dots + X_{in} + X_f \qquad (i = 1, \dots, n) \qquad (6.1)$$

where X_i is the total output of the i^{th} sector which must be equal in equilibrium to the sum of the intermediate demands of each of the j purchasing industries plus the demand of the final consumers.

The second assumption above states that the level of use of the output of sector i as an input by sector j depends only on the level of output of sector j. That is:

$$X_{ij} = a_{ij}X_j \qquad (6.2)$$

or

$$a_{ij} = \frac{X_{ij}}{X_j} \qquad (6.3)$$

The equilibrium condition of equation 6.1 can then be rewritten as

$$X_i = a_{i1}(X_1) + a_{i2}(X_2) + \dots + a_{in}(X_n) + X_f \qquad (6.4)$$

$$(i = 1, \dots, n)$$

or

$$X_i = \sum_j a_{ij}(X_j) + X_f \qquad (i = 1, \dots, n) \qquad (6.5)$$

These a_{ij}'s are known as the technical coefficients. They show the direct purchases of output i for use as inputs by sector j.

The condition set forth in equation 6.5 must hold for each of the n processing sectors. The resulting system of n equations may be written in matrix notation as

$$X + AX + Y \quad (6.6)$$

or

$$\begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_n \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & & & \\ \vdots & & & \vdots \\ a_{n1} & \cdots\cdots & & a_{nn} \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_n \end{bmatrix} + \begin{bmatrix} Y_1 \\ Y_2 \\ \vdots \\ Y_n \end{bmatrix} \quad (6.7)$$

where the column vectors X are the vectors of output of the n processing sectors. The elements of the X vector, the total amounts of production by each sector, are the unknowns of the system of equations to be solved. The nxn matrix A is the matrix of known technical coefficients. Each element of this matrix, a_{ij}, represents the direct dollar amount of industry i's output to produce one dollars worth of output in industry j.[3] The vector Y is the vector of final demand for the output of each of the n processing sectors.

To solve for X, the output vector X on the left hand side of the equation must be premultiplied by an nxn identity matrix, I, composed of ones on the diagonal and zeroes elsewhere. This allows the subtraction required in the solution as shown in equation 6.8.

$$\begin{bmatrix} 10 \ldots 0 \\ 01 \ldots 0 \\ \vdots \quad\quad \vdots \\ 0 \ \ldots 1 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_n \end{bmatrix} - \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & & & \\ \vdots & & & \vdots \\ a_{n1} & \cdots\cdots & & a_{nn} \end{bmatrix} \begin{bmatrix} X_i \\ X_2 \\ \vdots \\ X_n \end{bmatrix} = \begin{bmatrix} Y_i \\ Y_2 \\ \vdots \\ Y_n \end{bmatrix} \quad (6.8)$$

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[3]Miernyk, p. 21.

This may be rewritten as:

$$(I - A)X = Y \tag{6.9}$$

where the new nxn matrix (I - A) is known as the Leontief matrix.[4]

The solution of equation 6.9 is accomplished by multiplying it by the Leontief inverse matrix so that

$$(I - A)^{-1}(I - A)X = (I - A)^{-1}Y$$

or

$$IX = (I - A)^{-1}Y$$

or

$$X = (I - A)^{-1}Y \tag{6.10}$$

or

$$\begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_n \end{bmatrix} = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{in} \\ & & & \\ \vdots & & & \vdots \\ r_{n1} & & \cdots & r_{nn} \end{bmatrix} \begin{bmatrix} Y_1 \\ Y_2 \\ \vdots \\ Y_n \end{bmatrix}$$

The elements of this Leontief inverse or reciprocal matrix, r_{ij}, indicate that the total dollar amount of good i which must be produced per unit of time to sustain a one dollar final demand in sector j.[5] Those r_{ij}'s differ from the a_{ij}'s in that they represent direct input requirements plus indirect input requirements. The indirect requirements arise because delivering one dollar's worth of good j to final demand requires a_{ij} dollars worth of good i as direct intermediate input, but the production of the a_{ij} units of good i require further increases in the use of goods as inputs for the production of the a_{ij} th unit. For

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[4] Chenery, p. 49.

[5] Ibid., p. 51.

this reason, the elements r_{ij} are referred to as interdependence coefficients.[6]

For example, the total amount of X_1 required to sustain a final demand represented by the vector Y is:

$$X_1 = r_{11}Y_1 + r_{12}Y_2 + \ldots + r_{1n}Y_n \qquad (j = 1, \ldots, n)$$

Similarly, the impact on total output of a one unit change in final demand of the first sector would be equal to the sum of the elements in the first column of the Leontief inverse matrix, $r_{11} + r_{21} + \ldots + r_{n1} = k_1$. This column summation produced the output multiplier for each sector.

An Employment System

These direct and indirect increases in output also result in the increased usage of primary inputs such as labor, capital, and land. To examine the relationship between exogenous and endogenous employment changes, employment multipliers must be derived. Recalling that the elasticity of substitution in the production function was assumed to be zero, the labor requirement of sector j may be written as

$$l_j = b_j x_j \tag{6.11}$$

where l_j is the labor required by sector j to produce its output, x_j, and b_j is the constant labor/output ratio of sector j. Then the amount of labor employed will be BX where B is a 1xn row vector whose elements

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[6] Nelson L. Bills and Alfred L. Barr, An Input-Output Analysis of the South Branch Valley of West Virginia, (Morgantown, West Virginia: West Virginia University Agricultural Experiment Station, 1968), p. 20.

b_j are the labor/output ratios for each of the n sectors. Solving for the total labor required to meet the final demand represented by vector Y, we find

$$L = BX = B(I - A)^{-1}Y$$

or

$$L = [b_1 b_2 \ldots b_n] \begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_n \end{bmatrix} = [b_1 b_2 \ldots b_n] \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & & & \\ \vdots & & & \\ r_{n1} & & \cdots\cdots & r_{nn} \end{bmatrix} \begin{bmatrix} Y_1 \\ Y_2 \\ \vdots \\ Y_n \end{bmatrix} \quad (6.12)$$

Multipying the matrix of interdependence coefficients $(I - A)^{-1}$, by the vector of labor/output ratios, B, yields a new 1xn vector, P. The elements of this vector, P_j, are the sums of the products of the labor requirement coefficients, b_j, and the interdependence coefficients, r_{ij}. For example,

$$P_1 = b_1 r_{11} + b_{21} r_{21} + \ldots + b_n r_{n1}$$

so that P_1 is the total amount of employment, direct and indirect, required to sustain with inputs one worker employed in sector one. The employment multiplier is obtained by dividing the total effect by the direct effect.[7]

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[7]Gholam Mustafa and L. L. Jones, Regional Input-Output Models Using Location Quotients, (College Station, Texas: The Texas Agricultural Experiment Station, 1971), p. 24.

The Model Estimated

The above discussion dwelt upon the mathematical solution of the system of equations derived from the interindustry social accounts. With the high speed computer, the solution by inversion has become quite simple. The most serious obstacle to be overcome in performing small input-output analysis is the initial construction of the interindustry flow table.

The most accurate method of construction involves taking a survey of the producers via a detailed questionnaire. This method is, of course, the most expensive method.

The least expensive method consists of using the information and coefficients from an existing national input-output analysis. This methodology implicitly assumes the area under study is an exact duplicate of the national economy in every respect. The smaller the area to be examined and the more heterogenous the nation, the less applicable this approach would be

The Location Quotient Approach

An intermediate approach involves adjusting coefficients derived from an existing model to make them applicable to the area under study. The most straightforward and common approach involves adjusting the technical coefficients by means of location quotients. If the location quotient, which compares the relative importance of an industry in the component economy to the relative importance of that industry in the aggregate economy, is equal to or in excess of one, that industry in the component economy is said to be self sufficient. In this case of self sufficiency all of the technical coefficients derived in the aggregate economy for that industry's row may be used to represent that industry's row in the component economy. It will be recalled that in an industry with a location quotient of less than one, the industry accounts for a smaller share of output in the component economy than it does in the aggregate economy. In this case, the component economy is assumed to import the deficit production. The aggregate economy's technical coefficients of that industry's row must be proportionally reduced to account for the deficit production in the component economy.[8]

Jones and Mustafa present the following technique for deriving technical coefficients and transactions for the component economy from those of the aggregate economy.

Let $A_{ij} = \frac{X_{ij}}{X_j}$ = the known aggregate technical coefficient

$a_{ij} = \frac{x_{ij}}{x_j}$ = component technical coefficient to be estimated

Y_{if} = demand of the i^{th} industry by the f^{th} final demand sector in the aggregate economy

y_{if} = demand of the i^{th} sector by the f^{th} final demand sector in the component model.

If $LQ_i \geq 1$

$a_{ij} = A_{ij}$

$x_{ij} = A_{ij} \times j$

$y_{if} = Y_{if} \cdot \frac{x}{X}$

$v_j = V_j \cdot \frac{x_j}{X_j}$ $\qquad i = 1, 2, \ldots, n$

$\qquad f = 1, 2, \ldots, t$

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[8] Ibid., p. 16.

but if $LQ_i < 1$

$$a_{ij} = LQ_i A_{ij}$$

$$x_{ij} = a_{ij} x_j$$

$$y_{if} = Y_{if} \cdot \frac{x}{X}$$

$$v_j = V_j \cdot \frac{x_j}{X_j}$$

This procedure leaves imports and exports to be calculated as remainders so that imports for the i^{th} row and j^{th} column are

$$m_{ij} = A_{ij} x_j - x_{ij}.$$

That is, imports of the output of industry i used by industry j are equal to the local requirements of industry j less the amount of i's local output which is available for use by industry j. Exports are similarly calculated as

$$e_i = x_i - \sum_{j=1}^{n} x_{ij} - \sum_{f=1}^{t} y_{if}$$

But this may result in exports being estimated as negative rather than zero and imports being underestimated. To correct for this a "balancing" procedure is used. According to Mustafa and Jones, "This correction adjusts gross flows for the i^{th} importing sector downward and distributes to the column sectors the negative e_i in quantities proportional to each sector's within region output."[9]

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[9] Ibid., p. 17.

The Data

To derive a transactions table and matrix of technical coefficients for a component economy of an aggregate economy using the method described above requires the aggregate flow table, the aggregate technical coefficients derived from that table, and the industry output totals for each industry in the component economy.

The aggregate flow tables were calculated by Schreiner and Chang in their Projection and Analysis of the Economies of Substate Planning Districts in Oklahoma of 1974. This publication presents 20 sector interindustry flow tables for each of the 11 substate planning districts in Oklahoma for 1970. These tables were derived by adjusting and aggregating the 79 sector Harvard multiregional input-output analysis study for 1963. These unpublished 1963 flow tables for the 11 substate planning districts were further aggregated to form ten sector interindustry flow tables such as the one presented in Table XXVIII. This final aggregation was performed to achieve conformability among the flow tables, the data reported for communities of 5,000 to 10,000 population in the 1960 Census of Population and this data for those same communities in the 1970 Census of Population. The flows in these tables are reported in thousands of 1963 dollars.

The calculation of the sector output totals for each component or community economy was accomplished by use of output/employment ratios. Schreiner and Chang report employment/output ratios for each of their 20 sectors for 1970 for each planning district. They also report the annual rate of growth in these output/employment ratios from 1947 through 1963.[10] The 1963 output/employment ratio is calculated by inverting the 1970 employment/output ratio and multiplying by e^{rt} where r is the historical annual rate of growth in the output/employment ratio and t is minus seven years.

These 20 output/employment ratios are aggregated to form the ten output/employment ratios needed to calculate sector totals for the ten industry model actually estimated. Where aggregation is required, it is accomplished by means of taking a weighted average of the output/employment ratios using the sector's 1963 employment as the weight.

Community sector output totals are then calculated by multiplying the output/employment ratio by the community's employment in the appropriate sectors.

The Community Models

The model of Tonkawa is shown in Table XXIX. This ten sector model is closed by including the households sector in the processing sectors. This inclusion is necessary because the other sectors in the processing sector purchase factors of production from the households, and the households purchase finished goods and services from the other sectors. The levels of both the expenditure on factors and final goods and services thus depend upon the level of production and the composition of production.[11]

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[10]Dean F. Schreiner and James C. Chang, Projection and Analysis of the Economies of Substate Planning Districts in Oklahoma, (Stillwater, Oklahoma: The Ozarks Regional Commission, 1974), pp. 59-71.

[11]Chenery, pp. 64-65.

TABLE XXVIII

TRANSACTIONS TABLE FOR NORTHERN OKLAHOMA DEVELOPMENT ASSOCIATION, 1963 (THOUSANDS OF DOLLARS, 1963 PRICES)

From: / To:	Agriculture	Mining	Manufacturing	Construction	Transportation, Communications, and Utilities	Trade	Finances and Services
Agriculture, Forestry and Fisheries	22,206	7	5,833	223	6	9	77
Mining	11	995	45,997	324	523	0	0
Manufacturing	8,633	1,184	28,828	6,658	1,195	1,318	981
Construction	1,847	3,429	5,121	21	1,486	305	4,749
Transportation, Communication and Utilities	1,880	1,254	13,367	1,682	3,734	2,338	1,489
Wholesale and Retail Trade	5,283	1,081	8,198	6,541	738	1,651	1,870
Finance, Insurance, Real Estate, Business and Personal Services	17,341	19,306	14,838	3,006	1,979	8,782	10,339
Medical and Professional Services	326	50	116	75	39	97	268
Federal, State and Local Government Expenditures	19	80	364	82	142	440	845
Households	43,500	11,954	46,959	22,023	13,716	43,583	21,406
Imports	48,115	11,531	186,969	27,528	11,601	9,416	30,783
Value Added, Excluding Households	22,098	55,027	69,363	16,317	17,279	25,490	48,720
Sector Totals	169,259	105,898	425,953	84,480	52,438	93,429	121,527
(Row Totals)	168,917	105,947	425,099	83,936	44,724	102,621	138,920

Source: Dean F. Schreiner and James C. Chang, Projection and Analysis of the Economies of Substate Planning Districts in Oklahoma, 1974.

TABLE XXVIII (Continued)

From: / To:	Medical and Professional Services	Government Enterprises	House-holds	Invest-ment	Inven-tory Change	Government Expenditures	Exports
Agriculture, Forestry and Fisheries	14	1	2,623	0	-443	25	142,336
Mining	2	53	47	0	49	98	57,848
Manufacturing	297	103	24,250	1,249	2,375	1,369	346,659
Construction	281	1,180	0	38,973	0	26,544	0
Transportation, Communication and Utilities	449	794	13,381	636	44	1,592	2,034
Wholesale and Retail Trade	272	67	69,378	3,473	253	847	2,969
Finance, Insurance, Real Estate, Business and Personal Services	1,335	410	58,069	848	1	1,711	955
Medical and Professional Services	138	8	24,613	0	0	488	1,754
Federal, State and Local Government Expenditures	109	12	1,202	0	0	300	6,891
Households	9,382	3,573	1,731	0	0	32,075	0
Imports	1,415	1,050	111,382	29,825	784	21,777	0
Value Added, Excluding Households	775	3,574	6,602	-214	0	3,519	484
Sector Totals	14,519	10,825	313,278				
(Row Totals)	27,972	10,486	249,902				

The resultant multipliers when households are made endogenous include not only the respending through the interdependent processing sectors, but also the spending which is induced by the purchase of household assets from the rest of the processing sectors. These multipliers are known as Type II multipliers.[12] The Type II employment multipliers are calculated by dividing the sum of the direct effect, indirect effect and induced effect by the direct effect to get the Type II output multiplier and multiplying by the employment/output ratio for each industry.

The Predicted Changes in Total Employment

The predicted employment changes are calculated by multiplying the exogenous employment changes estimated in the preceding chapter by the appropriate industry employment multiplier. For Tonkawa, the multipliers and the two estimates of exogenous employment change are presented below. It will be recalled that method one classified all of the employment changes in manufacturing and mining as exogenous while method two calculates basic employment in these industries by use of the location quotient, and the entire change in manufacturing employment is classified as exogenous in both methods. Table XXX presents a comparison of the actual employment changes and those predicted by the method one model and the method two model.

For example, in Tonkawa the employment multiplier for the agricultural sector is 1.393. Method one calculates the exogenous employment

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[12] Harry W. Richardson, Input-Output and Regional Economics, (London: World University Press, 1972), p. 40.

TABLE XXIX

TRANSACTIONS TABLE FOR TONKAWA, 1963 (DOLLARS, 1963 PRICES)

From: / To:	Agriculture	Mining	Manufacturing	Construction	Transportation Communication, and Utilities	Trade	Finance, and Services
Agriculture, Forestry and Fisheries	4,140	10	16,210	690	10	20	170
Mining	20	12,980	1,069,220	8,370	5,870	0	0
Manufacturing	17,800	20,430	886,250	227,450	17,750	28,070	24,120
Construction	3,810	59,160	157,430	720	22,080	6,500	116,760
Transportation, Communication and Utilities	2,520	14,090	267,560	37,410	36,120	32,420	23,840
Wholesale and Retail Trade	9,890	1,693	228,830	202,890	9,950	31,930	41,750
Finance, Insurance, Real Estate, Business and Personal Services	35,760	333,080	456,160	102,690	29,400	187,050	254,210
Medical and Professional Services	670	860	3,570	2,560	580	2,070	6,590
Federal, State and Local Government Expenditures	40	1,380	11,190	2,800	2,110	9,370	20,780
Households	83,130	191,150	1,338,020	697,300	188,850	860,380	487,800
Imports	50,570	28,050	780,180	105,290	37,250	88,710	57,240
Value Added, Excluding Households	140,650	1,148,290	7,880,380	1,497,830	429,030	743,480	1,954,750

TABLE XXIX (Continued)

From: / To:	Medical and Professional Services	Government Enterprises	House-holds	Investment	Inventory Change	Government Expenditures	Exports
Agriculture, Forestry and Fisheries	80	0	5,010	0	-101,380	-2,670	426,720
Mining	90	1,140	750	0	1,120	2,240	725,190
Manufacturing	18,510	2,930	512,820	28,500	54,190	31,240	11,224,930
Construction	17,520	33,570	0	889,240	0	605,650	973,570
Transportation, Communication and Utilities	20,250	14,710	184,240	14,510	1,000	36,320	94,010
Wholesale and Retail Trade	15,390	1,730	1,332,130	74,860	5,450	18,260	0
Finance, Insurance, Real Estate, Business and Personal Services	83,210	11,670	1,228,010	19,350	20	39,040	208,360
Medical and Professional Services	8,600	230	520,500	0	0	11,130	347,640
Federal, State and Local Government Expenditures	6,790	340	25,420	0	0	6,850	220,930
Households	542,010	94,220	33,930	0	0	731,850	1,376,360
Imports	54,030	15,890	287,140	680,510	17,890	496,880	-2,702,220
Value Added, Excluding Households	136,510	131,570	2,495,050	-4,880	0	80,290	

change to be -3.820. The predicted induced change in total employment is then -5.323. For mining, the employment multiplier is 2.624. The estimated exogenous employment change was -8.120 so the predicted change in total employment is -21.309. Manufacturing generated an employment multiplier of 2.303. An exogenous change of 66 jobs occurred giving a predicted employment change of 151.985. The exogenous employment change in that sector was -8.620 giving a predicted employment change of -19.175. The transportation, communication and utilities sector employment multiplier is 1.395, but no exogenous change occurred in that sector. The trade sector multiplier is 1.386 and the exogenous employment change was 7.683. The total impact of this change in employment in the trade sector is then 10.652. The multiplier for the finance and personal services sector is 1.653 and the exogenous employment change is 0.1003. The total impact on employment is thus predicted to be 0.166 jobs. The medical and professional sector multiplier is 1.300, and 14.835 jobs were exogenously created in this sector. These professional jobs are predicted to result in a total increased employment of 19.279. The federal, state, and local government enterprises multiplier is 1.668, but no exogenous job generating changes occurred in that sector. Summing the separate and dissimilar exogenous and induced changes, the total change in employment in Tonkawa predicted by method two is 136.270.

The prediction given by method one differs becase the entire employment change in agriculture and mining is classified as exogenous. For example, the decrease in employment in agriculture in Tonkawa of 11 multiplied by the corresponding employment multiplier of 1.393 gives a predicted employment change of -15.323. The ten fewer jobs in the mining sector combined with an employment multiplier of 2.624 gives a predicted total employment change of -26.240 for method two. The remaining sectors receive identical treatment under the two approaches. Summing gives a predicted total employment change of 110.675 when method one is used. Table XXX presents predicted employment changes for each specification of exogenous change and the actual employment change in each of the 21 towns.

Conclusions Concerning the Applicability of the Multisector Model

As is shown in Figure 5 and Figure 6, either specification of exogenous employment change combined with the estimated input-output multipliers yields forecasts which are closely related to the observed changes for most of the towns. In these figures, predicted employment change is plotted against actual employment change. The heavy broken line is a reference line showing equality between actual and predicted.

The solid line in each of the figures is the regression line generated when predicted employment change was regressed on actual employment change. The estimated coefficients, standard errors, t-statistics, and r^2's are presented in Table XXXI.

The hypothesis that $B_0 = 0$ for the method one model cannot be rejected, but the same hypothesis for the method two model is rejected at the .05 level. The hypothesis that $B_1 = 1$ is easily rejected for either specification of exogenous employment change. An F-test to test the hypothesis that B_0 and B_1 were simultaneously equal to zero and one resulted in rejection of the null hypothesis in both cases. One could conclude then that neither specification of the multisector model gives perfect predictions over this ten year time period.

TABLE XXX

ACTUAL EMPLOYMENT CHANGE VS. EMPLOYMENT CHANGES PREDICTED BY INPUT-OUTPUT MULTIPLIERS AND TWO SPECIFICATIONS OF EXOGENOUS EMPLOYMENT CHANGE

Town	Method One	Method Two	Actual
Alva	565.77	488.05	748
Anadarko	-26.15	-29.72	-75
Atoka	28.23	5.62	111
Checotah	194.30	168.30	267
Frederick	377.31	367.12	283
Hobart	-312.70	-276.26	-123
Holdenville	-89.39	-81.40	-59
Hollis	34.03	40.98	91
Lindsay	61.51	72.34	-20
Madill	-267.56	-264.17	-128
Marlow	-172.91	-147.74	112
Pauls Valley	-563.32	-563.32	-363
Pawhuska	-254.28	-281.45	-297
Perry	-34.72	-33.72	283
Okemah	152.94	153.70	97
Sayre	81.71	9.03	-26
Tahlequah	1,153.05	1,121.20	1,662
Tonkawa	110.68	136.27	140
Watonga	169.32	137.74	125
Weatherford	1,290.26	1,091.10	1,732
Wewoka	-210.87	-220.47	-59

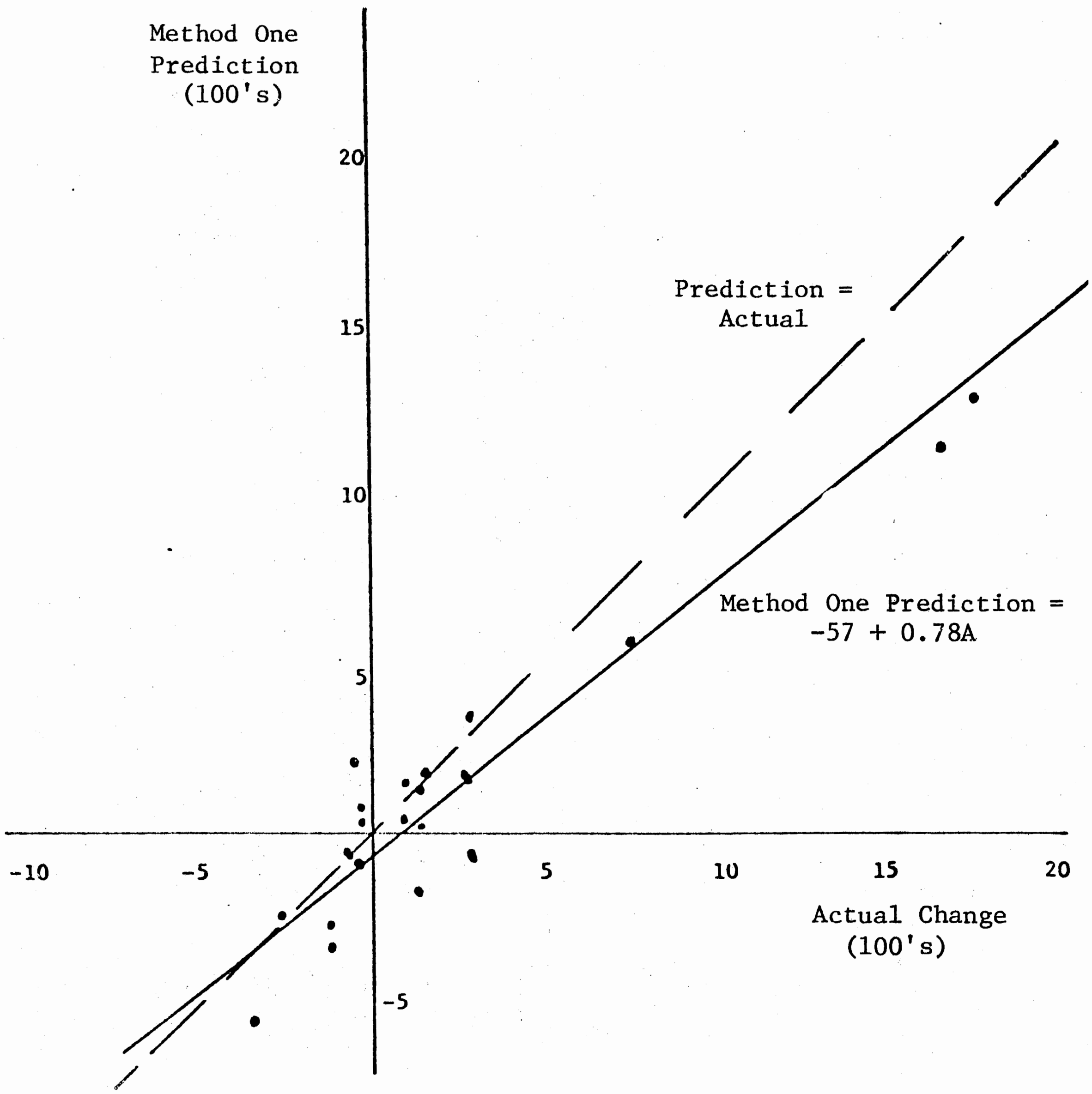

Figure 5. Predicted Change Regressed on Actual Change, Input-Output Method One

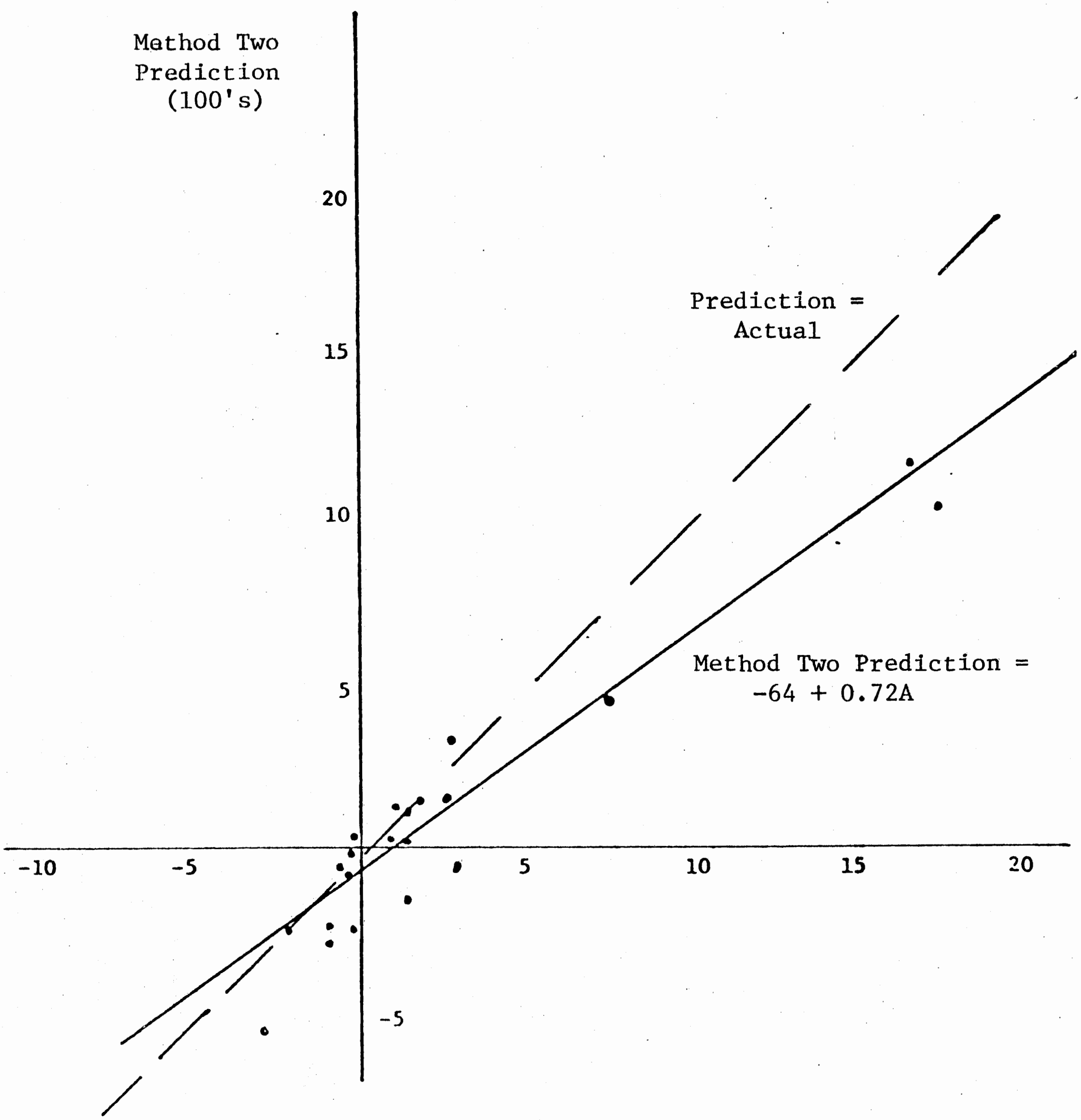

Figure 6. Predicted Change Regressed on Actual Change, Input-Output Method Two

TABLE XXXI

REGRESSION OF INPUT-OUTPUT FORECASTS ON ACTUAL EMPLOYMENT CHANGES

	Constant		Actual Employment Change
	Method One		
Coefficient	-64.22398	+	0.71915
Standard Error	29.576634		0.05161
t	-2.171443		13.934315
r^2	0.91087		
	Method Two		
Coefficient	-58.76814	+	0.78235
Standard Error	30.89021		0.05390
t	-1.902484		14.514842
r^2	0.91728		

To ascertain which method gives better forecasts the Mean Absolute Percentage Error (MAPE) was calculated for each specification. The MAPE generated by treating each nonmanufacturing sector in the same manner, method two, was 0.9523. The MAPE generated when agriculture and mining were given special treatment was 1.0823. Thus the mean absolute percentage error was reduced by 13 percent. A comparison of the applicabilities of the multisector model is presented in the following chapter.

Summary

In this chapter a multisector model of an economic system was described. This model focuses on differences in impacts of exogenous changes in the distinct sectors of the economy. A method for customizing an existing regional table for use in a single community was presented. This methodology was used to derive a model for each of the communities examined in Chapter IV and Chapter V. The sector multipliers developed by this technique were used in conjunction with the exogenous changes estimated in Chapter V to forecast total employment change.

CHAPTER VII

SUMMARY OF RESULTS, POLICY IMPLICATIONS, AND DIRECTIONS FOR FUTURE RESEARCH

Introduction

The intent of this chapter is to review the objectives of the entire study and to present the conclusions obtained by the fulfillment of the objectives.

It will be recalled that the objectives of the study were to:

1. Examine the process of the dispersal of manufacturing to allow community decision makers to rationally assess the probability of receiving a new manufacturing plant.

2. Determine the impact of an increase in manufacturing employment on selected economic variables by use of case studies to allow the community decision maker to estimate the general impacts of increased manufacturing activity.

3. Determine the applicability of using a simple economic base model to predict total employment change given an exogenous change in basic employment.

4. Determine the applicability of using a location quotient input-output model to predict total employment change given an exogenous change in basic employment.

In general, it was found that towns of less than 10,000 population proved to be very acceptable locations for new manufacturing plants. In Oklahoma, these towns received a more than proportionate share of jobs created by new manufacturing plants.

Decision makers in these communities should expect a greater probability of their town experiencing substantial population increases, employment increases, and substantial change in the local market for housing if, in fact, their community is to be the site of considerable manufacturing growth.

In housing markets, the value of owner occupied housing increased significantly in favor of the growing manufacturing towns, and so did the ratio of renter occupied to owner occupied units. This would suggest that increased manufacturing activity would lead to an increase in the demand for rental property. Increased supply of renter occupied units and an increase in the number of multiunit structures were also found in those towns with growing manufacturing sectors.

An attempt was made to develop and test two methods for predicting total employment change. This appears to be the first test of either economic base analysis or input-output analysis at the small community level. In general, both of these predictive tools gave good results. It is felt that the economic base model could be used by someone interested in estimating employment impact, and that the input-output model could be used by regional economics professionals to give easily understandable results to those parties interested in potential impacts.

A more specific summary of the results of this paper are found below.

Summary of Results

The Dispersion of Manufacturing

A model explaining least cost location of economic activity was described. Dynamic forces alter the distribution of least cost locations causing firms to relocate. This relocation has resulted in a secular redistribution of manufacturing employment from the principal cities of the old manufacturing belt. These locations experiencing an increase in their shares varied in size to include counties both in and outside the old manufacturing belt whose largest city was less than 10,000 and cities whose population exceeded 100,000.

While the areas experiencing positive growth were geographically dispersed, the region experiencing the greatest increase in share over the last century was the Southwest. Because of Oklahoma's membership in this rapidly expanding region and because of the existence of an excellent series of data on manufacturing employment, Oklahoma was chosen as the sample state in which to study the current trend in the dispersion of manufacturing employment.

In Oklahoma from 1963 through 1975 the communities of less than 10,000 people exhibited the largest per capita increase in manufacturing jobs. The new manufacturing jobs per capita was slightly less for those cities in excess of 100,000 population, and this measure was substantially less for those intermediate communities of more than 10,000 but less than 100,000.

A summary index, entropy, was developed to measure dispersion of employment in new plants. This index would take on its maximum value if each population interval's share of new manufacturing jobs was equal to the share of all intervals for some year. This index held an average level of 80 percent of its maximum and was shown to be increasing significantly over time.

Several industries revealed a specialized locational preference by doing the majority of their new hiring in one of the broad size intervals. Those industries preferring the communities of less than 10,000 were textile mill products, chemicals, petroleum refining, apparel, primary metals, lumber and wood products, and the leather and leather products industry. Those industries preferring the intermediate sized communities were rubber and plastic products, machinery, and the paper and allied products industry. Those industries showing preference for the largest cities were the printing and publishing industry, the instrument industry, and the electrical and electronic equipment industry.

The Impact of a Change in Manufacturing Employment

A methodology was developed to ascertain the impact of a change in manufacturing employment on a number of economic variables. This involved pairing similar communities of less than 10,000 and comparing changes in those variables between the pair member which experienced a substantial change in manufacturing employment to the change experienced in the community which received no substantial change in manufacturing employment.

Significant differences of changes between the two groups were observed in manufacturing employment, population, the rate of immigration and total employment. With regard to the change in employment other changes in the labor market were observed. These included an increase in the male labor force participation rate, an increase in retail payrolls and an increase in service employment.

As mentioned above, other significant differences were observed in the changes in the housing market.

In all the above cases the differences observed were in the predicted direction and of believable magnitude. It was deemed likely, however, that other exogenous changes could be occurring in the communities so a more general model was felt needed for prediction.

The Economic Base Model

A discussion of the logic and chronologic development of the model was presented. This model is essentially similar to the Keynesian model assuming a completely permissive monetary policy. Exogenous employment changes are thus thought to have a multiple impact upon total employment.

Employment multipliers were estimated for each of the communities examined in the case studies. These multipliers ranged from a low of 1.96 to a high of 3.12 using one exogenous specification and from 1.87 to 2.89 using a slightly less restrictive procedure for identifying the exogenous sector. Treating agriculture and mining exactly as all other nonmanufacturing industries gave a mean employment multiplier of 2.74. Using the less restrictive base identification procedure of assigning all agricultural and mining employment to a community's economic base gave a mean employment multiplier of 2.58.

A new methodology was developed in this paper which allowed exogenous changes in employment to be distinguished from endogenous changes. The exogenous changes were used in conjunction with the estimated multipliers to generate predicted changes in employment. The predicted employment changes were extremely highly correlated with the observed employment change.

An examination of the mean absolute percentage errors generated by each procedure for identifying the economic base for each community revealed that smaller errors were recorded when the base was calculated with agriculture and mining employment considered as partially endogenous.

The Multisector Model

To determine whether prediction could be improved by calculating a separate impact for each of the sectors a multisector model was estimated for each community. This model took the form of a ten sector input-output model. The interindustry matrix included agriculture, mining, manufacturing, construction, transportation and utilities, trade, finance, insurance, real estate, business and personal services, medical and professional services, government enterprise, and households.

Each of these models was derived from existing input-output models of the various substate planning districts of Oklahoma. The derivation involved adjusting the local interindustry flows by calculating local intermediate imports by the use of location quotients. By manipulating the interindustry flow tables and the final demand vector, a set of employment multipliers was estimated for each of the communities under study.

By using these multipliers in conjunction with the exogenous employment changes already estimated, a predicted employment change was generated for each community. The predicted employment changes were very highly correlated with those employment changes actually observed. Again, the mean absolute percentage error was minimized by classifying exogenous employment changes in agriculture and mining exactly as they were classified in all other nonmanufacturing industries. It is noted in Table XXXII that regardless of the method used to identify exogenous employment change, the mean absolute percentage error generated by the multisector model was about 20 percent less than the mean absolute percent error generated by the single sector model. The multisector model thus gives the superior forecasts of the two models examined, and it could be used by trained persons to give reliable predictions regarding economic impacts of exogenous changes.

The Policy Implications

There is no real question as to which specification of exogenous employment change one should use as this would be a given in a real situation. That is, some decision maker would be evaluating the impact of some known number of exogenously generated jobs. The choice of a forecasting tool presents some small quandary.

The input-output model gives forecasts which have some 20 percent less error than those forecasts generated by the economic base model. The local data gathering costs for the two techniques are similar, given that regional input-output flow tables already exists. The labor and capital costs for the input-output model, however, greatly outstrip those costs for the economic base model. The input-output model requires substantial investment in time for familiarization with the technique. The economic base model requires little. The input-output model requires a high speed computer for solution. The economic

TABLE XXXII

A COMPARISON OF MEAN ABSOLUTE PERCENTAGE ERRORS GENERATED BY THE MODELS

	Absolute Percentage Error			
	Input-Output		Economic Base	
Town	Method One	Method Two	Method One	Method Two
Alva	.2456	.3475	.5481	.4839
Anadarko	.6513	.6133	1.8400	.7733
Atoka	.7456	.9495	.9538	1.0721
Checotah	.2734	.4876	.3507	.1825
Frederick	.3332	.2968	1.0837	1.2332
Hobart	1.5423	1.2439	2.3821	2.2195
Holdenville	.4576	.3728	.1671	.0710
Hollis	.6264	.5494	.5118	.4829
Lindsay	4.0500	4.6000	4.4650	5.7340
Madill	1.0859	1.0638	1.2435	1.4229
Marlow	2.5357	2.3125	1.9732	1.6429
Pauls Valley	.5509	.5509	1.2488	1.4390
Pawhuska	.1447	.0539	.1246	.4714
Perry	1.1226	1.1191	1.0989	1.1567
Okemah	.5670	.5773	.6943	1.1484
Sayre	4.1154	1.3462	4.1680	.7865
Tahlequah	.3063	.3255	.4438	.4749
Tonkawa	.2143	.0286	.1357	.3220
Watonga	.352	.0616	.0730	.0607
Weatherford	.2552	.3701	.1095	.0662
Wenoka	2.5593	2.7288	3.1695	4.0588
	22.7286	19.9999	26.7851	25.3101
MAPE	1.0823	0.9523	1.2755	1.2052

base model can be manipulated with a hand calculator. The extra precision resulting from the use of the input-output model over the economic base model is rather costly. This is the quandary.

Most quandaries have solutions, and the solution to this one is to be found in any principles of economics text. The marginal benefits must be compared to the marginal costs. Should the value of the increased precision be deemed larger than the value of the alternatives foregone when additional resources are bid away from other things into forecasting, the input-output model should be used. Alternatively should the value of the alternatives foregone exceed the value of the better information, the economic base model should be used if any scientific forecast is to be made.

In the long run, all inputs are variable, save technology. It would be possible to reduce the alternatives foregone when the input-output model might be used. This might be accomplished by the one time investment of skilled labor to develop an easily usable and easily accessible program generating input-output multipliers to those decision makers concerned with the development planning process. The decision to develop such a program would again depend on the value assigned to the additional information generated and the incremental costs of its generation.

Directions for Future Research

This dissertation has been constructed to look only at markets where private goods are traded, and to examine their relation with manufacturing employment and total basic employment. It would be of interest to other decision makers to see an examination of the relationship between economic base and those markets where goods and services are provided collectively. This future research should address itself to the use of the various collectively provided services, on the one hand, and to the funding of such services, on the other.

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