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FACTORS AFFECTING PLANT LOCATION BY TYPE OF INDUSTRY AND COMMUNITY SIZE IN OKLAHOMA[1]

by

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Introduction

In Oklahoma, as in other parts of the United States, rural residents continue to move to urban centers. In 1960, 37 percent of Oklahoma's population resided in rural areas.[3] In 1970, rural areas accounted for only 32% of the State's population [20]. Many that move to urban areas may prefer to live in rural communities, but new industrially based employment opportunities in rural communities have not expanded sufficiently to offset reduced labor requirements of agriculture and other basic industries, and the natural increase in the rural work force.

Enticing new industries to locate in nonmetropolitan areas is seen by many rural leaders as a means of reducing the trek of rural people to

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[3]Rural is defined to include an area where persons are living in open country and towns of 2,500 or less.

cities and as a means of increasing the economic development and growth of the rural community. The increased congestion in urban centers and expanded problems of pollution, travelling times, crime, etc., have increased the interest in the development of rural communities by national and state leaders as well as rural leaders and industry itself.

This study is intended to develop a plant-location model capable of explaining factors associated with plant location by community size and industrial mix in Oklahoma from 1963 through 1971. Attempts to analyze and measure the relative significance of various factors on industrial location have resulted in a voluminous literature which reflects a variety of approaches to the problem.[4] Barloon [2], McCarthy [13], Beckt [3], Ball and Teitz [1] concentrate their efforts in proving the importance of transportation systems. North [13] discusses the importance of agglomeration economies. Wages and unionization have been the subject of a number of postwar studies. Segel [16], Soffer and Korenich [17] and de Vyver [8] are a few which analyzed wages and industrial location. Another factor, government intervention, such as tax incentives has been studied by Garwood [10], Bridges [4], Moes [13], and Rinehard [15].

This analysis of industrial location is intended to determine if any of the above reasons can explain industrial location in Oklahoma from 1963 through 1971. Characteristics were classified into three groups which included (1) labor factors, (2) market factors, and (3) agglomeration factors.[5] The study then determines which factors in each group

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[4]For a complete annotated bibliography of work completed through 1967 see [9].

[5]This approach to location theory is closely related to that provided in the writings of Greenhut [11].

were influential in explaining industrial location in Oklahoma from 1963 through 1971.

Objectives and Data

The objective of this study is twofold:

1. to determine those forces associated with employment change resulting from locating new manufacturing plants in Oklahoma in each community size interval; and

2. to explain those forces associated with changes in employment resulting from specific manufacturing industries, classified at the two digit standard industrial classification (SIC) level locating in the state of Oklahoma.

Multiple regression models were developed to meet this twofold objective.

Of the previous studies using multiple regression, Spiegelman [18] has completed the most comprehensive study. He used multiple regression to explain changes in manufacturing employment from 1947 to 1958. His study was aimed at determining those forces associated with the location of individual manufacturing industries by state economic districts in the U. S.

The present study utilized employment data which specified new manufacturing plant employment in Oklahoma from 1963 through 1971. The data, which for each new plant included number of employees, location and the SIC code were obtained from the Bureau of Business Research, University of Oklahoma [9].[6] Data specific to each community were obtained from community profiles [7] and from the Bureau of the Census.

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[6] Data were collected by the Bureau from dues provided to them by major utility companies on the basis of new gas and electricity connections and by the Chamber of Commerce in each community as to new plants and plant expansions. For a complete discussion of the data, see [9].

Method

Multiple regression analysis was used in this study to explain observed variations in employment change for the state of Oklahoma from 1963 to 1971. First, regression models were developed to explain employment change from plants locating in communities in each of seven different community size intervals. Second, models were developed to explain employment change in specific manufacturing industries classified at the two-digit SIC code level. Independent variables used to explain the variation in employment change in plants located in communities of different sizes included characteristics of communities where manufacturing industries located and dummy variables representing two-digit SIC codes for manufacturing. Independent variables used to explain the variation in employment change in specific manufacturing industries included characteristics of communities where manufacturing industries located, and dummy variables representing community size intervals. A number of different combinations of these variables were tried in different regression equations. A final selection of 15 multiple regression equations was made based upon the significance level of variables in the equations and the magnitude of the coefficient of determination. One regression equation was selected for each of the seven community size intervals studied, and one regression equation was selected for each of the eight SIC codes studied. Community size intervals were based on population and the population ranges were 0-2,499, 2,500-4,999, 5,000-9,999, 10,000-14,999, 15,000-29,999, 30,000-99,999 and 100,000+. The eight SIC codes were food and kindred products (SIC 20), apparel and related products (SIC 23), furniture and fixtures (SIC 25), chemicals and allied products (SIC 28), stone, clay and glass products (SIC 32), fabricated metals (SIC 34), machinery except electrical

(SIC 35), and transportation equipment (SIC 37). The number of observations for each SIC code regression equation depended upon the number of plants in each SIC code that located in the state of Oklahoma. For example, if 30 plants which produced transportation equipment located in the state, then there were 30 observations for the regression equation representing SIC 37. An observation existed for a community size interval if one new plant located in a community with a population that conformed to that interval.

A complete list of variables used in this study includes:

Community Size Intervals:
D_1 = 0-2,499
D_2 = 2,500-4,999
D_3 = 5,000-9,999
D_4 = 10,000-14,999
D_5 = 15,000-29,999
D_6 = 30,000-99,999
D_7 = 100,000+

Labor Factors:
X_8 = persons available for work in county
X_9 = average weekly employment earnings for county
X_{10} = population 25-mile radius

Market Factors:
X_{11} = distance in miles to nearest interstate
X_{12} = distance in miles to Tulsa
X_{13} = distance in miles to Oklahoma City
D_{14} = all interstate miles to Tulsa
D_{15} = all interstate miles to Oklahoma City

Agglomeration Factors:
X_{16} = value of all farm products in county
X_{17} = value of all forestry products in county
X_{18} = value of all mineral products mined in county
X_{19} = percent urban population in county
X_{20} = percent minority population in county
X_{21} = population growth rate 1960-1970
X_{22} = population served by one physician
X_{23} = pupil-teacher ratio

X_{24} = average tax per $1,000 assessed value
D_{25} = inducement for new industry

Standard Industrial Classification Code:
D_{26} = SIC 20, Food and Kindred Products
D_{27} = SIC 22, Textile Mill Products
D_{28} = SIC 23, Apparel and Related Products
D_{29} = SIC 24, Lumber and Wood Products
D_{30} = SIC 25, Furniture and Fixtures
D_{31} = SIC 26, Paper and Allied Products
D_{32} = SIC 27, Printing, Publishing and Allied Products
D_{33} = SIC 28, Chemicals and Allied Products
D_{34} = SIC 29, Petroleum and Coal Products
D_{35} = SIC 30, Rubber and Plastic Products
D_{36} = SIC 31, Leather and Leather Products
D_{37} = SIC 32, Stone, Clay, and Glass Products
D_{38} = SIC 33, Primary Metals
D_{39} = SIC 34, Fabricated Metals
D_{40} = SIC 35, Machinery Except Electrical
D_{41} = SIC 36, Electrical Machinery
D_{42} = SIC 37, Transportation Equipment
D_{43} = SIC 38, Instruments and Related Products
D_{44} = SIC 39, Miscellaneous Manufacturing

Community Size Interval Model

To explain the change in employment by community size interval, 37 factors were studied. Labor factors were represented by X_i, where i = 8, 9, 10; market factors were represented by X_i, where i = 11, 12, 13, and D_i, where i = 14, 15; agglomeration factors were represented by X_i, where i = 16, 17, ..., 24, and D_{25}; Standard Industrial Classification codes were represented by D_i, where i = 26, 27, ..., 44. Variables D_{26} through D_{44} had a value of 1 if that industry created new employment in a community, otherwise the variable had a value of zero.

A complete form of the multiple regression equation used in this study, where one regression equation was estimated for each of the seven community size intervals is:

$$(1)\quad Y_i = \beta_0 + \beta_8 X_8 + \cdots + \beta_{10} X_{10} + \beta_{11} X_{11} + \cdots + \beta_{13} X_{13} + \beta_{14} D_{14} + \beta_{15} D_{15}$$
$$+ \beta_{16} X_{16} + \cdots + \beta_{24} X_{24} + \beta_{25} D_{25} + \beta_{26} D_{26} + \cdots + \beta_{44} D_{44} + \mu_i$$

An Industrial Sector Model

To explain the change in employment by industrial sectors, 25 factors were studied as possibilities for influencing location decisions. Community size intervals were represented by dummy variables D_i, where i = 1, 2, ..., 7; labor factors were represented by X_i, where i = 8, 9, 10; market factors were represented by X_i, where i = 11, 12, 13 and D_i, where i = 14, 15; and agglomeration factors were represented by X_i, where i = 16, 17, ..., 24, and D_{25}. Variables D_1 through D_7 had a value of 1 if a particular manufacturing industry created new employment in a community that conformed to the particular community population size interval, otherwise the variable had a value of zero.

A complete form of the multiple regression equation used in this study where one regression equation was estimated for each of the eight manufacturing industries represented by the SIC code is:

$$(2)\quad Y_i = \beta_0 + \beta_1 D_1 + \ldots + \beta_7 D_7 + \beta_8 X_8 + \ldots + \beta_{10} X_{10} + \beta_{11} X_{11} + \ldots + \beta_{13} X_{13} + \beta_{14} D_{14} + \beta_{15} D_{15} + \beta_{16} X_{16} + \ldots + \beta_{24} X_{24} + \beta_{25} D_{25} + \mu_i$$

Empirical Results

A total of 15 equations were derived to explain the change in employment observed in different community size intervals or different SIC codes.

A Community Size Interval Model

There were seven models, one for each community size interval. Each observation included a new plant creating employment in a community in that community size interval. One of these models has been selected for presentation herein.

The regression equation model selected to explain the observed variance in employment change for communities conforming to the 30,000 to 99,999 community size interval consists of dummy variables. The estimated regression equation is:

$$\text{(3)}\quad \hat{Y} = \underset{\substack{(21.686)\\ \text{n.s.}}}{36.667} + \underset{\substack{(78.189)\\ 1\%}}{313.33D_{35}} + \underset{\substack{(78.189)\\ 1\%}}{463.333D_{40}} + \underset{\substack{(48.490)\\ 5\%}}{107.0D_{42}}$$

This model has an R^2 value of 0.790 which means that these types of manufacturing industries explain 79.0 percent of the variation in employment change occurring among communities with a population between 30,000 and 99,999. Equation 3 has an overall F-test value significant at the 0.0002 probability level. The coefficient of variation is 74.2.

There are no real variables significant in the regression equation for this community size interval. This indicates that none of those community characteristics represented by labor, market and agglomeration variables were helpful in explaining the variation in employment change in communities of these sizes between 1963 and 1971.

All variables significant in the selected regression equation are dummy variables representing manufacturing industries. Industrial types being significant in the explanation of employment change in this community size interval include those industries manufacturing rubber and plastic products (D_{35}), machinery except electrical (D_{40}), and transportation equipment (D_{42}).

Signs of those coefficients for dummy variables conform to the hypothesized relationship. All signs are positive which indicate that the presence of these manufacturers enhance the chance for employment change over and above the average employment change by industry in communities with a population conforming to the 30,000 to 99,999 population interval. Each of these three dummy variables (D_{35}, D_{40}, and D_{42}) in equation 3 explained a substantial proportion of the change in employment in communities conforming to this population interval.

An Industrial Sector Model

There are eight models, one for each SIC code which had a sufficient number of observations in which there was some employment generated during the study period. The employment change generated by each of these eight manufacturing industries was analyzed by determining those factors which explain the largest portion of observed variance.

The regression equation model selected to explain employment change among manufacturers of machinery except electrical, (SIC Code 35) utilized data from 28 firms that located new plants between 1963 and 1971. The estimated regression equation is:

$$(4)\quad \underset{\substack{(48.687)\\ \text{n.s.}}}{Y = 105.575} + \underset{\substack{(57.865)\\ 1\%}}{427.888D_6} + \underset{\substack{(27.452)\\ 1\%}}{136.256D_7} + \underset{\substack{(.224)\\ \text{n.s.}}}{0.247X_{13}} - \underset{\substack{(.002)\\ 1\%}}{0.005X_{16}} - \underset{\substack{(1.751)\\ 10\%}}{3.19X_{20}}$$

This model has an R^2 value of 0.844 with an overall F-test value significant at the 0.0001 probability level. The coefficient of variation for the model in equation 4 is 72.9.

There are two population intervals significant in explaining employment change by manufacturers of machinery except electrical. These two intervals include communities with a population between 30,000 and 99,999 (D_6) and metropolitan centers with a population over 100,000 (D_7). The coefficient for the dummy variable D_6 is larger than the coefficient for the dummy variable D_7. This indicates that communities with a population between

30,000 and 99,999 have had a larger change in employment resulting from manufacturers of machinery except electrical than larger centers.

Real variables in the regression equation for industries with an SIC code of 35 are distance in miles to Oklahoma City (X_{13}), value of all farm products in the county (X_{16}), and percent minority population (X_{20}). The latter two variables are significant at the 1 percent and 10 percent levels respectively. The coefficient for variable X_{13} suggests that manufacturers of machinery except electrical increase employment in communities as the distance of these communities from Oklahoma City increases. For variable D_7 to agree with this statement, most jobs located in centers with a population over 100,000 must have been located in Tulsa instead of Oklahoma City during 1963-71. Coefficients for variables X_{16} and X_{20} indicate that employment change by producers of nonelectrical machinery vary inversely with value of all farm products in the surrounding area and with the percentage of population being in minority groups. In summary, it can be suggested that the existance of manufacturers of machinery except electrical explain employment change in communities with a population between 30,000 and 99,999 with Tulsa being one of these centers having a small amount of farm products in the surrounding area and also having a small percent of minority population.

Results Of Overall Study

The variables significant at the 5 percent level or better for the seven community models are listed in Table 1 while the variables significant at the 5 percent level or better for the eight industry models are listed in Table 2.

Community Model Results. Industrial inducements as reflected by variable D_{25} was nonsignificant in the seven community models. Thus,

Table 1. Description of Significant Coefficients of Variables, Levels of Significance, and R^2 of the Regression Equation Selected For Each Community Size Interval Studied.

Community Population Size Interval	Description of Significant Variables In Equation	% Significance Level of Coefficient	R^2 of Equation (%)
0-2,499	α Intercept	5	51.6
	X_{12} distance in miles to Tulsa	5	
	X_{16} value of all farm products in county	5	
	X_{17} Value of all forestry products in county	1	
	X_{23} Pupil-teacher ratio	5	
	D_{27} SIC 22, Textile Mill Products	1	
	D_{28} SIC 23, Apparel and Related Products	1	
	D_{30} SIC 25, Furniture and Fixtures	1	
	D_{31} SIC 26, Paper and Allied Products	1	
	D_{38} SIC 33, Primary Metals	1	
2,500-4,999	X_{21} population growth rate 1960-1970	5	46.3
	D_{27} SIC 22, Textile Mill Products	1	
	D_{28} SIC 23, Apparel and Related Products	1	
5,000-9,999	D_{28} SIC 23, Apparel and Related Products	5	28.4
	D_{30} SIC 25, Furniture and Fixtures	1	
	D_{38} SIC 33, Primary Metals	1	
10,000-14,999	D_{27} SIC 22, Textile Mill Products	1	34.1
	D_{42} SIC 37, Transportation Equipment	5	
15,000-29,999	X_{12} distance in miles to Tulsa	5	29.0
	D_{35} SIC 30, Rubber and Plastic Products	1	
30,000-99,999	D_{35} SIC 30, Rubber and Plastic Products	1	79.0
	D_{40} SIC 35, Machinery Except Electrical	1	
	D_{42} SIC 37, Transportation Equipment	5	
100,000+	α Intercept	5	71.4
	D_{28} SIC 23, Apparel and Related Products	1	
	D_{35} SIC 30, Rubber and Plastic Products	1	
	D_{41} SIC 36, Electrical Machinery	1	

Table 2. Description of Significant Coefficients of Variables, Levels of Significance, and R^2 of the Regression Equation Selection For Each Industry Studied.

SIC Code	Description of Significant Variable in Equation	% Significance Level of Coefficient	R^2 Equation (%)
20 (Food and Kindred Product)	α Intercept	1	75.8
	D_3 5,000-9,999	1	
	X_9 average weekly employment earnings for county	1	
	D_{15} all interstate miles to Oklahoma City	1	
	X_{17} value of all forestry products in county	5	
	X_{21} population growth rate 1960-1970	1	
	X_{24} average tax per $1,000 assessed value	1	
23 (Apparel and Related Products)	X_{10} population 25-mile radius	1	63.7
	X_{12} distance in miles to Tulsa	1	
25 (Furniture and Fixtures)			35.7
28 (Chemical and Allied Products)	α Intercept	5	57.5
	D_7 100,000+	1	
	D_{14} all interstate miles to Tulsa	1	
	D_{15} all interstate miles to Oklahoma City	1	
32 (Stone, Clay and Glass)	α Intercept	1	53.8
	D_{14} all interstate miles to Tulsa	5	
	X_{21} population growth rate 1960-70	1	
34 (Fabricated Metals)	D_5 15,000-29,999	5	58.1
	D_7 100,000+	1	
	X_{16} value of all farm products in county	5	
35 (Machinery Except Electrical)	D_6 30,000-99,999	1	84.4
	D_7 100,000+	1	
	X_{16} value of all farm products in county	1	
37 (Transportation Equipment)	α Intercept	5	42.5
	X_8 persons available for work in county	1	
	D_{25} inducement for new industry	1	

community incentives used to attract industrial plants was not important in explaining employment change from 1963 through 1971. Wage and labor variables (X_8, X_9, and X_{10}) also did not appear in any of the community models. Thus, the availability of labor at a low wage was nonsignificant in explaining employment change. Being close to a potential market for the product, such as Tulsa, (X_{12}) was significant in explaining employment change in communities with 0-2,499 population and for communities between 15,000-29,999 population. In general, community structure variables (X_{19}, X_{20}, X_{22}, and X_{23}) were nonsignificant in these models.

The variables which explained most of the employment change by community size were those representing various industries. Manufacturers of textile mill products (D_{27}), apparel and related products (D_{28}), furniture and fixtures (D_{30}), and primary metals (D_{38}) tended to best explain employment change in communities with less than 15,000 population. Manufacturers of rubber and plastic products (D_{35}), machinery except electrical (D_{40}), and electrical machinery (D_{41}) tended to best explain employment change in communities with populations greater than 15,000.

Industry Model Results. The variable representing industrial inducements (D_{25}) was nonsignificant in all equations except for manufacturers of transportation equipment (SIC 37). The wage and labor variables (X_8, X_9, and X_{10}) were significant in explaining employment change in the manufacturers of food and kindred products (SIC 20), apparel and related products (SIC 23), transportation equipment (SIC 37) and fabricated metals (SIC 34). Being located on an interstate (D_{14} and D_{15}) was a significant variable in the models developed for food and kindred products (SIC 20), chemical and allied products (SIC 28), and stone, clay and glass products (SIC 32). One market variable (X_{12}) was significant in the apparel and related products model (SIC 23). Employment change in this sector tended to be partially explained by this industry locating in communities near the market for the product. The presence of natural resources (variables X_{16} and X_{17}) was only partially useful in explaining employment change in the food and kindred products sector (SIC 20), and the machinery except electrical sector (SIC 35). Community structure variables (X_{19}, X_{20}, X_{22}, and X_{23}) were nonsignificant at the 5 percent level in all of the equations developed to explain employment change observed within each industry.

Employment change was explained in the food and kindred product sector (SIC 20) by jobs being created in communities with a population of 5,000-9,999. Manufacturers of chemical and allied products (SIC 28), fabricated metals (SIC 34), and machinery except electrical (SIC 35) tended to be highly significant in explaining employment change in large population centers.

Summary and Conclusions

The objective of this study was twofold: (1) to determine those forces associated with plants being located in communities in each community size interval in Oklahoma from 1963 through 1971; and (2) to explain those forces associated with each manufacturing industry's plant location decisions. Multiple regression models were developed from data which specified employment in new manufacturing plants located in Oklahoma from 1963 through 1971.

In general, variables which researchers, planners, and local leaders often feel are important in attracting industry were not found in this study to be significant in explaining employment change. Industrial inducement variables, such as tax credits, or loans, were nonsignificant in all but one equation. The level of property tax was another variable which was nonsignificant in explaining employment change. Furthermore, variables representing community structure were never highly significant in explaining employment change. Market variables, labor variables and transportation facilities were significant in explaining employment change in only a few industries.

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