AN INPUT-OUTPUT ANALYSIS OF THE STRUCTURE
OF THE ECONOMY OF OKLAHOMA

By

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PREFACE

The study was concerned with measuring the interrelationship of the sectors in the Oklahoma economy. The analysis used the input-output model. Output, income, and employment multipliers were obtained for each sector, as well as a leakage effect associated with each multiplier. Future output requirements were also estimated from the interrelationship measure.

The author wishes to express graditude to Dr. Charles H. Little, major adviser, for his guidance and assistance throughout this study. His encouragement and willingness to council with me at any time was greatly appreciated. The other members of my advisory committee, Dr. Neil R. Cook and Dr. Odell Walker, also deserve special thanks. The author was also assisted by Dr. James S. Plaxico, who read parts of the draft and made helpful comments and suggestions.

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CHAPTER I

INTRODUCTION

Adjustment Problem

Oklahoma is a state with a variety of economic activity. These activities range from the individually operated farms to the large firms located near the urban centers of Oklahoma City and Tulsa. Efforts to understand the complex economic system are being made by the leaders of agriculture, business, and government. A knowledge of the structure of the economy is needed to assess the effects of various courses of action for economic development.

Proposed economic development policy is geared to implement changes in Oklahoma that will generate growth in income and employment. Presently, median personal income in Oklahoma is below the national average, and the rate of unemployment is high in Oklahoma, particularly in certain areas of the state. These economic conditions are associated with shifts in the population, which in turn indicate changes in economic activity. Rural population has been decreasing, while urban population has been increasing. Certain regions have witnessed a larger decline in economic activity than others. This shift in population has resulted in adjustment problems for rural and urban areas. Rural areas have to provide goods and services with a declining economic base, while urban areas have to provide employment opportunities.

Leaders in agriculture, business and government desire to know how various programs will affect the economy of the state and of the depressed regions. For example, state agricultural leaders desire to know how a proposed farm program will affect the income of farmers, governmental leaders desire to know what effect highway construction will have on the economy, and business leaders are concerned with the effects a new industry will have on business activity in their community. A measure to evaluate how the various proposed public programs will affect the state and the depressed regions in Oklahoma is needed, before public funds are committed for development projects.

Need for the Study

In order to measure the total effect that a change will have on the entire economy, both direct and indirect effects must be examined. The direct effect of a proposed change is relatively simple to ascertain, but indirect effects are not as easily measured. An example will help to clarify the two effects. If a new plant is located in a community, the initial effect on employment will be the number of men the new plant will employ. The indirect effects created by the location of the new plant are the increased employment opportunities resulting in other businesses in the region. These indirect effects arise as the new plant demands additional services, thus the service industries hire additional men. In turn these service industries will increase their demand for goods from other industries. These industries will have to hire more men. The reverberations will continue until the economy adjusts completely to the initial change. All reprecussions of the new plant on the employment are included in the indirect effect.

One analytical device used to measure the total effect of an induced change in the economy is the input-output model. The model can be constructed to measure the total effect of a change on the sectors included in the Oklahoma model. Each sector consists of a group of similar-type industries. Various predictive indicators can be computed. These are the output, income and employment multipliers. The multipliers indicate how much output, income, and employment is expected to change throughout the economy as a result of a one unit change in a sector. Once these indicators are known, they can be used to evaluate the interrelationship of the various sectors of the economy of Oklahoma.

Objectives

The general objective of this study was to measure and evaluate the interrelationship of the various sectors of the economy of Oklahoma. Emphasis was focused on the main economic activities found in the state. Another objective was to derive a method to measure leakage from a state economy using the input-output analysis. More specifically, the objectives of the study were:

1. To formulate an input-output model to study the interrelationship of the Oklahoma economy;
2. To measure the direct and indirect effect of changes in economic activities in Oklahoma;
3. To illustrate how changes in final demand will effect output, employment, and income;
4. To compute output, income, and employment multipliers;
5. To measure the amount of leakage associated with each multiplier;

6. To illustrate how the input-output model can be used as a predictive device.

The empirical analysis will attempt to illustrate: (a) that secondary data are available to set up and implement the input-output model; and (b) that the input-output model can be used to obtain the above objectives. The empirical results are intended to measure the structure of the economy of Oklahoma, so that the leaders in agriculture, business and government can evaluate various proposed economic development programs.

CHAPTER II

INPUT-OUTPUT ANALYSIS

Interest in economic growth and development, especially at the regional, state, and local level, has increased during the past several years. To study economic growth, some measure of the interdependence among industries within a region is needed. One of the tools of regional analysis -- the input-output model -- can be used to measure the interrelationships of industries and sectors within the economy. Only during the past 15 years has this model received widespread use. In fact, its use has grown to the extent that input-output studies have been conducted for many national economies. Also in recent years, many regional input-output studies have been conducted.

Review of Literature

Historically, input-output analysis had its beginning with Francois Quesnay in his Tableau Economique published in 1758. Quesnay's original tableau[1] stressed the interdependence of economic activities in the operation of a single firm. Later Quesnay published a modified version of the tableau[2] which represented the entire economy of France in the form of circular flows.

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[1]William H. Miernyk, The Elements of Input-Output Analysis (New York, 1965), p. 4.

[2]William Fellner, Emergence and Content of Modern Economic Analysis (New York, 1960), pp. 40-42.

Approximately 100 years later, Leon Walrus developed a model depicting the interdependence among the producing sectors of the economy and the competing demands of each sector for the factors of production. His model included equations representing consumer income and expenditures. It also took into account cost of production in each sector, the total demand for and supply of commodities and the demand for and supply of factors of production. From this model, he desired a simultaneous determination of all prices in the economy.

Input-output analysis as used today is based mainly upon work done by Professor Wassily Leontief, who formulated the first empirical interindustry model of the United States economy[3] in 1936. Later, he published[4] the first transaction table for the United States. The transaction table was a double entry system which showed the production and consumption of each sector in the economy. The table was constructed for 1919 and 1929 and consisted of 44 sectors.

Leontief constructed a more detailed transaction table[5] for the year 1939. This table was used to analyze postwar economic problems. An even more detailed transaction table was constructed in 1947 by Evans and Hoffenberg.[6] This 450 sector table was used for many regional

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[3]Wassily Leontief, "Quantitative Input-Output Relations in the Economic System of the United States," <u>The Review of Economics and Statistics</u>, XVIII (August, 1936), pp. 105-125.

[4]Wassily Leontief, <u>The Structure of the American Economy, 1919-1939</u>, 2nd edition (New York, 1951).

[5]Wassily Leontief and Members of the Harvard Economics Research Project, <u>Studies in the Structure of the American Economy</u> (New York, 1959).

[6]Duane W. Evans and Marvin Hoffenberg, "The Interindustry Relations Study for 1947," <u>The Review of Economics and Statistics</u>, XXXIV (May, 1952), pp. 97-142.

studies. More recently, the Bureau of Labor Statistics has published a transaction table for 1958.[7] The present plans[8] are for an input-output table to be prepared at a minimum of every five years by an agency of the Federal Government.

At least fifty-four other nations have had input-output studies of their economy published. These studies are briefly summarized in three comprehensive bibliographies.[9] The usefulness of the results in analyzing national economies prompted economists to apply the input-output approach to study regional economies. Two different types of input-output approaches have been used to analyze regions within a nation. One approach is an inter-regional model which consists of separating the economy into industrial sectors, each of which is represented in every region. This approach was initiated by Walter Isard.[10] The model requires data from each sector of the economy within each region. As expected, the availability of data limits the use of this model.

The second and most popular approach is simply an application of the national inter-industry model to a region, such as a county,

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[7] United States Department of Commerce, Office of Business Economics, Survey of Current Business, VL, No. 9 (September, 1965), pp. 33-49.

[8] William E. Martin and Harold O. Carter, A California Interindustry Analysis Emphasizing Agriculture, Part II, Giannini Foundation Research Report No. 250 (davis, 1962), p. 7.

[9] V. Riley and R. J. Allen, Interindustry Economics Studies, Bibliographic Reference Series No. 4 (Maryland, May, 1955); C. E. Tashier, Input-Output Bibliography 1955-1960, Statistical Series No. 7 (New York, 1961); and Input-Output Bibliography 1960-1963, Statistical Series No. 39 (New York, 1964).

[10] Walter Isard, "Interregional and Regional Input-Output Analysis: A Model of a Space Economy," Review of Economics and Statistics, XXXIII, No. 4 (November, 1951), pp. 318-328; and Walter Isard, Methods of Regional Analysis: An Introduction of Regional Science (New York, 1960).

community, state or a group of states. In many of these studies, the national coefficients are often adjusted to characterize the production patterns of the region. Some examples are studies of the economies of: Utah,[11] Maryland,[12] and of the New York-Philadelphia area.[13] An extensive input-output study[14] of the state of Washington is now in process.

Several input-output studies with emphasis on agriculture have been published. The models contain a large number of agricultural sectors while the non-agricultural industries are aggregated into a few sectors. The results of some of these input-output studies are reported in a series of publications[15] from Iowa State University. Many of these studies were generally concerned with the agricultural industry in several states. A study conducted in California concentrated primarily on the agriculture industry in that state. Secondary statistical data were

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[11]Frederick T. Moore and James W. Peterson, "Regional Analysis: An Inter-Industry Model of Utah," The Review of Economics and Statistics, XXXVIII (November, 1955), pp. 368-383.

[12]University of Maryland, Bureau of Business and Economic Research, "A Regional Inter-Industry Study of Maryland," Studies in Business and Economics, VIII, No. 2 (September, 1954).

[13]Walter Isard and Robert E. Kuenne, "The Impact of Steel Upon the Greater New York-Philadelphia Region: A Study in Agglomeration Projection," The Review of Economics and Statistics, XXV, No. 4 (November, 1953), pp. 289-301.

[14]Philip J. Bourgue, et. al., The Washington Inter-Industry Study for 1963 (Seattle: University of Washington, Reprint No. 10, 1966).

[15]G. A. Peterson and Earl O. Heady, Application of Input-Output Analysis to a Simple Model Emphasizing Agriculture, Iowa Agr. Expt. Station Bulletin 427, 1955; John Alvin Scknitther and Earl O. Heady, Application of Input-Output Analysis Emphasizing Regional and Commodity Sectors of Agriculture, Iowa Agr. Expt. Sta. Res. Bulletin 469, 1959; Wilbur R. Maki and Dean F. Schreiner, Regional Intersectional Relations and Demand Projections with Emphasis on the Feed-Livestock Economy of the North Central States, Iowa Agr. Expt. Sta. Res. Bulletin 530, 1964; and Wilbur R. Maki, Projections of Iowa's Economy and People in 1974, Iowa Agr. Expt. Sta. Special Report No. 41, 1965.

mainly used in the California study. The results are published in two bulletins.[16] Also, an input-output study[17] for North Dakota has been completed, which used survey data.

Theoretical Explanation of the Basic Model

The input-output model consists of three basic parts -- a transaction or flow table, a set of technical or direct coefficients, and a set of interdependence or direct and indirect coefficients. The flow table is the base of the model. The technical and interdependence coefficeients are derived directly from it.

The Flow Table

To illustrate the flow table, assume an economy has three producing sectors and a primary input sector. Each sector consists of a set of relatively homogenous industries aggregated according to a predetermined classification. Each of these sectors produces a certain amount of output, which is used within the sector, purchased by the other sectors, or purchased for final demand by the consumer. The primary input row indicates the amount of primary services used by the processing and final demand sectors. In equation form, the transactions of the economy can be presented as a system of equations:

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[16]William E. Martin and Harold O. Carter, A California Interindustry Analysis Emphasizing Agriculture, Part I: The Input-Output Models and Results, Giannini Foundation Report No. 250 (February, 1962); and William E. Martin and Harold O. Carter, A California Interindustry Analysis Emphasizing Agriculture, Part II: Statistical Supplement, Giannini Foundation Research Report No. 250 (Februrary, 1962).

[17]Larry D. Sands, "Analysis of Effects of Income Changes on Intersectoral and Intercommunity Economic Structure" (Unpublished Master's Dissertation, North Dakota State University, 1966).

$$X_1 = x_{11} + x_{12} + x_{13} + Y_1$$

$$X_2 = x_{21} + x_{22} + x_{23} + Y_2$$

$$X_3 = x_{31} + x_{32} + x_{33} + Y_3$$

$$R_0 = r_{01} + r_{02} + r_{03} + Y_0$$

X_i = gross output of the i^{th} sector.

R_0 = primary input.

X_{ij} = purchases of the j^{th} sector from the i^{th} sector needed to produce X_i.

r_{0j} = purchases of primary inputs by the j^{th} sector needed to produce X_i.

Y_i = final or consumer demand for products of sector i.

Y_0 = final or consumer demand for primary inputs.

An outlined form of the transaction table may help to explain the system of equations. The equations inserted in the outlined form are presented in Figure 1.

		Purchasing Sectors 1	Purchasing Sectors 2	Purchasing Sectors 3	Final Demand Y_i	Total Output X_i
Producing Sectors	1	x_{11}	x_{12}	x_{13}	Y_1	X_1
	2	x_{21}	x_{22}	x_{23}	Y_2	X_2
	3	x_{31}	x_{32}	x_{33}	Y_3	X_3
Primary Input		r_{01}	r_{02}	r_{03}	Y_0	R_0
Total Input		X_1	X_2	X_3	R_0	

Figure 1. Representation of a Transaction Table

The processing sectors are the endogenous sectors of the economy. These sectors contain the industries which are producing goods and services. In an empirical input-output table, the processing section normally would contain a large number of sectors and would therefore constitute the largest portion of the flow table. There must be as many rows as there are columns in the processing section and the corresponding row and column totals for each section must be equal. The final demand section consists of the exogenous sectors of the economy. Household and government purchases generally make up the bulk of the final demand sector. The primary input section consists mainly of the import, households, and government rows. The figures in these rows indicate the amount of primary input purchased by the sectors in the processing and final demand sections. It is not necessary to have a primary input row for each sector in the final demand section. The number of sectors in the processing or final demand sections will depend to some extent on the availability of data and on the research problem. If time and money are available, the collection of primary data will permit a large number of sectors; whereas, the number of sectors will be limited for a regional model if secondary data are used.

The input-output table as illustrated in Figure 1 provides a systematic account of the sales and purchases of each sector. Reading across each row indicates the sales of that sector, while reading down each column indicates purchases of that sector. For example, consider the first row of the transaction table. Output of sector 1 is X_1. Of this output, x_{11} is purchased by sector 1, x_{12} is purchased by sector 2, x_{13} is purchased by sector 3, and Y_1 is the amount distributed to the final demand sector. The inputs of each sector are summarized in that sector's column. Reading down the first column, sector 1 requires x_{11} of its own output, x_{21} of sector 2, x_{31} of sector 3, and r_{01} of primary inputs.

There are no fixed standards as to whether a specific sector should be located in the processing or final demand section. The model, as illustrated above, is considered an "open" input-output model. An "open" model assumes that constant input-output coefficients hold only for those sectors which are normally considered as intermediate production activities, while final demand activities such as households and governments are autonomous.[18] The system is referred to as a "closed" system if all sectors are endogenous. Also, it may be desirable to close the system with respect to a particular sector in the final demand section. This is accomplished by moving the sector from the final demand section to the processing section. The researcher can then measure the interaction of that sector with other sectors. The exact composition of the table will depend on the research problem. The basic model as illustrated can be altered in a number of ways to fit the problem being investigated.

Technical Coefficients

The technical coefficients are derived from the transaction table. The technical coefficients indicate the input requirement per dollar of output. These are derived by assuming that the relationship between the

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[18] Tibor Barna, The Structural Interdependence Economy (New York, 1956), pp. 45-46.

purchases of a sector and the level of output of that sector is linear. This relationship can be expressed in the following form:[19]

$$x_{ij} = a_{ij}X_j + c_{ij} \qquad i = 1, 2, 3;\ j = 1, 2, 3$$

The a_{ij}'s and the c_{ij}'s are parameters in the expresssion and in most empirical studies[20] the c_{ij}'s are assumed zero. Then the technical coefficient (a_{ij}) is the ratio of the purchase of output of industry i by industry j, over the gross output of industry j. Mathematically, this is represented as:

$$(2) \qquad a_{ij} = \frac{x_{ij}}{X_j} .$$

Each a_{ij} indicates the direct dependence per dollar of output of each sector on any other sector.

Interdependence Coefficients

An even more important measure is the interdependence coefficient. This coefficient is often referred to as the direct and indirect coefficient. The interdependence coefficient indicates the output required from sector i per dollar of output of sector j delivered to final demand. In other words, the interdependence coefficient measures not only the direct effects, but also all secondary effects of a change in the economy.

The calculation of the interdependence coefficient includes taking

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[19]Harold O. Carter, "Input-Output -- Uses and Problems in Regional Analysis," Regional Economic Development, Proceedings of the Methodology Workshop (Denver, 1966), pp. 56-84.

[20]Ibid., p. 59.

the technical coefficients in matrix form and subtracting this from an identity matrix. Then the inverse of the resulting matrix provides the set of interdependence coefficients. The mathematical procedure is as follows:[21] First, the a_{ij}'s are substituted into the set of equations listed in (1). The equations are then solved for Y_i.

$$(3) \quad \begin{aligned} Y_1 &= X_1 - a_{11}x_1 - a_{12}x_2 - a_{13}x_3 \\ Y_2 &= X_2 - a_{21}x_1 - a_{22}x_2 - a_{23}x_3 \\ Y_3 &= X_3 - a_{31}x_1 - a_{32}x_2 - a_{33}x_3 \end{aligned}$$

Rewriting equation (3),

$$(4) \quad \begin{bmatrix} 1-a_{11} & -a_{12} & -a_{13} \\ -a_{21} & 1-a_{22} & -a_{23} \\ -a_{31} & -a_{32} & 1-a_{33} \end{bmatrix} \cdot \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} = \begin{bmatrix} Y_1 \\ Y_2 \\ Y_3 \end{bmatrix}$$

In matrix notation, it would read as:

$$(\underline{I} - \underline{A})\ \underline{X} = \underline{Y}\ .$$

The matrix $(\underline{I} - \underline{A})$ is known as the "Leontief Matrix" and has the special properties that the diagonal elements are positive, while the remaining elements are negative or zero.[22] The solution of the set of equations in (4) is simply obtained by finding the inverse of the Leontief Matrix. This solution is as follows:

$$(5) \quad \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} = \begin{bmatrix} A_{11}A_{12}A_{13} \\ A_{21}A_{22}A_{23} \\ A_{31}A_{32}A_{33} \end{bmatrix} \cdot \begin{bmatrix} Y_1 \\ Y_2 \\ Y_3 \end{bmatrix}$$

In matrix notation the equation is:

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

[22] Ibid., p. 66.

Each A_{ij}, which is an element of the $(\underline{I} - \underline{A})^{-1}$ matrix, indicates the amount of production from sector i necessary to sustain a final demand of one unit in sector j. This procedure yields direct and indirect requirements of each sector upon the rest of the economy.

Assumptions of the Basic Input-Output Model

The input-output model is based upon two fundamental assumptions. The most restrictive assumption is that the input-output coefficients are fixed. The assumption of fixed coefficient implies that technology remains constant, no external economies or diseconomies exist, and substitution possibilities due to changes in relative prices or availability of new material are not considered.[23]

The fixed coefficient assumption places limits on the use of the input-output model as a long range forecasting technique. Cameron and Chenery conducted research to check on the reasonableness of this assumption. Cameron[24] found from an input-output study of the Australian economy that the model applied with this assumption yielded a reasonable approximation of the actual Australian economy. Chenery in his discussion concluded that this assumption is realistic in the short run; however, continued technological change causes the actual relationship to change over time. Therefore, adjustment of the coefficients or the construction of a new table is suggested every four or five years.[25]

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[23]Holbs B. Chenery and Paul G. Clark, Interindustry Analysis (New York, 1959).

[24]B. Cameron, "The Production Function Leontief Models," The Review of Economic Studies, XX, No. 1, pp. 62-69.

[25]Chenery, p. 16.

This suggestion has probably been the main reason an agency of the Federal Government plans to construct a new input-output table every five years.

The other assumption of the basic input-output model is that there are no errors of aggregation in combining industries into sectors. This assumption implies that the coefficients for a sector are representative of the industries within that sector. Conclusions drawn from the analysis exemplify the average conditions of the industries within the sector. The more sectors included in the model, the less chance that errors of aggregation will arise.

CHAPTER III

SURVEY OF THE ECONOMY OF OKLAHOMA

To conduct an input-output study of a state economy, a knowledge of the geographic and economic conditions of the state is necessary. The descriptive material will aid in formulating the input-output model for Oklahoma and evaluating the results.

Geographic Characteristics

Oklahoma consists of a land area of approximately 68,887 square miles, most of which is flat plains broken by the Ozark Mountains in the northeastern part of the state and the Ouachita Mountains in the southeastern part. A distinct rainfall pattern exists moving from the northwest to the southeast part of the state. Annual precipitation[1] ranges from about 15 inches in the northwest counties to about 60 inches in the southeast counties. The temperature pattern in Oklahoma is similar to the rainfall pattern. The average temperature[2] in the southeastern counties is about six degrees above the temperature in the counties in the northwestern section of the state.

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[1] U.S. Weather Bureau, Climaliological Data, Oklahoma, LXVIII No. 1-120.

[2] Ibid.

Economic Characteristics

The agricultural industry is most affected by temperature and rainfall. The difference in rainfall and temperature makes for a distinct difference in the type of agriculture moving from the northwest to the southeast. Agriculture in the northwestern part of the state consists of large farms and ranches with wheat and cattle as the main enterprises. Agriculture is also a dominant industry in the southeastern counties; however, the farms are rather small with more diversification of operations. Industrial activity in the state is located mainly around the two large urban centers of Oklahoma City and Tulsa. A descriptive analysis of the resources found in the state will help explain further the organization of economic activity.

The Human Resource

Characteristics of the population are important factors affecting economic activity in a region. The population of Oklahoma in 1959 was 2,301 thousand.[3] Approximately 62.9 percent were urban residents, 26.0 percent were rural non-farm, and 11.1 percent were rural farm residents.[4] Rural residents are divided into two sectors: rural non-farm and rural farm. Rural farm residents are those who sell more than $50 worth of agricultural goods and farm at least ten acres. Rural non-farm residents consist of those not classified as rural farm residents and living in places with a population of less than 2,500. Urban residents are those

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[3]U.S. Bureau of the Census, Current Population Reports: Population Estimates, Series P-25, No. 229, May 22, 1961.

[4]U.S. Bureau of the Census, U.S. Census of Population: 1960, General Social and Economic Characteristics, Oklahoma, Final Report PC(1)-38C (Washington, 1961), Table 38, p. 145.

living in places with a population greater than 2,500. Of the urban residents, 47.9 percent are located in and around Oklahoma City and Tulsa. A listing of the urban places with more than 10,000 people is given in Table I. These urban places account for 70.6 percent of the total urban population and 44.4 percent of the total population of the state.

The median age of the people in Oklahoma in 1960 was 30.0 years[5] as compared to an average of 29.5 years for the United States. This median ranged from 40.5 in Alfalfa County to 23.0 years in Comanche County. The state's median education level ranged from a low of 8.1 years in McCurtain County to 12.2 years median education in Washington County.

Income

The income distribution in the state follows somewhat the pattern indicated by the median educational level in each county in Oklahoma. Data in Figure 2 show the median family income and median education level in each county in Oklahoma. It can be seen that the residents of the southeastern section of Oklahoma have the lowest per family income and educational level. The state's median family income[6] equaled $4,620 in 1959, with a range of $1,919 in Adair County to $6,279 in Washington County.

Civilian income by industrial source is shown in Table II. The sources of civilian income are ranked according to percent of total income to indicate the relative importance of each sector. The wholesale and retail sector accounted for 21.0 percent of the civilian income

[5]Ibid., Table 37, p. 144.

[6]Ibid., Table 66, p. 166.

TABLE I

TOTAL POPULATION OF URBAN PLACES IN OKLAHOMA OF 10,000 OR MORE, 1960

Urban Place	Population
Bethany	12,342
Chickasha	14,866
Del City	12,934
Duncan	20,009
Durant	10,467
El Reno	11,015
Enid	38,859
Lawton	61,697
McAlester	17,419
Miami	12,869
Midwest City	36,058
Muskogee	38,059
Norman	33,412
Oklahoma City	314,253
Okmulgee	15,951
Ponca City	24,411
Sapulpa	14,282
Seminole	11,464
Shawnee	24,326
Stillwater	23,965
The Village	12,118
Tulsa	261,685
Total	1,022,461

Source: U.S. Bureau of the Census, _U.S. Census of Population, 1960, Oklahoma, General Social and Economic Characteristics_, Table 72, pp. 180-181.

Parenthesized Figures - Median Education Level

Unparenthesized Figures - Median Family Income

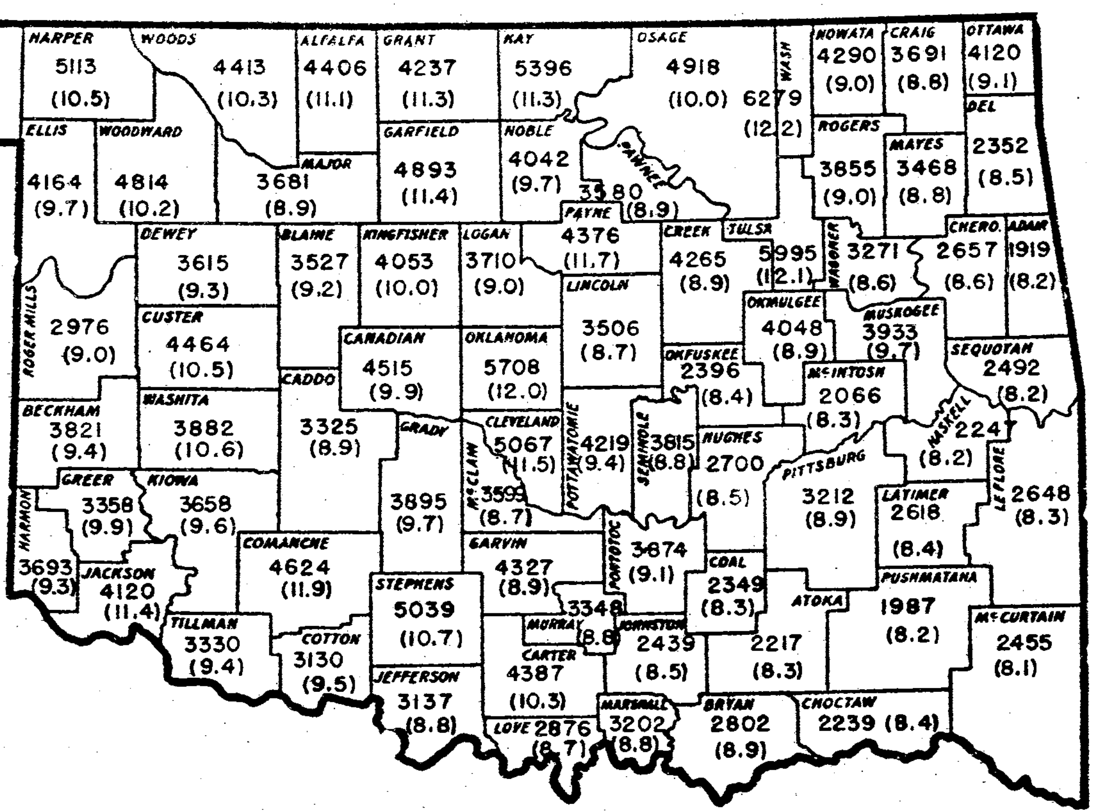

Figure 2. Median Family Income and Median Education Level by Counties for Oklahoma, 1960

Source: U.S. Bureau of the Census, Median Family Income, <u>County and City Data Book</u>. (Washington, 1962) Table 2. Median Education Level, <u>Census of Population, 1960, General Social and Economic Characteristics</u>. (Washington, 1962), Table 83.

TABLE II

INDUSTRIAL SOURCE OF CIVILIAN INCOME RECEIVED BY PERSONS FOR PARTICIPATION IN CURRENT PRODUCTION, OKLAHOMA 1959

	Income Received (millions of dollars)	Percent of total
Wholesale and Retail	674	21.0
Services	478	14.9
Manufacturing	441	13.7
Government	386	12.0
Mining	287	8.9
Farms	280	8.7
Construction	233	7.3
Transportation	165	5.2
Finance, Insurance and Real Estate	149	4.6
Communication and Public Utilities	106	3.3
Other	14	.4
	3,213	100.0

Source: U.S. Department of Commerce, Survey of Current Business, Vol. 40, No. 8, August, 1960, Table 70, p. 23.

earned in Oklahoma. Next, in order were the services, manufacturing, and government sectors which contributed 14.9, 13.7 and 12.0 percent respectively of the total civilian income earned. The ranking of the industrial sources of wages and salaries according to the percent of the total is very similar to the pattern established for the sources of civilian income. These figures are presented in Table III. The largest proportion of the wages and salaries was received from the government, wholesale and retail, and manufacturing sectors. Comparing Tables II and III, the top five sectors are government, manufacturing, mining, services, wholesale and retail in both tables though in slightly different order. The greatest difference between the two tables is the rank of the farm sector. The percent of total income from this sector was 8.7, but only 1.5 percent of wages and salaries was derived from this source. The reason is that most of the farm labor is owner or family labor and the amount of hired labor is relatively small.

Employment

Census figures[7] indicate that the industries in the service sector hire the largest number of employees. Service employees constitute 22.3 percent of the total employed. The wholesale and retail and manufacturing sectors are next, hiring 21.0 and 13.2 percent respectively of the total labor force. The remaining employment is distributed rather equally among the other sectors.

Closely aligned to the income distribution pattern in Oklahoma is the pattern of unemployment rates. The unemployment rates for counties

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[7]Ibid., Table 62, p. 163.

TABLE III

INDUSTRIAL SOURCE OF WAGES AND SALARIES IN OKLAHOMA, 1959

	Amount of Wages and Salaries (millions of dollars)	Percent of Total
Government	616	24.4
Wholesale and Retail	465	18.5
Manufacturing	396	15.7
Mining	266	10.6
Services	230	9.1
Construction	159	6.3
Transportation	148	5.9
Finance, Insurance and Real Estate	102	4.1
Communication and Public Utilities	94	3.7
Farm	38	1.5
Other	7	.2
	2,521	100.0

Source: U.S. Department of Commerce, Survey of Current Business, Vol. 41, No. 8, August, 1961, Table 47, p. 17.

in Oklahoma for 1960 are shown in Figure 3. The highest unemployment rates are in the southeastern section of the state. Unemployment in some counties in this section is over 10 percent of the labor force.

Agricultural Resources

Changes taking place in the agricultural sector in Oklahoma are the same as those occurring in agriculture elsewhere in the United States. The number of farms continues to decrease, and farm size continues to increase. According to the 1959 census, there were 94,676 farms in Oklahoma with an average size of 378.1 acres. This compares with 118,979 farms with an average size of 299.5 acres in 1954. Value of farm production totaled 741 million dollars in 1959. Of this total, 380 million were from the sale of livestock and livestock products, 324 million from crops produced, 24 million from government payments, and farm rental received by farmers totaled 13 million dollars. A listing of the receipts for the major crops and livestock categories is presented in Table IV. It is evident that cattle and wheat production are important sources of income to Oklahoma farmers.

Agriculture activity varies across the state. The northeast and northcentral areas of the state specialize more in wheat production, whereas cotton production is concentrated in the southwest. The production of sorghum is found mainly in the northwestern and western counties of the state. Corn is raised mainly in the eastern and central parts of the state where railfall is more favorable. The production of peanuts is centered in the southcentral portion of the state, while vegetable production is concentrated around the urban centers of the state.

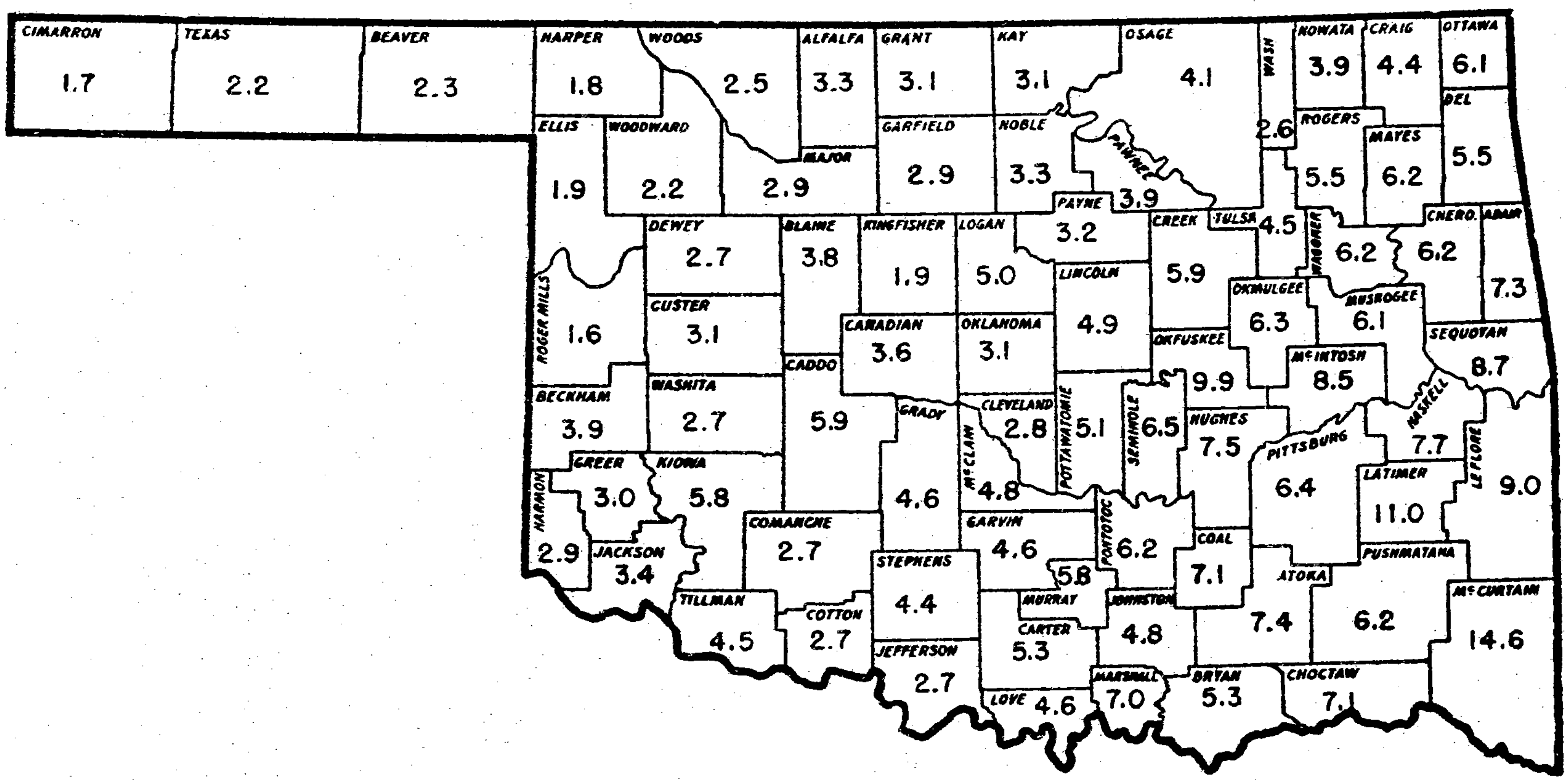

Figure 3. Percent Unemployed in Oklahoma by Counties, 1960

Source: U.S. Bureau of the Census. U.S. Census of Population, 1960, General Social and Economic Characteristics. (Washington, 1961), Table 83, pp. 211-216.

TABLE IV

TOTAL VALUE OF FARM PRODUCTION BY COMMODITIES, OKLAHOMA, 1959

	Thousands of Dollars	Percent of Total
Cattle and Calves	260,610	37.0
Wheat	148,215	21.1
Dairy Products	62,152	8.8
Cotton	55,455	7.9
Sorghum	30,166	4.3
Hogs	27,705	3.9
Poultry Products	26,308	3.7
Alfalfa Hay	15,325	2.2
Peanuts	11,284	1.6
Barley	10,078	1.4
Corn	7,744	1.1
Oats	7,694	1.1
Wild Hay	5,883	.8
Sheep and Wool	3,334	.5
Soybeans	2,863	.4
Broomcorn	2,607	.4
Other	26,420	3.8
	703,843	100.0

Source: U.S. Department of Agriculture, *U.S. Census of Agriculture, 1959*, Vol. I Counties, Part 36, Oklahoma, and *Oklahoma Agriculture 1959-60*, Crop and Livestock Reporting Service, Table 8, pp. 11-13.

Cattle and calves are raised throughout the state. Osage county led all counties in Oklahoma in the number of cattle and calves sold in 1959. Census data indicate that the farmers in Osage County sold 70 thousand head valued at over 10 million dollars. Dairying is important in a number of counties. The main dairy counties are located around the large metropolitan areas of Tulsa and Oklahoma City. These metropolitan areas constitute the bulk of the market for dairy products in Oklahoma. The main counties producing poultry and poultry products are located in the eastern counties of the state. Other important poultry production counties are located around the two main consuming centers. Sheep and lamb production is concentrated in the northcentral counties, while hog production is greatest in the eastern half of the state.

Mineral Resources

The mining sector has an important role in the economic activity in Oklahoma. The resources from the mining sector provide the base for much of the industrial activity of the state. All but one county reported the presence of some mining activity.[8] The value of mineral production from the other 76 counties totaled 860 million dollars in 1959. The total mineral production was reported[9] as follows: 830 from oil and gas production, 4 from metal production, 11 from coal production and 18 million dollars from non-metal production. The non-metals consisted of clay, gypsum, lime, salt, sand and gravel, stone, limestone and dolomite. Included in these reported totals is 3 million dollars worth of mineral

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[8]U.S. Department of Interior, Bureau of Mines, Mineral Yearbook, 1959 (Washington, 1960) p. 787.

[9]Ibid., pp. 787-811.

processing, which must be substracted to give the value of mineral production for Oklahoma in 1959.

Oklahoma ranked fourth among all states as a producer of crude petroleum and third as a producer of natural gas. Oil and natural gas are mined in a broad belt extending from the northeastern to the southeastern and western parts of the state. Non-metals are mined in widely extended parts of the northeast, north-central and central regions. Also some non-metals are found in the Arbuckle and Wichita Mountains, which are located in southwestern and south-central Oklahoma. A significant part of the mineral output is processed by Oklahoma industries into semi-finished and finished products for both intra- and inter-state shipment and consumption.

Manufacturing Sector

The output of the agricultural and mineral sectors provide the base of the manufacturing activity. Census data indicate that over 50 percent of the industrial activity in Oklahoma is in processing mineral and agricultural products. A listing of the value of shipments by industry is presented in Table V.

As expected, Tulsa and Oklahoma Counties are the manufacturing centers in Oklahoma because of the large urban centers in the two counties. By operating in these areas, plants can take advantage of the available transportation facilities, distribution facilities, public utilities, and other service-type businesses generally located in a metropolitan complex. In terms of number of establishments, Tulsa County was first in the number of plants in the following industrial groups: machinery, primary and fabricated metal products, stone, clay and glass, and

TABLE V

VALUE OF SHIPMENTS OF INDUSTRIES IN OKLAHOMA, 1958

	Thousands of Dollars	Percent of Total
Petroleum	635,837	26.6
Food and Kindred Products	460,189	19.3
Fabricated Metal	166,160	7.0
Machinery	158,942	6.7
Stone, Clay and Glass	155,687	6.5
Primary Metals	80,667	3.4
Electrical Machinery + Appliance	66,596	2.8
Printing and Publishing	66,594	2.8
Chemicals	54,758	2.3
Apparel	51,813	2.2
Concrete Products	49,688	2.1
Paper Products	31,903	1.3
Lumber Products	30,376	1.3
Transportation	14,741	.6
Furniture and Fixtures	13,403	.5
Miscellaneous	350,027	14.6
	2,387,401	100.0

Source: U.S. Department of Commerce, Bureau of the Census, U.S. Census of Manufacturing: 1958, Area Statistics, (Washington, D. C., 1961), Vol. III, Table 3, pp. 35-45.

transportation equipment. Oklahoma County had the largest number of plants in the following categories: food and kindred products, petroleum and coal products, printing and publishing, and chemical and chemical products.

Public and Private Services

During the past years, the role of the government sector has grown tremendously and plays a major role in the economy of Oklahoma. The Federal government collected 810 million dollars in taxes in 1959. Individual income tax collections at 363 million dollars made up the largest share. Manufacturing excise tax and corporation taxes of 190 million dollars and 142 million dollars were second and third, respectively. Employment taxes of 92 million dollars were also rather large. Most of the state and local revenues were obtained from sales taxes, transfer payments and property taxes. The total state and local revenue amounted to 545 million dollars in 1959.

Expenditures of the state and local governments are concentrated mostly in three areas. The largest public expenditure in Oklahoma is for education. The two large universities account for much of the state's expenditures for higher education. The second largest public expenditure was for highway construction and repair. The expenditure in Oklahoma for highway construction is larger than indicated by the amount the state pays, since the federal government matches some of the funds used to defray the cost of many highway projects. The amount spent for welfare was the third largest expenditure by state and local governments. These payments vary sharply among counties and are greatest, as would be expected, in the counties with the lowest mediam family income. The data presented in Figure 4 show the percentage of the population in each county that is receiving public assistance. The southeastern part of the state has the largest share of its people receiving welfare.

The largest private service sector is the retail and wholesale sector. A major share of this sector's activities are centered around the large metropolitan areas. Food stores account for the major portion of the retail sales, while automotive establishments are second in retail sales. These two account for 42 percent of the retail sales. Merchant wholesalers accounted for 46 percent of the total wholesale sales. The activities of the remaining service-type sectors also are concentrated near the population centers of the state. Included are the transportation, communication and public utilities, finance, insurance and real estate, and service sectors. The service sector includes such business activities as auto repair shops, hotels, recreation centers, and professional services such as personal and medical services.

Summary

The economic activity determines the income, educational, and unemployment present in the state. As compared to the national average, the people of Oklahoma have a lower median income and education level. Unemployment in Oklahoma is higher than in many other areas of the United States. These conditions are especially prevalent in the counties located in the southeastern corner of the state.

The geographic conditions determine the agricultural activities that can be supported by each area of the state. The main agricultural enterprises are the production of cattle and calves. The state has large reserves of oil and natural gas. The raw materials from the agricultural

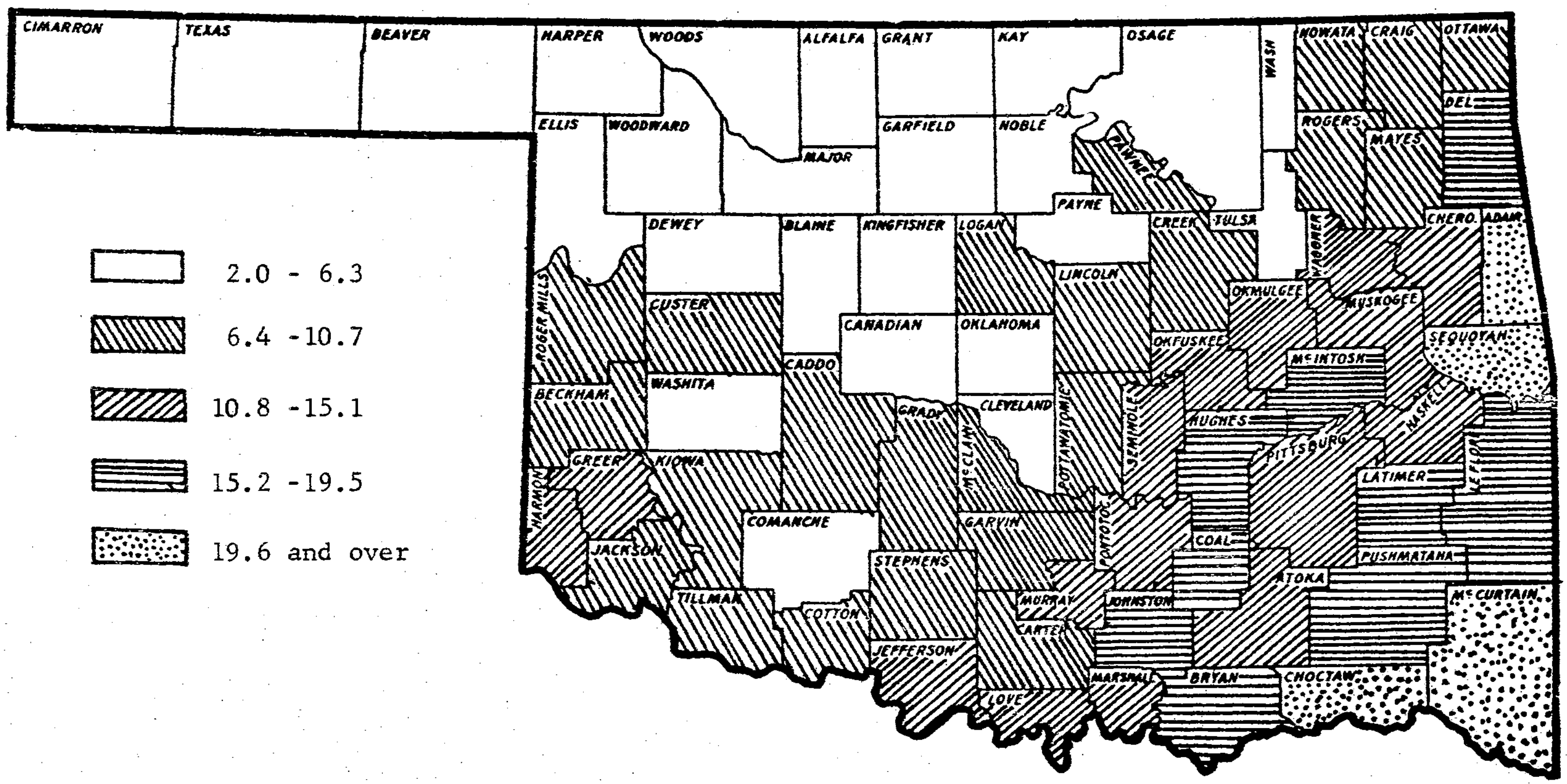

Figure 4. Percent of Oklahoma's Civilian Population Receiving Public Assistance by Counties, 1959-1960.

Source: Oklahoma Department of Public Welfare, Annual Report, Fiscal Year Ending, June 30, 1960, Chart 10.

and mining sectors provide the base for much of the economic activity of the state. Large quantities of resources from these sectors are processed in the manufacturing plants found mainly near Oklahoma City and Tulsa. These plants demand goods and services from the service-type industries. Therefore, the importance of the agricultural and mining sectors is exemplified by the amount of economic activity created by the products from these sectors.

The above descriptive information about Oklahoma will aid in formulating the input-output model. The empirical results of the study will be interpreted in light of this information.

CHAPTER IV

EMPIRICAL RESULTS OF THE OKLAHOMA STUDY

With the descriptive analysis as a background, an input-output model for Oklahoma can be formulated. This chapter contains a description of the Oklahoma model and an analysis of the three input-output tables: the flow table, technical coefficient table, and interdependence coefficient table. Data sources, definitions and techniques used in gathering data for the model are presented in the Appendix.

Oklahoma Model

The data used in the study of the Oklahoma economy were for the year 1959, primarily because secondary data contained in the 1959 census were the most complete of all available data. Secondary data were used because of the prohibitive time and cost necessary for the collection of primary data. Most of the data needed for the Oklahoma model were available in census and other government publications.

The industries in the economy had to be aggregated into a workable number of sectors. Also the amount of available data was often restricted to groups of industries or activities as classified by the Bureau of Labor Statistics. It was necessary to decide which groups of industries reported according to this classification should be included in the model.

Agricultural activities were divided into two sectors: the crop and the livestock and livestock products sectors. This division allowed the two main agricultural enterprises in the state; wheat and cattle to be studied separately.

Because of the large amount of agricultural products being processed in Oklahoma, a separate sector was included for the agricultural processing firms. The remaining industrial firms were aggregated into the manufacturing sector. The service-type activities of the economy were aggregated into five sectors: transportation, communication and public utilities; real estate, finance and insurance; wholesale and retail; and service sectors. Also since the mining of crude oil plays an important role in the economy of Oklahoma, a separate sector for mining activity was included. These are the processing or endogenous sectors of the Oklahoma model.

Seven exogenous or final demand sectors were considered. Construction activities were divided up into new construction and maintenance construction. Also the government activities were split up into two sectors. The other exogenous sectors were households, imports and exports. A complete listing of the endogenous and exogenous sectors is given below:

Endogenous Sectors	Exogenous Sectors
Livestock and Livestock Products	Maintenance Construction
Crops	New Construction
Agricultural Processing	Federal Government
Manufacturing	State and Local Governments
Transportation, Communications and Public Utilities	Households
Real Estate, Finance and Insurance	Exports
Services	Imports
Wholesale and Retail	
Mining	

The Inter-industry Flow Table

The inter-industry flow of goods and service (Table VI) provides the base for analysis of the input-output model. This table presents the dispersion of each sector's output among the purchasing and final demand sectors. Each row entry represents the dollar amount of goods or services sold by the producing sector to the purchasing sector represented by each column. Reading across the first row of Table VI, for example, the livestock and livestock products sector sold 83.5 million dollars worth of goods to farmers within that sector, 117.9 million dollars worth of goods to the agricultural processing firms, 0.5 million dollars worth of goods to the manufacturing firms, 3.4 million dollars worth of goods to the real estate, finance and insurance sector, 0.4 million dollars worth to the service sector, 0.1 million dollars worth to the state and local governments, 17.0 million dollars worth to households and 168.4 million dollars worth of goods were exported from the state.[1] The agricultural processing sector purchased large quantities of raw materials from the livestock producer. The most common ones were slaughter animals, milk products, and eggs. Purchases of hides accounted for the major portion of the sales of livestock products to the manufacturing sector. The real estate, finance and insurance sector purchased a small amount of miscellaneous livestock products. The purchases by the service sector were small and were used mainly for recreational purposes. A small amount was purchased by state and local governments. The value of goods and services purchased by households equaled 17.0 million

[1]These figures were obtained by rounding to the nearest tenth of a million dollars.

TABLE VI

INTERINDUSTRY FLOWS OF GOODS AND SERVICES, OKLAHOMA ECONOMY, 1959

(Thousands of Dollars)

	Lvsk. & Lvsk. Products	Crops	Agric. Proc.	Manf.	Trans., Comm. & Pub. Ut.	Real Est. Fin. & Ins.	Service	Wholesale and Retail	Mining	Construction Maintn.	Construction New	Government Federal	Government State & Local	Household	Export	Total
Livestock and Livestock Products	83,539	-	117,923	520	0	3,372	433	0	0	0	0	-	109	16,979	168,390	391,265
Crops	101,108	18,011	64,790	10,319	340	5,269	866	1,818	0	0	2,885	32,360	-	21,763	90,549	350,078
Agricultural Processing	31,427	-	68,076	2,213	913	193	19,030	5,724	0	0	192	5,663	2,952	330,709	-	467,092
Manufacturing	6,287	38,982	34,377	377,952	42,875	31,470	150,717	89,908	87,138	70,289	183,465	177,051	43,884	584,145	-	1,918,540
Transportation, Communication and Public Utilities	14,261	11,476	19,840	110,309	69,265	8,252	66,879	43,410	36,921	7,840	25,257	55,974	23,335	183,084	3,897	680,000
Real Estate, Finance and Insurance	3,705	9,856	3,473	29,340	9,694	31,260	11,223	20,097	15,281	1,132	5,317	212	16,335	154,959	39,388	351,272
Services	2,620	8,691	17,995	64,037	26,297	14,102	74,412	92,420	85,346	3,205	38,149	36,499	22,663	379,454	-	865,890
Wholesale and Retail	14,747	20,897	17,409	180,438	17,613	12,643	28,688	34,956	42,967	31,915	60,582	84,749	21,006	567,690	-	1,136,300
Mining	101	1,382	374	474,545	18,066	632	433	114	51,234	3,027	7,628	5,293	1,909	2,315	293,577	860,630
Construction																
Maintenance	1,650	2,659	1,205	2,805	25,614	7,824	957	2,630	6,518	0	64	3,322	33,634	127,999	-	216,881
New	3,739	6,024	2,011	27,015	34,955	21,284	2,605	7,155	29,109	0	0	8,139	82,395	365,542	-	589,973
Government																
Federal	837	2,161	10,308	37,510	91,757	31,392	8,055	31,772	14,706	2,600	7,072	6,135	5,213	560,349	-	809,867
State and Local	12,372	16,286	7,426	40,698	35,925	4,965	3,282	24,402	42,296	2,922	7,948	91,950	0	251,536	-	542,008
Households																
Wages and Salaries	11,047	26,953	66,000	330,000	242,000	102,000	230,000	465,000	266,000	42,739	116,261	358,000	258,000	7,000	-	2,521,000
Proprietor Income	94,031	147,968	10,000	35,000	29,000	48,000	157,000	208,000	21,000	17,203	46,797	0	0	15,955	-	829,954
Rent Income	3,458	20,642	1,602	17,884	14,439	13,946	36,903	64,202	120,000	809	2,567	3,000	12,398	189,150	-	501,000
Imports	6,336	18,090	24,283	177,955	21,247	14,668	74,407	44,692	42,114	33,202	85,788	84,655	21,389	318,590	-	967,416
Total	391,265	350,078	467,092	1,918,540	680,000	351,272	865,890	1,136,300	860,630	216,883	589,972	953,002	545,222	4,077,219	595,801	

dollars. Included in this figure was the amount used by the producer himself and the amount purchased for final consumption directly from the farmer by the households. The export column indicated that Oklahoma produces more livestock and livestock products than were demanded in the state. The major share of these exports was cattle and calves, which made up the bulk of the livestock sector. Entries in the table for the remaining sectors can be interpreted similarly. Additional information is given in the Appendix to clarify each entry.

The entries in each column of Table VI represent the input structure of each purchasing or consuming sector. As an illustration, consider column three. The agricultural processing sector purchased 182.7 million dollars worth of goods from the basic agricultural sectors which includes the crop and the livestock and livestock products sectors. Of this amount, 117.9 million dollars worth was for livestock products, while 64.8 million dollars worth was purchased from the crop sector. The main items purchased from the livestock sector were slaughter animals, whereas the crop sector sold mostly wheat and other grains to the agricultural processing sector. The agricultural processing industries purchased 68.9 million dollars worth of goods and services from other industries within the sector. Most of the 34.4 million dollars spent for manufactured products was for packaging materials needed in the operation of the processing industries. The processing sector spent 19.8 million dollars for transportation, communication, and public utilities, whereas their expenses for services from the real estate, finance and insurance sector totaled 3.5 million dollars. The purchases from the other endogenous sectors were: service sector, 18.0 million; retail and wholesale, 17.4 million; and mining, 0.4 million dollars. The agricultural processing sector spent 3.2 million dollars on new and maintenance construction. It also paid 17.7 million dollars in taxes. Workers received 66.0 million dollars in wages and salaries, while the amount of proprietor income and rent paid by the agricultural processing sector totaled 10.0 million dollars and 1.6 million dollars respectively. Materials imported from outside the state totaled 24.3 million dollars. These imports consist mostly of manufactured products. The remaining columns can be interpreted similarly.

Of special interest in Table VI is the export column and the import row. Examining the export column, it is obvious that Oklahoma is a large exporter of agricultural and mining products. These figures were computed by determining the total demand of each sector and the amount of the product for final consumption within the state. The amount produced above these demands was the amount exported. Computed in this way, this figure is the amount of net exports. The amount imported was also a net figure. The excess of demands above that which was produced within the state was imported. (The amount imported by each sector was determined by assuming its share of the total imports was equal to the proportion it used of the total demand in the state.) Therefore, each sector had an import entry, which consisted mainly of manufactured products. In fact, 92 percent of the net imports in Oklahoma were manufactured products.

Technical Coefficients

The technical coefficients in Table VII show the direct purchases of each sector from every other sector per dollar of output. The technical coefficient shows only the first round effects of a change in output of one industry on the industries from which it purchases goods and

TABLE VII

TECHNICAL COEFFICIENTS, OKLAHOMA ECONOMY, 1959

	Lvsk. & Lvsk Products	Crops	Agric. Proc.	Manf.	Trans., Comm. & Pub. Ut.	Real Est., Fin. & Ins.	Service	Whole-sale & Retail	Mining
Livestock and Livestock Products	.21351	.00000	.25246	.00027	.00000	.00960	.00050	.00000	.00000
Crops	.25841	.05145	.13871	.00538	.00050	.01500	.00100	.00160	.00000
Agricultural Processing	.08032	.00000	.14574	.00115	.00134	.00055	.02198	.00504	.00000
Manufacturing	.01607	.11135	.07360	.19700	.06305	.08900	.17416	.07912	.10125
Transportation, Communication, and Public Utilities	.03645	.03278	.04247	.05750	.10186	.02349	.07724	.03820	.04290
Real Estate, Finance and Insurance	.00947	.02815	.00744	.01529	.01426	.08959	.01296	.01769	.01776
Services	.00670	.02483	.03852	.03338	.03867	.04015	.08594	.08134	.09916
Wholesale and Retail	.03769	.05969	.03727	.09405	.02590	.03599	.03313	.03076	.04992
Mining	.00026	.00395	.00080	.24735	.02657	.00180	.00050	.00010	.05953
Construction									
Maintenance	.00422	.00760	.00258	.00146	.03767	.02227	.00111	.00232	.00757
New	.00956	.01721	.00431	.01408	.05140	.06059	.00301	.00630	.03382
Government									
Federal	.00214	.00617	.00207	.01955	.13493	.08937	.00930	.02796	.01709
State and Local	.03162	.04652	.01590	.02121	.05283	.01413	.00379	.02157	.04914
Households									
Wages and Salaries	.02823	.07699	.14130	.17201	.35588	.29037	.26562	.40922	.30910
Proprietor Income	.24033	.42267	.02141	.01824	.04265	.13665	.18130	.18305	.02440
Rent Income	.00883	.05996	.00343	.00932	.02124	.03970	.04262	.05650	.13943
Total	.27739	.55862	.16614	.19957	.41977	.46672	.48954	.64877	.47293
Imports	.01619	.05168	.05199	.09276	.03125	.04175	.08594	.03933	.04893
Total	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000

services. The technical coefficients are relevant only for the processing sectors; therefore, technical coefficients are not computed for the final demand sectors. By considering a particular column, say column four, the technical coefficients can be interpreted as follows. If the manufacturing sector increases its output by one dollar, its purchases from the two agricultural sectors will change very little. However, purchases among manufacturing industries within the sector will increase by 20 cents. To meet this new output, the manufacturing sector will buy 6 cents worth of goods and services from the transportation, communication and public utility sector; 2 cents worth of services from the real estate, finance and insurance sector; 3 cents worth of services from the service sector; 9 cents worth of services from the retail and wholesale sector; and 25 cents worth of goods and services from the mining sector.[2] As expected the manufacturing sector has a large direct effect on the mining sector, because a large part of the manufacturing in the state consists of processing raw products from the mining sector. The one dollar increase in output of the manufacturing sector will cause the exogenous sectors to change as follows: 2 cents will be spent on construction (new and maintenance), 4 cents will be paid to the government (federal, state, and local), 17 cents will be paid for wages and salaries, and 3 cents will be paid for rent and proprietor income.

The technical coefficients are assumed constant over time; thereby assuming no change in technology. If forecasts are desired, new flow tables will have to be constructed regularly or present tables will have

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[2]These figures were obtained by rounding off to the nearest cent the technical coefficient presented in Table VII.

to be adjusted to account for technological changes. An up-to-date technical coefficient table can be used to analyze the direct effects of changes in each sector of the economy.

Interdependence Coefficients

The interdependence coefficients in Table VIII indicate the total change in input requirements as a result of a one dollar change in final demand in a sector. The total change includes the direct effect as well as all indirect effects resulting from the initial one dollar change. For illustration purposes, consider a one dollar change in demand for products of the livestock sector. Column 1 of Table VII shows that this would directly change intra-industry transactions by 21 cents. However, as the livestock industry changes its own output, the amount of purchases from the other sectors will also change. As the amount of purchases from other sectors change, each sector will change its output to meet the new demand. These sectors in turn will change their purchases from every other sector, including the livestock sector. This secondary change on the livestock sector is referred to as the indirect effect. The interdependence coefficients in Table VIII indicate the combined direct and indirect effects. By subtracting the technical coefficients (Table VII) from the interdependence coefficients, the indirect effect is obtained. The indirect effects of the model are shown in Table IX.

An analysis of a change in a sector can be obtained by examining the appropriate columns in the last three tables. For example, a listing of the coefficients for the livestock sector is presented in Table X. From the table, it is obvious that the basic agricultural sectors have the largest direct and indirect effects as a result of the initial increase.

TABLE VIII

INTERDEPENDENCE COEFFICIENTS, OKLAHOMA ECONOMY, 1959

	Lvsk. & Lvsk. Products	Crops	Agric. Proc.	Manf.	Trans., Comm. & Pub. Ut.	Real Est., Fin. & Ins.	Service	Whole-sale & Retail	Mining
Livestock and Livestock Products	1.31225	.00137	.38915	.00292	.00167	.01506	.01112	.00354	.00203
Crops	.37735	1.05689	.28510	.01033	.00284	.02336	.01096	.00553	.00313
Agricultural Processing	.12553	.00243	1.21069	.00604	.00406	.00455	.03109	.00965	.00471
Manufacturing	.12589	.18375	.20920	1.34527	.11909	.15737	.27903	.14221	.19020
Transportation, Communication and Public Utilities	.09202	.06268	.11317	.12106	1.13266	.05143	.12480	.06664	.08237
Real Estate, Finance, and Insurance	.03324	.04038	.03267	.03649	.02298	1.10587	.02640	.02652	.03005
Services	.04799	.05398	.09185	.10927	.06474	.06807	1.12755	.10792	.14061
Wholesale and Retail	.09859	.09090	.11005	.15825	.04855	.06456	.07623	1.05487	.08450
Mining	.03786	.05466	.06068	.35743	.06342	.04511	.07764	.03954	1.11581

TABLE IX

INDIRECT COEFFICIENTS, OKLAHOMA ECONOMY, 1959

	Lvsk. & Lvsk. Products	Crops	Agric. Proc.	Manf.	Trans., Comm. & Pub. Ut.	Real Est., Fin. & Ins.	Service	Whole-sale & Retail	Mining
Livestock and Livestock Products	.09874	.00137	.13669	.00265	.00167	.00546	.01062	.00354	.00203
Crops	.11894	.00544	.14639	.00495	.00234	.00836	.00996	.00393	.00313
Agricultural Processing	.04521	.00243	.06495	.00489	.00272	.00400	.00911	.00461	.00471
Manufacturing	.10982	.07240	.13560	.14827	.05604	.06837	.10497	.06309	.08895
Transportation, Communi-cation, and Public Utilities	.05557	.02990	.07070	.06356	.03080	.02794	.04756	.02844	.03947
Real Estate, Finance, and Insurance	.02377	.01223	.02523	.02120	.00872	.01628	.01344	.00883	.01229
Services	.04129	.02915	.05333	.07589	.02607	.02792	.04161	.02658	.04145
Wholesale and Retail	.06090	.03121	.07278	.06420	.02265	.02857	.04310	.02411	.03458
Mining	.03760	.05071	.05988	.11008	.03685	.04331	.07714	.03744	.06628

The change in demand for livestock products will cause farmers to change their requirements for breeding animals and feeder animals, thus causing the large direct and indirect change in that sector. A change in feed requirements as a result of the change in the livestock sector accounts for the direct and indirect effects of the crop sector. The manufacturing sector has the largest indirect effect of the non-agricultural sectors. The remaining non-agricultural sectors have small indirect effects as a result of the small interaction between these sectors and the livestock sector. If the initial change is an increase in demand, then all signs would be positive, whereas negative effects would result if demand was decreasing. A table indicating the direct, indirect, and total effects could be constructed for each sector. The information is presented in the appropriate columns of Tables VII, VIII, and IX.

TABLE X

EFFECTS OF ONE DOLLAR INCREASE IN LIVESTOCK SECTOR

	Total Effect	Direct Effect	Indirect Effect
Livestock and Livestock Products	1.31	1.21	.10
Crops	.38	.26	.12
Agricultural Products	.13	.08	.05
Manufacturing	.13	.02	.11
Transportation, Communication and Public Utilities	.09	.04	.05
Real Estate, Finance and Insurance	.03	.01	.02
Services	.05	.01	.04
Wholesale and Retail	.10	.04	.06
Mining	.04	.00	.04

The interdependence coefficient table is very useful for those working with the adjustment problem. From this table, the effects of a change in the economy can be determined. Forecasts can be made of the effect of the change on output, income and employment in Oklahoma. These concepts will be discussed in the following chapter.

CHAPTER V

EMPIRICAL PREDICTIVE DEVICES

Analytical measures of changes for the various sectors of the economy are attainable from the input-output model. These input-output multipliers are used to determine what effect a change in demand for goods and services from a particular sector will have on total output, employment and income. The output multiplier indicates how the production of each sector will change as output is changed in any one of the sectors. If employment is changed in a sector, the employment multiplier indicates how this change will effect employment in the rest of the economy. Similarly, the income multiplier measures the effect a change in income in a sector will have on the rest of the economy.

The theory underlying the various multipliers and the empirical results obtained from the Oklahoma model are presented in this chapter. Output, income and employment multipliers will be discussed in this order. How the output of various sectors must change to meet a specified change in demand will also be discussed and illustrated.

Output Multipliers

Output multipliers measure the amount of output generated by a one dollar change in final demand for products of a particular sector. They are computed directly from the interdependence coefficients (Table VIII) by adding down the column for each sector to obtain the output multiplier of that purchasing sector. For example, from Table VIII, by adding down the column for the livestock and livestock products sector, the output multiplier for this sector is 2.25. This indicates that a one dollar change in final demand for livestock and livestock products will cause a change in total output of $2.25. Of this total, $1.31 is generated by interaction among industries within the livestock sector and $0.38 by interaction among industries in the crop sector. These two figures account for a major part of the multiplier.

The output multipliers computed from Table VIII for each sector are listed in column (1) of Table XI. The agricultural processing sector has the largest multiplier. If demand for products in this sector changes by one dollar, there will be a change in output of $2.50. The size of the multiplier indicates the large interaction of this sector with the other sectors, especially the two basic agricultural sectors. From Table VIII, it is seen that a one dollar change in output for agricultural processing products requires a change of $0.39 from the livestock and livestock products sector and $0.29 from the crop sector. Also, a rather large amount is purchased from the manufacturing sector, which is mainly packaging materials. The initial change in the agricultural processing sectors causes a $0.11 change in the activities of the transportation, communication, and public utilities sector, principally because of the movement of the raw materials to the processing plant and then the movement of finished products from the plant to the retailer or wholesaler. The change in the wholesale and retail sector is $0.11 per dollar change in output of the agricultural processing sector. Results of the initial change are relatively small in the remaining three sectors.

TABLE XI

OUTPUT MULTIPLIERS AND LEAKAGE OF THE SECTORS IN THE OKLAHOMA MODEL

	Output Multiplier (1)	Output Multiplier No Input Assumption (2)	Output Multiplier Leakage (3)
Livestock and Livestock Products	2.25	2.44	.19
Crops	1.55	1.77	.22
Agricultural Processing	2.50	2.83	.33
Manufacturing	2.15	2.57	.42
Transportation, Communication and Public Utilities	1.46	1.61	.15
Real Estate, Finance and Insurance	1.54	1.74	.20
Services	1.76	2.12	.36
Retail and Wholesale	1.46	1.64	.18
Mining	1.65	1.89	.24
Economy Multipliers	1.81	2.07	.26

The third largest output multiplier as seen from Table XI is that of the manufacturing sector. A look at Table VIII indicates that the manufacturing sector has a large amount of interaction with industries within the manufacturing sector and with industries in the mining sector. The total effect is \$1.35 from industries within the manufacturing sector, and \$0.36 from industries within the mining sector. Direct and indirect effects of a dollar change in demand for manufactured products on transportation, communication and public utility; service and wholesale and retail sectors are \$0.12, \$0.10 and \$0.16 respectively. The remaining sectors are influenced very little by the increase in demand of manufactured products.

The output multipliers of the crop and mining sectors look somewhat small. However, upon investigation, the interdependence of these sectors with industries within the other sectors is small. There has been underutilization of resources in agriculture, and this is reflected in the interdependence coefficients. With an increase in demand for agricultural products, many resources were used more intensively and the new output requirements were met with little additional increase in the demand for these inputs. This explains why the interdependence between the crop sector and the other sectors is small. Also, for the same reason as explained for the crop sector an increase in demand for mining products will not affect the other sectors to a large extent. The figures in Table VIII indicate that only three sectors will change by a sizeable amount if the demand for mining output is increased by one dollar. These are the manufacturing, service, and mining sectors, which will increase their activities by $0.19, $0.14 and $0.12 respectively.

The interdependence of the other sectors with the processing sectors is not very large, this explains why the output multipliers are small. These sectors are similar in nature and could be called service-type sectors as their activity depends on the activities of the primary sectors (manufacturing, mining, agricultural, and agricultural processing) and of the final demand sectors. Also these sectors are rather labor intensive and purchase less from the primary sectors, thus a smaller output multiplier would be expected.

Assuming that final demand changes in all sectors simultaneously by one dollar, this change in demand would generate a change in output of $16.32. Dividing this total by the amount of the change in demand would indicate that every dollar change in demand would generate on the average a change in output of $1.81. This $1.81 is an average output multiplier of the endogenous sectors, and is referred to as the economy multiplier in Table XI.

An interesting result is obtained by assuming that the Oklahoma economy produces all of the products demanded by the producing and final demand sectors. In other words, no goods and services are imported from outside the state. To compute the multiplier under this assumption, the amount of imports in the import row are distributed among the endogenous sectors in each column. The export column remains in the flow table; however, the figure for each sector is reduced by the amount of imports added to the sector. Again the column and row total are equal for the endogenous sectors.

The sector multipliers computed under this assumption are listed in column (2) of Table XI. Again assume that final demand changes by one dollar in each sector. The total change in output generated throughout the economy would be $18.61. Dividing this by the total demand change will yield an economy output multiplier of $2.07.

The difference between the multipliers in column (1) and (2) can be referred to as the leakage associated with the output multiplier effect. Leakage is defined as the net amount of the change in total output which is obtained outside the state as a result of the one dollar change in final demand in Oklahoma. The leakage effect for each sector is listed in column (3) of Table XI. The manufacturing sector has the largest amount of leakage, since most of the net imports for Oklahoma are manufactured products. The large amount of imports of manufactured products determines to a great extent the magnitude of the remaining leakage figures as all sectors demand large quantities of products from the manufacturing sector. This is verified by the interdependence coefficients listed in the row of the manufacturing sector on Table VIII.

In summary, the two economy multipliers indicate that a one dollar increase in final demand in Oklahoma, will generate $2.07 worth of new output. Of this increased output, $1.81 worth of goods and services will be produced within Oklahoma. This leaves a net leakage for the economy of Oklahoma of ~~$2.06~~ .26, that is, $0.26 worth of goods and services are produced outside the state due to an increase in final demand within the state.

Income Multipliers

The income multiplier measures the total change in income throughout the economy resulting from a one dollar change in income in a sector. The concept of the input-output income multiplier was developed by Hirsch.[1] The underlying basis of the multiplier is that a certain amount of income is generated with each change in output. A direct and indirect effect due to a change is distinguished in arriving at the income multiplier for each sector.

The direct income effect in the amount of each dollar of output which goes to households in the form of income either as wages or salaries, proprietor's income or rent income. The direct effect for each sector is the total of the three household columns and is presented in Table VII. The direct effect is presented in column (1) of Table XII.

The retail and wholesale sector has the largest direct income effect at 0.65 while the agricultural processing sector has the smallest direct

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[1]Warner Z. Hirsch, "Interindustry Relations of a Metropolitan Area," The Review of Economics and Statistics, XLI (November, 1959), pp. 360-369.

TABLE XII

INCOME MULTIPLIERS AND INCOME LEAKAGE WITH HOUSEHOLDS TREATED AS AN EXOGENOUS SECTOR

	Direct Income Effect (1)	Direct & Indirect Income Effect (2)	Indirect Income Effect (3)	Type I Income Multiplier (4)	Type I Income Multi. No Import Assumption (5)	Income Multiplier Leakage (6)
Livestock and Livestock Products	.27739	.78028	.50289	2.81	3.02	.21
Crops	.55862	.78426	.22564	1.40	1.52	.12
Agricultural Processing	.16614	.71792	.55178	4.32	4.92	.60
Manufacturing	.19957	.66911	.46954	3.35	4.01	.66
Transportation, Communication and Public Utilities	.41977	.60586	.18609	1.44	1.56	.12
Real Estate, Finance and Insurance	.46672	.68365	.21693	1.46	1.61	.15
Services	.48954	.77292	.28338	1.58	1.80	.22
Wholesale and Retail	.64877	.83030	.18153	1.28	1.37	.09
Mining	.47293	.74101	.26808	1.57	1.72	.15
			Economy	2.13	2.39	.26

effect at 0.17. The difference among the direct effects of the various sectors is largely the result of the nature of the sector. A labor intensive sector such as the retail and wholesale sector will spend more for wages and salaries than a capital intensive sector like the agricultural processing sector.

Indirect and direct income effects are the total changes in income as a result of the one dollar change in output. This effect is measured by considering how output in each sector changes as a result of an initial one dollar change in final demand and how the output change affects income. For example from Table VIII, it can be seen that a dollar change in final demand for livestock products will change in that output in that sector by \$1.31. Households receive as income \$0.28 of every dollar change in output; therefore, an initial change will cause household income to change by \$0.36. The initial change in final demand for livestock and livestock products of one dollar will cause a direct and indirect output change of \$0.38 in the crop sector. From the direct effect, \$0.56 of every dollar change in output in the crop sector goes to households. Thus household income changes by \$0.21 as the result of the one dollar change in output of the livestock and livestock products sector. Similarly, the change in income as a result of the one dollar change in output in the livestock and livestock products sector can be computed for the remaining sectors. The sum of these income changes will give the total amount of direct and indirect income generated as a result of the initial one dollar change in final demand for that sector. The same procedure is used for each sector to compute the amount of the direct and indirect effects, which are listed in column (2) of Table XII.

The indirect income effect [column (3)] is obtained by subtracting the direct effect from the direct and indirect effect. The retail and wholesale sector has the lowest indirect effect and the agricultural processing sector has the highest indirect effect. The reason is that activity in the agricultural processing sector depends quite heavily on the other sectors in the economy, whereas the wholesale and retail sector has an appreciably less amount of interaction with the other sectors. The activities of the agricultural processing sector depend largely on goods and services from the basic agricultural and manufacturing sectors. The livestock sector shows a large indirect effect mainly as a result of its dependence on the crop sector and on the agricultural processing sector for processed feed.

Income multipliers are listed in column (4). They are computed by dividing the direct and indirect effect by the direct effect (column 2 ÷ column 1). Each multiplier indicates the total amount of income generated by the increase of one dollar of income in that sector. The agricultural processing, manufacturing and livestock sectors have by far the largest income multipliers, as a result of the large indirect effect of these sectors.

The income multipliers listed in column (5) are computed under the assumption that there are no imports in the Oklahoma economy. The difference between these multipliers and those in column (4) is the net leakage associated with the income multiplier. The leakage effect is listed in column (6). Income leakage is defined as the net amount of the new income which is generated outside the state as a result of a one dollar increase in income in Oklahoma. In examining the volumn for leakage, the sectors with the largest indirect effect have the largest amount of income leakage. These sectors also import more products from outside the state than the other sectors.

Again assuming that income in increased by one dollar in each sector simultaneously with imports included in the model, the nine dollar increase in income will generate \$19.21 in income throughout the economy. Dividing this by the change in income yields an income multiplier of 2.13 for the economy of Oklahoma. If the same procedure is used to calculate an income multiplier for the economy under the assumption that Oklahoma produces all of the products used in the state, a dollar increase in income for each sector will yeild \$21.53 worth of income to the economy. The income multiplier for the economy computed as an average of the endogenous sectors is 2.39. The two multipliers indicate that for each dollar increase in income to the economy, \$2.39 of new income is generated. Of this \$2.39 increase in income, \$0.26 of it is generated outside the state of Oklahoma. The economy leakage figure is an average of the leakage effects for the endogenous sectors.

The income multipliers as computed above are considered to be low as they take into account only the direct and indirect changes on the industries in the processing sectors.[2] Therefore, another income multiplier has been proposed which considers the household sector as an endogenous sector. The inclusion of the household sector permits a measure of the reaction of the consumer to a change in income, often referred to as the induced effect.

To estimate the induced effect, the interdependence coefficients must be computed with household as a processing sector. The household row of this new matrix yields the direct, indirect and induced income effects.

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[2]Ibid., p. 364.

These are listed in column (1) of Table XIII. Listed in column (2) are the induced effects which are merely the difference between column (2) of Table XII and column (1) of Table XIII. The induced effects for all sectors are approximately the same. This indicates that the households receiving the income from the various sectors have similar spending habits. The indirect and induced effects computed by adding column (3) of Table XII and column (2) of Table XIII are listed in column (3) of Table XIII.

The income multipliers estimated with the household sector included as an endogenous sector are listed in column (4) of Table XIII. They were computed by dividing the direct effect [column (1), Table XII] into the direct, indirect, and induced effect [column (1), Table XIII]. These multipliers indicate the amount of income generated throughout the economy with each additional one dollar income increase from a particular sector. The income multiplier for the entire economy, including households as an endogenous sector is 3.94.

The question now arises as to which set of the income multipliers is the most relevant when used for predictive purposes. By considering the household sector as endogenous, the assumption of a linear relationship between income and consumption is implied as income increases, consumption will increase by a constant proportion of the change in income. Empirical studies[3] indicate that this relationship generally is not linear; therefore, the resulting multipliers are considered to be on the high side. By considering the household sector as exogenous, no change in consumption by the households is considered; therefore, the corresponding estimates are too small. The actual income multiplier for a sector will be

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[3]Gardner Ackley, Macroeconomic Theory, (New York, 1961), pp. 221-231.

TABLE XIII

INCOME MULTIPLIERS WITH HOUSEHOLDS TREATED AS AN ENDOGENOUS SECTOR

	Induced Direct and Indirect Effects	Induced Effects	Indirect and Induced Effects	Type II Income Multiplier
	(1)	(2)	(3)	(4)
Livestock and Livestock Products	1.43750	.65722	1.16011	5.18
Crops	1.44482	.66056	.88620	2.59
Agricultural Processing	1.32261	.60469	1.15647	7.96
Manufacturing	1.23268	.56357	1.03311	6.18
Transportation, Communication and Public Utilities	1.11615	.51029	.69638	2.66
Real Estate, Finance and Insurance	1.25947	.57582	.79275	2.70
Services	1.42393	.65101	.93439	2.91
Wholesale and Retail	1.52964	.69934	.88087	2.36
Mining	1.36515	.62414	.89222	2.89
Economy				3.94

somewhere in between the two estimates, depending on the consumption pattern of the households in the state.

Employment Multipliers

The employment multiplier as computed from the input-output model is defined as the change in employment due to a one unit change in the labor force of a particular sector. The concept of the input-output employment multiplier was developed by Peterson and Moore.[4] The basic assumption in computing the employment multipliers of Oklahoma is that there is a linear relationship between employment and output in a sector. The relationship does not strictly hold for several sectors as output has been increasing while the number employed has been decreasing. For example, in the more capital intensive sectors, such as the agricultural and manufacturing sectors, new technology has replaced labor. So for these industries the estimated multipliers may be too high. Another condition, particularly relevant in the basic agricultural sectors, is the presence of underemployed resources and unused capacity. Mainly because of this condition, employment multipliers for the agricultural sectors were not computed. The linear assumption holds more nearly for the labor intensive service sectors; therefore, the multipliers are more nearly correct.

The input-output employment multiplier is again related to a change in output. The change in output creates a direct and indirect effect.

The direct employment effect indicates the number of men employed per year per million dollars worth of output. These direct effects are

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[4]Frederick T. Moore and James W. Petersen, "Regional Analysis: An Industry Model of Utah." The Review of Economics and Statistics, XXXVII (November, 1955), pp. 368-381.

listed in column (1) of Table XIV. The direct employment effect of the agricultural processing sector indicatates that 36.40 additional man-years of employment will be needed if final demand for that sector is increased by one million dollars. The service sector has the largest employment per million dollars worth of output. This is because this sector produces personal services requiring large amounts of labor.

The direct and indirect effects are computed by considering the repercussions on employment in all the sectors as a result of the initial change in final demand in a sector. For example, a one million dollar increase in final demand will increase the output within the agricultural processing sector by 1.21 million dollars. This output increase will require 36.40 man-years of employment per million dollars increase in output. As a result of the initial increase in demand, the direct and indirect effect of the manufacturing sector will increase output by 0.21 million dollars. This sector requires 45.86 man-years of employment per million dollars worth of output. The total direct and indirect effect is obtained by summing up the additional man-years of employment needed by each sector as a result of the one million dollar increase in output of a particular sector. Column (2) of Table XIV shows these effects.

Subtracting column (1) from column (2) will yield the indirect effects. Manufacturing has the largest indirect effect, because of the large amount of interaction among industries in this sector and the other sectors. The indirect effects of the agricultural processing, mining and service sectors are somewhat similar.

Column (4) shows the employment multipliers. These multipliers are computed by dividing the direct effect [column (1)] into the direct and indirect effect [column (2)]. Each multiplier indicates the change in

TABLE XIV

EMPLOYMENT MULTIPLIERS AND LEAKAGE OF THE SECTORS IN THE OKLAHOMA MODEL

	Direct Effects (1)	Direct and Indirect Effects (2)	Indirect Effects (3)	Employment Multiplier (4)	Employment Multiplier No Import Assumption (5)	Employment Multiplier Leakage (6)
Livestock and Livestock Products	*	man-years				
Crops	*					
Agricultural Processing	36.402	102.701	66.299	2.821	3.351	.530
Manufacturing	45.859	134.510	88.651	2.933	3.518	.585
Transportation, Communication and Public Utilities	82.353	123.502	41.149	1.450	1.616	.166
Finance, Real Estate, and Insurance	82.621	127.954	45.333	1.549	1.712	.163
Services	202.078	268.470	66.392	1.328	1.439	.111
Wholesale and Retail	145.246	191.185	45.939	1.316	1.396	.080
Mining	40.697	104.258	63.561	2.562	2.936	.374
			Economy	2.000	2.281	.281

* Employment multiplier not computed for sector.

employment generated throughout the Oklahoma economy by the one unit employment change in the sector specified.

The manufacturing sector has the largest multiplier, because of the large amount of interaction of this sector with the other sectors. Also the agricultural processing sector and the mining sector have rather large employment multipliers due also to a large amount of interdependence with other sectors which have a high employment-output ratio.

The employment multipliers listed in column (5) are computed under the assumptions that there are no imports in the Oklahoma economy. These multipliers indicate the total amount of employment change per unit change in employment in Oklahoma. The difference between these multipliers and those listed in column (4) is the amount of leakage associated with each employment multiplier. Employment leakage is defined as the net amount of the employment change taking place outside the state due to a one unit change in employment in Oklahoma. Employment leakage figures [column (6)] indicate that manufacturing has the largest leakage because of the large amount of manufacturing imports. The agricultural processing and mining sectors also have rather large leakage effects. The dependence of the activity of these sectors upon the activity of the manufacturing sector explains the magnitude of the leakage effect.

The employment multiplier for the economy under the assumption of no imports was computed. An economy employment multiplier leakage figure was also calculated. The multipliers indicate that a one unit change in employment in Oklahoma will change total employment by 2.28 units. Of the 2.28 unit change, units employment in Oklahoma will change by 2.00 whereas employment in areas outside of Oklahoma will change by 0.28 units.

Output Requirements for 1964 and 1975 Demand

The input-output model can be used to predict the change of output of each sector necessary to meet a change in final demand. The Oklahoma model was used to estimate output for 1964 and 1975. The actual output for each sector is available for 1964, so the predictions can be tested against the actual data. Also future employment needs for 1964 and 1975 necessary to meet this new output were estimated.

Final demand for the sectors in the Oklahoma model were estimated for 1964 and 1975. Final demand consists of local and export demand. Local demand is determined by economic activity in Oklahoma, whereas export demand is determined by economic activity elsewhere in the United States.

To estimate the final demand for the basic agricultural sectors in the Oklahoma model for 1964 and 1975, the work done by Rogers and Barton[5] was used. Rogers and Barton used population estimates, income trends, and expected consumer taste to arrive at changes in future demand. Most of their emphasis in predicting final demand was placed on changes in population. Their estimated change in demand from 1959 to 1975 for the United States was used to determine export demand. To arrive at the figures, it was assumed that the demand for agricultural exports from Oklahoma would be identical to the predicted change in United States demand for agricultural products. The export demand for the livestock sector computed from this assumption was expected to increase by 45 percent and the crop sector by 25 percent from 1959 to 1975. Local demand

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[5]Robert O. Rogers and Glen T. Barton, Our Farm Production Potential 1967, United States Department of Agriculture, Information Bulletin 233, 1960.

was determined by adjusting the estimated demand for the United States, using population data. United States' population was expected to increase by 23 percent between 1959 and 1975 while Oklahoma's population was expected to increase 17 percent between 1959 and 1975.[6] The national expected change in demand for 1975 was adjusted downward according to the population trend to arrive at the local demand. Local demand was expected to increase by 42.8 percent in the livestock sector and 23.8 percent in the crop sector from 1959 to 1975.

To obtain estimates for 1964, the annual percentage change was calculated for both export and local demand. These annual percents were then used to derive the amount of export and local demand for the crop and livestock sectors. Changes in final demand for the agricultural processing sector were estimated by taking the weighted average of the expected changes in the crop and livestock sector, weighting according to the sector's output. Local demand in the agricultural processing sector was expected to increase by 33 percent from 1959 to 1975 and 10 percent from 1959 to 1964.

The change in demand for the non-agricultural sectors were estimated from income data. Local demand was determined by assuming that demand for products from the non-agricultural sectors would increase at the same rate as personal income has been increasing in Oklahoma. Export demand was assumed to increase at the same rate as personal income has been increasing in the United States. A data source indicated that personal income has been increasing at an annual rate of 4.9 percent in Oklahoma,

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[6]Estimates based on those computed by U. S. Government, published in <u>Current Population Estimates</u>, Series P-25, No. 326 (February 7, 1966), and No. 345 (July 29, 1966).

while personal income in the United States has been increasing annually at about 5.5 percent each year.[7] Thus, local demand in Oklahoma was assumed to expand by 4.5 percent per year and export demand by 5.5 percent annually.

From the estimated percent changes, the amount that local and export demand is expected to change from 1959 to 1964 and from 1959 to 1975 can be computed. These estimates are obtained by multiplying the percentage change in demand times the 1959 demand and adding the results to the 1959 demand. Table XV shows the amount of local and export demand for 1964 and 1975.

The output requirements for a sector necessary to meet the projected final demand was found by multiplying the vector of the total estimated final demand for each sector times the interdependence coefficients for each row. The output requirements for 1964 and 1975 are listed in columns (1) and (2) of Table XVI.

A comparison of the prediction and the actual output for 1964 can be made by comparing columns (1) and (3) of Table XVI. The estimates are similar to the actual values. The difference is rather small as the estimated total output is 2.8 percent greater than the actual output. Some of the variation can be caused by unexpected weather conditions, which cause the actual annual changes to deviate from the estimated changes.

By assuming that a linear relationship between employment and output holds for 1959, 1964, and 1975, an estimate of the change in employment can be computed. Of course, technology will change over time which would

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[7]U.S. Department of Commerce, Survey of Current Business, XXXXV (July, 1965), No. 7, Table I, p. 11.

TABLE XV

PREDICTED DEMAND REQUIREMENTS

	Local Demand		Export Demand		Total Demand	
	1964	1975	1964	1975	1964	1975
	(Thousands of Dollars)					
Livestock and Livestock Products	19,241	24,402	190,617	24,165	209,858	268,567
Crops	62,113	70,576	97,521	113,186	158,634	183,762
Agricultural Processing	373,468	454,272	---	---	373,468	454,272
Manufacturing	1,455,387	2,168,496	---	---	1,455,387	2,168,496
Transportation, Communication, and Public Utilities	375,272	605,164	5,093	8,694	380,365	613,858
Real Estate, Finance, and Insurance	226,005	264,454	51,480	87,875	277,485	452,329
Service	627,321	982,978	---	---	627,321	982,978
Wholesale and Retail	972,746	1,568,649	---	---	972,746	1,568,649
Mining	25,618	41,312	382,705	654,970	408,410	696,282

TABLE XVI

ESTIMATED OUTPUT AND EMPLOYMENT FOR 1964 AND 1975

	Output Needed to Meet Estimated Demand			Estimated Man-Years Employment Needed for New Demand	
	1964	1975	1964 Output	1964	1975
1959	(1)	(2)	(3)	(4)	(5)
	(000)	(000)	(000)		
Livestock and Livestock Products	441,241	561,510	441,214	*	
Crops	389,453	481,409	379,609	*	
Agricultural Processing	521,299	650,776	524,604	18,976	23,690
Manufacturing	2,571,609	3,853,904	2,472,921	117,931	176,736
Transportation, Communication and Public Utilities	869,557	1,353,275	802,400	71,611	111,446
Real Estate, Finance and Insurance	448,891	713,125	470,704	37,088	58,919
Service	1,125,216	1,747,557	1,091,020	227,381	353,143
Wholesale and Retail	1,451,371	2,283,854	1,477,190	210,806	331,721
Mining	1,138,992	1,797,458	1,049,899	46,354	73,151

* Employment estimates not computed for sector.

keep employment from expanding according to the assumed linear relation. Therefore, the employment estimate for each sector in columns (4) and (5) of Table XVI should be adjusted downward to account for changing technology in each sector. The adjustment for technology will vary among sectors. It is expected that new technology will affect the primary and manufacturing sectors more than it will the service-type sectors. From columns (4) and (5) of Table XVI, it can be seen that the service and wholesale and retail sectors have the largest demand for future employment. This is due to two reasons. First, demand is increasing rather rapidly in these sectors, and second, these sectors are labor intensive.

In using the input-output model to predict future output requirements, it must be remembered that the assumption of fixed technical coefficients was used. However, technology is changing; therefore, some restriction must be placed on the length of the predictions. Generally, short-run estimates are reliable, as shown when the 1964 output requirements were predicted within 3.0 percent of the 1964 output. However, predictions made for a longer period of time should be carefully analyzed before conclusions are drawn.

CHAPTER VI

SUMMARY, IMPLICATIONS AND LIMITATIONS

Summary

The general objective of the study was to examine the interdependence of the structure of the economy of Oklahoma, using an input-output model. Secondary data were used to formulate the input-output model for Oklahoma. Economic activity within the state was classified into nine endogenous and seven exogenous sectors. The agricultural producing and mining sectors provide the raw materials for the agricultural processing and manufacturing sectors. The remaining producing sectors consist of service-type industries whose output depends directly on the demands of the agricultural, mining and manufacturing sectors as well as the final demand sectors.

The empirical results are reported in the flow table, technical coefficient table and the interdependence coefficient table. The flow table is the foundation of the model, and the other tables are computed directly from it. The flow table provides a double entry system of accounts, as sales and purchases of each sector are included in the table.

The technical coefficients reveal the direct dependence of each sector on the other sectors. The livestock and livestock products sector has a large direct effect with activities within the basic agricultural sectors, and the crop sector has a relatively large direct effect with the manufacturing sector. Of the industrial sectors, the technical coefficients between the agricultural processing and the basic agricultural sectors are large, while the manufacturing sector has a large direct effect with the mining sector. The technical coefficients also indicate that the service-type sectors depends to a large extent on the manufacturing sector.

The interdependence coefficients measure the total effect of a change in demand for a sector, that is, both the direct and secondary changes. These coefficients indicate that economic activity in the livestock and livestock products sector is highly interdependent with the activity in the basic agricultural sectors, agricultural processing sector and manufacturing sector. Total activity in the crop sector is quite heavily dependent on activity in the manufacturing sector. Of the industrial sectors, the interdependence coefficients between the agricultural processing sector and the agricultural and manufacturing sectors are large, while the manufacturing sector has a large total effect with industries within the manufacturing sector and with the mining sector. The interdependence coefficients for the remaining sectors are large with the manufacturing sector and with industries within their sector.

Implications

Implications from this input-output analysis are best seen by examining the various predictive devices, which were derived from the technical and interdependence coefficient tables. These predictive devices included three multipliers -- output, income, and employment. Also future output and employment needs were forecasted.

Output multipliers measure the change in output in the economy as a result of a one dollar change in output in a sector. The agricultural processing sector output multiplier at 2.50 is the largest. Thus, a change in output in this sector would generate more output throughout the economy of Oklahoma than an identical change in any other sector. The output multiplier of the livestock and livestock products sector of 2.25 is the second largest, while the output multiplier of the manufacturing sector at 2.15 ranks third. The output multiplier was also computed for the economy of Oklahoma and equals 1.81.

The agricultural processing sector also had the largest income multiplier. The multiplier for the agricultural processing sector indicates that a one dollar increase in income in this sector would increase income by 4.32 throughout the economy. The income multiplier for the manufacturing sector at 3.35 is the second largest, while the livestock and livestock products sector income multiplier at 2.81 ranks third. The income multiplier for the economy of Oklahoma is 2.13.

Of the employment multipliers, the manufacturing sector had the largest multiplier of 2.93. This indicates that for each man-year addition to employment in this sector, 2.93 additional man-years of labor will be hired throughout the economy. The employment multiplier for the agricultural processing sector at 2.81 is the second largest, while the employment multiplier for the mining sector at 2.56 ranks third. The economy employment multiplier for Oklahoma is 2.00.

Output, income and employment leakage effects were computed for each sector. Leakage in each case is the net amount of change created outside the state as the result of a one unit change in a sector in Oklahoma. Of the leakage effects associated with the output multipliers, the manufacturing sector had the largest leakage effect at 0.42. The leakage effect of the output multiplier of the agricultural processing sector at 0.33 is the second largest. The greatest income multiplier leakage effects are also for the manufacturing sector and agricultural processing sector and are 0.66 and 0.60 respectively. These two sectors also have the largest employment multiplier leakage effects. The employment multiplier leakage effect for the manufacturing sector is 0.58, while the agricultural processing sector has a leakage effect of 0.53. The large leakage in these two sectors is due to the large amount of imports of manufactured products.

Multipliers and leakage effects reveal that an increase in final demand in the agricultural processing, livestock and livestock products, and manufacturing sectors would generate more economic activity throughout the economy than similar changes in the other sectors. An expansion of economic activity in these sectors would encourage the development of industries which use the resources found in the state. Expanding the economic activity in these sectors would mean; (1) the livestock sector would demand more products from the crop sector, that are produced in the state, (2) the agricultural processing sector would demand more raw materials from the crop and livestock sectors, and (3) the manufacturing sector would process more raw mineral products from the mining sector. If industries were encouraged to develop which depended very little on resources found in the state, then the amount of leakage would be large and less economic activity would be generated within the state.

Predictions for future output requirements were made for 1964 and 1975. The reliability of the model for predictive purposes was checked as the 1964 estimates were compared with the actual output. Over the five year period from 1959 to 1964, the model predicted within three percent of the actual total output. The number of man-years employment to produce the estimated 1964 and 1975 output was also predicted. From these predictions of employment, it is seen that the wholesale and retail sector and service sector are expected to hire the largest number of employees in 1964 and 1975. This fact may be important to those who are responsible for the training of future employees in the state's educational institutions. These leaders of these institutions may desire to strengthen their educational program and expand the educational facilities in the areas where the demand for future employment is the greatest.

Limitations

The limitations of the empirical analysis are primarily the result of the basic assumption of fixed coefficients. First technology is changing; therefore, the technical coefficients will change over time. This means that if an input-output model is to be used for predictive purposes, it must be adjusted for technological changes or reconstructed every four or five years.

Another limitation is that the empirical results apply to the sectors included in the model and cannot be generalized for every specific industry within a sector. This limitation arises because similar industries are aggregated into a sector; therefore, the coefficients which are derived are averages of all the industries within the sector. If an industry is to be analyzed, the coefficients would have to be adjusted to represent the production pattern of that industry. The empirical results are also limited in that they illustrate the average conditions of the economy of Oklahoma and cannot be directly used for county or multi-county analysis. If the model is to be used for a region within the state the coefficients for the state will have to be adjusted to represent the production pattern of the region.

There is a need for additional research in using the input-output model for an inter-regional analysis within a state. Such an analysis would indicate the economic conditions within the region as well as how the economic conditions of the region effect or are affected by the conditions of the other regions in the state. The implementations of an inter-regional model would require a large amount of primary data. The time and cost involved in collecting this data might necessitate developing shortcuts to minimize the data requirement. The answer to the data problem can only come after additional research is done in this area. The usefulness of the inter-regional analysis may outweigh the time and cost involved in collecting data. This too, can only be determined with additional research.

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APPENDIX

METHODS AND SOURCES USED FOR CONSTRUCTION OF THE FLOW TABLE

The Oklahoma model consists of nine endogenous sectors and seven exogenous sectors. Each sector is defined according to the classification used by the Bureau of Labor Statistics [42].[1] Appendix Table I summarizes the classification of the endogenous sectors as used in this study.

General Estimating Procedures

The Oklahoma transaction table is presented in Table VI in the text. Although each of the sectors in this table will be described individually, the sectors are combined into three broad sections for general comment. The availability of data presented some problems. Wherever data were limited, the "best" alternative estimate was used.

The Agricultural Sectors

Information for the basic agricultural sectors (livestock and livestock products and crops) was primarily collected from data published by the United States Department of Agriculture and the Oklahoma Department of Agriculture. Sources [31] and [76] were extremely useful.

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[1] Sources of data used for this study will be referred to in the Appendix by the number which corresponds to the publication as listed in the Bibliography.

APPENDIX TABLE I

Model Sector	Included in Sector
1. Livestock and livestock products	a) Cattle and calves b) Dairy products c) Hogs d) Poultry products e) Sheep and lambs f) Wool g) Other livestock products
2. Crops	a) Wheat b) Cotton lint c) Hay d) Peanuts e) Cottonseed f) Sorghum grain g) Broomcorn h) Oats i) Alfalfa seed j) Corn k) Barley l) Watermelons m) Spinach n) Soybeans o) Rye p) Other q) Fruits and nuts r) Other crop products
3. Agricutlural Processing	a) Meat products b) Dairy products c) Canned and frozen foods d) Grain mill products e) Bakery products f) Sugar g) Candy and related products h) Beverages i) Other food preparations

APPENDIX TABLE I (CONTINUED)

Model Sector	Included in Sector
4. Manufacturing	a) Petroleum refining b) Fabricated metals c) Machinery d) Stone, clay and glass e) Primary metals f) Printing and publishing g) Chemical h) Apparel i) Concrete products j) Paper products k) Lumber products l) Transportation machinery m) Furniture and fixtures n) Miscellaneous
5. Transportation, communication, and public utilities	a) Transportation b) Warehousing c) Communications d) Radio and TV broadcasting e) Electric, gas, and water service
6. Real estate, finance and insurance	a) Finance and insurance b) Real estate and rental
7. Services	a) Hotels and lodging places b) Personal service c) Miscellaneous business services d) Auto repair and services e) Motion pictures f) Amusements, recreation services g) Medical services h) Other professional services
8. Wholesale and retail	a) Lumber, building materials b) General merchandise c) Food stores d) Automotive dealers e) Gasoline service f) Apparel stores g) Furniture, home furnishing and equipment h) Eating and drinking i) Drug stores j) Other (includes liquor, jewelry, fuel and ice dealers)

APPENDIX TABLE I (CONTINUED)

Model Sector	Included in Sector
9. Mining	a) Crude petroleum and natural gas b) Iron and ferroalloy ores mining c) Nonferrows metal ores mining d) Coal mining e) Stone and clay mining f) Chemical and fertilizer mineral mining

These sources list both producers' and purchases' value for each major input to United States agriculture.

Nonagricultural Sectors

The construction of flows from nonagricultural industries to non-agricultural industries presented special estimating difficulties. For most of the industries in Oklahoma, input information was not readily available for any given year. For this reason, it was necessary to use as a starting point the 1958 Bureau of Labor Statistics' input-output coefficients for the United States [76].

The flows were derived by using the individual technical coefficients for the sectors from the 1958 United States table, weighted by Oklahoma industry outputs. The technical coefficients indicate the value of inputs per dollar's worth of output. The multiplication of the State's output by the coefficients yielded the input requirements. From this first approximation of the nonagricultural inputs, the figures in the rows and columns were adjusted to represent more nearly the economy of Oklahoma. Output estimates as well as methods used to check and alter the derived input coefficients are explained later.

Exogenous Sectors

The exogenous sectors were divided into four major sections. They include household, government, construction, and exports and imports. The government and construction sections were each broken down into two subsectors. Government sector consisted of a federal subsector and a state and local subsector, whereas the construction sector was split up into new and maintenance construction. Total outlays of the exogenous sector, in contrast to the endogenous sectors of the economy, need not equal total input. Thus, total expenditures of the exogenous sectors required individual estimation.

Data on the amount of exports and imports by each sector were not available. The estimation procedure is explained in the export and import section of this Appendix. The procedure used to estimate imports reduced some of the reported purchases, thus some figures in the following section of the Appendix will not correspond to those in the Flow Table. This method of adjustment is also explained in the export and import section of this Appendix.

Explanation of Endogenous Sectors

1 and 2. Livestock and Livestock Products Sector and Crop Sector

Agricultural output was defined as the value of all agricultural commodities produced on the farm in 1959, plus the value of government payments, and the rental value received by farmers. The value of livestock and livestock products produced was obtained from [39]. The Agricultural Census [65] provided an estimate of the value of crops harvested. Government payments were reported in [59] and [39], while rental received was reported in [38]. Final estimate of gross output included:

Livestock and livestock products	$380,109,000
Crops produced	323,734,036
Government payments	24,400,000
Farm rental received	13,100,000
Total	$741,343,036

Government payments were allocated to the crop sector, while farm rental received was allocated between the sectors by assuming each sector's share was in the same proportion as output of the crop and livestock sectors was to total agricultural output.

The inputs or column figures in the flow table show the dollar value of agriculture's consumption of the raw materials, semi-finished products, and services bought from the various industries. United States Department of Agriculture and Census publications provided data for most of the agricultural inputs.

Sources [54], [59], [61], and [66] gave estimates of the various agricultural expenditures. Included in these reports was marketing margins or the amount paid to wholesalers and retailers, sales tax charges, and transportation charges. An estimate of the size of the marketing margins was obtained from [31]. The margins found in [31] were supported by more general figures found in [53] and [101]. The expenses of the farmer and the amount of the margin paid is presented as follows:

Commodity	Amount Paid by Farmer	Margin Percent	Margin	Amount Paid to Producer
Fuel	$30,137,979	52	$15,731,675	$ 14,406,304
Fertilizer	9,100,000	20	1,854,777	7,245,223
Machinery	64,633,000	32	20,475,734	44,157,266
Feed	34,649,566	3	910,943	33,738,623
Feed (prepared)	42,591,213	18	7,594,325	34,996,888
Livestock	92,310,870	9	8,771,621	83,539,249
Seeds	8,177,634	18	1,458,132	6,719,502
Total	$281,600,262		$56,797,207	$224,803,055

The purchases less the amount of the margin are the expenses the farmer paid the sectors, whereas the marketing margin was his expenses incurred with the wholesale and retail, transportation, communication, and real estate, and government sectors. Each of these will be discussed separately below.

Source [66] reported $83,539,249 worth of livestock purchased by farmers. Data on feed purchased by farmers were also available in [66]. This figure included the amount paid for commercial feeds as well as feed grains. The commercial feed was purchased by the livestock sector from the agricultural processing sector. Sources [31] and [76] were used to arrive at the amount each purchased. Data in [56] supported the derived estimate. The total amount spent for commercial feeds and feed grains was $168,735,511.

Crops produced on the farm and used on the farm had to be estimated. Data in [39] indicated that $323,734,036 of crops had been produced, $250,613,671 had been sold, therefore, $73,120,165 was the amount used on the farm. Inventory change [39] during the year indicated a reduction of $5,541,000 in value of farm products on the farm. The amount of the harvest used for seed was given in [62]. Also the amount of money spent by farmers in purchasing seeds was reported in [65]. The final allocation of crops used on the farm (whether home grown or purchased) during 1959 was as follows:

	Livestock	Crops	Total
Seed purchased		$ 6,719,502	$ 6,719,502
Seed (home grown)		11,291,643	11,291,643
Fed to livestock (home grown)	$ 67,369,522		67,369,522
Fed to livestock (purchased)	33,738,623		33,738,623
Total	$101,108,145	$18,011,145	$119,119,290

Agricultural inputs from the agricultural processing sector included processed mill products, such as soybean oil meal and cottonseed oil meal. The value was calculated to be $34,996,888 and was charged to the livestock sector. Purchases by farmers from the manufacturing sector totaled $65,808,793 and included fertilizer, fuel and machinery. The fertilizer products were charged aginst the crop sector, whereas fuel and machinery were distributed to both sectors. Data found in [74] gave a percentage of the machinery manufactured which was used for crop production. This percentage (84.69 percent) was supported by coefficients in [31] and [76]. Applying this percentage, the distribution was:

Total machinery and fuel expense	$58,563,570
Crop share	49,597,487
Livestock share	8,966,083

The total amount spent for manufactured products, allocated to the agricultural sectors then became:

	Livestock	Crops	Total
Machinery and fuel	$8,966,083	$49,597,487	$58,563,570
Fertilizer		7,245,223	7,245,223
Total	$8,966,083	$56,842,710	$65,808,793

Expenditures for communication, transportation and public utilities were estimated to equal $25,736,713. The amount paid for transportation determined from the margins equaled $16,726,777. Communication expenditures consisted mainly of telephone services. Average charge for phone service per month was reported in [51]. Percentage of farm families having phones was reported in [52]. These two sources combined to give the annual expenditure for phone service. Rural electrical charges for farmers were reported on a per farm basis in [11]. This estimate plus the average price per kilowatt hour together yielded the final amount spent on electricity. Final expenses allocated to transportation, public utilities, and communication were as follows:

Transportation	$16,726,777
Electricity	5,860,634
Telephone	3,149,302
Total	$25,736,713

This total was allocated between the two sectors by assuming each sector's expenses was in the same proportion as that sector's output was to total agricultural output.

Value of services from the real estate, insurance, and finance sector received by the agricultural sectors were mainly found in [59]. Again [31] and [76] were used to check the results. Interest paid by the agricultural sectors totaled $10,900,000 while $2,660,226 was paid for insurance. Expenditures for services were obtained from [31] and [76]. Of the $11,555,003 estimated as expenditures for services, $3,860,000 was veterinary expenses. The information was obtained from [61].

The wholesale and retail figures were computed by using margins from [31]. The amounts were distributed between the livestock and crop sector as follows:

Products Purchased	Livestock	Crops	Total
Fuel	$ 2,408,519	$13,323,156	$15,731,675
Fertilizer		1,854,777	1,854,777
Machinery	3,134,835	17,340,899	20,475,734
Feed grains	910,943		910,943
Feed (commercial)	7,594,325		7,594,325
Livestock	8,771,621		8,771,621
Seeds		1,458,132	1,458,132
Total	$22,820,243	$33,976,964	$56,797,207

Included in the margin total were taxes and transportation expenses. These expenses had to be subtracted to get the amount of service from retail and wholesale sectors. The results are as follows:

	Livestock	Crops	Total
Margin total	$22,820,243	$33,976,964	$56,797,207
Less transportation	6,720,562	10,006,215	16,726,777
Less taxes	1,322,086	3,032,504	4,354,590
Wholesale and retail share	$14,777,595	$20,938,245	$35,715,840

Information indicating the amount spent by farmers for mining material was not available. Therefore, sources [31] and [76] were used to arrive at an estimate. Both sources had similar estimates.

Money spent on new construction by the farmers in the United States was estimated at $9,762,951. Data for Oklahoma were not available in the form needed; therefore, the percent of United States farmers' expenditure on construction was assumed to hold for Oklahoma. The information was taken from [87]. A check of the estimate, using the coefficient given in [31], indicated a similar result. United States building maintenance and repair data were published in [88]. The same procedure as for new construction was applied to arrive at the Oklahoma estimate of $4,609,367.

Services received by farmers from the government sector were assumed to be equal to taxes paid by the farmer. Federal taxes paid were obtained from [96] and [97]. They included:

Corporation tax	$2,298,375
Social security tax	693,468
Stamp tax	6,200
Total	$2,998,043

State and local taxes were reported in [41], [42], [43], and [78]. They included:

Property tax	$21,600,000
Miscellaneous	608,140
Fuel tax	1,322,436
Sales tax	3,032,154
Corporation	241,066
Other	1,854,185
Total	$28,657,981

Wages and salaries and proprietor income were reported in [75].

3. Agricultural Processing

Output was defined as the value of production of the industries in this sector. Gross output was estimated by adding the value of products shipped and the value of inventory change. Data on value of shipments were obtained from [80] and [83]. Oklahoma's share of inventory change was assumed to be in the same proportion to Oklahoma's shipments as United States' inventory change was to United States' shipments. Gross output was as follows:

Value of shipments	$460,189,399
Value of change in inventory	6,902,841
Total	$467,092,240

Most of the information used to arrive at the input statistics was found in the four volumes of the United States Census of Manufacturing [80], [81], [82], and [83]. Purchases made by the agricultural processing sector included raw products, supplies (consisting mainly of container materials), machinery and equipment, and fuel. Again, the estimates included the marketing margins. Data from [31] and [76] were used to distribute the final amount to the proper sectors. The distribution of purchases made by the agricultural processing sector was as follows:

Commodity	Amount paid by processing industry	Margin Percent	Margin	Amount paid to Producer
Livestock	$129,586,000	9	$11,663,000	$117,923,000
Crops	66,794,000	3	2,004,000	64,790,000
Supplies	55,432,251	18	9,977,805	45,454,446
Machine and Equipment	6,180,000	32	1,978,000	4,202,000
Fuel and Fuel Products	1,657,000	52	862,000	795,000
Total	$259,649,251		$26,484,805	$233,164,446

All purchases by the agricultural processing industry of livestock and livestock products except dairy products were reported in [80]. The amount of dairy products purchased by the processing industry was reported in [39] and [40]. These sources indicated the following distribution:

Cattle	$ 39,069,000
Calves	7,926,000
Sheep and Lambs	6,508,000
Hogs	29,147,000
Poultry	14,986,000
Dairy Products	20,287,000
Total	$117,923,000

Purchases from the crop sector by the processing industry consisted mainly of wheat. Information was obtained from [80] and [39], and purchases were distributed as follows:

Wheat	$41,534,000
Corn	3,380,000
Oats	1,392,000
Barley	531,000
Other[2]	17,953,000
Total	$64,790,000

[2]Includes: peanuts, cottonseed, broomcorn, spinach, soybeans, and rye.

Data were not available on purchases among agricultural processing industries or used by each processing industry. Therefore, the coefficient from [76] was used to arrive at the estimate. This coefficient indicates how much of the sector's dollar goes for interindustry expenditures:

0.1624 x $467,092,240 = $75,855,780.

Information found in [81] and [82] supported this estimate.

Agricultural processing industries purchased $50,451,446 worth of manufactured goods. Data on fuel consumption, and machinery and equipment purchased were obtained from [80]. The amount spent on supplies by processing industries in Oklahoma was not available. Therefore, it was assumed that Oklahoma's cost per dollar's worth of output was proportional to that of the United States. This information was available in [81]. Most of the supplies were in the form of containers, bags, etc. The amount purcahsed from the manufacturing sector consisting of supplies, machinery, and fuel totaled $50,451,446.

The amount paid by the processing industries for transportation, communication, and public utilities was estimated at $19,839,775. Of the total margin as shown at the beginning of this section, $7,799,775 was expenses for transportation services. Public utility expenses were reported in [80]. Expenditures for communication and warehousing had to be estimated from sources [31] and [76]. Final allocation was as follows:

Transportation	$ 7,799,775
Public utilities	2,040,000
Warehousing and communication	10,000,000
Total	$19,839,775

Services received from the insurance, real estate and finance sector was reported in [81], [82], and [83]. The breakdown included:

Insurance	$1,433,000
Rent payments	1,602,000
Finance	2,040,000
Total	$5,075,000

Coefficients from [31] and [76] were used to arrive at the amount spent by the processing industry for services from the service and mining sectors. The amount spent for services from the wholesale and retail sector was derived from the margins discussed previously and equaled $26,484,805.

The amount spent on construction was obtained from [80] and totaled $2,011,000. Maintenance and repair charges were also reported in [80] and equaled $1,205,000. Services received from the government sector were assumed to be equal to taxes paid. Data on taxes were found in [41], [42], [96], and [97]. The composition of federal taxes was:

Corporation taxes	$ 8,526,688
Social security	1,207,826
Stamp	10,900
Vehicle	209,000
Other[3]	354,000
Total	$10,308,414

The state and local taxes paid by the processing sector consisted of:

Corporation tax	$ 894,324
Fuel tax	68,370
Sales tax	1,240,574
Property tax	1,049,000
Other[4]	4,125,950
Total	$7,425,821

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[3]Includes various licenses paid by processing plants.

[4]Includes value of services received such as government owned utilities.

Source [75] indicated that $66,000,000 was paid for wages and salaries by the agricultural processing industry. Proprietor's income amounted to $10,000,000 and was also obtained from [75].

4. Manufacturing Sector

The value of gross output of the manufacturing industries was obtained from sources [81], [82], and [83]. The breakdown of value of shipments of Oklahoma's industries was as follows:

Petroleum refining	$ 635,857,000
Fabricated metals	166,160,000
Machinery	158,942,000
Stone, clay, and glass	155,687,000
Primary metals	80,667,000
Electrical machinery and appliances	66,596,000
Printing and publishing	66,594,000
Chemicals	54,758,000
Apparel	51,813,000
Concrete products	49,688,000
Paper products	31,903,000
Lumber products	30,376,000
Transportation machinery	14,741,000
Furniture and fixtures	13,403,000
Miscellaneous	350,027,000
Total	$1,927,212,000

Oklahoma's inventory change was assumed to be the same proportion to Oklahoma's shipments as United States' inventory change was to United States' shipments. Final gross output was:

Value of shipments	$1,927,212,000
Decrease in inventory	8,672,454
Gross output	$1,918,539,546

Products purchased from the livestock sector by the manufacturing sector consisted mainly of hides used for leather goods. Expenditures for crops were mainly for raw cotton and lumber products. Estimates of these expenditures were obtained from [60].

Expenditures for agricultural processing products, manufacturing products and wholesale and retail services by the manufacturing sector were not readily available. National coefficients from [31] and [76] were used as a starting point, and then data in [80], [81], [82], and [83] were used to check the estimates.

Manufacturing industries spent $110,309,271 for transportation, communication and public utilities. Most of this expense was for transportation of raw materials to the plant. Expenditures for electrical power was available in [81] and totaled $11,228,000.

Real estate, finance, and insurance services received by the manufacturing sector totaled $47,224,000. This information was reported in [81]. The amount paid to the service sector was estimated from [31] and [76]. Value of minerals purchased by the manufacturing sector was obtained from census data. Petroleum refining makes up about 90 percent of the purchases by the manufacturing sector. The exact amount of purchases was as follows:

Crude petroleum	$435,430,000
Stone and clay products	9,886,000
Metals	6,736,000
All other	22,493,000
Total	$474,545,000

The amount spent on construction was obtained from [80] and totaled $27,015,000. Maintenance and repair charges were also reported in [80] and supported by information from [36]. A check on the estimate using data from [88] yielded a very similar estimate.

Taxes paid by the manufacturing industries were reported in [41], [42], [80], [96], and [97]. It was assumed that the value of services received equaled taxes paid. The various taxes paid were:

Federal Taxes Paid

Corporation	$29,325,562
Social security	6,029,953
Stamp tax	54,200
Vehicle tax	948,000
Other taxes	1,152,000
Total	$37,509,715

State and Local Taxes Paid

Property tax	$11,120,000
Other local taxes	14,179,064
State corporation tax	3,075,819
Gross production	518,130
Fuel tax	310,774
Sales and use tax	11,283,100
Other	211,004
Total	$40,697,891

Data on the amount paid by manufacturers for wages and salaries, and proprietor's income were obtained from [75] and [80].

5. Transportation, Communication and Public Utility Sector

Output was assumed to be equal to the value of receipts received by these service industries. Information on receipts for this sector was obtained from [17]. Estimates for inputs from the endogenous sectors were obtained with data from [31] and [76].

The amount spent on construction was obtained from [86] and [87]. Maintenance and repair data were estimated from data found in [88]. Government services received were again assumed to equal taxes paid. Sources [41], [43], [63], [95], [96], and [97] provided the following information. Federal taxes paid by the manufacturing sector consisted of:

Corporation tax	$33,085,250
Social security	4,422,578
Stamp	39,800
Vehicle	53,770,000
Other	439,000
Total	$91,756,628

State and local taxes paid consisted of:

Property tax	$ 1,708,626
Other local tax	1,198,432
Corporation tax	3,470,155
Fuel	17,627,107
Sales and use tax	1,011,498
License	10,897,809
Other	11,153
Total	$35,924,780

Wages and salaries paid by this sector and proprietor income was obtained from [75].

6. Real Estate, Finance and Insurance Sector

Output was the value of receipts received for services provided by this sector. Output had to be estimated as no source yielded the data directly. The estimate was obtained by assuming that the ratio between output in Oklahoma and the United States for this sector was the same as employment between Oklahoma and the United States for the real estate, finance and insurance industries. Employment statistics were obtained from [93] and [94]. Oklahoma's employment was 9.64 percent of the total employment in this sector. Using this percentage to derive an output figure yielded an estimate of $852,272,240.

Again as in the transportation, communication and public utilities sector, the inputs from the endogenous sectors had to be estimated from [76]. Expenditures for construction, maintenance and repair were obtained from [86], [87], and [88]. Tax data were taken from [41], [43], [63], [95], [96], and [97]. Federal taxes paid consisted of:

Corporation	$29,098,563
Social security	1,864,555
Stamp	16,800
Vehicle	190,000
Other	222,000
Total	$31,391,918

State and local taxes paid by this sector consisted of:

Property tax	$ 977,321
Other tax	665,796
Corporation tax	3,052,010
Fuel tax	62,155
Sales and use tax	166,428
License	37,230
Other tax	3,892
Total	$4,964,832

Information relating the amount of wages and salaries paid, and the amount of income received by proprietors was obtained from [75].

7. Service Sector

Output was the amount paid to the industries in this sector for services performed. Gross output for some of the services was listed in [69] and [70]. In addition to these data, medical and professional expenditures had to be estimated. The most accurate output estimate was derived using the employment ratio. This procedure yielded an output estimate of $865,889,280. This estimate was substantiated by the data found in [17], [69], and [70].

Input data were again limited, therefore, coefficients from [76] were used to arrive at estimates of purchases from the endogenous sectors. These estimates were adjusted to represent the Oklahoma economy as much as was possible.

Again, as in the previous sector, construction data were obtained from [86], [87], and [88]. Sources [41], [42], [43], [95], [96], and [97] yielded tax data, and [75] yielded income, wage and salary data.

8. Wholesale and Retail Sector

Output was the value of the services performed in handling goods. When a housewife purchases meat, this was considered a direct purchase to the meat processing sector. The price added to the producer's price (above transportation cost) was considered to be the portion of services allocated to the wholesale and retail sector.

Current marketing and transportation margins were not available for many of the sectors included in the model. Where current margins were avilable, they were not in detail as to the classification used in this model. Output was estimated from employment data. Again, output of the Oklahoma retail and wholesale sector was assumed to be in direct proportion to that of Oklahoma's employment to United States employment in that sector. The ratio of Oklahoma employment to United States employment times the output of the wholesale and retail sector for the United States yielded the following amount of output for Oklahoma.

$$0.1193 \times \$95{,}250{,}000{,}000 = \$1{,}136{,}300{,}000.$$

Employment data were obtained from [69] and [70] while United States output data were obtained from [97].

Input statistics were estimated for this sector the same as they were estimated for the previous sector. The same sources were used to obtain information on construction, government, wages and salaries and proprietor's income.

9. Mining Sector

Output of the mining sector was defined as the value of receipts plus the value of minerals used in the mining industry. Data on value of production were available in [84] and [89]. Most of Oklahoma's mineral production consisted of the extraction of oil and gas. The exact breakup was:

Oil and gas	$830,280,000
Metal mining	4,272,000
Coal	11,327,000
Non-metal	18,227,000
Total	$864,106,000
Mining processing included in manufacturing	- 3,476,000
Value of output	$860,630,000

Purchases of the mining sector from the livestock, crop and agricultural processing sectors were found to be zero from coefficients found in [31] and [76]. Expenditures for manufacturing includes fuel, supplies, and machinery. These statistics were found in [84] and [85] and were as follows:

Machinery	$ 60,422,000
Supplies	116,622,000
Fuel	12,062,000
Total	$189,106,000

Again this value included market margins. Data from [76] were used to separate out marketing margins from the amount paid. The result was as follows:

Total amount paid	$189,106,000
Less taxes	3,707,961
Less transportation services	15,017,241
Less retail and wholesale services	43,055,228
Amount paid to manufacturers	$127,325,570

Coefficients from [76] were used to arrive at the estimate of expenditures for transportation, communication and public utilities. Transportation of oil accounts for the largest portion of this expense. Data in [84] and [85] reported the expenditures for electrical power and transportation. The value of services received from the real estate, finance and insurance sector was estimated from data in [84] and [85]. The largest proportion of this expense was for oil rights. The amount spent by the mining sector for services totaled $87,363,634. The majority of this expense was for research and development of oil wells.

Mining industries received $50,538,000 worth of minerals from other industries in the sector. These minerals were received for additional processing or for distribution. Also, the mining industry used $695,970 worth of its own production. Total amount of material used and obtained for additional processing was as follows:

Minerals received for preparation	$50,538,000
Minerals used (own production)	695,970
Total	$51,233,970

Construction expenditures were reported in [84], while maintenance and repair construction data were obtained from [85]. Data obtained on taxes paid were obtained from [41], [42], [96], and [97]. The amount of federal taxes paid by the mining sector was as follows:

Federal income and corporation tax	$ 8,923,936
Social security	4,858,866
Stamp	44,700
Vehicle	398,000
Other	481,000
Total	$14,706,502

State and local taxes paid consisted of:

Property	$ 3,818,430
Other local taxes	1,731,069
State corporate taxes	935,989
Sales	2,299,002
Gross production	31,882,173
Other	1,629,484
Total	$42,296,147

Sources [75], [84], and [85] yielded data on wages and salaries paid by the mining industry and also on the income received by the owner.

Explanation of the Exogenous Sectors

1 and 2. Construction

Construction was defined as the design, erection, maintenance and repair of immobile structures and utilities together with those service facilities which become an integral part of the structure. Construction activity for the Oklahoma model was divided into new construction and maintenance construction.

Total output was estimated as follows: The value of total construction for Oklahoma was estimated in [36]. No state data for the value of maintenance construction activity were available. Therefore, Oklahoma's ratio of total maintenance and repair to total construction was assumed to be the same as that for the United States. The ratio of 26.27 percent was obtained from [86]. Data in [86] also indicated that in the

South, building permit activity for additions, alterations, and repairs was 9.81 percent of total building permit activity as compared to 9.59 for the United States as a whole. These percentages were used to adjust the United States percentage so as to represent Oklahoma's amount spent on maintenance and repair. The adjustment was computed as follows:

$$\frac{26.27}{9.59} : \frac{x}{9.81} ; \quad X = 26.88 \text{ percent.}$$

Using this percentage, total construction was allocated to the two sectors.

Maintenance and repair	$216,882,893
Construction (new)	589,973,107
Total construction	$806,856,000

Inputs were estimated using the technical coefficients from the national input-output table as reported in [76]. These estimates were then adjusted upward by a constant percent so that the sum of the inputs equaled the total output estimate. This procedure is similar to that used in input-output studies for California [28], [29], and Utah [33].

3. Federal Government

Total receipts collected in Oklahoma were used as a measure of the gross output of the federal government sector. Data were available from [95], [96], and [97].

Total output by government, in contrast to the endogenous sectors of the economy, need not equal total input. Therefore, total expenditures required individual estimation. Data were not available on the amount of federal expenditures in Oklahoma. A study done by Mashkin [30] indicated that benefits were 17.74 percent above collections. Therefore, federal expenditures were assumed to be 117.74 percent of federal tax receipts in Oklahoma. Estimate of federal government expenditures in the United States was presented in [76]. However, the distribution of purchases by the federal government was undoubtedly different in each state. Therefore, purchases were determined by assuming purchases in Oklahoma were directly proportional to federal employment in Oklahoma. Employment data were obtained from [92].

4. State and Local Governments

This sector included state, county, municipal, special districts and school districts. Output was defined as the services rendered by the component government units as measured by their total receipts. State receipts were obtained from [42] while local data were obtained from [78].

Again, expenditures were estimated individually as output does not have to equal input. Sources used were [42], [63], and [78]. The amount spent on construction was reported in [78]. Information in [88] indicated the amount allocated to maintenance and repair. Governmental expenditures were reported in [88], while wages and salaries paid by the state and local governments were reported in [75]. Expenditures by state and local governments for transportation, communication, and public utilities were reported in [75]. Also, the amount spent for real estate, finance and insurance was reported in [75]. The remaining inputs had to be estimated from the national study [76].

5. Households

Expenditures for goods and services by individuals appear as purchases by the household sector. Household income or output included wages, salaries, proprietor's income, and property income. Household expenditures were mainly taken from three publications. These studies [90], [91], and [92] gave per family expenditures for rural, non-rural, and urban families in the Southern region.[5] Estimates of expenditures by state were not available so the regional per family expenditures figures were used. These estimates were checked with those used in [76].

Expenditures for current consumption totaled $3,580,042,266. This figure was arrived at by obtaining per family figures from [90], [91], and [92] and expanding these to state totals with the use of population estimates in [73]. The amount spent by households for capital goods totaled $497,178,162. This was obtained by similar methods as above. Goods purchased through wholesalers and retailers totaled $1,543,497,900. This was distributed to the proper sectors by using margins from [30]. Final allocation was as follows:

Livestock products	$ 16,978,477
Crops	21,763,320
Agricultural processing	368,432,949
Manufacturing	472,310,357
Transportation	166,080,374
Wholesale and retail	495,617,176
Mining	2,315,247
Total	$1,543,497,900

[5]The Southern region includes the following states: Oklahoma, Texas, Arkansas, Louisiana, Kentucky, Tennessee, Mississippi, Alabama, West Virginia, Maryland, Delaware, Virginia, North Carolina, South Carolina, Georgia, and Florida.

The distribution of the $497,178,162 spent on capital goods was determined using coefficients from [76] and is shown below:

Manufacturing	$383,324,363
Transportation, communication and public utilities	17,003,493
Real estate, finance and insurance	23,615,963
Wholesale and retail	73,234,343
Total	$497,178,162

Combining the above estimates, one gets the total consumer expenses for the manufacturing and wholesale and retail sectors as follows:

Manufacturing	$855,634,720
Wholesale and retail	568,851,519

Expenditures by households for transportation, communication and public utilities were obtained from [92]. The total is allocated among the sectors as follows:

Public utilities	$ 64,098,750
Transportation	86,166,557
Communication	32,818,560
Total	$183,083,867

Information on expenditures for finance, real estate and insurance was located in [92]. The total spent was $154,959,000. Household's expenditures for services were reported in [92]. Service expenditures include:

Hotels, motels, etc.	$ 25,639,500
Laundry and services	49,227,840
Auto services	12,306,960
Medical services	154,349,790
Personal services	72,303,390
Amusements	73,841,760
Total	$387,669,240

Construction information was taken from [86] and [87]. All construction totaled $493,540,877; of this $127,998,935 was designated as maintenance and repair construction. Maintenance estimates were made from data given in [88]. Households paid over 810 million dollars in taxes. This data were obtained from [41], [42], [43], [95], [96], and [97]. Federal taxes paid included:

Personal income tax	$363,000,000
Federal gas tax	132,187,000
Social security tax	45,925,000
Other	19,236,799
Total	$560,348,799

State and local taxes paid included:

Property tax	$ 51,293,000
Fuel tax	43,334,342
Income tax	17,219,671
Auto license	21,881,272
Sales tax	28,830,272
Miscellaneous tax	37,862,990
Total	$251,536,339

6 and 7. Exports and Imports

Figures for the export and import sectors were computed as a residual. These residuals were estimated as follows: A flow table was completed using the entries discussed in the endogenous section of the Appendix. The row entries were summed to show the demand for the product. This sum was then subtracted from the estimate of gross output. A positive figure indicated a surplus, whereas a negative figure indicated a shortage. Surplus figures were assumed to make up exports, while shortages indicated imported products. The export and import figures computed in this way show the value of net exports and imports only.

The net import figures were distributed to the various sectors by assuming each sector's amount of imports was equal to the percentage it required of the total demand for products of that sector. The amount of imports for each sector was subtracted from the amount the purchasing sector bought of products from that producing sector. For example, consider the livestock and livestock products sector. This sector had imports from the agricultural processing, manufacturing, service and wholesale and retail sectors. The total amount of imports of products from these sectors for Oklahoma was as follows:

Agricultural processing	$ 53,282,000
Manufacturing	893,050,000
Services	18,757,000
Wholesale and retail	2,324,000
Total	$957,413,000

The livestock and livestock products sector required the following percents of the total state demand for the above sectors:

Agricultural processing	6.7
Manufacturing	0.3
Services	0.3
Wholesale and retail	1.3

These were computed by considering how much of the total demand for the state was demanded by the livestock sector for production of its output from these sectors. For example, the livestock and livestock products sector demanded $34,996,888 worth of goods and services from the agricultural processing sector. This was 6.7 percent of the total state demand, which was $520,375,116, for agricultural processing products.

Multiplying these percents times the total amount imported yields the amount imported by the livestock and livestock products sector. The multiplication gave the following results:

Agricultural processing	$3,570,000
Manufacturing	2,679,000
Services	56,000
Wholesale and retail	30,000
Total	$6,336,000

The amount imported had to be subtracted from the amount the livestock and livestock products sector purchased (as given in the endogenous section of the Appendix) from these sectors. This was as follows:

	Amount Purchased	Minus Imports	Amount purchased within state
Agricultural processing	$34,997,000	$3,570,000	$31,427,000
Manufacturing	8,966,000	2,679,000	6,287,000
Service	2,676,000	56,000	2,620,000
Wholesale and retail	14,777,000	30,000	13,747,000

The input figures in the original table adjusted for imports were the amounts reported in the flow table (Table VI in the text).

VITA

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