A SOCIAL ACCOUNTING SYSTEM AND SIMULATION MODEL PROJECTING ECONOMIC VARIABLES AND ANALYZING THE STRUCTURE OF THE OKLAHOMA ECONOMY

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PREFACE

The study consisted of developing a social accounting system and simulation model to project economic variables and analyze the Oklahoma economy. The social accounting system included a capital account, an interindustry account, and a human resource account. The simulation model was a recursive equation model containing over 300 equations. Income, employment, gross product, and taxes were the economic variables projected. Also, the effect of a million dollar capital investment in each sector was determined.

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CHAPTER I

INTRODUCTION

Need for the Study

Economic projections and planning are especially needed at the state level. Planners in industry, government, and agriculture seek research which will guide and evaluate their programs. Industrial leaders desire to know the future level of economic activity so that they can plan their investments accordingly. Government leaders need information which will help them evaluate the effects of various governmental decisions. Agricultural leaders need to know the impact of rural legislation on their operations and their rural communities. Research is needed to evaluate development strategies and provide a basis for regional plans. The need for planning is indeed clear and attention is now turned to the reasons for using the state as a decision making unit.

Richard S. Herman [30] gives four reasons why states are being pressured and need economic development plans.[1] First, state government leaders are faced with changing economic and social problems. Recent shifts in population have led to these problems in rural and urban areas. Migration from rural areas has resulted in a smaller base

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[1]Numerals appearing in [ ] refer to bibliography references in the dissertation.

from which the remaining social and economic activities must be supported. Metropolitan areas receiving the increased population must rapidly expand their educational and other public services to meet the increased needs. Second, state governments must have a long-range planning program to qualify for federal assistance. Some examples of programs which require state planning are the Community Mental Health Facilities Act, the Economic Opportunity Act, and the Area Redevelopment Act. Third, state governments are being forced into planning by local governments which need to anticipate state actions over a planning period. A city or county often finds its road building program upset as a result of a state decision to buy land for a recreational area, or for some other state purpose which the local jurisdiction was unable to anticipate. Four, development is not confined to state boundaries and hence, officials are becoming increasingly aware of the importance of co-ordinated state programs.

The Oklahoma Economy

Oklahoma's economic activity ranges from individually operated farms to large firms located in or near the urban centers of Oklahoma City and Tulsa. Presently, median personal income in Oklahoma is below the national average and the rate of unemployment is high, particularly in certain areas designated as "redevelopment" areas of the state. These economic conditions are associated with shifts in population, which in turn indicate changes in economic activity. Rural population has declined and continues to decline, whereas urban areas have increased and continue to increase in population. This shifting in population is resulting in adjustment problems for rural and urban areas alike. Rural areas have to provide public and private services with a declining economic base, while urban areas require increasing amounts of housing, transportation facilities, and other public facilities including schools, parks, and water and sewerage systems.

These conditions clearly exemplify the changes occurring in the economy of Oklahoma. Thus, they add support to the need for regional economic research which evaluates development strategies and provides data for a regional economic plan. Herman's first reason for a regional plan is clearly visible in the changing economic structure of Oklahoma. The second criteria in support of having a regional plan was to qualify for federal assistance. As of July 1, 1968, Oklahoma had 23 counties which qualified as redevelopment areas under the Public Works and Economic Development Act of 1965.[2] Local governments as well as multi-county development agencies in Oklahoma are pressuring state officials to construct economic development plans. The pressure exerted by local governments for state plans exemplifies the third criteria as presented by Herman. The fourth reason for support of a state economic plan was for joint state economic ventures. Oklahoma has a clear example of this as part of the Ozark Regional Commission.[3] The state economic plan should be consistent with the multi-state plan of Oklahoma, Missouri, and Arkansas as the economic plight of the Ozarks does not stop with state boundaries.

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[2]See _The Public Works and Economic Development Act of 1965_, Senate Report No. 193, 89th Congress, May 14, 1965, for qualification and benefits of redevelopment areas.

[3]Ibid, pp. 22-23.

Previous research completed for Oklahoma which aids in evaluating strategies and developing economic plans is scarce. Charles H. Little analyzed the economic and social changes which occurred in Oklahoma from 1950 to 1960.[4] The study was conducted to determine differences in growth rates in Oklahoma in order to plan for economic development. Two input-output studies were completed which measured the interrelationships of industry sectors of the Oklahoma economy. These included: an analysis of the state economy, and an analysis of three districts within the state.[5] Another study was completed by Larken Warner which used shift-share analysis.[6] The purpose was to provide a frame of reference for viewing selected aspects of recent economic growth in Oklahoma.

These recent studies were extremely helpful, but do not provide projections for economic planning. Again, the need for a dynamic analysis which will provide economic projections and evaluate various development strategies is exemplified.

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[4]Charles H. Little, Economic Changes in Oklahoma, Oklahoma State University Experiment Bulletin No. B-652, January, 1967.

[5]Charles H. Little and Gerald A. Doekson, An Input-Output Analysis of Oklahoma's Economy, Oklahoma State University Experiment Station Bulletin T-124, February, 1968 and An Analysis of the Structure of Oklahoma's Economy by Districts, Oklahoma State University Experiment Station Bulletin B-660, May, 1969.

[6]Larkin Warner, The Oklahoma Economy: Sources of Recent Growth, College of Business Extension Service, Business Paper No. 8, Oklahoma State University, September, 1969.

The Objectives of This Study

In general, the overall objectives of this study were to develop a social accounting system for Oklahoma and to utilize this information in developing an economic model for purposes of evaluating development strategies. More specifically, the primary and secondary objectives are listed below:

1. To develop social accounts for Oklahoma which include:
    - A. A current transaction account;
    - B. A capital account; and
    - C. A human resource account.
2. To develop a simulation model applicable to Oklahoma which will
    - A. Project output, employment, income, revenue, and other state economic variables to 1980;
    - B. Provide estimates of structural parameters such as short, intermediate, and long-run income and employment multipliers by industry sector; and
    - C. Provide a prototype analysis of the impact of alternative strategies for state economic development.

The accounts will provide the data for the simulation model which in turn will be used to evaluate various development strategies of value to industrial, governmental and agricultural planners.

The Organization of the Study

Social accounting systems (income and product accounts, input-output analysis, flow-of-funds, national balance sheets, and balance of payments) are reviewed in the following chapter. In Chapter III, the social accounting systems are synthesized and the Oklahoma social accounting system is presented and critiqued. The Oklahoma social account include: an interindustry account (Chapter IV), a capital account (Chapter V), and a human resource account (Chapter VI). The simulation model is developed and presented in Chapter VII. Two analytical chapters follow. Economic projections (income, employment, gross product, taxes, etc.) are presented and discussed in Chapter VIII, whereas an economic impact approach (income and employment multipliers and cost per job created or million dollars generated) is presented and analyzed in Chapter IX. Summary, conclusions, and implications are contained in Chapter X.

CHAPTER II

SOCIAL ACCOUNTING SYSTEMS

Recent interest in regional economic analysis has led to the application of social accounts to regions, states, and districts within states. The main accounting systems adapted to regions have been income and product, input-output, and flow-of-funds. The income and product accounts measure income, final product, consumption and capital accumulation. The input-output account measures the process and movement of commodities, while the flow-of-funds account shows how consumption, production, and investment are financed. Developed as sub-accounts to the three main accounts have been the national balance sheet and the balance of payments account.

Income and Product Accounts

Composition and Derivation

Income and product accounts for the United States were officially initiated in the 1930's [68]. Since then, the National Income Division of the Office of Business Economics in the U. S. Department of Commerce each year prepares a national income and product account. The income and product accounts for the United States for 1963 are presented in Table I (the accounts are presented for 1963 to provide a comparison with the 1963 input-output table presented in the next section). National income and product accounts are useful for solving national

TABLE I

NATIONAL INCOME AND PRODUCT ACCOUNTS, 1963

I. National Income and Product Account, 1963
(Billions of Dollars)

1.	Compensation of employees	340.3	12.	Personal consumption expenditures	375.0
2.	Proprietors' income	50.6	13.	Gross private domestic investment	82.0
3.	Rental income of persons	12.3	14.	Net exports of goods and services	4.4
4.	Corporate profits and inventory adjustment	50.8	15.	Government purchases of goods and services	122.6
5.	Net interest	24.4			
6.	National income	478.5			
7.	Business transfer payments	2.4			
8.	Indirect business tax and nontax liability	55.9			
9.	Current surplus of government enterprise	-1.0			
10.	Capital consumption allowances	50.8			
11.	Statistical discrepancy	-2.7			
	Gross National Product	583.9		Gross National Product	583.9

II. Personal Income and Outlay Account, 1963
(Billions of Dollars)

1.	Personal tax and nontax payments	61.6	4.	Wage and salary adjustment	312.1
2.	Personal consumption expenditures	375.0	5.	Other labor income	13.1
3.	Personal savings	27.5	6.	Proprietors' income	50.6
			7.	Rental income of persons	12.3
			8.	Dividends	18.0
			9.	Personal interest income	32.9
			10.	Transfer payments	36.7

TABLE I (Continued)

			11.	Less personal contribution to social insurance	11.8
	Personal Income	464.1		Personal Income	464.1

III. Government Receipts and Expenditures Account, 1963
(Billions of Dollars)

1.	Purchase of goods and services	122.6	6.	Personal tax and nontax receipts	61.6
2.	Transfer payments	35.9	7.	Corporate profit tax accruals	24.6
3.	Net interest paid	8.6	8.	Indirect business tax and nontax accruals	55.9
4.	Subsidies less current surplus of government enterprises	1.0	9.	Contributions for social insurance	26.9
5.	Surplus of deficit on income	.9			
	Government Expenditures and Surplus	168.9		Government Receipts	168.9

IV. Foreign Transaction Account, 1963
(Billions of Dollars)

1.	Exports of goods and services	30.7	2.	Imports of goods and services	26.3
			3.	Transfer payments from U. S. government	1.6
			4.	Net foreign investment	2.8
	Receipts from Abroad	30.7		Payments to Abroad	30.7

V. Gross Saving and Investment Account, 1963
(Billions of Dollars)

1.	Gross private domestic investment	82.0	3.	Personal saving	27.5
2.	Net foreign investment	2.8	4.	Excess of wage accruals over disbursements	.0
			5.	Undistributed corporate profits	8.7

TABLE I (Continued)

		6. Corporate inventory valuation adjustment	.4
		7. Capital consumption allowances	50.8
		8. Government surplus or deficit	.9
		9. Statistical discrepancy	-2.7
Gross Investment	84.8	Gross Savings and Statistical Discrepancy	84.8

Source: Adopted from *Survey of Current Business*, July, 1964.

problems. Sam Rosen [68, p. 40] illustrates how the accounts can be used to tell at a glance with some degree of confidence which of the components on the product side is primarily responsible for a recession in economic activity. On the income side, he states that a rapid growth in retained corporate profits may indicate a reliance on internal sources for financing business expansion.

The income and product accounts can be constructed by using firms income statements. For this procedure the income statement is modified and a production statement is constructed. This modification consists of changing the income statement from a sales basis to a picture of production by allowing for inventory changes. The next step is to convert the production statement into an income and product account. This is accomplished by eliminating purchases from other firms. Thus, what remains is the firm's contribution to current production or value added. The final step in constructing a national income and product account is the aggregation of all individual firms. Also, included in this aggregation are the activities of non-business productive units. The aggregation process is such that double counting is eliminated.

The income and product accounts provide a vast amount of information concerning production, income, consumption and capital accumulation. The national account is presented in five separate accounts (Table I). These include: a national income and product account, personal income and outlay account, government receipts and expenditure account, foreign transaction account and a gross saving and investment account.

The National Income and Product Account. This account includes transactions which deal with the disposition of goods and services produced with reimbursement to the owners of the primary inputs for the value of the services rendered. Transactions included in the production account in addition to the usual business transactions are current transactions of government enterprises, owner-occupied homes, and non-profit institutions serving private business. All of these transactions have the common characteristics of goods and services either being sold at their market price or having a market value imputed for the goods and services. The account indicates the source of the sale in one column and how the producing sector spent its money in the other column. The source of sales is from consumers, government, capital accounts, and exports; while the main expenditures include employee compensation, income, interest, taxes, and capital consumption allowances.

Personal Income and Outlay Account. Transactions included in this account include income payments to households as well as expenditures on goods and services. Personal income is the sum of the sources in the consumption account and these sources make up one column of the account. Personal income includes such things as wages and salaries, rental income, dividends, personal interest, and governmental transfer payments. The expenditures of households makes up the other column of the consumption account. The main headings in this column include personal outlays, personal taxes, and personal savings.

Government Receipts and Expenditures Account

The Government account includes transactions of both income payments and expenditures for goods and services. Sources of government receipts include personal tax receipts, corporate profit taxes, indirect business taxes, and contributions for social insurance.

Expenditures by government include purchases of goods and services (such things as wages for personnel, office supplies, etc.), transfer payments, and interest payments.

Foreign Transaction Account. Referred to as the foreign transaction account in Table I, this account includes transactions which contribute to the balance of payments position of a country. The sources of this account include imports of goods and services, transfer payments, and net foreign investment; whereas the uses or allocations include the value of exports and services.

Gross Savings and Investment Account. This account represents the accumulation and disposition of savings. Essentially the sources consist of business, personnel, and government savings. Business savings is made up of capital consumption allowances and retained corporate earnings. Uses or expenditures of gross savings mainly include business purchases of plant and equipment. Also included are changes in inventories and net foreign investment.

Regional Applications of Income and Product Accounts

Regional income and product accounts generally are said to have initiated with the work of Richard B. Andrews [3, pp. 128-129]. Actually, his work was centered around economic base studies, but he looked at these studies in a different way than researchers before him. He considered the economic base techniques as a vehicle for describing and analyzing a region's economic structure, and the process of regional growth itself. Charles L. Leven criticized Andrew's work for its lack of precision [45]. His argument was that income, employment, and production were all functionally related, thus the appropriate measure was "value added." Others supported this and claimed that the value added concept or gross product concept lent itself readily to the making of allowances for charges against a region's trade balance as well as the credits to it [56]. The allowance for a region's trade led to the "rest of world" account and eventually to the double entry income and product accounts for a regional economy.

Until recently, very few regional accounts have been constructed because of the vast data problems. Despite these problems, Walter Isard reports several studies completed on a regional level [35, p. 90]. Also an income and product account has been developed for Iowa for 1954 [5].

Current Transaction Account

Historical Development[1]

Historically, interdependent analysis had its beginning with Francois Quesnay in his Tableau Economique published in 1758. Quesnay's original tableau stressed the interdependence of economic activities in the operation of a single firm [54]. Later Quesnay published a modified version of the tableau which represented the entire economy of France in the form of circular flows.

Approximately 100 years later, Leon Walras 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

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[1]For a more detailed discussion of the historical development of input-output see Miernyk [54] and Isard [35].

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 derived 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 inter-industry model of the United States economy in 1936 [43, pp. 105-125]. Later, he published the first transaction table for the United States [44]. 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 for the year 1939. This table was used to analyze postwar economic problems. An even more detailed transaction table was constructed in 1947 by Duane W. Evans and Marvin Hoffenberg [19, pp. 97-142]. This 450 sector table was used for many regional studies. The Bureau of Labor Statistics initiated a policy to prepare a transaction table for the U. S. every five years. Thus far, the Bureau has published a transaction table for 1958 [106], and 1963 [108]. An aggregate form of the 1963 input-output table for the U. S. is presented in Table II. At least 54 other nations have had input-output studies of their economy published. These studies are briefly summarized in three comprehensive bibliographies [67].

TABLE II

AN AGGREGATE PRESENTATION OF THE 1963 U. S. TRANSACTION TABLE

Sector	Agri-culture	Mining	Constr.	Manf.	Trans., Comm. & Pub. Ut.	Whole-sale & Retail	Real Est., Fin. & Ins.	Services	Personal Consump. Expend.	Gross Private Fixed Cap. Formation	Govts.	Exports, Inven. Chg., & Other Final Demand	Total
Agriculture	17,818	0	326	26,771	90	169	2,560	60	5,065	0	-173	4,803	57,489
Mining	128	1,135	737	14,629	2,619	14	122	15	182	0	297	683	20,561
Construction	567	415	24	1,400	2,434	397	7,327	954	0	46,151	24,290	1,351	85,310
Manufacturing	7,821	1,670	31,559	185,786	3,973	6,616	2,367	15,461	127,396	28,022	28,985	26,804	466,460
Transportation, Communication and Public Utilities	1,420	948	3,187	17,006	10,368	4,245	2,154	5,928	25,846	1,059	3,828	8,730	84,719
Wholesale and Retail Trade	1,811	320	7,155	13,931	1,361	2,159	1,645	3,124	80,791	4,858	842	2,618	120,615
Real Estate, Finance and Insurance	2,830	2,717	1,003	6,760	2,368	8,313	13,068	6,861	70,757	1,225	945	739	117,586
Services	1,415	295	3,657	12,456	2,963	7,124	5,187	6,220	55,781	0	5,780	2,175	103,053
Government	9	21	64	786	5,520	1,635	1,710	1,201	1,526	516	0	104	
Other Primary Inputs	968	1,994	576	15,963	2,554	1,495	1,309	2,270	8,196	-806	57,878	-18,364	
Value Added	22,702	11,046	37,022	170,972	50,469	88,448	80,137	60,959	0	0	0	68,634	
Total	57,489	20,561	85,310	466,460	84,719	120,615	117,586	103,053	375,540	80,025	122,672	98,277	

Source: Survey of Current Business, Vol. 49, No. 11, pp. 30-35.

The Input-Output Model[2]

The input-output model consists of three basic parts: a transaction or flow table, a set of direct coefficients, and a set of direct and indirect coefficients. The flow table is the base of the model as the direct and indirect coefficients are computed from it.

The Flow Table. Consider an economy with three endogenous sectors, one final demand sector and one primary input sector. The three sector economy can be presented as a system of equations:

$$\begin{aligned} X_1 &= x_{11} + x_{12} + x_{13} + Y_1 \\ X_2 &= x_{21} + x_{22} + x_{23} + Y_2 \\ X_3 &= x_{31} + x_{32} + x_{33} + Y_3 \\ R_0 &= r_{01} + r_{02} + r_{03} + Y_0 \end{aligned} \tag{2.1}$$

where

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

R_0 = primary input;

x_{ij} = purchases of 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; and

Y_0 = final or consumer demand for primary inputs.

Each equation indicates the sales of that sector to the producing sectors and to final demand.

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[2]For a complete discussion of the input-output model, see William H. Miernyk [54].

<u>Direct Coefficients</u>. The direct or technical coefficients are derived from the flow table by assuming that the relationship between the purchases of a sector and the level of output of that sector is linear. The relationship can be expressed in the following form:

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

The a_{ij}'s and c_{ij}'s are parameters in the expression. In most empirical work the intercept c_{ij} is assumed zero and the a_{ij} obtained from the ratio between x_{ij} and X_j. Then, the technical coefficient (a_{ij}) is the ratio of the purchases of output of industry i by industry j over the gross output of industry j. Mathematically, this is presented as:

$$a_{ij} = \frac{x_{ij}}{X_j}$$

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

<u>Direct and Indirect Coefficients</u>. The calculation of the direct and indirect coefficients begins by subtracting the matrix of technical coefficients from an identity matrix. Then, the inverse of the resulting matrix provides the set of direct and indirect coefficients. The mathematical procedure is as follows: First, the a_{ij}'s are substituted into the set of equations listed in (2.1). The equations are then solved for Y_i's as follows:

$$Y_1 = X_1 - a_{11}X_1 - a_{12}X_2 - a_{13}X_3$$
$$Y_2 = X_2 - a_{21}X_1 - a_{22}X_2 - a_{23}X_3$$
$$Y_3 = X_3 - a_{31}X_1 - a_{32}X_2 - a_{33}X_3$$

Rewriting equation (2.3),

$$\begin{bmatrix} 1-a_{11} & -a_{12} & -a_{13} \\ -a_{21} & 1-a_{22} & -a_{23} \\ -a_{31} & -a_{32} & 1-a_{33} \end{bmatrix} \cdot \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} = \begin{bmatrix} Y_1 \\ Y_2 \\ Y_3 \end{bmatrix} \qquad (2.4)$$

In matrix notation it would read as:

$$(I-A)\ X = Y$$

where $I = \begin{bmatrix} 100 \\ 010 \\ 001 \end{bmatrix}$ and $A = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix}$

The matrix (I-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. The solution in terms of the Y_i's of the set of equations in (2.4) is obtained by finding the inverse of the Leontief Matrix. The solution is as follows:

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

where $\begin{bmatrix} A_{11} & A_{12} & A_{13} \\ A_{21} & A_{22} & A_{23} \\ A_{31} & A_{32} & A_{33} \end{bmatrix} = \begin{bmatrix} 1-a_{11} & -a_{12} & -a_{13} \\ -a_{21} & 1-a_{22} & -a_{23} \\ -a_{31} & -a_{32} & 1-a_{33} \end{bmatrix}^{-1}$

In matrix notation the equation is

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

Each A_{ij}, which is an element of the $(I-A)^{-1}$ matrix, indicates the amount of production from sector i necessary to sustain a final demand of one unit in sector j.

Regional Applications of Current Transactions Accounts

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 Isard [34, p. 318-328]. The model requires data for 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, community, state, or group of states. It is impractical to review all of the regional studies, thus reference is made to a bibliography which lists them [6].

Flow-of-Funds Analysis

Historical Development

The newest social account--flow-of-funds or simply money flows--is probably still in its formative stage. In 1944, Professor Morris A. Copeland was invited by the National Bureau of Economic Research "to direct an exploratory project to determine what could be done to provide a fuller statistical picture of the money circuit" [10, p. 3]. In his study, Professor Copeland set out a conceptual approach to a detailed accounting framework for money flows and compiled the data for the United States from 1936 to 1947. The Federal Reserve System continues to improve and develop the accounts so that they can be useful in analyzing monetary problems. The Board of Governors of the Federal Reserve System publishes annually the U. S. flow-of-funds accounts [109]. A summary of the flow-of-funds account for the U. S. for 1966 is presented in Table III.

Flow-of-funds accounts have not caught on in other countries as they have in the United States. A few countries have studies which resemble the flow of funds accounts, but have much less detail than the U. S. accounts and often are combined with other national accounts of the country [14, pp. 174-175].

The Objective and Makeup of the Flow-of-Funds Account

Professor James S. Duesenberry gives an excellent statement of the objective of the flow-of-funds analysis [14, p. 173]. He states,

> The object of the flow-of-funds analysis is to trace in a systematic way the connections between production, prices, expenditures, and other variables in the so-called real system and the terms and conditions on which funds can be raised in the financial markets.

The flow-of-funds account focuses attention upon the sources and uses of funds by institutional sectors, rather than by productive activity as input-output analysis does or by activity or institutional grouping as the national income account does. The number of sectors in the various analysis are as follows: input-output analysis covers as many sectors as the analyst desires, national income and product accounts are broken down into five sectors, and flow-of-funds account

TABLE III

SUMMARY OF FLOW-OF-FUNDS ACCOUNTS, 1966 ANNUAL FLOWS

	Private Domestic Nonfinancial Sectors								Financial Sectors											
	Households		Business		State & Local		U.S. Govt.		Monetary Auth.		Comml. Banks		Nonbank Finance		Rest of World		All Sectors		Discrepancy	Nat. Svg. and Inv.
	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source		
	(Billions of Dollars)																			
1 Gross Savings	—	115.3	—	76.3	—	-.8	—	-.9	—	—	—	2.3	—	1.0	—	-2.2	—	190.9	—	193.1
2 Capital Consumption	—	64.1	—	53.7	—	—	—	—	—	—	—	.5	—	.6	—	—	—	118.9	—	118.9
3 Net Savings	—	51.1	—	22.6	—	-.8	—	-.9	—	—	—	1.8	—	.4	—	-2.2	—	72.0	—	74.1
4 Gross Investment (5+10)	114.5	—	71.9	—	-2.2	—	-.2	—	—	—	1.7	—	1.7	—	-1.8	—	185.7	—	5.2	190.1
5 Pvt. Capital Expenditures, Net	93.1	—	94.2	—	—	—	—	—	—	—	.5	—	.5	—	—	—	188.3	—	2.6	188.3
6 Consumer Durables	70.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	70.3	—	—	70.3
7 Residential Constr.	18.4	—	6.0	—	—	—	—	—	—	—	—	—	—	—	—	—	24.4	—	—	24.4
8 Plant + Equipment	4.4	—	74.8	—	—	—	—	—	—	—	.5	—	.5	—	—	—	80.2	—	—	80.2
9 Inventory Change	—	—	13.4	—	—	—	—	—	—	—	—	—	—	—	—	—	13.4	—	—	13.4
10 Net Financial Invest. (11-12)	21.4	—	-22.3	—	-2.2	—	-.2	—	—	—	1.2	—	1.2	—	-1.8	—	-2.6	—	2.6	1.8
11 Financial Uses, Net	43.4	—	19.7	—	8.5	—	8.6	—	4.2	—	20.6	—	31.0	—	3.9	—	139.9	—	—	5.7
12 Financial Sources	—	22.0	—	42.0	—	10.7	—	8.8	—	4.2	—	19.4	—	29.8	—	5.7	—	142.5	—	3.9
13 Gold + Official U.S. Foreign Exchange	—	—	—	—	—	—	-.2	—	-.3	—	—	—	—	—	.6	—	—	—	—	—
14 Treasury Currency	—	—	—	—	—	—	—	.9	.7	—	—	—	—	—	—	—	.7	.9	.2	—
15 Demand Dep. + Curr.	—	—	—	—	—	—	—	—	—	2.3	—	.3	—	—	—	—	3.4	2.6	—	—
16 Time + Svg. Accounts	19.2	—	—	—	—	—	—	—	—	—	—	—	-.3	—	—	—	—	20.3	—	—
17 At Comm. Banks	11.9	—	-.7	—	1.3	—	—	—	—	—	—	13.3	—	—	.8	—	—	13.3	—	—
18 At Svgs. Instit.	7.3	—	—	—	—	—	—	—	—	—	—	—	-.2	7.1	—	—	—	7.1	—	—
19 Life Insurance Res.	4.7	—	—	—	—	—	—	.1	—	—	—	—	—	4.5	—	—	—	4.7	—	—
20 Pension Fund Reserves	13.3	—	—	—	—	3.7	—	1.3	—	—	—	—	—	8.3	—	—	—	13.3	—	—
21 Consol. Bank Items	—	—	—	—	—	—	—	—	.3	1.9	1.9	.3	—	—	—	—	2.3	2.3	—	—
22 Credit Mkt. Instr.	10.6	21.7	3.2	33.5	6.2	6.8	7.9	6.3	3.5	—	17.0	.1	29.6	6.5	-1.5	1.5	76.6	76.5	—	—
23 U.S. Govt. Secur.	7.9	—	-1.2	—	1.3	—	—	6.3	3.5	—	-3.4	—	.9	—	-2.6	—	—	6.3	—	—
24 State + Local Oblig.	2.2	—	.8	—	-.3	6.0	—	—	—	—	2.4	—	1.0	—	—	—	—	6.0	—	—
25 Corp. + Fgn. Bonds	1.2	—	—	10.2	4.4	—	—	—	—	—	.1	.1	4.9	.8	1.2	.7	—	11.8	—	—
26 Corp. Stocks	-.4	—	—	1.2	—	—	—	—	—	—	—	—	5.4	3.8	-.3	-.3	—	4.7	—	—
27 1-4 Fam. Mortgages	-.4	12.0	—	-1.0	.8	—	2.4	—	—	—	2.4	—	4.8	-.9	—	—	—	10.0	—	—
28 Other Mortgages	—	1.1	—	8.5	—	—	.9	—	—	—	2.3	—	6.4	—	—	—	—	9.6	—	—
29 Consumer Credit	—	6.9	1.4	—	—	—	—	—	—	—	3.1	—	2.3	—	—	—	—	6.9	—	—
30 Bank Loans N.E.C.	—	-.1	—	9.9	—	—	—	—	—	—	8.2	—	—	-1.4	—	-.2	—	8.2	—	—
31 Other Loans	—	1.8	2.3	4.8	—	.8	4.6	—	—	—	2.0	—	4.0	4.3	.3	1.2	13.0	13.0	-.1	—
32 Security Credit	—	-.2	—	—	—	—	—	—	—	—	.5	—	-.1	.6	—	—	—	.4	—	—
33 To Brkrs. + Dlrs.	—	—	—	—	—	—	—	—	—	—	.6	—	.1	.6	—	—	—	.6	—	—
34 To Others	—	-.2	—	—	—	—	—	—	—	—	—	—	-.2	—	—	—	—	-.2	—	—
35 Taxes Payable	—	—	6.6	.2	.2	—	-.5	—	—	—	—	—	—	.1	—	—	-.3	.2	.5	—
36 Trade Credit	—	.1	10.8	9.1	—	.1	1.2	.7	—	—	—	—	.2	—	—	—	12.3	10.0	-2.3	—
37 Equity in Noncorp. Busi.	-7.4	—	—	-7.4	—	—	—	—	—	—	—	—	—	—	—	—	—	-7.4	—	—
38 Miscellaneous Fin.	1.2	.4	5.7	6.6	—	—	.3	-.5	—	-.1	1.1	5.5	1.1	2.8	4.2	4.1	13.7	18.8	5.1	—
39 Insurance Accruals	.7	—	1.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.8	—	—
40 Direct Fgn. Inv.	—	—	3.5	.1	—	—	—	.2	—	—	—	—	—	—	.2	3.5	—	—	—	—
41 Unallocated	—	—	1.3	6.5	—	—	—	-.6	—	—	—	—	—	—	1.9	.5	5.0	10.1	NS	—
42 Sector Discrepancies (1-4)	.8	—	4.3	—	1.3	—	-.7	—	—	—	.6	—	-.7	—	-.4	—	5.2	—	5.2	3.0

Source: Flow-of-Funds Accounts 1947-1967, The Board of Governors of the Federal Reserve System, February, 1968.

can contain any number of sectors. For the U. S. flow-of-funds account, the maximum number of sectors is 20, however the account is often summarized in eight sectors. These are the sectors included in Table III and are:

1. Private Domestic Nonfinancial
    - A. Households
    - B. Business
    - C. State and Local Government
2. U. S. Government
3. Financial Sector
    - A. Monetary Authorities
    - B. Commercial Banks
    - C. Nonbank Finance
4. Rest of World.

This sectoring scheme is clearly determined on an institutional basis. A brief explanation of each sector will clarify even more their institutional framework.

1. Households. This sector includes members of households, personal trusts, and nonprofit organizations serving individuals. All financial and nonfinancial consumer transactions are included in this sector as well as expenditures for housing (old and new purchases as well as maintenance). The activity of the nonprofit organizations are included in this sector since data limitations make it impossible to separate them from the activities of consumers.

2. Business. The activities included in this sector include farm business, nonfarm noncorporate business and corporate nonfinancial business. Farm business covers all farming activities including corporate

farms, credit cooperatives consolidated with the farms that own them, and farm household activities. Nonfarm noncorporate business covers unincorporated nonfinancial enterprises in trade, construction and other professions. Private nonfinancial, nonfarm corporations which are mainly engaged in producing and selling of goods and services make up the corporate nonfinancial businesses.

3. State and Local Government. This sector includes all state and political sub-divisions such as state government, manicipalities, county councils, school districts, townships, and special districts. The sector accounts for individual government units.

4. Federal Government. Included in this sector are the activities of the legislative, judicial, and executive branches of the federal government. Also included are the activities of trust funds, deposit funds, and the postal service system.

5. Monetary Authorities. Covered in this sector are the transactions of the Federal Reserve System and certain monetary accounts of the treasury such as the gold account and silver account.

6. Commercial Banks. All banks in the 50 states are included in this sector. Banks in U. S. territories and possessions are excluded.

7. Nonbank Finance. This sector covers the transactions of savings institutions such as mutual savings banks and credit unions, insurance companies such as life insurance companies and finance companies, and other finance operations such as security brokers and dealers.

8. Rest of World. This sector contains the activities of all residents and governments of all countries outside the United States and its territories and possessions. Also included are all the

international organizations and their foreign staff, as well as all the foreign embassies and consulates.

In general, all transactions which involve money and credit are included, while imputations are ignored in flow-of-funds accounts. The emphasis is on financial transactions, which are designed to indicate the sources and uses of funds.

Major Uses of Flow-of-Funds Accounts

In general, the nature of flow-of-funds indicates their primary use is closely related to the agency responsible for their preparation, the Board of Governors of the Federal Reserve System. The account provides a way to analyze the effect that different monetary policies may be expected to have upon the national economy. The Board of Governors along with the Treasury determine the volume of the money supply through commercial bank reserves and the level of interest rates. Their major means are open market operations in federal securities, reserve requirements, and discount rates. Suppose the Board is interested in determining the effects of a tight money policy. Information from flow-of-funds accounts in previous tight money policy periods would show how federal security sales, increases in reserve requirements, and increases in the discount rate affect each of the eight sectors. These past effects could be used to estimate effects in the future, and the Board of Governors could rely on past empirical events rather than theories of money, such as the quantity theory approach.

Several analytical applications of flow-of-funds analysis which measure past monetary effects have been completed. Professor Copeland used flow-of-funds analysis to determine the federal government's sources and uses of funds during World War II [11, pp. 195-232]. He determined what part consumers, business, and other nonbank sectors played in the financing of the war. Professor James J. O'Leary attempted to analyze the uses to which flow-of-funds data may be put in the analysis of the demand and supply for long run capital funds [63, pp. 263-284]. He concluded that flow-of-funds accounts provided a fruitful means of both forecasting future trends in the capital markets, including trends in interest rates, and analyzing past relationships between the factors of demand and supply.

Flow-of-funds provide the data for the financial side of any theory of economic development. Interregional flow-of-funds analysis shows the distribution of excess reserves in the banking system, the disaggregation by regions of treasury receipt and expenditures, and why funds move between districts. The usefulness of flow-of-funds as a regional tool is limited mainly to the federal reserve districts because this is the smallest region for which data are available.

Regional Application of Flow-of-Funds Analysis

Regional application of the flow-of-funds account in the United States is dependent upon the Federal Reserve System. The Federal Reserve System provides an efficient method of clearing payments between its 12 districts. Each district has a definite boundary and regional flow-of-funds analysis is based on these districts. The data available for each district makes possible several types of studies. One type of analysis has concentrated on the money flows in and out of a federal reserve district without reference to interregional relations. This type of study was made for the Boston Federal Reserve

District [20]. From this study the Federal Reserve Bank of Boston was able to compute the net gold inflow and outflow and thus better understand the regional economy.

Another type of regional flow-of-funds analysis involves the disaggregation of gold inflows by originating region and subregion and outflows by terminating region and subregion. J. Bowsher, Dewey Duane, and Robert Einzig [7] showed how money flows analysis can be used to diagnose a region's monetary ills and to suggest solutions.

A third type of flow-of-funds is proposed by Isard [35, pp. 151-163]. Weekly data from the 36 Federal Reserve head offices and branches would reveal the pattern of financial relationships among the 36 Federal Reserve areas. Like the other types of analysis, it is limited to the area delineation as set forth by the Federal Reserve System. This delineation restricts seriously the use of flow-of-funds accounts in regional analysis.

Other Accounts

Presented above are the three basic types of accounts. Two other accounts--national balance sheets and balance-of-payments--provide detailed sub-systems of the above accounts. A brief description is given for these accounts before a synthesis of all accounts is presented in Chapter III.

National Balance Sheet

The adoption of flow-of-funds analysis will bring new emphasis on the national balance sheet as a social account. Before 1920, estimates of national wealth were made in the United States based on the decennial census, with the last such estimate being made in 1922 [68, p. 203]. Raymond Goldsmith followed up this work with estimates of national wealth from 1896 to 1949. His estimates include several dozen components of national wealth and were given in current and 1929 prices. National balance sheets are not prepared for the nation as a whole, but two agencies representing major segments of the United States economy prepare individual accounts. The Department of Agriculture prepares an annual agricultural balance sheet and the Securities and Exchange commission prepares a balance sheet on the current assets and liabilities of corporations [68, pp. 203-204].

To prepare a national balance sheet, one begins with the balance sheets of individual firms. The next step is to combine into sectors. These could be aggregated for regions, and then by combining regions a national balance sheet is obtained. A model national balance sheet could look as follows [68, p. 204]:

National Assets

Tangible assets in U. S.
- a. Reproducible
- b. Nonreproducible

Claims against U. S. debtors
Equity securities of U. S. issuers
Claims against foreign debtors and equities in foreign properties and enterprises

National Liabilities, Net Worth

Liabilities to U. S. creditors
Equities of U. S. issues held by U. S. owners
Foreign claims against U. S. debtors, foreign holdings and of equities of U. S. issues
National net worth

From a balance sheet, a wealth statement can be derived. A model national wealth statement could look as follows [68, p. 205]:

National Wealth

Tangible assets in U. S.
  a. Reproducible
  b. Nonreproducible
Net foreign

National Net Worth

Net Worth
  Nonbusiness sectors
    1. Households
    2. Nonprofit organizations
    3. Government

In order to construct regional or national balance sheets all economic units must cover, classify, and value their assets and liabilities in a similar manner. From a national or regional balance sheet, it would be easy to obtain many ratios which are useful to economists such as: capital-output ratios, debt-equity ratios, and liquidity ratios. Again, the major limitation is the lack of reliable data.

Balance of Payments Account

A balance of payments account describes the relationship between payments and receipts of one economy with its trading economies. Thus, this account makes use of both commodity flow and money flow data. Because of the vast data requirements, very few regional balance of payments accounts have been constructed. A list of the more important studies is provided in Isard [35, p. 163].

A balance of payments account must include all transactions during a year which result in inflows and outflows. The number of categories included is left up to the researcher and the problem under investigation. Whatever the classification, the balance of payments statement must equate total inflows with total outflows.

The balance of payments account is generally divided into four major categories; current account, gold and currency movement, capital account, and errors and omissions. The current account includes transactions completed in the current period, while the gold and currency account indicates gold flow. The capital account includes transactions which take time to complete and which relate to the creditor-debtor position of a region. The last category, errors and omissions, is included since it is virtually impossible to collect data on flows that will completely balance. The balance of payments account contains three columns; an export column, an import column, and a net column.

The difficulties associated with conceptual problems and with the multitude of needed data discourages construction of the balance of payment account. But once constructed, it provides a comprehensive view of a regional economy by understanding the entire network of economic relations with the rest of the world.

CHAPTER III

SYNTHESIZING THE SOCIAL ACCOUNTING SYSTEMS WITH APPLICATION TO OKLAHOMA

The five social accounts were presented in the previous chapter. The accounts include: the income and product account, current transaction account, the flow-of-funds account, the balance of payments, and the national balance sheet. This chapter is concerned with synthesizing these accounts and developing a social accounting system for Oklahoma.

The state of development in integrating social accounting systems can be summarized by quoting M. Yanovsky [127, p. 6].

> The problem of integrating the social accounting systems, particularly those of the national accounts and the financial transactions accounts, is actually only at the discussion stage among statistical experts.

Figure 1 shows the interrelations of the various social accounts in broad perspective. The task of integrating various accounts has been undertaken and the results have been fruitful in some cases and discouraging in others.

Flow-of-Funds Account and the Income and Product Account

It wasn't until the late 50's that an attempt was made to reconcile dissimilarities in sectoring and reporting between flow-of-funds analysis and income and product accounts. This study was conducted

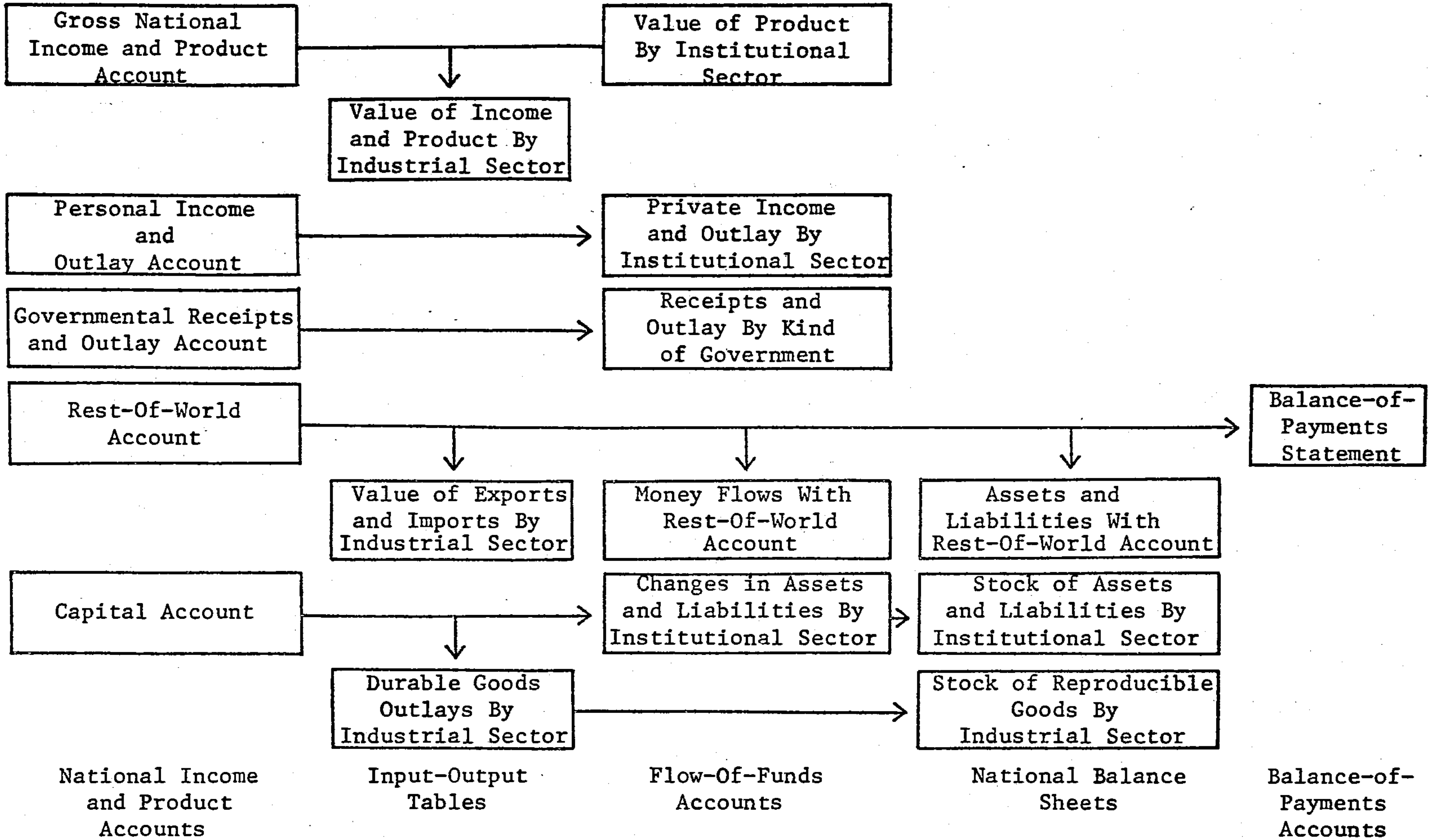

Figure 1. Interrelations of the Social Economic Accounts

Source: Adapted from [3, p. 26].

by the Division of Research and Statistics of the Federal Reserve System. Any reconciliation of systems must be accomplished without making the accounts unusable for the purposes they were originally designed. In 1959, an attempt was made to make flow-of-funds more similar to the income and product account by increasing the number of sectors and sub-sectors and by shifting some components among sectors. It was decided that even more disaggregation and changes were needed to make them comparable. Such an extension in sectoring would not lead to an improvement in flow-of-funds analysis and would not coincide with the national income and product account unless the sectoring was over-stretched. The Division of Research and Statistics concluded that it was almost impossible to synthesize flow-of-funds analysis and income and product accounts without changing the original usefulness of each technique. A summary of the work completed by the research team of the Federal Reserve System on this project is presented by Stanley J. Siegel [69, pp. 11-101]. The division also attempted to integrate flow-of-funds with the national balance sheet [127, p. 220]. The success or failure of this attempt was not reported.

The Input-Output Account and the Income and Product Account

In contrast to the many problems encountered in synthesizing flow-of-funds with the income and product account, there are many places where the input-output account coincides with the income and product account. The first realized connection between the two accounts is that the expenditure on gross domestic product and the gross domestic income given in the national accounts is regarded as the final bill of goods and the value of primary inputs, respectively, of the input-output model. The endogenous section of the input-output table is linked with the value of total production and with the income of the factors of production in the income and product account. The integration of the input-output account with the income and product account has been made in a number of national studies. It has been accomplished in the United Kingdom for 1954 and in a number of other European countries [127, p. 227]. It has been completed for the United States for 1958 [24, p. 10].

The Flow-of-Funds Account and the Input-Output Account

The integration of these accounts has been described by the national accounts review committee as conceptually not feasible and statistically impractical. The committee stated that the two concepts are far removed from each other. The flow-of-funds account concentrates on financial flows and collects data on an enterprise basis, while the input-output account concentrates on the flow of goods and services among producers which is determined on a process basis.

The Integration of All Accounts

Several attempts have been made to integrate the various social accounts. Richard Stone [73] has developed a comprehensive social accounting system for a nation and has applied his system to England. On the regional level, two publications have reported research conducted on integrating social accounts. Harvey S. Perloff and Charles L. Leven [64] present a theoretical method of integrating the various accounts, while Jerald R. Barnard [5] constructed a social accounting system for a region and applied his system to the state of Iowa. A brief summary of Stone's and Barnard's work is presented with a more complete description given of Perloff and Leven's theoretical model. The latter model provides a basis for the Oklahoma regional social accounting system presented in the next section.

Stone's [73] social accounting matrix is designed to serve as a framework for an economic growth model. His matrix centers on four basic forms of activity. These include production, consumption, accumulation, and trade. The accounts in Stone's social accounting matrix relate to flows. Stocks existing at a point in time are not recorded; however, changes in stocks appear in his matrix. The sectors and their transactions in the economic process are integrated through a series of classification converters to form an elaborate treatment of intersectoral relations and interdependency. An example is one used with government activities. Here, government classifications and converters were used to cover government in its activities of collecting taxes and providing social capital and services. Stone used his model, with 1960 as its base year, to project economic growth to 1970 and future years [73, p. 1].

Barnard [5] bases his social accounting system upon aggregate economic theory as developed at the national and regional levels and uses the five social accounts. His social accounting matrix is basically an integration of input-output analysis and the income and product account, with the underlying concepts of flow-of-funds, national balance sheets, and balance of payments. Thus, Barnard says his social accounting matrix is not a complete system because the three latter accounts are not directly used. Also his matrix is concerned only with flows and ignores level of stocks and stock changes.

Perloff and Leven [64] have constructed a theoretical system which considers the effects of stocks as well as stock flows. This, Barnard's and Stone's models failed to do. Perloff and Leven first begin their presentation by deciding how regional accounts should be used. They say [64, p. 175] that a system of regional accounts should be designed to aid decision-making in the following ways:

1. It should provide a useful base of information for decision-making by both public and private units in urban communities;
2. It should help in the evaluation of the regional impact of national policies and activities, as with regard to spending, tariff changes, and the like; and
3. It should contribute to a deeper understanding of our urban regions and to the full development of a theory of regional change.

They contend that information is needed not only on the magnitude of flows and stocks, but also on information concerning the relationships between changes in stocks and subsequent changes in flows, and the effect changes in flows have on resource stocks. Perloff and Leven's model is presented in Figure 2. The major parts of the model will be explained in order to see how the authors propose to meet their objectives. Classification includes a core account which covers current production and income data, and associated accounts which include human, non-human, and government expenditure and revenue accounts.

1. The Current Production and Income Account. The upper matrix records the interindustry transactions (T_{ij}) internal to the region (Figure 2). It is not in the standard input-output form, rather it has been designated as a "from--to" table [47]. The industrial classification of imports is shown in the lower matrix (M_{ij}). If we combine this matrix and the intermediate intraregional sales matrix we arrive at the common input-output coefficients [64, p. 190]. Final demand is

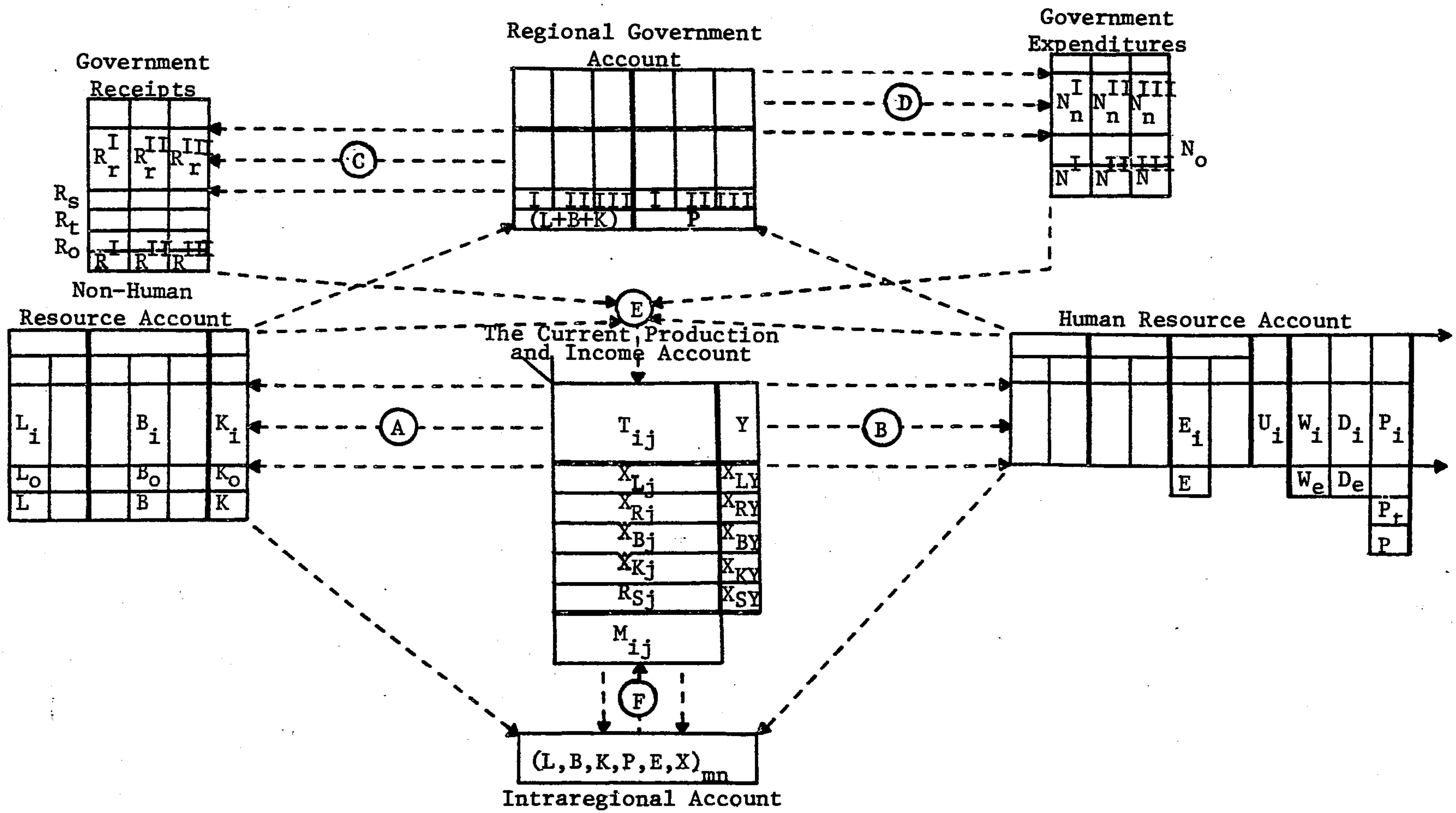

Figure 2. Integrated Regional Accounts System

Source: Perloff, Harvey S. and Charles L. Leven, "Toward an Integrated System of Regional Accounts: Stocks, Flows, and the Analysis of the Public Sector," in Elements of Regional Accounts, Werner F. Hirsch (ed.), The John Hopkins Press, Baltimore, 1964.

shown as a single column (Y) and could of course be composed of several columns. Below the intermediate intraregional sales matrix are listed five rows. These rows record income to labor, X_{Lj}; income to land owners, X_{kj}; and local sales and other taxes, R_{Sj}. This information is commonly found in the primary input sector of an input-output analysis and is needed for an income and product account.

2. Non-Human Resources Account. The non-human resources account is simply a relationship between stock resources and current flows. Generally included in this account is land, buildings, and equipment (Figure 2). One could record characteristics which are of most concern to the researcher, such as land area, floor space, and equipment value. Idle resources pose no problem as they can be included as a separate row below the employed resources. Some difficulties are encountered with underemployed resources, but that issue is not taken up in this paper.

3. Human Resources Account. Included in this account is information on employment (E_i) for flow-stock analysis and labor force (W_i) for stock-flow analysis (Figure 2). Other information includes work force (W_i) and population (P_i) by industry. To go along with the population data, another column presents the number of dependents (D_i) associated with each industry.

4. Regional Government Account. This account is located directly above the income and product account (Figure 2). It is related to the rest of the system through the human and non-human resource account. In fact, almost all government outlays are related to the stock of resources (human and non-human) rather than to current activity levels. For example, fire protection is related to the number and kind of

buildings rather than to current levels of production. Government receipts are located on the left and related to the taxable human and non-human resources. Located on the left is a record of government expenditures and the relationship to the human and non-human resources.

5. Intraregional Account. Perloff and Leven propose an intra-regional account mainly to show the importance of the internal spatial arrangement in a complex society. They did not attempt to be explicit with this account, and as it stands, it only records the location of employment, output, and all human and non-human resources in the system.

The above brief outline of Perloff and Leven's accounting matrix was presented to give an idea on how a regional accounting system could be constructed to meet the three objectives mentioned earlier. It is mainly towards these objectives that an Oklahoma social accounting system is developed.

The Oklahoma Social Accounting System

The social accounting system adopted for Oklahoma is a modified form of Perloff and Leven's proposed model [64]. It contains stock-flow and flow-stock relationships that Perloff and Leven say are essential for most types of dynamic regional analyses.[1] The sector specification will first be discussed, followed by the social accounting system. Finally the system will be discussed in regard to Perloff and Leven's [64] three criteria of a good system.

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[1]By stock-flow relationships they mean the increase in flows that would result from a given increase in stocks, such as capital-output ratios. Flow-stock relationships refer to the induced effect on capital formation of an increased demand in the region's output.

<u>Sector Aggregation and Broad Data Sources</u>

The base year for this study of the Oklahoma economy was 1963, primarily because secondary data were most complete for that year. Secondary data were used because of the time and cost involved in collecting primary data. Most of the data needed for the model were available in census and other governmental publications.[2]

The industries in the economy were aggregated into a workable number of sectors to be consistent with available data as classified by the Bureau of Labor Statistics. It was necessary to decide which groups of industries reported according to this classification and should be aggregated to adequately represent the economic structure within Oklahoma.

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

Manufacturing activities were divided into four sectors. Agricultural processing and oil refining were two separate sectors because of their importance within the state. A sector including the manufacturing of machinery except electrical was also included as this sector was relatively large in 1963. The remaining industrial firms were aggregated into the "other manufacturing" sector.

Since mining of crude oil plays an important role in the economy of Oklahoma, a separate sector for the mining activity was included.

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[2]For a complete list of sources see Chapters V, VI and Appendix A.

The service-type activities of the economy were aggregated into five sectors: transportation, communication and public utilities; real estate, finance and insurance; services; wholesale and retail trade; and construction.

These 12 activities represent the endogenous sectors of the Oklahoma Model. Five exogenous sectors or final demand sectors were included in the model. Government activities were divided into Federal government and State and Local government. Other exogenous sectors were households, private capital formation, and exports. A complete listing of the endogenous and exogenous sectors is given below:

Endogenous Sectors

Agriculture
1. Livestock and Livestock Products
2. Crops

Manufacturing
3. Agricultural Processing
4. Petroleum and Coal Processing
5. Machinery, Except Electrical
6. Other Manufacturing

Mining
7. All Mining

Services
8. Transportation, Communication and Public Utilities
9. Real Estate, Finance and Insurance
10. Services
11. Wholesale and Retail Trade
12. Construction

Exogenous Sectors

1. Federal Government
2. State and Local Government
3. Households
4. Private Capital Formation
5. Exports

The Oklahoma Accounts

The system is outlined in Figure 3 and includes three main accounts: a capital account, an interindustry account; and a human resource account. The interindustry account forms the base of the

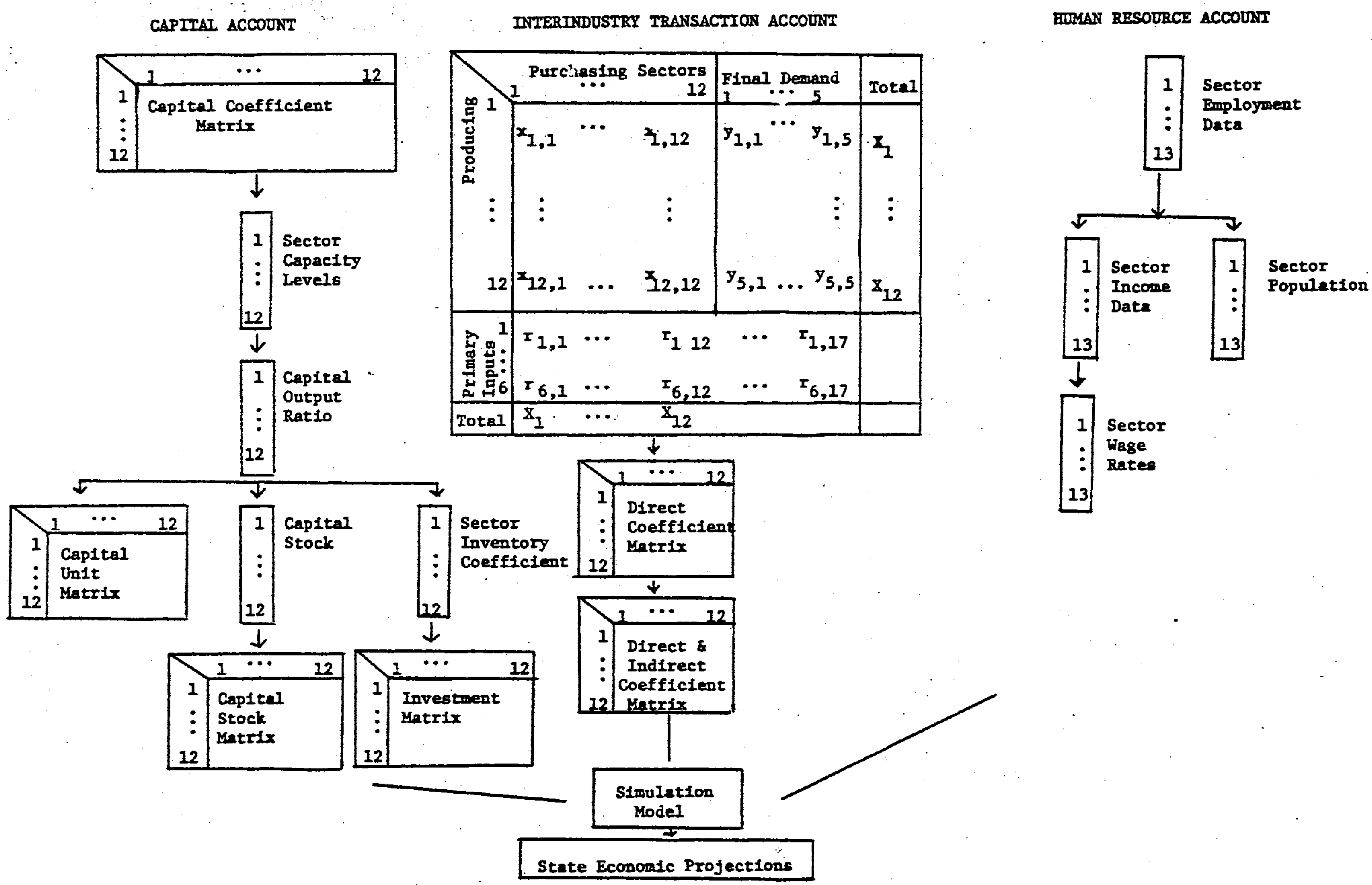

Figure 3. The Oklahoma Social Accounting System

complete system. Related directly to the transaction table are the capital and human resource accounts.

The Interindustry Account. As noted in Figure 3, the interindustry account of the Oklahoma information system consists of three basic parts: a transaction or flow table, a direct coefficient table, and a direct and indirect coefficient table. The transaction table is the base of the interindustry account and the other tables are derived directly from it.

The transaction table is a double accounting system. Reading down the columns of the endogenous sectors, purchases of each sector are determined; whereas reading across each row, sales of each sector are determined. The final demand section includes the exogenous sectors and consists of the activities of those who purchase goods and services from the producing sectors. The primary input section consists mainly of imports, households, government, and depreciation. The figures in these rows indicate the amount of primary inputs purchased by the sectors in the processing and final demand sectors.

The direct coefficients indicate input requirements per dollar of output for a given sector. The direct coefficients are relevant only for the processing sectors; therefore, technical coefficients are computed only for the columns of the purchasing sectors. Calculation of the coefficients consists of dividing entries in each industry's column by the total input for that sector. The direct and indirect coefficients indicate the total change in input requirements as a result of a one dollar change in final demand. The total change includes the direct effect as well as all indirect effects resulting from the initial one dollar change.

The Capital Account. The capital coefficient matrix forms the base of the Oklahoma capital analysis. Each capital coefficient indicates the amount of capital goods required from each sector per dollar's worth of capital expenditures in the sector represented in that column. Capital-output ratios were computed for the 12 endogenous sectors. Capital-output ratios were defined as the ratio of total cost of plant and equipment to output at capacity. Estimates of capacity operating levels for each sector were obtained from employment data. Peak employment was assumed equal to 100 percent capacity operation.

The capital unit matrix is derived from the capital-output ratios and the capital coefficient matrix. Each coefficient in this matrix indicates the capital goods required from the sector represented in that row to produce one unit of output capacity for the sector represented in that column. The coefficients are computed by multiplying the capital coefficients of a sector times the capital-output ratio of that sector. The capital stock matrix can be derived with the capital-output ratios, an output estimate, and the capital coefficient matrix. The capital-output ratio times the estimated output at capacity yields the amount of capital in each sector. The amount of capital in a sector times that sector's capital coefficients column yields the composition of each sector's capital. Each element in the matrix represents the total value of capital goods produced by the sector represented in that row and invested in the sector represented in that column.

Inventory coefficients were derived that indicate the amount of inventory needed per unit of output. Some researchers desire to know the total amount of capital needed to expand output as well as its composition. By adding the capital unit coefficients and the inventory coefficients for a sector, the total amount of capital required per unit of output expansion is estimated. This addition yields a combined capital and inventory unit matrix from which the investment matrix is calculated. Each coefficient is obtained by dividing the column entry of the combined capital and inventory unit matrix by the total of all entries for that column. Investment coefficients are defined as the value of output of the row sector needed by the column sector per unit of investment in the column sector. To complete the capital structure analysis, depreciation coefficients were estimated. Depreciation rates were estimated as the ratio of depreciation to depreciable assets.

The Human Resource Account. Of vital importance in a state accounting system is the human resource section. From this section, the researcher presents data about the employment, income, and population of the state. Included are estimates of wage and salary employment and proprietor employment by sector. With employment and output data, labor-output ratios are developed. The income portion includes wage and salary payments and proprietor income by sector. With the employment and income data, income rates for wage and salary workers as well as proprietors are calculated. To complete this section, population data are presented by sector.

Grading the Accounting System

The Oklahoma social accounting system was evaluated and met the three criteria of an effective accounting system as specified by Perloff and Leven. The system provides a useful base of information for decision-making to both public and private decision-makers and thus satisfies the first criteria. The second and third criteria are met by an analysis of the data in the accounts and by using the data in various economic models. These two types of analyses allow an evaluation of national policy on the region as well as an understanding of regional development.

The three main accounts are presented and discussed in Chapters IV, V, and VI. Following this, the simulation model is presented in Chapter VII, while the simulation results are presented in Chapters VIII and IX.

CHAPTER IV

THE INTERINDUSTRY TRANSACTION ACCOUNT

The implementation of an integrated social accounting system for a state economy is basic to the construction of a current transaction account. This chapter contains the transaction account and is presented in three tables: current transaction flows (1963 base year), direct requirement coefficients, and direct and indirect requirement coefficients. Data sources, definitions, and techniques used in constructing the current account are presented in Appendix A.

The Current Transaction Flow Table

The interindustry flow of goods and services (Table IV) provides the base for analysis of the interindustry transaction account. 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 and services sold by the producing sector to the purchasing sector represented by each column. For example, reading across the first row of Table IV, the livestock and livestock products sector sold 70.3 million dollars worth of goods to farmers within that sector, 118.1 million dollars worth of goods to the agricultural processing firms, 0.8 million dollars worth of goods to the other manufacturing firms, 6.3 million dollars worth of goods to the real estate, finance, and insurance sector, 0.3 million dollars worth to the service

TABLE IV

CURRENT TRANSACTION TABLE, OKLAHOMA ECONOMY, 1963

Sector	Lvsk. & Lvsk. Products	Crops	Agric. Proc.	Petro.	Mach.	Other Manf.	Mining	Trans., Comm. & Pub. Ut.	Real Est., Fin. & Ins.	Services	Whole-sale & Retail	Constr.	Government Federal	Government State & Local	Private Capital Formation	Personal Household Consumption	Export	Total
Livestock and Livestock Products	70,272	—[a]	118,124	—	—	805	—	32	6,268	292	—	—	—	—	—	19,514	164,993	380,300
Crops	100,438	11,920	72,776	—	—	7,010	—	1,375	10,447	440	3,587	4,404	36,528	349	69	25,014	132,004	406,361
Agricultural Processing	40,447	5,520	70,381	616	51	2,311	—	1,714	572	3,043	12,736	323	10,078	—	—	347,086	—	494,878
Petroleum and Coal Products	2,467	14,515	1,244	42,467	600	8,852	2,660	28,955	3,748	6,632	28,825	22,420	974	6,484	5,304	57,707	426,053	659,907
Machinery, Except Electrical	459	2,695	127	67	17,159	9,956	16,901	618	469	3,536	2,683	7,584	—	88	167,196	1,741	—	231,279
Other Manufacturing	1,865	9,366	22,581	14,378	30,242	214,449	53,132	40,882	4,468	77,050	72,717	175,474	2,444	10,144	302,831	219,823	—	1,251,846
Mining	102	1,796	341	383,901	82	24,090	101,747	40,900	796	183	295	9,959	3,848	14,386	1,705	2,661	452,712	1,039,504
Transportation, Communication and Public Utilities	11,481	16,361	20,213	41,772	5,972	50,898	47,921	111,920	14,064	72,153	90,100	43,074	78,301	96,063	38,675	211,059	11,555	961,582
Real Estate, Finance and Insurance	4,973	26,107	6,948	17,884	8,595	20,129	14,097	22,143	53,020	22,993	52,559	15,219	8,174	16,884	23,864	166,734	—	480,323
Services	3,406	11,274	25,374	15,209	10,110	29,954	110,980	45,928	33,616	75,143	110,373	49,057	7,294	31,584	8,111	467,088	—	1,034,501
Wholesale and Retail Trade	11,546	21,126	17,345	11,151	8,114	87,147	30,693	20,804	10,514	37,215	44,853	94,649	3,597	4,503	157,559	812,909	—	1,373,725
Construction	1,708	4,300	775	8,303	366	7,671	22,515	29,932	37,672	9,142	6,634	253	61,595	148,569	897,640	—	—	1,232,075
Government Federal	1,469	3,194	6,370	10,926	5,746	29,815	23,583	107,727	23,726	16,224	32,646	33,202	7,898	5,986	—	652,906	—	961,416
State and Local	11,284	24,537	6,499	10,083	4,375	22,929	43,364	55,129	11,091	12,822	19,493	15,546	169,184	5,471	—	456,338	—	868,145
Households Wages and Salaries	10,713	23,287	58,514	32,222	53,897	341,367	272,000	267,000	131,000	307,000	518,000	177,000	449,000	340,000	—	7,000	—	2,988,000
Other Income	57,273	155,399	12,371	24,195	10,876	64,157	128,556	34,154	57,964	229,533	218,000	334,813	357,650	146,250	—	294,809	—	2,126,000
Depreciation	37,451	54,688	11,169	25,608	9,923	59,781	71,854	92,102	60,422	57,771	59,577	24,845	—	—	—	—		
Imports	12,946	20,276	43,726	21,125	65,171	275,525	99,501	60,267	20,466	103,329	100,647	224,253	22,435	53,775	882,914	372,511		
Total	380,300	406,361	494,878	659,907	231,279	1,251,846	1,039,504	961,582	480,323	1,034,501	1,373,725	1,232,075	1,219,000	880,536	2,485,868	4,114,900		

[a]Dashes indicate zero or negligible quantity.

sector, 19.5 million dollars worth to households and 165.0 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 purchases were slaughter animals and milk products. Sales to the remaining endogenous sectors were small and consisted of miscellaneous livestock products. The value of goods and services purchased by households equaled 19.5 million 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 households. The export column indicated that Oklahoma produces more livestock and livestock products than were used within 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 Appendix A to clarify each entry.

The entries in each column of Table IV represent the input structure of each purchasing or consuming sector. As an illustration, consider column three. The agricultural processing sector purchased 190.9 million dollars worth of goods from the basic agricultural sectors which includes both the livestock and livestock products sector and the crop sector. Of this amount, 118.1 million was for livestock and livestock products, while 72.8 million 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

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

grains to the agricultural processing sector. The agricultural processing industries purchased 70.4 million dollars worth of goods and services from other industries within the sector. Purchases from the petroleum, machinery, and other manufacturing sectors were 1.2, 0.1, and 22.6 million dollars respectively. Most of the purchases from the other manufacturing sector were packaging materials. The processing sector spent 20.2 million dollars for transportation, communication and public utilities, whereas their expenses for services from the real estate, finance and insurance sector totaled 6.9 million dollars. Purchases from other endogenous sectors included: services, 25.4 million; wholesale and retail trade, 17.3 million; construction, 0.7 million; and mining, 0.3 million dollars. Agricultural processing firms paid 12.8 million dollars in taxes. Workers received 58.5 million dollars in wages and salaries, while other income payments amounted to 12.4 million. Depreciation charges amounted to 11.2 million and imports totaled 43.7 million dollars. The remaining columns can be interpreted similarly.

Of special interest in Table IV is the export column and the import row. Examining the export column, it is noted that Oklahoma is a large exporter of products from the agricultural processing, mining, and petroleum products sectors. These figures were computed by determining the total demand of each sector and the amount of the product demanded for final consumption within the state. The amount produced above these demands was considered as exports. Computed in this way, the amount is net exports. Imports were also determined as net amounts. 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.

Direct Coefficients

The direct coefficients in Table V 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 services. The technical coefficients are relevant only for the endogenous sectors and therefore, 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 petroleum sector increases its output by one dollar, its purchases from the two agricultural sectors will not change. Purchases from firms within the sector will increase by six cents.[2] To produce an additional dollar's worth of output, the petroleum sector will purchase two cents and 58 cents worth of inputs from other manufacturing and mining, respectively. As expected the petroleum sector has a large direct effect on the mining sector. A large part of the sector's activity in the state is the processing of raw products from mining. The remaining purchases from endogenous sectors are as follows: six cents from transportation, communication and public utilities; three cents from real estate, finance and insurance; two cents from services; two cents from wholesale and retail trade; and one cent from construction. A one dollar

[2]These figures were obtained by founding off to the nearest cent.

TABLE V

DIRECT COEFFICIENTS, OKLAHOMA ECONOMY, 1963

Sector	Lvsk., & Lvsk. Products	Crops	Agric. Proc.	Petro.	Mach.	Other Manf.	Mining	Trans., Comm. & Pub. Ut.	Real Est., Fin. & Ins.	Service	Whole-sale & Retail	Constr.
Livestock and Livestock Products	.18478	.00000	.23869	.00000	.00000	.00064	.00000	.00003	.01305	.00028	.00000	.00000
Crops	.26410	.02933	.14706	.00000	.00000	.00560	.00000	.00143	.02175	.00042	.00261	.00357
Agricultural Processing	.10635	.01358	.14222	.00093	.00022	.00185	.00000	.00178	.00119	.00294	.00927	.00026
Petroleum and Coal Products	.00649	.03572	.00251	.06435	.00259	.00707	.00256	.03011	.00780	.00641	.02098	.01820
Machinery, Except Electrical	.00121	.00663	.00027	.00010	.07419	.00795	.01626	.00064	.00098	.00342	.00195	.00616
Other Manufacturing	.00490	.02305	.04563	.02179	.13076	.17131	.05111	.04252	.00930	.07448	.05294	.14242
Mining	.00027	.00442	.00069	.58175	.00035	.01924	.09788	.04253	.00166	.00018	.00021	.00808
Transportation, Communication and Public Utilities	.03019	.04026	.04084	.06330	.02582	.04066	.04610	.11639	.02928	.06975	.06559	.03496
Real Estate, Finance and Insurance	.01308	.06425	.01404	.02710	.03716	.01608	.01356	.02303	.11038	.02223	.03826	.01235
Services	.00896	.02774	.05127	.02305	.04371	.02393	.10676	.04776	.06999	.07264	.08035	.03982
Wholesale and Retail Trade	.03036	.05199	.03505	.01690	.03508	.06961	.02953	.02164	.02189	.03597	.03265	.07682
Construction	.00449	.01058	.00157	.01258	.00158	.00213	.02166	.03113	.07843	.00884	.00483	.00021
Government Federal	.00386	.00786	.01287	.01656	.02484	.02382	.02269	.11203	.04940	.01568	.02376	.02695
State and Local	.02967	.06038	.01313	.01528	.01892	.01832	.04172	.05733	.02309	.01239	.01419	.01262
Households Wages and Salaries	.02817	.05731	.11823	.04883	.23304	.27269	.26166	.27767	.27273	.29676	.37708	.14366
Other Income	.15060	.38242	.02500	.03666	.04703	.05125	.12367	.03552	.12068	.22188	.15869	.27175
Depreciation	.09848	.13458	.02257	.03881	.04291	.04775	.06912	.09578	.12579	.05585	.04337	.02016
Imports	.03404	.04990	.08836	.03201	.28179	.22010	.09572	.06268	.04261	.09988	.07327	.18201
Total	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000

increase in output of the petroleum and coal products sector will cause the exogenous sectors to change as follows: three cents for government, five cents for wages and salaries, four cents for other income, four cents for depreciation, and three cents for imports.

Direct and Indirect Coefficients

The direct and indirect coefficients in Table VI indicate the total change in input requirements as a result of a one dollar change in sector final demand. The total change includes the direct effect as well as all indirect effects. For illustration purposes, consider a one dollar change in demand for products of the livestock sector. Column one of Table V shows that direct intraindustry transactions would change by 18 cents. However, as the livestock sector changes its own output, the amount of purchases from 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. A secondary change in the livestock sector is referred to as the indirect effect. The interdependence coefficients in Table VI indicate the combined direct and indirect effects.

The current transaction account is highly useful to those working in regional planning. It presents a picture of regional economic structures, although of a static nature. The direct and indirect interdependence coefficients, when used in a model allowing changes in resource productivities, additions to capital and human stock, and changes in market demand sources, provide a basis for total simulation

TABLE VI

DIRECT AND INDIRECT COEFFICIENTS, OKLAHOMA ECONOMY, 1963

Sector	Lvsk., & Lvsk. Products	Crops	Agric. Proc.	Petro.	Mach.	Other Manf.	Mining	Trans., Comm. & Pub. Ut.	Real Est., Fin. & Ins.	Service	Whole-sale & Retail	Constr.
Livestock and Livestock Products	1.27613	.00689	.35721	.00197	.00165	.00284	.00109	.00185	.01992	.00258	.00478	.00136
Crops	.37431	1.03753	.28388	.00345	.00338	.00970	.00221	.00444	.03260	.00379	.00807	.00659
Agricultural Processing	.16558	.01867	1.21645	.00318	.00202	.00459	.00169	.00374	.00567	.00526	.01296	.00253
Petroleum and Coal Products	.02983	.04559	.02438	1.07963	.00879	.01516	.00964	.04094	.01672	.01370	.02933	.02655
Machinery, Except Electrical	.00591	.00924	.00502	.01446	1.08254	.01187	.02150	.00374	.00332	.00568	.00413	.00955
Other Manufacturing	.04875	.05295	.10399	.10453	.18718	1.22864	.09927	.08426	.04727	.11325	.08900	.19397
Mining	.02703	.03931	.02570	.70548	.01286	.03968	1.12110	.08321	.01773	.01645	.02597	.03356
Transportation, Communication and Public Utilities	.08705	.06978	.10671	.13798	.05401	.07353	.08217	1.15601	.05956	.10027	.09775	.06692
Real Estate, Finance and Insurance	.05810	.08521	.05756	.05646	.05521	.03207	.02874	.03900	1.13591	.03596	.05457	.02751
Services	.05452	.05665	.10389	.13008	.07028	.05273	.14536	.08134	.10203	1.09753	.10808	.06784
Wholesale and Retail Trade	.07805	.07016	.08830	.06113	.05940	.09618	.05289	.04303	.04517	.05477	1.05127	.10090
Construction	.01915	.02229	.01679	.03933	.00947	.00955	.03104	.04254	.09323	.01675	.01461	1.00711

of regional economies not easily duplicated by other models. Chapter VII presents a simulation model.

CHAPTER V

THE CAPITAL ACCOUNT

For an objective evaluation of alternative regional development strategies, a model must consider the present capital structure and incorporate the effects of new capital investment. John H. Cumberland [13, pp. 74-75] summarizes the need for capital inclusion as follows:

> The universal pressures for regional development cannot be understood fully without analysis of the investment process and the role of the capital formation sector in the region.

The need for a capital account led to an additional study which provides capital data for 27 sectors in Oklahoma.[1] The analysis in this section is confined to the 12 endogenous sectors of the Oklahoma model.

Lack of data and methodology have resulted in few regional studies including data from a capital account in their analysis.[2] Capital data presented in this study and in the expanded report will be highly useful to state researchers conducting either sector analyses or economy-wide studies. The development economist should find the data useful in evaluating various policies and programs, whereas the sector

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[1]For the complete analysis, see Gerald A. Doeksen and Dean F. Schreiner, An Analysis of the Capital Structure by Private Sectors in Oklahoma, Technical Bulletin in Process, Oklahoma State Agricultural Experiment Station, Stillwater.

[2]Research reports by Zusman [128], Maki [50], and Spiegelman [71] contain regional capital accounts. Zusman constructed a capital account for California while Maki and Spiegelman constructed only that part of the capital account required for their model.

analyst should find the data helpful in studying individual sectors of the economy. Regional economists confronted with problems of constructing a regional capital account should find both reports helpful in terms of methodology and documentation.

Concepts and definitions used in deriving the capital account for this study are presented first. Following this development, the capital data are presented, the methodology is discussed, and data sources are specified.

Concepts and Definitions Used in the Oklahoma Capital Account

The capital coefficient matrix forms the base of the Oklahoma capital analysis. It can be derived from a capital flow matrix or by using direct survey techniques. Construction of capital coefficients using survey data was completed by R. M. Waddel [125]. Construction of capital coefficients from a capital flow matrix is illustrated by Jack Alterman [1]. Both of these studies were employed in this analysis. A capital coefficient matrix computed from capital flows is given as:

$$w_{ij} = \frac{b_{ij}}{b_j} \qquad (5.1)$$

where the b_{ij}'s are capital purchases of the j^{th} sector from the i^{th} sector and b_j is the total capital purchases of the j^{th} sector. Each capital coefficient (w_{ij}) indicates the amount of capital goods required from the i^{th} sector per dollar's worth of capital expenditures by the j^{th} sector.

A capital stock matrix is computed from the capital coefficient matrix and sector capital-output ratios. Capital-output ratios (K/X) for this analysis are defined as the ratio of total cost of plant and equipment to output at capacity.[3] Capacity is defined as that output equal to peak production. Once capacity output (X_j^c) is estimated the total amount of capital in each sector is known. The procedure is as follows:

$$X_j^c (K/X)_j = K_j \qquad (5.2)$$

where X_j^c is output at capacity for sector j and $(K/X)_j$ is the capital-output ratio for sector j. The capital stock matrix is determined by multiplying total sector capital stock estimates (K_j) by the capital coefficient matrix, that is:

$$K_j \cdot w_{ij} = K_{ij} \qquad (5.3)$$

where each K_{ij} represents the total amount of capital goods from sector i invested in sector j.

Some researchers desire to know the amount of capital invested and the composition of that capital per unit of output capacity of the producing sector. A matrix yielding this information is referred to as the capital unit coefficient matrix. It is computed as follows:

$$(K/X)_j \cdot w_{ij} = 0_{ij} \qquad (5.4)$$

where $(K/X)_j$ is the capital-output ratio of sector j and w_{ij} is the corresponding capital coefficient. Each coefficient (0_{ij}) indicates

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[3]Output is defined as value of total production rather than value added.

the amount of capital needed from the i^{th} sector to provide one unit of output capacity for the j^{th} sector.

Another matrix of importance is the investment coefficient matrix. By adding the capital unit coefficients (O_{ij}) and the inventory coefficients (S_{ij}) for a sector, the total amount of capital required per unit of output expansion is estimated. The investment coefficient matrix is calculated as follows:

$$\frac{O_{ij} + S_{ij}}{\sum_i (O_{ij} + S_{ij})} = I_{ij} \tag{5.5}$$

where ($O_{ij} + S_{ij}$) are the combined capital unit and inventory coefficients. Each I_{ij} indicates the value of output of the i^{th} sector required by the j^{th} sector per unit of investment in j. The difference between the investment coefficient matrix and the capital coefficient matrix are the inventory estimates. Inventory coefficients are defined as the amount of inventory held per unit of output.

The capital analysis is completed by developing depreciation coefficients. The coefficient d_j indicates the depreciation rate per dollar of depreciable assets:

$$d_j = \frac{D_i}{K_j} \tag{5.6}$$

where D_j is the total annual depreciation of capital stock in sector j.

The Oklahoma Capital Account

The sectors included in the Oklahoma capital analysis are the 12 endogenous sectors as specified in Chapter IV. A basic outline of the data was presented in Figure 3. The core matrix consists of the capital coefficients.

Capital Coefficient Matrix

Until recently, capital coefficients were estimated based on data obtained in the late 40's and early 50's. The primary source was a study conducted by Robert N. Grosse [26]. Data were obtained from studies prepared by several government agencies and universities participating in the Inter-industry Economics Research Program (1948-54) sponsored by the U. S. Air Force. The capital requirements presented by Grosse were for the year 1947 and based mainly on new plants or expansions of existing plants. One weakness of these data is that the studies covered only a small and not necessarily representative set of plants. Another weakness is that the technology represented in the studies is obsolete.

The Agency for International Development provided a more recent source [117 and 118] of capital data. Again these data are deficient in several ways. Capital coefficients were designed for small scale and simplified industrial operations. They also represented technologies adaptable for initial industrialization in developing countries rather than for the United States.

Two other research projects have measured the country's capital requirements. These include the McGraw-Hill Capital Expenditure Surveys [52] and the Harvard Economic Capital Research Project [29]. The Harvard project was for the year 1947 and thus is somewhat dated, whereas the McGraw-Hill estimates are for broad sectors and used mainly in national aggregate studies. Robert Eisner [17 and 18] used the McGraw-Hill expenditure data in some of his studies.

R. M. Waddel and others [125] have filled the research gap created since the above capital studies became outdated. Their study yielded capital coefficients for 252 manufacturing groups. The manufacturing industry groups were classified according to the four digit standard industrial classification and the data were for the year 1963. Thus, this source yielded coefficients which are the latest and most detailed. The 252 manufacturing industry groups were aggregated to represent the 19 Oklahoma manufacturing sectors in the 27 sector model and then re-aggregated to four sectors for the 12 sector state model. The aggregation was accomplished in two steps. First, the purchases of each four digit industrial group were aggregated to the two digit level. The number of computations for this task was large as the National Planning Association classified many purchases as modules. The module concept was used to simplify presentation of the capital data, but for the Oklahoma capital analysis, the composition of each module had to be determined.

A second step in the aggregation process consisted of aggregating the four digit industrial groups to the two digit industrial classification. Value of shipments as reported in the 1963 Census of Manufacturing were used as weights. In some instances, census data on the value of shipments were incomplete and the more available employment data were used.

Capital coefficients for the non-manufacturing sectors were not included in the National Planning Association study but were developed from a study by the U. S. Department of Labor [1]. This study used data from the Census of Manufacturers and the Office of Business

Economics to estimate the level of capital production by industry and to allocate to consuming sectors. Consumption of capital goods represented purchases made for replacement as well as for new plant construction. The Department of Labor study differs from Waddel's in its presentation and needed to be adjusted in order to have consistent coefficients for all sectors. Waddel's analysis distributed expenditures going to the construction sector back to input originating sectors, whereas the U. S. Department of Labor's analysis shows only construction expenditures. Thus, Waddel's capital coefficient matrix has a value added row which includes wages and salaries, profits, depreciation, etc., going to the construction sector. In order to make the Department of Labor's analysis similar to Waddel's, expenditures for construction were allocated to the various sectors according to the construction modules developed by Waddel [125].

Capital coefficients for the 12 endogenous sectors of the Oklahoma economy are presented in Table VII. By reading down a column, purchases of capital goods from producing sectors per dollar of capital investment by that sector are determined. For instance, for each dollar investment by sector 1 (livestock and livestock products), .00649 dollars worth of capital goods are purchased from sector 4 (petroleum and coal products), .23956 dollars from sector 5 (machinery, except electrical), etc.

Capital-Output Ratios

To analyze the relationship between capital and output, either the marginal ratio or average ratio is used. For this analysis,

TABLE VII

CAPITAL COEFFICIENTS, OKLAHOMA ECONOMY, 1963

Sector	Lvsk., & Lvsk. Products	Crops	Agric. Proc.	Petro.	Mach.	Other Manf.	Mining	Trans., Comm. & Pub. Ut.	Real Est., Fin. & Ins.	Service	Whole-sale & Retail	Constr.
Livestock and Livestock Products	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
Crops	.00000	.00000	.00033	.00050	.00036	.00040	.00000	.00000	.00000	.00000	.00000	.00000
Agricultural Processing	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
Petroleum and Coal Products	.00649	.00369	.00516	.00499	.00622	.00580	.00044	.00680	.00701	.00668	.00436	.00891
Machinery, Except Electrical	.23956	.40362	.25935	.16825	.30491	.27818	.59159	.07012	.16009	.10892	.19485	.26048
Other Manufacturing	.40653	.30175	.32933	.34202	.25361	.27176	.23299	.58560	.45614	.53174	.48505	.35284
Mining	.00150	.00085	.00365	.00461	.00414	.00408	.00010	.00157	.00162	.00154	.00101	.00206
Transportation, Communication and Public Utilities	.01180	.01680	.01369	.01570	.01491	.01497	.02180	.04204	.01027	.01210	.01533	.00841
Real Estate, Finance and Insurance	.00000	.00000	.03601	.04121	.03915	.03932	.00000	.00000	.00000	.00000	.00000	.00000
Services	.00000	.00000	.04415	.05052	.04803	.04819	.00000	.00000	.00000	.00000	.00000	.00000
Wholesale and Retail Trade	.09982	.14048	.00000	.00000	.00000	.00000	.13700	.04832	.11155	.09767	.14182	.04537
Construction	.23430	.13281	.30833	.37220	.32867	.33730	.01608	.24555	.25332	.24135	.15758	.32193

[a]Dollar amount of capital goods required from the sector at the left per dollar's worth of capital expenditures by the sector at the top.

capital-output ratios are used as averages and defined as the ratio of total cost of plant and equipment to output at capacity.

Manufacturing Sectors. The relationship between capital and output is discussed in detail by D. Creamer, S. P. Dobrovolsky, and I. Borenstein [12]. Their analysis studies the movement of capital-output ratios in manufacturing from 1880-1953 and in mining from 1870-1953. Another important source for capital-output data was completed by S. Kuznets [41]. Both Creamer and Kuznets used data published by the Internal Revenue Service [123] as the primary source.

Other capital studies for manufacturing were completed by G. H. Hildebrand and T. C. Liu [32], George J. Stigler [72], and Bert G. Hickman [31]. Hildebrand and Liu determined the marginal physical product and the marginal revenue product of capital. Stigler computed capital-output ratios for various manufacturing sectors. He calculated a capital-output ratio for a small and large plant in each sector for 1947 and 1954. Hickman developed an investment model from which he calculated long-run capital-output ratios.

The National Planning Association [125] provides the most recent and comprehensive capital-output ratios. This study provided ratios for 252 manufacturing sectors for 1963. To reflect the Oklahoma economy, value of shipments were used as weights to aggregate to four manufacturing sectors. The capital-output ratios are presented in column (1) of Table VIII. Listed in column (2) are the capital-output ratios with output defined at capacity.

Non-Manufacturing Sectors. Capital data for the non-manufacturing sectors of Oklahoma were not available and hence national capital-output ratios were used. National capital-output ratios were based on a definition of capital to average output rather than output at capacity. Using capacity estimates,[4] capital-output ratios based on average output were converted to output at capacity and are presented in column (2), Table VIII.

TABLE VIII

CAPITAL-OUTPUT RATIOS BY SECTOR, OKLAHOMA, 1963

Sector	Capital-Output Ratios[a] I (1)	II (2)
Livestock and Livestock Products	1.36609	1.30831
Crops	1.36609	1.30831
Agricultural Processing	.31724	.30160
Petroleum and Coal Products	.89871	.85000
Machinery, Except Electrical	.50998	.48555
Other Manufacturing	.66585	.56416
Mining	1.03068	.95534
Transportation, Communication and Public Utilities	2.32469	2.22868
Real Estate, Finance and Insurance	1.05314	1.03397
Services	.51244	.48036
Wholesale and Retail Trade	.51897	.49017
Construction	.19259	.18358

[a]The type I capital-output ratio is defined as average output, whereas the type II ratio is defined at capacity output. Output is equal to value of production and is consistent with sector output of the transaction account.

[4]Capacity estimates are presented in a later section.

The capital structure of agriculture is discussed in detail by A. S. Tostlebe [76]. He estimated capital-output ratios by regions for agriculture for 1950. The capital-output ratio for the Texas-Oklahoma region was 4.02 when including the value of land and 1.22 when using only reproducible assets [76, pp. 117, 108, and 109]. The change in the capital-output ratio from 1950 to 1963 was estimated by John W. Kendrick [37, p. 170]. These sources yielded a reproducible capital-output ratio for agriculture of 1.36609 for 1963.

Capital-output ratios for the remaining non-manufacturing sectors were estimated from Internal Revenue Service data [119]. Depreciable assets and receipts are reported by the Internal Revenue Service (IRS). Sector classification and sector output are defined similarly in the IRS and Oklahoma study. Sector output is defined as equal to receipts except for the wholesale and retail trade sector where output is equal to value of products sold minus cost of goods purchased.

Capital Unit Matrix

The capital coefficients and the capital-output ratios are used to construct a capital unit matrix. Each coefficient (O_{ij}) indicates the capital goods required from sector i to produce one unit of output capacity for sector j. The coefficients are computed by multiplying the capital coefficients of sector j from Table VII by the corresponding j^{th} sector capital-output ratio from Table VIII. The capital unit coefficients are presented in Table IX. For this analysis, a unit of output is defined in dollars, thus each coefficient indicates the dollar amount of capital goods needed from the producing sector per dollar increase in output of the purchasing sector. For example,

TABLE IX

CAPITAL UNIT MATRIX, OKLAHOMA ECONOMY, 1963

Sector	Lvsk., & Lvsk. Products	Crops	Agric. Proc.	Petro.	Mach.	Other Manf.	Mining	Trans., Comm. & Pub. Ut.	Real Est., Fin. & Ins.	Service	Whole-sale & Retail	Constr.
Livestock and Livestock Products	.80197	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
Crops	.00000	.00000	.00010	.00042	.00018	.00022	.00000	.00000	.00000	.00000	.00000	.00000
Agricultural Processing	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
Petroleum and Coal Products	.00328	.00482	.00156	.00424	.00302	.00327	.00042	.01515	.00725	.00321	.00214	.00164
Machinery, Except Electrical	.12129	.52806	.07822	.14301	.14805	.15694	.56517	.15627	.16553	.05232	.09551	.04782
Other Manufacturing	.20588	.39478	.09933	.29072	.12314	.15332	.22258	1.30513	.47163	.25543	.23776	.06477
Mining	.00076	.00111	.00110	.00392	.00201	.00230	.00010	.00350	.00167	.00074	.00050	.00038
Transportation, Communication and Public Utilities	.00597	.02198	.00413	.01335	.00724	.00845	.02083	.09369	.01062	.00581	.00751	.00154
Real Estate, Finance and Insurance	.00000	.00000	.01086	.03503	.01901	.02218	.00000	.00000	.00000	.00000	.00000	.00000
Services	.00000	.00000	.01332	.04294	.02332	.02719	.00000	.00000	.00000	.00000	.00000	.00000
Wholesale and Retail Trade	.05054	.18379	.00000	.00000	.00000	.00000	.13088	.10769	.11534	.04692	.06951	.00833
Construction	.11862	.17377	.09298	.31637	.15958	.19029	.01536	.54725	.26193	.11593	.07724	.05910
Capital-Output Ratio	1.30831	1.30831	.30160	.85000	.48555	.56416	.95534	2.22868	1.03397	.48036	.49017	.18358

[a]Dollar amount of capital goods required from the sector at the left to produce one unit of output capacity for the sector at the top.

consider sector 3 (agricultural processing). For each dollar of output at capacity the sector requires .00010 dollars worth of capital goods from sector 2 (crops), .00156 dollars worth of capital goods from sector 4 (petroleum and coal products), etc.

This matrix is useful when considering the amount of capital needed to increase output in a particular sector. Output can be increased without additional capital as long as the sector is not operating at capacity. If a sector is at capacity and output needs to be expanded, capital per unit of output will be required according to the capital-output ratio. Composition of the required capital is determined from the capital unit matrix.

Capacity Estimates

Capacity estimates are difficult to measure and all present studies have inherent weaknesses. At least five different research groups measure industrial capacity at the national level. These groups include McGraw-Hill Department of Economics, the National Industrial Conference Board, Fortune magazine, the Wharton School Econometrics Unit, and the Division of Research and Statistics, Federal Reserve System.

The McGraw-Hill Department of Economics' estimates are based on their "Annual Survey of Business Plans for New Plants and Equipment." Firms are aggregated into 15 major industrial classifications at the national level. No effort has been made to define capacity in the survey and the individual companies are aggregated to industry levels through the use of employment weights [25]. The capacity estimates of the National Industrial Conference Board are obtained from fixed capital data as reported on the balance sheet of corporate income tax returns and published in Statistics of Income [123].

Very little can be said about the capacity estimates of Fortune magazine because of the lack of information describing how the estimates are derived and the admitted use of subjective judgment in the determination of data [25]. The Division of Research and Statistics of the Federal Reserve Board has two measures of capacity. One is the monthly output and annual capacity series. The other is a capacity measure based on a combination of the Index of Production, McGraw-Hill capacity data and the Department of Commerce estimate of constant dollar fixed capital stock. Both measures are aggregate economy capacity estimates and of little use for this analysis.

The most recent capacity measure is that of the Wharton School Econometrics Unit [38]. The procedure is extremely simple, but yet is considered as good as the other estimates [40]. The Federal Reserve Board Indexes of Industrial Production are averaged into quarterly figures. These are charted and peaks are determined by inspection. One hundred percent capacity is assumed for each peak period and a straight line connecting peaks describes capacity between peaks. For any period which the latest peak has not been reached, a straight line is extrapolated from the last peak period until production intersects that line. After such an intersection, capacity is assumed equal to the line connecting the last peak and the most recent production figure.

A similar method was used to derive capacity levels for the 12 sectors in Oklahoma. However employment data were used as proxies for the production indexes. Although employment data are not as good an indicator as the production index, it is the best statistic available at the state level. The capacity estimates for Oklahoma's 12 sectors are presented in Table X. For example, sector 4 (petroleum and coal products) is estimated to be operating at 94.58 percent of capacity. With capacity estimates, capital-output ratios and the capital coefficient matrix, a capital stock matrix is estimated.

TABLE X

CAPACITY LEVELS BY MAJOR INDUSTRY GROUP, OKLAHOMA, 1963

Sector	Capacity Level 1963
	(Percent)
Livestock and Livestock Products	95.77
Crops	95.77
Agricultural Processing	95.07
Petroleum and Coal Products	94.58
Machinery, Except Electrical	95.21
Other Manufacturing	84.73
Mining	92.69
Transportation, Communication and Public Utilities	95.87
Real Estate, Finance and Insurance	98.18
Services	93.74
Wholesale and Retail Trade	94.45
Construction	95.32

Capital Stock Matrix

The capital-output ratio (defined as capital to output at capacity) times the estimated output at capacity yields the amount of capital in each sector. The amount of capital in a sector times that sector's capital coefficients column from the capital coefficient matrix yields the composition of each sector's capital. The capital stock matrix for the 12 sectors in the Oklahoma model for 1963 is presented in Table XI. Each element (K_{ij}) represents the total value of capital goods produced by sector i and invested in sector j. For example, in sector 5 (machinery, except electrical), total investment for 1963 is $117,947,000 of which $42,000 is from sector 2, $734,000 from sector 4, etc.

Inventory Coefficients

Inventories consist of two types: (1) raw materials and goods in process, and (2) finished goods. Data to derive estimates on the state level are, in general, unavailable and hence national inventory coefficients were adopted. Use of national coefficients assume that the inventory level per unit of output in Oklahoma is the same as in the nation as a whole. The inventory coefficients are presented in Table XII and indicate the amount of inventory needed per unit of output. Techniques used to derive the coefficients and the data sources are discussed under three groupings: the agricultural sectors, manufacturing sectors, and the remaining sectors.

Agricultural Sectors. For sector 1 (livestock and livestock products), finished goods were assumed to be the total value of cattle, sheep, and hogs on farms. The estimate of total value of livestock on farms was obtained by taking the average of the value of cattle, sheep and hogs on farms on January 1, 1963, and January 1, 1964 [59]. An adjustment was made to remove the value of livestock included as capital

TABLE XI

CAPITAL STOCK MATRIX BY MAJOR INDUSTRY GROUP, OKLAHOMA, 1963

Sector	Lvsk., & Lvsk. Products	Crops	Agric. Proc.	Petro.	Mach.	Other Manf.	Mining	Trans., Comm. & Pub. Ut.	Real Est., Fin. & Ins.	Service	Whole-sale & Retail	Constr.
Livestock and Livestock Products	318,459	0	0	0	0	0	0	0	0	0	0	0
Crops	0	0	52	297	42	591	0	0	0	0	0	0
Agricultural Processing	0	0	0	0	0	0	0	0	0	0	0	0
Petroleum and Coal Products	1,304	2,043	810	2,959	734	8,569	471	15,201	3,546	3,541	3,108	2,114
Machinery, Except Electrical	48,165	224,061	40,717	99,783	35,963	411,009	633,827	156,745	80,981	57,741	138,913	61,809
Other Manufacturing	81,753	167,510	51,703	202,840	29,912	401,523	249,625	1,309,039	230,737	281,886	345,803	83,724
Mining	301	472	573	2,734	488	6,028	107	3,510	820	816	720	489
Transportation, Communication and Public Utilities	2,369	9,326	2,149	9,311	1,759	22,118	23,357	93,975	5,195	6,414	10,929	1,996
Real Estate, Finance and Insurance	0	0	5,653	24,440	4,618	58,095	0	0	0	0	0	0
Services	0	0	6,931	29,962	5,665	71,200	0	0	0	0	0	0
Wholesale and Retail Trade	20,069	77,984	0	0	0	0	146,781	108,013	56,427	51,777	101,107	10,766
Construction	47,106	73,732	48,407	220,739	38,766	498,358	17,228	548,897	128,141	127,944	112,342	76,390
Total	519,526	555,128	156,995	593,065	117,947	1,477,491	1,071,396	2,235,380	505,847	530,119	712,922	237,288

[a]Total value of capital goods produced by the sector at the left and invested in the sector at the top.

stock. The amount of raw materials and goods in process was assumed equal to one month's production. For sector 2 (crops), the amount of finished goods as inventory was obtained by taking the average of the value of stocks of grain on farms on January 1, April 1, June 1, and October 1 [58]. Inventory of raw materials and goods in process was assumed equal to one month's production.

TABLE XII

INVENTORY COEFFICIENT BY MAJOR INDUSTRY GROUP, OKLAHOMA, 1963

Sector	Coefficient[a]
Livestock and Livestock Products	.556153
Crops	.455087
Agricultural Processing	.096812
Petroleum and Coal Products	.101158
Machinery, Except Electrical	.219640
Other Manufacturing	.144953
Mining	.066821
Transportation, Communication and Public Utilities	.040943
Real Estate, Finance and Insurance	.005525
Services	.027519
Wholesale and Retail Trade	.366129
Construction	.050028

[a]Dollar amount of inventory per dollar of output.

<u>Manufacturing Sectors</u>. The Census of Manufacturers [84 and 85] provided national inventories of raw materials and goods in process

and of finished goods on January 1, 1963, and January 1, 1964. The average was assumed the inventory level for 1963. The amount of domestic production was the value of shipments plus the change in finished goods inventory. Value of inventories divided by domestic production yielded the inventory coefficient.

Remaining Sectors.[5] The inventory coefficients of the remaining sectors were obtained using Internal Revenue data [124] and the 1963 U. S. input-output table [108]. Internal Revenue data presented the amount of inventory for each of the remaining sectors. The Internal Revenue Service definition of inventory was similar to that used in this analysis. Value of output for these sectors was also obtained from the Internal Revenue Service [124], except for wholesale and retail trade which was obtained from the national input-output table [108]. The inventory and output estimates were used to derive inventory coefficients for the remaining sectors.

Investment Matrix

Frequently it is desirable to know the total amount of capital needed to expand output as well as its composition. By adding the capital unit coefficients and the inventory coefficients for a sector, the total amount of capital required per unit of output expansion is obtained. From the combined capital unit and inventory coefficient matrixes, an investment matrix is calculated. Each coefficient (I_{ij}) in the investment matrix is obtained by dividing the column entry of the combined matrix by the total of all entries for that column.

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[5]Includes: mining; construction; transportation, communication and public utilities; real estate, finance and insurance; wholesale and retail trade; and services.

Investment coefficients are defined as the value of output of the producing sector i needed by the purchasing sector j per unit of investment in j. The investment matrix is presented in Table XIII.

Sector 6 (other manufacturing) shows that for each dollar of investment in that sector, .00031 dollars worth of capital goods are required from sector 2, .00461 dollars worth from sector 4, .22132 dollars worth from sector 5, .42063 dollars worth (which includes investment of its own capital products and the necessary inventory) from sector 6, .00324 dollars worth from sector 7, etc. The difference between the investment coefficients and the capital coefficients is that the investment coefficients include capital and inventory expenses per unit of investment, while the capital coefficients include only the capital requirements per dollar of capital investment in a sector.

Depreciation Coefficients

To complete the capital structure analysis, depreciation coefficients were estimated. Depreciation rates were estimated as the ratio of depreciation to depreciable assets. The amount of annual depreciation and depreciable assets were obtained from U. S. Internal Revenue Service, U. S. Business Tax Return [124]. Depreciation rates adopted for the Oklahoma capital analysis are presented in Table XIV. These coefficients indicate that the annual depreciation rate for the various sectors ranges from four percent to ten percent of total depreciable assets.

TABLE XIII

INVESTMENT MATRIX BY MAJOR INDUSTRY GROUP, OKLAHOMA, 1963

Sector	Lvsk., & Lvsk. Products	Crops	Agric. Proc.	Petro.	Mach.	Other Manf.	Mining	Trans., Comm. & Pub. Ut.	Real Est., Fin. & Ins.	Service	Whole-sale & Retail	Constr.
Livestock and Livestock Products	.72843	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
Crops	.00000	.25808	.00025	.00044	.00024	.00031	.00000	.00000	.00000	.00000	.00000	.00000
Agricultural Processing	.00000	.00000	.24299	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
Petroleum and Coal Products	.00176	.00273	.00391	.11081	.00428	.00461	.00041	.00668	.00697	.00632	.00250	.00702
Machinery, Except Electrical	.06505	.29946	.19633	.15035	.52140	.22132	.55292	.06885	.15924	.10302	.11154	.20470
Other Manufacturing	.11042	.22387	.24931	.30565	.17462	.42063	.21775	.57504	.45371	.50293	.27766	.27726
Mining	.00041	.00063	.00276	.00412	.00285	.00324	.06547	.00154	.00612	.00146	.00058	.00163
Transportation, Communication and Public Utilities	.00320	.01246	.01036	.01404	.01027	.01192	.02038	.05932	.01022	.01144	.00877	.00659
Real Estate, Finance and Insurance	.00000	.00000	.02726	.03683	.02696	.03128	.00000	.00000	.00531	.00000	.00000	.00000
Services	.00000	.00000	.03343	.04514	.03307	.03834	.00000	.00000	.00000	.05419	.00000	.00000
Wholesale and Retail Trade	.02711	.10423	.00000	.00000	.00000	.00000	.12804	.04745	.11096	.09238	.50875	.03566
Construction	.06362	.09854	.23340	.33262	.22631	.26835	.01503	.24112	.25197	.22826	.09020	.46714

[a]Dollar amount of output from the producing sector on the left per unit of total investment needed by the sector at the top.

TABLE XIV

DEPRECIATION RATES BY MAJOR INDUSTRY GROUP, OKLAHOMA, 1963

Sector	Depreciation Rate[a]
Livestock and Livestock Products	.072086
Crops	.098516
Agricultural Processing	.071142
Petroleum and Coal Products	.043179
Machinery, Except Electrical	.084133
Other Manufacturing	.071719
Mining	.067066
Transportation, Communication and Public Utilities	.041202
Real Estate, Finance and Insurance	.047404
Services	.108985
Wholesale and Retail Trade	.083568
Construction	.104708

[a]Annual dollar depreciation to depreciable assets.

CHAPTER VI

THE HUMAN RESOURCE ACCOUNT

A comprehensive social accounting system needs to incorporate the impact of changes in human resources. Data in the account describes the quantity and quality of human resources. Quantity is recorded by means of resource stock accounts, such as population, employment, and labor force. Quality of resources may be recorded in terms of productivity units, such as output-employment ratios, and wage, salary, and income rates.

Population

In 1963, an estimated 2,411,000 people lived in Oklahoma. This compares with a population of 2,233,000 in 1950 and 2,498,000 in 1970. Population estimates for the state, Standard Metropolitan Statistical Areas (SMSA's) and non-SMSA's are presented in Table XV. From 1950 to 1960, the population in Oklahoma increased four percent, whereas from 1960 to 1970 it increased seven percent. From 1950 to 1970, Oklahoma's population has also been shifting to large metropolitan areas. In 1950, 776,000 people or 35 percent of the state's population lived in SMSA's. By 1960, 1,022,000 people or 44 percent of the state's inhabitants lived in SMSA's and by 1970 the population of SMSA's rose to 1,200,000 or 48 percent of the total state's population.

TABLE XV

TOTAL POPULATION FOR 1950, 1960, 1963 and 1970
FOR OKLAHOMA AND SMSA'S IN OKLAHOMA

Year	SMSA's[a]	Non-SMSA's	Total
		(In Thousands)	
1950	776	1,457	2,233
1960	1,022	1,306	2,328
1963	1,064	1,347	2,411
1970	1,200[b]	1,298[b]	2,498[b]

[a]Counties included in the SMSA's are Canadian, Cleveland, Camanche, Creek, Oklahoma, Osage, and Tulsa.

[b]Preliminary estimates.

Source: U. S. Census of Population, 1950, 1960 and Preliminary 1970, United States Bureau of the Census and Statistical Abstract of Oklahoma, Bureau of Business Research, University of Oklahoma.

Employment

Associated with the population movement to the metropolitan areas was a decrease in employment in agriculture and an increase in employment in industry and related services. General characteristics of the labor force for 1950, 1960, and 1963-1969 are presented in Table XVI. Employment in agriculture (family workers and hired workers) decreased 39 percent from 255,000 in 1950 to 156,000 in 1960. From 1960 to 1969, the number employed in agriculture decreased 21 percent from 156,000 to

124,000. Employment in industry and related services as reflected in wage and salary employment estimates was 477,000 in 1950, 582,000 in 1960 and 754,000 in 1969. This was a 22 percent increase from 1950 to 1960, and a 30 percent increase from 1960 to 1969.

TABLE XVI

OKLAHOMA LABOR FORCE FOR 1950, 1960 AND 1963-69

Year	Agri-culture	Non-Agricultural Wage and Salary Employment	Self-Employed	Total Employed	Un-employed[a]	Total Labor Force
			(In Thousands)			
1950	255	477				
1960	156	582	123	861	44	905
1963	144	612	119	875	43	918
1964	129	624	118	871	36	907
1965	120	648	119	887	32	919
1966	120	682	118	920	30	950
1967	129	706	114	949	33	982
1968	125	726	114	965	30	995
1969	124	754	115	993	35	1,028

[a]Includes thos unemployed as a result of labor disputes.

Source: Oklahoma Department of Agriculture, Oklahoma Agriculture, various years, and Oklahoma Employment Security Commission.

The number of self-employed decreased seven percent from 1960 to 1969, while the number of unemployed decreased 20 percent from 44,000 in 1960 to 35,000 in 1969. Total labor force increased from 905,000 in 1960 to 1,028,000 in 1969.

Data in Table XVII show how wage and salary employment by sector and proprietor employment has changed from 1963 through 1968. Wage and salary employment in agriculture decreased 35 percent from 26,000 in 1963 to 17,000 in 1968. In the agricultural processing and petroleum and coal products sectors, wage and salary employment increased slightly from 1963 through 1968. A substantial increase in wage and salary employment occurred from 1963 through 1968 in the machinery and other manufacturing sectors. These sectors had a 51 and 42 percent growth in wage and salary employment, respectively.

From 1963 through 1968, the construction and mining sectors had a decrease in wage and salary employment of seven and four percent, respectively. The transportation, communication and public utilities, and real estate, finance and insurance sectors had a 12 and 18 percent increase in wage and salary employment, respectively. Wage and salary employment in the services sector increased 27 percent from 82,400 in 1963 to 104,300 in 1968. In the wholesale and retail trade sector, wage and salary employment increased 13 percent from 141,900 in 1963 to 160,100 in 1968. Government employment increased by 26 percent from 1963 through 1968.

A sector's percent of total wage and salary employment indicates the relative importance of that sector as a source of employment. The government sector employed 22.4 percent of all wage and salary workers in 1963. Following were wholesale and retail trade and services with

TABLE XVII

WAGE AND SALARY EMPLOYMENT BY INDUSTRY SECTOR AND PROPRIETOR EMPLOYMENT, OKLAHOMA, 1963-1968

	1963	1964	1965	1966	1967	1968
Wage and Salary Employment						
Agriculture	26,000	20,000	19,000	18,000	19,000	17,000
Agricultural Processing	15,500	15,400	15,300	15,500	15,400	15,800
Petroleum and Coal Products	7,500	7,500	7,700	7,900	8,000	7,900
Machinery, Except Electrical	10,500	11,300	12,200	14,200	15,400	15,900
Other Manufacturing	57,300	62,400	67,800	75,700	77,600	81,200
Mining	42,400	42,200	42,400	42,100	41,000	40,800
Transportation, Communication and Public Utilities	46,000	45,900	46,500	47,800	49,500	51,500
Real Estate, Finance and Insurance	29,100	30,500	31,300	32,500	33,800	34,300
Services	82,400	86,400	88,200	92,300	99,500	104,300
Wholesale and Retail Trade	141,900	143,600	148,100	153,200	157,200	160,100
Construction	36,900	35,500	35,500	34,400	32,500	34,500
Government	142,900	143,600	152,900	166,500	176,400	180,200
Total Wage and Salary Employment	638,400	644,300	666,900	700,100	725,300	743,500
Proprietor Employment						
Agriculture[a]	117,500	109,000	101,000	102,000	110,000	108,000
Non-agriculture	118,800	118,000	119,000	118,000	114,000	114,000
Total Proprietor Employment	236,300	227,000	220,000	220,000	224,000	222,000
Total Employment	874,700	871,300	886,900	920,100	949,300	965,500

[a]Includes family workers in agriculture.

Source: Oklahoma Department of Agriculture, Oklahoma Agriculture, Annual Reports from 1963 to 1969, U. S. Department of Labor, Employment and Earnings Statistics for States and Areas 1939-1968, and Oklahoma Employment Security Commission.

22.2 and 12.9 percent respectively in 1963. The other manufacturing sector employed 9.0 percent of the total 1963 wage and salary workers. By 1968, the ranking of the four sectors with the largest number of wage and salary employees had not changed. The government sector employed 24.2 percent, wholesale and retail trade 21.5 percent, services 14.0 percent, and other manufacturing 10.9 percent of the total wage and salary employment.

Proprietor employment decreased from 236,300 in 1963 to 222,000 in 1968 (Table XVII). During this period, proprietor employment in agriculture decreased eight percent from 117,500 to 108,000, whereas non-agricultural proprietor employed decreased four percent from 118,800 to 114,000. The self-employed or proprietor employment by industrial class for 1963 is presented in Table XVIII. The agricultural sector contained nearly half of the self-employed in 1963. Following the agricultural sector, were the service and wholesale and retail trade sectors with 16.6 and 15.0 percent respectively of the total proprietor employment.

Income

Personal income in Oklahoma increased from $4,880 million in 1963 to $7,259 million in 1968. The components of personal income for 1963 through 1968 are specified in Table XIX. Wage and salary payments increased 49 percent from $2,986 million in 1963 to $4,446 million in 1968. The manufacturing sector has a 70 percent increase in wage and salary payments from 1963 through 1968. Following were the government and services sectors with increases of 61 percent and 53 percent respectively. From 1963 through 1968, an increase of 31 percent occurred

TABLE XVIII

PROPRIETOR EMPLOYMENT BY INDUSTRY SECTOR, OKLAHOMA, 1963

Sector	Proprietor Employment	Percent of Total Proprietor Employment
Agriculture	117,500	49.7
Agricultural Processing	445	.2
Petroleum and Coal Products	215	.1
Machinery, Except Electrical	298	.1
Other Manufacturing	1,650	.7
Mining	5,824	2.5
Transportation, Communication and Public Utilities	5,062	2.1
Real Estate, Finance and Insurance	16,360	6.9
Services	39,205	16.6
Wholesale and Retail Trade	35,425	15.0
Construction	14,316	6.1
Total	236,300	100.0

Source: Estimates were obtained from the U. S. Internal Revenue Service, Statistics of Income, 1963, and Oklahoma Employment Security Commission.

TABLE XIX

PERSONAL INCOME, OKLAHOMA, 1963-1968

	1963	1964	1965	1966	1967	1968
			(Millions of Dollars)			
Wage and Salary Payments	2,986	3,193	3,390	3,719	4,059	4,446
Farm	33	27	27	27	31	30
Mining	272	281	295	305	311	334
Contract Construction	177	178	188	193	197	225
Manufacturing	486	544	598	685	733	825
Wholesale and Retail	518	552	591	629	688	720
Real Estate, Finance and Insurance	131	141	147	160	173	188
Transportation, Communication and Public Utilities	267	280	292	315	340	374
Services	307	332	339	368	413	469
Government	789	853	905	1,030	1,185	1,273
Other Industries	7	6	8	8	8	11
Other Labor Income	132	148	162	182	194	213
Proprietor's Income	667	710	809	812	870	872
Farm	213	217	305	298	292	273
Nonfarm	454	494	504	514	577	599
Property Income	370	789	883	1,001	1,084	1,160
Transfer Payments	482	502	543	599	696	791
Less Personal Contributions to Social Insurance	117	122	130	168	205	222
Total Personal Income	4,880	5,220	5,657	6,145	6,697	7,259

Source: U. S. Department of Commerce, *Survey of Current Business*, Various issues from 1966-69.

in proprietor income. During this period, farm proprietor income increased 28 percent. Property income increased from $730 million in 1963 to $1,160 million in 1968 for a 59 percent increase, transfer payments increased 64 percent from $482 million in 1963 to $791 million in 1968.

Wage and salary payments and proprietor payments by sector are presented in Table XX. Listed in column (1) of Table XX are wage and salary payments by sector and in column (2) are the percentages by sector of the total wage and salary payments. These percentages indicate the relative importance of each sector as a source of wage and salary income earned in Oklahoma in 1963. The wholesale and retail trade sector had the largest percent at 17.4. Federal government, other manufacturing, state and local government, and services contributed 15.0, 11.4, 11.4, and 10.3 percent, respectively, to total wage and salary income earned in 1963.

Proprietor income earned in Oklahoma totaled $667 million in 1963, of which $213 million was earned by farm proprietors. Data from tax returns were used to allocate the nonfarm proprietor income to the various sectors.[1] Column (3) of Table XX lists sector proprietor income allocations and column (4) lists percentages by sector of total proprietor income. These percentages indicate the relative importance of each sector as a source of proprietor income. In 1963, the agricultural sector accounted for 31.9 percent of the proprietor income

[1]Data from U. S. Treasury Department, Statistics of Income, 1963, Washington, D. C., provided profits by industrial classification of sole proprietors and partnership firms in Oklahoma. These data were used to allocate the proprietor income as reported in the Survey of Current Business, Vol. 46, Number 8, August, 1966.

TABLE XX

SOURCE OF WAGE AND SALARY INCOME, PROPRIETOR INCOME, AND TOTAL CIVILIAN INCOME BY INDUSTRY SECTOR, OKLAHOMA, 1963

Sector	Wage and Salary Payments (1)	Percent of Total Wages and Salaries (2)	Proprietor Income (3)	Percent of Total Proprietor Income (4)	Total Civilian Income (5)	Percent of Total Civilian Income (6)
	(000)		(000)		(000)	
Agriculture	$ 33,000	1.1	$213,000	31.9	$ 246,000	6.7
Agricultural Processing	58,514	2.0	1,917	.3	60,431	1.7
Petroleum and Coal Products	32,222	1.1	925	.1	33,147	.9
Machinery, Except Electrical	53,897	1.8	1,283	.2	55,180	1.5
Other Manufacturing	341,367	11.4	7,107	1.1	348,474	9.5
Mining	272,000	9.1	13,316	2.0	285,316	7.8
Transportation, Communication and Public Utilities	267,000	8.9	14,700	2.2	281,700	7.7
Real Estate, Finance and Insurance	131,000	4.4	40,978	6.1	171,978	4.7
Services	307,000	10.3	206,898	31.0	513,898	14.1
Wholesale and Retail Trade	518,000	17.4	119,733	18.0	637,733	17.5
Construction	177,000	5.9	47,143	7.1	224,143	6.1
Other Industries	7,000	.2	---	---	7,000	.2
Federal Government	449,000	15.0	---	---	449,000	12.3
State and Local Government	340,000	11.4	---	---	340,000	9.3
Total	$2,987,000	100.0	$667,000	100.0	$3,654,000	100.0

Source: Estimates were obtained from U. S. Treasury Department, Statistics of Income, 1963, and U. S. Department of Commerce, Survey of Current Business, Vol. 46, Number 8, August, 1966, Table 47.

earned in Oklahoma. Services ranked second with 31.0 percent and wholesale and retail trade ranked third with 18.0 percent of total proprietor income.

Total civilian income by industrial grouping is listed in column (5) of Table XX. In column (6) are the percentages that each sector contributed to total income. The wholesale and retail sector accounted for 17.5 percent of the total civilian income earned in Oklahoma in 1963. Next in order were the service, federal government, and other manufacturing sectors which contributed 14.1, 12.3, and 9.5 percent, respectively.

Productivity Rates

Output-Employment Ratios

From the employment data presented above and output data presented in Chapter IV, output-employment ratios are calculated. The ratio indicates the amount of output accounted for by each worker by industry grouping. The output-employment ratios are presented in Table XXI.

The petroleum sector had the highest output-employment ratio at $85,535. The high degree of capital intensity in this sector accounts for the large output-employment ratio. Following the petroleum sector in order of magnitude of the output-employment ratios were the agricultural processing and construction sectors at $31,036 and $24,056 respectively. Next in order of magnitude were the mining and machinery sectors.

TABLE XXI

OUTPUT-EMPLOYMENT RATIOS BY INDUSTRY
GROUPING, OKLAHOMA, 1963

Industry	Ratio
Agriculture	$ 5,482
Agricultural Processing	31,036
Petroleum and Coal Products	85,535
Machinery, Except Electrical	21,419
Other Manufacturing	21,236
Mining	21,556
Transportation, Communication and Public Utilities	18,832
Real Estate, Finance and Insurance	10,566
Services	8,507
Wholesale and Retail Trade	7,747
Construction	24,056

Wage and Salary and Proprietor Income Rates

Using the employment and income data, wage and salary and proprietor income rates for each industry grouping are calculated. Wage and salary rates per employee are presented in column (1) of Table XXII. These rates were computed by dividing wage and salary payments by the number of wage and salary workers in each sector (Table XVII). Mining had the highest yearly wage and salary rate at $6,415 per worker. Next in order of magnitude were the other manufacturing and transportation, communication and public utilities sectors at yearly wage and salary rates of $5,957 and $5,804, respectively.

Proprietor income rates are listed in column (2) of Table XXII. The rates are calculated by dividing the number of proprietors

(Table XVIII) into the proprietor income of that industry grouping (Table XX). The service sector had the highest proprietor income rate at $5,277 per year.

TABLE XXII

WAGE AND SALARY AND PROPRIETOR INCOME RATES, OKLAHOMA, 1963

Industry Grouping	Wage and Salary Wage Rate (1)	Proprietor Income Rate (2)
Agriculture	$1,269	$1,813
Agricultural Processing	3,775	4,307
Petroleum and Coal Products	4,296	4,307
Machinery, Except Electrical	5,133	4,307
Other Manufacturing	5,957	4,307
Mining	6,415	2,286
Transportation, Communication and Public Utilities	5,804	2,904
Real Estate, Finance and Insurance	4,502	2,505
Services	3,726	5,277
Wholesale and Retail Trade	3,650	3,380
Construction	4,797	3,293
Government	5,521	---

CHAPTER VII

SIMULATION MODEL OF THE OKLAHOMA STATE ECONOMY

A model is one methodological device employed by economists to investigate economic problems. Often, models are a simple abstraction of real problems. But, simple abstraction is seldom sufficient to satisfy the quest for reality, and hence, models are modified in many ways in order to approach the real world conditions. Modifications often make the model very complex and frequently unmanagable. The introduction of the digital computer made it possible to manage larger, more complex models and simulation became popular as a tool in reducing abstraction and increasing reality in economic models.

There is no clear, concise definition of simulation. Robert C. Meier, William T. Newell, and Harold L. Payer[1] define simulation as the use of a model to represent, over time, essential characteristics of a system or process under study. In a problem, the system would be given the initial conditions, parameters, and variables. The simulation model then generates values of certain preselected variables. These values, in turn, are used for the next time span and the model is run again. Simulation allows the introduction of many relationships

[1]Robert C. Meier, William T. Newell, and Harold L. Payer, Simulation in Business and Economics, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1969, page 2.

which conventional models do not. In this sense, simulation is a technique for testing and evaluating a proposed system in a laboratory environment. This approach makes simulation a very powerful tool in economic analysis. Meier, Newell, and Payer state the usefulness of simulation as a tool for solving economic problems as follows:[2]

> Simulation as a tool of economic analysis and model building is particularly useful in dealing with the dynamic behavior of economic systems over time. In contrast to some mathematical approaches to analysis of dynamic systems, simulation enables the investigator to determine not only the long-run state of the system, but also the time path through which the system travels to reach its final state.

Previous Simulation Studies

Economic studies using simulation became popular in the mid 50's. Since then, many researchers have used the technique. These studies can be broadly classified as either macro or micro in nature. A. Halter and G. W. Dean's [27] range-feedlot operation is an illustration of a micro simulation study. Macro simulation studies initially centered around national economics. Edward P. Holland and Robert L. Gillespie [33] constructed a simulation model to investigate problems of economic growth. A very useful simulation model is the Brookings econometric model [15]. It contains over 300 equations and was developed with the objective of forecasting and analyzing economic events. Macro studies based on regions have been more limited.

H. R. Hamilton and others [28] developed a simulation model for the Susquehanna River Basin. The model is composed of three major

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[2] Robert C. Meier, William T. Newell, and Harold L. Payer, Simulation in Business and Economics, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1969, p. 118.

sectors representing important categories of variables: demographic, employment, and water. The model has important feedbacks which permit projection of population, labor-force, unemployment and migration. Wilbur R. Maki, Richard E. Suttor, and Jerald R. Barnard [50] have developed a simulation model around the basic Leontief input-output equation. Additional equations were added in a recursive nature to make the model as realistic to a state economy as possible. They simulated Iowa's employment, population, tax revenues and income to 1974. W. E. Mullendore [55] added a demographic sector to the Iowa model similar to that found in the Susquehanna study. J. A. MacMillion adapted the Maki, Suttor, and Barnard simulation model to provide a structural framework for the appraisal of state and substate public systems performance [49].

The Oklahoma Simulation Model

The Oklahoma simulation model is formulated around the basic Leontief input-output system. The complete multiple-sector recursive model consists of 51 major equations. Many of the 51 major equations are disaggregated into sub-equations; that is, having one sub-equation for each endogenous sector in the Oklahoma economy. Thus, the entire system includes over 300 equations. The model was formulated in Fortran and can be run on the computer at relatively low cost. The researcher can experiment with the model by changing variables and measuring their impact.

The model can be generalized as comprising three main subparts which include: (1) estimating final demand, (2) determining sector output, and (3) deriving state projections. First, equations were developed to estimate final demand. Included as final demand sectors were capital formation, households, exports, federal government, and state and local governments. Secondly, after final demand was estimated, output requirements by endogenous sector were determined with the Leontief input-output model. Thirdly, sector output estimates were used to derive state economic projections. Variables projected by the model include income, employment, taxes, and gross product.

The model is presented in detail in this chapter. The complete listing of variables, matrixes, and scalars are presented in Tables XXIII, XXIV and XXV. Variables are presented by letters, matrixes by the capital letter A, and scalars by the small letter s. In Figure 4, a flow chart of the variables is presented. The flow chart helps in explaining how final demand is used to estimate output and how output is used to project various state economic variables.

Relationships Projecting Final Demand

Capital Formation. The accelerator principle reflects the fact that a change in output over time, or from one period to another, influences net investment as the addition to capital stock in a period of time. The investment due to changes in output is known as "induced investment" as opposed to "autonomous investment" which is not influenced directly by recent changes in output. Thus, total investment in a period is made up of two components: (1) replacement or autonomous investment, and (2) new plant and equipment or induced investment. The technique adopted in this analysis is similar to recent theory proposed by Jorgenson and contains the two components of investment [36].

TABLE XXIII

VARIABLES IN OKLAHOMA SIMULATION MODEL

Variable	Description
K_t	Column vector of capital stock in year t
X_t	Column vector of output in year t
$(I_r)_t$	Column vector of replacement investment in year t
$(I_n)_t$	Column vector of new plant and equipment investment in year t
I_t	Column vector of total investment in year t
$(CA)_t$	Column vector of composition of new investment
$(PCH_n)_t$	Column vector of per capita consumption of non-durable goods in year t
P_t	Population in year t
$(H_n)_t$	Column vector of household consumption of non-durable goods in year t
$(Y^{DI})_t$	Disposable income in year t
$(PCY)_t$	Per capita disposable income
$(hd)_t$	Household purchases of durables in year t
$(Hd)_t$	Column vector of household purchases of durable goods in year t
$(PCH_s)_t$	Column vector of household per capita consumption of services in year t
$(H_s)_t$	Column vector of household consumption of services in year t
$(H_t)_t$	Column vector of total household purchases of all goods in year t
$(E_n)_t$	Column vector of total household purchases of all goods in year t
$(E_d)_t$	Column vector of export demand for durables in year t
$(E_t)_t$	Column vector of total export demand in year t
$(E_s)_t$	Column vector of service demand in year t

TABLE XXIII (Continued)

Variable	Description
$(SL)_t$	Column vector of state and local government demand in year t
$(SL_T)_t$	Total state and local government expenditures in year t
$(F)_t$	Column vector of federal government purchases in Oklahoma in year t
$(F_T)_t$	Total federal expenditures in Oklahoma in year t
Z_t	Column vector of total final demand in year t
$(X^d)_t$	Column vector of output necessary to meet estimated final demand
L_t	Column vector of available labor force in year t
$(L^e)_t$	Column vector of state employment in year t
$(X^L)_t$	Column vector of maximum output due to labor restriction in year t
$(X^c)_t$	Column vector of maximum output due to capital restriction in year t
$(X^r)_t$	Column vector of realized output in year t
$(L^w)_t$	Column vector of wage and salary employment in year t
$(L^p)_t$	Column vector of proprietor employment in year t
$(WS)_t$	Column vector of wage and salary payments for year t
$(L^f)_t$	Labor force of federal government in Oklahoma in year t
$(L^s)_t$	Labor force of state and local government in year t
$(Y^p)_t$	Column vector of proprietor income in year t
$(AF)_t$	Military payroll in state in year t
$(FS)_t$	All government wages and salaries in year t
$(Y^T)_t$	Transfer payments in year t
$(Y^{Py})t$	Property income in year t
$(OY)_t$	Other labor payments in year t

TABLE XXIII (Continued)

Variable	Description
$(Y^{PI})_t$	Personal income in year t
$(X^G)_t$	Gross product of state in year t
$(G_1^f)_t$	Federal government indirect taxes
$(G_2^f)_t$	Federal personal income taxes
$(G_3^f)_t$	Federal government corporation taxes
$(T^f)_t$	Total federal government taxes
$(G_1^s)_t$	State income tax
$(G_2^s)_t$	State property tax
$(G_3^s)_t$	State federal aid
$(G_4^s)_t$	Other state and local taxes
$(G_5^s)_t$	Miscellaneous taxes
$(T^s)_t$	Total state and local taxes
V_t	Column vector of value added in year t
$(L^T)_t$	Total employment in year t

TABLE XXIV

MATRIXES IN OKLAHOMA SIMULATION MODEL

Matrix	Description
A_1	Diagonal matrix of sector depreciation rates
A_2	Diagonal matrix of average sector capital-output ratios
A_3	Diagonal matrix of 1 plus the annual change in sector capital-output ratios
A_4	Capital coefficient matrix
A_5	Diagonal matrix of 1 plus the annual growth rate of household demand on non-durable goods
A_6	Diagonal matrix of proportions of total durable purchases
A_7	Diagonal matrix of 1 plus growth rate of services by sector
A_8	Diagonal matrix where elements are 1 plus the United States growth trend for non-durables
A_9	Diagonal matrix where elements are 1 plus the United States growth trend for durables
A_{10}	Column vector where elements are proportions of total state and local expenditures
A_{11}	Column vector where elements are proportions of total federal expenditures within Oklahoma
A_{12}	Inverse matrix $(I-A)^{-1}$ where A is the direct coefficient matrix
A_{13}	Diagonal matrix of equilibrium labor force employment ratios
A_{14}	Diagonal matrix with elements being 1 plus growth rate in employment
A_{15}	Diagonal matrix with elements representing lower bonds of percentage change in labor force
A_{16}	Diagonal matrix with elements representing upper bonds of percentage change in labor force
A_{17}	Diagonal matrix of output-labor ratios

TABLE XXIV (Continued)

Matrix	Description
A_{18}	Diagonal matrix with elements being 1 plus the annual rate of growth in the output-labor ratios
A_{19}	Diagonal matrix of capital-output ratios with output defined at capacity level
A_{20}	Diagonal matrix of ratios of wage and salary employment to total employment
A_{21}	Diagonal matrix with elements being one plus the growth rate of the corresponding elements of A_{20}
A_{22}	Diagonal matrix of wage rates by sector
A_{23}	Diagonal matrix with elements being the growth rate in wages by sector
A_{24}	Diagonal matrix of income rates for proprietors
A_{25}	Diagonal matrix of the ratio value added to output
A_{26}	Diagonal matrix of indirect tax receipts per unit of output

TABLE XXV

SCALARS IN OKLAHOMA SIMULATION MODEL

Scalar	Description
a_1	Ratio of durable expenditures to disposable income
a_2	1 plus expected rate of growth of per capita disposable income
a_3	1 plus change in ratio of durable purchases to disposable income
a_4	1 plus annual rate of growth in state and local expenditures
a_5	1 plus annual rate of growth in Oklahoma federal expenditures
a_6	Federal employment-expenditure ratio
a_7	1 plus annual change in federal employment-expenditure ratio
a_8	State and local government employment-expenditure ratio
a_9	1 plus annual change in state and local government employment-expenditure ratio
a_{10}	1 plus growth rate of proprietor income
a_{11}	Wage rate of state and local government employees
a_{12}	1 plus annual change in state and local government wage rate
a_{13}	Wage rate of federal employees
a_{14}	1 plus annual change in federal wage rate
a_{15}	1 plus annual increase in military payroll
a_{16}	1 plus annual increase in transfer payments
a_{17}	1 plus annual rate of growth in property income
a_{18}	1 plus annual rate of growth in other labor income
a_{19}	Ratio of social security payments to wage and salary income
a_{20}	1 plus annual rate of growth in ratio a_{19}
a_{21}	Ratio of indirect taxes to expenditures in Oklahoma by the federal sector

TABLE XXV (Continued)

Scalar	Description
a_{22}	Ratio of indirect taxes to expenditures of state and local government
a_{23}	Ratio of indirect taxes to expenditures by the household sector
a_{24}	Federal income tax rate
a_{25}	Federal corporation income tax rate of total value added
a_{26}	State income tax rate
a_{27}	1 plus annual rate of change in property taxes
a_{28}	1 plus annual rate of change in federal aid
a_{29}	Proportion of other state and local taxes to personal income paid by households
a_{30}	Proportion of state and local taxes to value added paid by industry
a_{31}	Proportion of miscellaneous state and local taxes to personal income paid by households
a_{32}	Proportion of miscellaneous state and local taxes to value added paid by industry
a_{33}	Proportion of miscellaneous state and local taxes to government expenditures paid by government

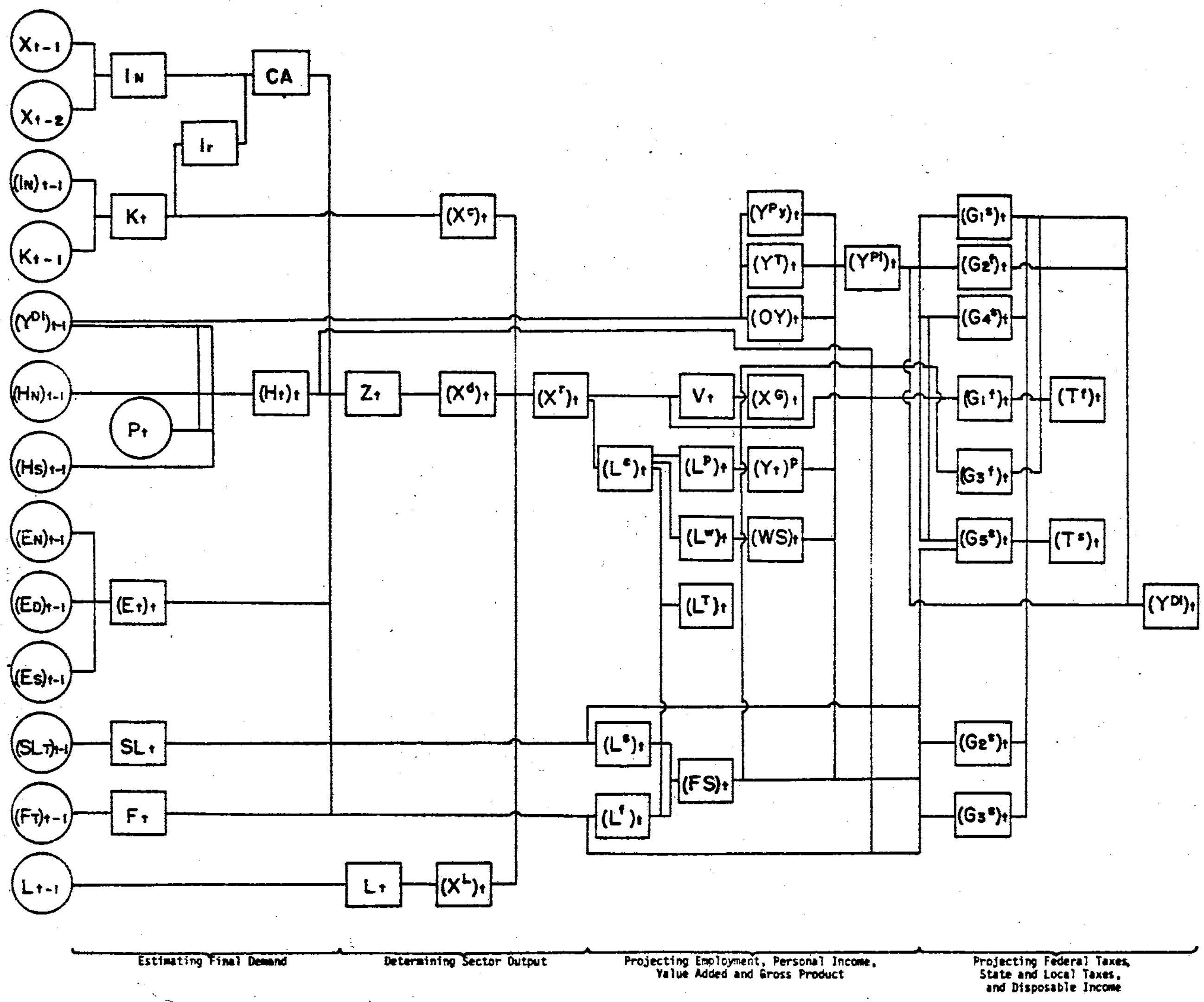

Figure 4. Flow Chart of the Oklahoma Simulation Model

The replacement component is merely a function of capital stock times the depreciation rate. Capital stock (K_t) at the beginning of each period is equal to capital stock available the preceding period plus new plant and equipment investment made during the preceding year.

$$K_t = K_{t-1} + (I_n)_{t-1} \tag{7.1}$$

where:

K_{t-1} = vector of capital stock in year t-1, and

$(I_n)_{t-1}$ = vector of new plant and equipment investment in year t-1.

Replacement investment $(I_r)_t$ is then calculated as follows:

$$(I_r)_t = A_1 K_t^j \tag{7.2}$$

where:

A_1 = diagonal matrix of depreciation rates.

The second component of investment, new plant and equipment $(I_n)_t$, is estimated using the accelerator principle as follows:

$$(I_n)_t = (A_2)_{t-1} A_3 (X_{t-1} - X_{t-2}) \tag{7.3}$$

where:

$(A_2)_{t-1}$ = diagonal matrix of average capital-output ratios in year t-1,

A_3 = diagonal matrix of one plus change in capital-output ratio, and

X_t = column vector of output in year t.

The matrix A_3 incorporates a change in technology into future estimates of capital as trends in the capital-output ratios are included in the estimate of new plant and equipment. Total investment (I_t) is a sum of the two components.

$$I_t = (I_r)_t + (I_n)_t \tag{7.4}$$

The composition of each sector's new investment is determined as follows:

$$(CA)_t = A_4 \, I_t \tag{7.5}$$

where:

A_4 = capital coefficient matrix, and

$(CA)_t$ = column vector of composition of new investment in year t.

Household Demand. Models which estimate consumer expenditures usually consider three categories of goods: non-durables, durables, and services.[3] William F. Butler [9] and Margaerite C. Burk [8] analyze the trends in consumption of durables, non-durables, and services. Two of these components, non-durables and services, have relatively smooth trends, whereas durables fluctuate quite widely.

Non-durable outlays tend to move in a positive trend with very few declines, if any. Since 1950, consumer expenditures have increased every year but the proportion of income spent on them has declined. Non-durables include food, clothing, gasoline, drugs, household supplies and other similar items.

Purchase of durable goods, which include such things as automobiles, appliances, and furniture, may be postponed more readily than

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[3]An illustration is found in Klein's model [39]. Also Suits [74] and Fromm [21] use a somewhat similar breakdown in their models.

non-durables, and thus adding to business cycles. Expenditures on durables as a percentage of total consumption expenditures has increased only slightly since 1950. Demand for services have increased the most during recent years, reflecting the fact our society is becoming increasingly service oriented. Included as service outlays are utilities, telephones, cleaning, transportation, recreation, medical care, education, and religious activities.

With these trends and characteristics, a separate equation was used for each consumer good category. Nondurable purchases $(H_n)_t$ were estimated with per capita demand and population as follows:

$$(H_n)_t = [A_5(PCH_n)_{t-1}]\ P_t \tag{7.6}$$

and

$$(PCH_n)_{t-1} = (H_n)_{t-1}/P_{t-1} \tag{7.7}$$

where:

$(PCH_n)_{t-1}$ = column vector of per capita consumption of non-durable goods in year t-1,

P_t = population in year t,

$(H_n)_{t-1}$ = column vector of total non-durable purchases in year t-1, and

A_5 = one plus growth rate of per capita demand for non-durable goods.

Durable purchases were computed as follows:

$$(hd)_t = a_3a_1[a_2(PCY)_{t-1}]\ P_t \tag{7.8}$$

and

$$(PCY)_{t-1} = (Y^{DI})_{t-1}/P_{t-1} \tag{7.9}$$

where:

$(hd)_t$ = total demand for durable goods in year t,

a_1 = ratio of durable expenditures to disposable income,

a_2 = one plus the expected rate of growth of personal disposable income,

a_3 = one plus the change in the ratio of durable goods to disposable income in year t-1,

$(PCY)_{t-1}$ = per capita disposable income in year t-1, and

$(Y^{DI})_{t-1}$ = disposable income in year t-1.

The composition of the durable purchases were computed as follows:

$$(Hd)_t = A_6(hd)_t \tag{7.10}$$

where:

A_6 = diagonal matrix of proportion of durable purchases from sector j, and

$(Hd)_t$ = column vector of sector purchases of durable goods in year t.

Service demand was estimated as follows:

$$(H_s)_t = A_7[(PCH_s)_{t-1}]\ P_t \tag{7.11}$$

and

$$(PCH_s)_{t-1} = (H_s)_{t-1}/P_{t-1} \tag{7.12}$$

where:

$(H_s)_t$ = column vector of consumption of services in year t,

$(PCH_s)_{t-1}$ = column vector of per capita consumption of services in year t-1, and

A_7 = diagonal matrix of one plus the growth rate of services.

Total household demand is the sum of its parts:

$$(H_t)_t = (H_n)_t + (Hd)_t + (H_s)_t \tag{7.13}$$

<u>Export Demand</u>. In national models such as the Brookings model [15], exports are related to world demand. In state models, exports are influenced mainly by U. S. demand. A study which uses this procedure was completed by Charles M. Tiebout [75]. Trends in U. S. production are obtained and applied to the present share of Oklahoma exports. This assumes that Oklahoma exports will grow in the same proportion as U. S. demand. Services (defined to include construction; transportation, communication and public utilities; real estate, finance and insurance; wholesale and retail trade; and services) are assumed to be determined by state economic activity and are not related to U. S. demand. Thus, their export demand is assumed zero. Export demand is specified in two equations (durables and non-durables) as follows:

$$(E_n)_t = A_8 \; (E_n)_{t-1} \tag{7.14}$$

where:

A_8 = diagonal matrix of one plus growth of non-durables, and

$(E_n)_t$ = column vector of export demand of non-durables in year t; and

$$(E_d)_t = A_9 \; (E_d)_{t-1} \tag{7.15}$$

where:

A_9 = diagonal matrix of one plus growth rate of durables, and

$(E_d)_t$ = column vector of export demand of durables in year t.

Total export demand is:

$$(E_t)_t = (E_n)_t + (E_d)_t \tag{7.16}$$

Government Purchases. In recent years, state and local government spending has followed an equal annual percent increase as closely as can be expected in economic forecasting. Under these circumstances, simple extrapolation procedures may be the best resort for the forecaster. Research by Murry L. Weidembaum [126] and Butler [9] support these results. Thus, state and local government final demand is estimated as:

$$(SL)_t = (A_{10})\ (a_4)\ (SL_T)_{t-1} \tag{7.17}$$

where:

$(SL)_t$ = column vector of state and local government purchases in year t,

A_{10} = column vector where elements are proportions of state and local government purchases,

a_4 = one plus annual rate of growth in state and local government purchases, and

$(SL_T)_{t-1}$ = scalar of total state and local government purchases in year t-1.

Federal government purchases at the national level fluctuate quite widely [21, 75, 126]. The overhead costs remain rather constant and are fairly easy to predict. However, expenditures for national defense and special programs controlled by the legislature are difficult to determine and as a result, forecasting of federal expenditures by states is almost an unattainable task. For Oklahoma, the best estimate seems to be a trend established from previous years government expenditures. Thus,

$$F_t = A_{11} [a_5 (F_T)_{t-1}] \tag{7.18}$$

where:

A_{11} = column vector where elements are proportions of total federal purchases within Oklahoma,

a_5 = one plus growth rate in federal expenditures in Oklahoma,

F_t = column vector of federal government purchases in Oklahoma in year t, and

$(F_T)_{t-1}$ = total federal government purchases in Oklahoma for year t-1.

Total final demand is the sum of demands from households, federal government, state and local government, exports, and capital formation. It is computed as follows:

$$Z_t = (CA)_t + F_t + (SL)_t + (H_t)_t + (E_t)_t. \tag{7.19}$$

<u>Determining Sector Output</u>

Sector output X_t^d required to produce final demand is

$$X_t^d = A_{12} Z_t \tag{7.20}$$

where:

A_{12} = matrix of direct and indirect coefficients.

However, this output cannot be produced if labor and plant capacity are not available. Available labor (L_t) by sector is:

$$L_t = A_{13} (A_{14}) (L^e)_{t-1} \quad (7.21)$$

where:

$(L^e)_{t-1}$ = column vector of employment for year t-1,

A_{13} = diagonal matrix of labor force-employment ratio,[4] and

A_{14} = diagonal matrix of one plus growth rate of employment.

The labor force is bounded by certain upper and lower limits which are incorporated in equation (7.22).

$$A_{15}(L^e)_{t-1} \leq L_t \leq A_{16}(L^e)_{t-1} \quad (7.22)$$

where:

A_{15} = diagonal matrix with elements representing lower bonds of percentage change in labor force, and

A_{16} = diagonal matrix with elements representing upper bonds of percentage change in labor force.

Thus maximum output $(X^L)_t$ due to labor is computed as follows:

$$(X^L)_t = (A_{17})_{t-1} A_{18} L_t \quad (7.23)$$

where:

$(A_{17})_{t-1}$ = diagonal matrix of output-labor ratios in year t-1, and

[4]Labor force-employment ratio is the available labor force for each sector divided by the employment in that sector. It was determined by calculating capacity employment and adjusting this downward by sector to the 1963 labor force. This was divided by 1963 sector employment to yield the ratio. Sector employment was not allowed to increase in an unrestricted manner due to institutional restraints.

A_{18} = diagonal matrix of one plus annual rate of growth in output-labor ratios.

The maximum output $(X^c)_t$ due to capital is:

$$(X^c)_t = (X^c)_{t-1} + (I_n)_t/[(A_{17})_t \cdot A_3] \qquad (7.24)$$

where:

$(X^c)_{t-1}$ = column vector of maximum production due to capital restriction for year t-1,

$(I_n)_t$ = column vector of new plant and equipment investment in year t,

$(A_{17})_t$ = diagonal matrix of capital-output ratios defined at capacity levels in year t, and

A_3 = diagonal matrix of one plus change in capital-output ratio.

Realized output $(X^r)_t$ in each sector is the minimum constrained by final demand, plant capacity, or labor force. It is expressed as follows:

$$(X^r)_t = \min[(X^d)_t, (X^L)_t, (X^c)_t] \qquad (7.25)$$

Relationships Projecting State Economic Variables

Once output is estimated, the simulation model projects employment (wage and salary workers, and proprietors), income (wage and salary, proprietor, property, and transfer payments), value added, state and local taxes, federal taxes, and disposable income. Equations (7.26) through (7.51) present the relationships used to project these economic variables.

Employment. State employment consists of four components: wage and salary workers, proprietors, federal government employees, and state and local government employees. State employment by sector (L^e) is projected as follows:

$$(L^e)_t = (X^r)_t/[(A_{17})_{t-1}*A_{18}] \quad (7.26)$$

where:

$(A_{17})_{t-1}$ = diagonal matrix output-labor ratios in year t-1, and

A_{18} = one plus the annual rate of growth in the output-labor ratios.

Wage and salary employment (L^w) is equal to:

$$(L^w)_t = (A_{20})_{t-1}\ A_{21}\ (L^e)_t \quad (7.27)$$

where:

$(A_{20})_{t-1}$ = ratio of wage and salary employment to total employment in year t-1, and

A_{21} = one plus growth rate of ratio in A_{20}.

Proprietor employment is the difference between total sector employment and wage and salary employment. The calculations are represented in equation (7.28).

$$(L^p)_t = (L^e)_t - (L^w)_t \quad (7.28)$$

Federal, and state and local government employment is projected from government expenditures. Equations (7.29) and (7.30) contain these relationships.

$$(L^f)_t = (a_6)_{t-1}\, a_7\, (F_T)_{t-1} \qquad (7.29)$$

where:

$(a_6)_{t-1}$ = federal employment-expenditure ratio in year t-1,

a_7 = one plus growth rate of federal employment-expenditure ratio, and

$(L^f)_t$ = federal employment in Oklahoma in year t.

$$(L^s)_t = (a_8)_{t-1}\, a_9\, (SL_T)_{t-1} \qquad (7.30)$$

where:

$(a_8)_{t-1}$ = state and local government employment-expenditure ratio in year t-1,

a_9 = one plus annual change in employment-expenditure ratio, and

$(L^s)_t$ = state and local government employment in year t.

Total employment (L^T) is the sum of wage and salary workers, proprietors, and government workers.

$$(L^T)_t = i(L^w)_t + i(L^p)_t + (L^f)_t + (L^s)_t \;^{5} \qquad (7.31)$$

Income. Personal income is composed of five parts: wage and salary payments, proprietor income, other labor income, property

[5] i is a row vector of 1's.

income, and transfer payments. Sector wage and salary payments $(WS)_t$ are estimated from employment and wage rates as follows:

$$(WS)_t = (A_{22})_{t-1} A_{23} (L^w)_t \qquad (7.32)$$

where:

$(A_{22})_{t-1}$ = wage rates in year t-1, and

A_{23} = annual growth rate of wages by sector.

Proprietor income (Y^p) is a function of proprietor employment and income rate and is equal to:

$$(Y^p)_t = (A_{24})_{t-1} a_{10} (L^p)_t \qquad (7.33)$$

where:

$(Y^p)_t$ = proprietor income in year t,

$(A_{24})_{t-1}$ = proprietor income rate by sector in year t-1, and

a_{10} = one plus growth rate of proprietor income.

Government wages and salaries $(FS)_t$ equal:

$$(FS)_t = (a_{11})_{t-1} a_{12} (L^s)_t + (a_{13})_{t-1} a_{14} (L^f)_t + a_{15} (AF)_{t-1} \qquad (7.34)$$

where:

$(FS)_t$ = all government wages and salaries in year t,

$(a_{11})_{t-1}$ = wage rate of state and local government employees in year t-1,

a_{12} = one plus growth rate of state and local government wage rate,

$(a_{13})_{t-1}$ = wage rate of federal employees in year t-1,

a_{14} = one plus annual change in federal wage rate,

$(AF)_{t-1}$ = military payroll in year t-1, and

a_{15} = one plus annual increase in military payroll.

Transfer payments (Y^T), property income (Y^{Py}), and other labor payments (OY) were projected as follows:

$$(Y^T)_t = a_{16}(Y^T)_{t-1} \tag{7.35}$$

$$(Y^{Py})_t = a_{17}(Y^{Py})_{t-1} \tag{7.36}$$

$$(OY)_t = a_{18}(OY)_{t-1} \tag{7.37}$$

where:

a_{16} = one plus annual increase in transfer payments,

a_{17} = one plus annual rate of growth in property income, and

a_{18} = one plus annual rate of growth in other labor income.

Finally, total personal income is the sum of payments in equations (7.32) through (7.37) minus contributions to social insurance:

$$(Y^{PI})_t = i(WS)_t + i(Y^P)_t + (FS)_t + (Y^T)_t + (Y^{Py})_t + (OY)_t - \{a_{19} \cdot a_{20}[i(WS)_t + (FS)_t]\} \tag{7.38}$$

where:

a_{19} = ratio of social security payments to wage and salary income, and

a_{20} = one plus annual rate of growth in ratio a_{19}.

Value Added and Gross State Product. Value added (V_t) by sector is determined by:

$$V_t = A_{25}(X^r)_t \tag{7.39}$$

where:

A_{25} = matrix of the ratio value added to output.

Gross product is calculated as follows:

$$(X^G)_t = iV_t + (FS)_t \tag{7.40}$$

Federal Tax Revenues. Tax revenue collected by the federal government is composed of indirect income taxes, corporation tax, and personal income tax. Federal indirect income taxes $(G_1^f)_t$ are a function of industry output, government expenditures, and household expenditures.

$$(G_1^f)_t = [iA_{26}(X^r)_t] + a_{21}(F_T)_t + a_{22}(SL_T)_t + a_{23}[i(Hn)_t + (i(Hs)_t) + (hd)_t] \tag{7.41}$$

where:

A_{26} = diagonal matrix of indirect tax receipts per unit of output,

a_{21} = ratio of indirect taxes to expenditures in Oklahoma by the federal sector,

a_{22} = ratio of indirect taxes to expenditures of state and local government, and

a_{23} = ratio of indirect taxes to output in household sector.

Federal personal income tax $(G_2^f)_t$ is equal to:

$$(G_2^f)_t = a_{24}(Y^{PI})_t \tag{7.42}$$

where:

a^{24} = federal income tax rate.

Federal corporation taxes $(G_3{}^f)_t$ were calculated as follows:

$$(G_3{}^f)_t = a_{25}(iV_t) \tag{7.43}$$

where:

a_{25} = federal corporation income tax rate of total value added.

Total federal tax collections (T^F) were then the sum of equations (7.41), (7.42) and (7.43).

$$(T^F)_t = (G_1{}^f)_t + (G_2{}^f)_t + (G_3{}^f)_t. \tag{7.44}$$

State and Local Tax Revenues. State personal income tax, property tax, federal aid, other state and local taxes, and miscellaneous taxes make up the components of state and local tax revenues. State personal income tax $(G_1{}^s)_t$ is projected as:

$$(G_1{}^s)_t = a_{26}(Y^{PI})_t \tag{7.45}$$

where:

a_{26} = state income tax rate.

State property income tax $(G_2{}^s)_t$ is determined as follows:

$$(G_2{}^s)_t = a_{27}(G_2{}^s)_{t-1} \tag{7.46}$$

where:

a_{27} = one plus annual rate of change in property taxes.

Other state and local federal aid is a function of last year's federal aid.

$$(G_3^{s})_t = a_{28}(G_3^{s})_{t-1} \tag{7.47}$$

where:

a_{28} = one plus annual rate of change in federal aid.

Other state and local taxes are computed as a function of personal income and value added.

$$(G_4^{s})_t = a_{29}(Y^{PI})_t + a_{30}iV_t \tag{7.48}$$

where:

a_{29} = proportion of other state and local taxes to personal income paid by households, and

a_{30} = proportion of state and local taxes to value added paid by industry.

Miscellaneous taxes $(G_5^{s})_t$ are determined as follows:

$$(G_5^{s})_t = a_{31}(Y^{PI})_t + a_{32}iV_t + a_{33}[(SL_T)_t + (F_T)_t] \tag{7.49}$$

where:

a_{31} = proportion of miscellaneous state and local taxes to personal income paid by households,

a_{32} = proportion of miscellaneous state and local taxes to value added paid by industry, and

a_{33} = proportion of miscellaneous state and local taxes to government expenditures paid by government.

The sum of equations (7.45) through (7.49) yield total state and local government revenue $(T^s)_t$.

$$(T^s)_t = (G_1{}^s)_t + (G_2{}^s)_t + (G_3{}^s)_t + (G_4{}^s)_t + (G_5{}^s)_t. \qquad (7.50)$$

<u>Disposable Income</u>. Disposable personal income is computed as:

$$(Y^{DI})_t = (Y^{PI})_t - (G_1{}^s)_t - (G_2{}^F)_t. \qquad (7.51)$$

An Evaluation of the Model

An almost universal weakness of models having large data requirements is the lack of data. This model is no exception as improved data would allow additional refinements. This evaluation of the Oklahoma model begins by pointing out the small number of endogenous sectors included in the model. If the model contained additional sectors, it would prove to be more useful in regional planning decisions. However, additional resources would be required as primary data would have to be collected.

Several weaknesses are inherent in the model both in the construction of relationships and in basic assumptions. Several of the equations predicting final demand could be improved. For example, the accelerator principle is used in the Oklahoma model to determine new investment. Additional research might prove that some other relationship or measure such as businessmen's expectations might be a better indicator. Another final demand equation, the export function, was developed such that the state's export demand for a product would grow at the same rate as national demand. Over time, comparative advantage may cause Oklahoma's share of particular exports to increase, while others decrease.

Another concern in the model is that once final demand is estimated, the input-output model is employed to determine sector output. The fixed coefficient assumption of the input-output model must be mentioned as a weakness of the simulation model. The fixed coefficient assumption implies that technology remains constant and does not allow substitution. Incorporated into the simulation model are capital-output ratios, labor-output ratios, and annual changes in these ratios. These ratios and their annual changes incorporate some measure of technical change into the model; however, the fixed technical coefficients of the input-output model still remain.

Sector aggregation, relationships used to estimate new capital expenditures, the constant share assumption explicit in the export equation, and the fixed input-output coefficients are the main concern in evaluating the model. Obviously, additional data and research could improve other relationships used in the model. However, the researcher feels that the best equations were employed considering the available data.

The model has several advantages over static models such as input-output and economic base studies. First, the model is dynamic and the time path of economic variables through which the system travels is determined. Second, technological change is incorporated into the model through changes in capital-output ratios and labor-output ratios. Third, simulation allows introduction of many real world relationships which conventional models do not. Fourth, the model can best be judged by its predictions and analytical power. Chapter VIII shows that the model yields reasonably accurate projections, while Chapter IX presents an impact analysis which seems reasonable.

CHAPTER VIII

SIMULATION OF STATE ECONOMIC VARIABLES TO 1980

The model simulated values for state economic variables by year from 1963 to 1980 using the data presented in the Oklahoma social accounts are described in Chapters IV, V, VI, and Appendix A. Data not presented in the accounts (such as rates of change) are presented in Appendix B. The projections were made to 1980 to yield data for planners (industry, agriculture, and government) for the next decade. The model could have been run for any time length, but a planning horizon of a decade was considered sufficient for most planners. This chapter presents and discusses simulation results of state economic variables from 1963 to 1980. The following chapter includes a presentation and discussion of certain structural parameters of the model and the impact effect resulting from a one million dollar investment in each sector. Projections include employment, income, taxes, and gross state product. Where published data were available, the projected values are compared to measure closeness of fit provided by the simulation model.

Employment Projections

Employment projections are presented in Figures 5 through 12. Figure 5 contains estimates of aggregate, proprietor, and wage and salary employment. The solid line indicates values derived from the

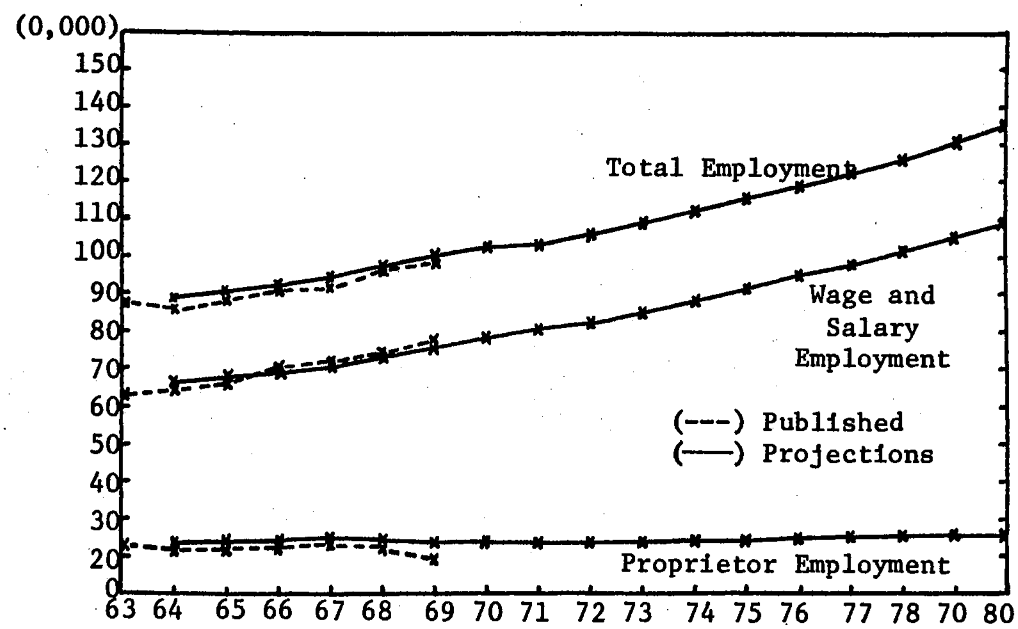

Figure 5. Total Employment, Proprietor Employment, and Wage and Salary Employment, Oklahoma

simulation model, whereas the broken line shows the estimates as published by the Oklahoma Employment Security Commission and the U. S. Department of Agriculture. Total employment is forecast to increase from 874,700 in 1963 to 1,347,645 in 1980. The forecasted data from 1964 to 1969 are slightly higher than the published estimates. Wage and salary employment is projected to increase from 638,400 in 1963 to 1,094,841 by 1980. The projections are above the published estimates for 1964 through 1967, and slightly below for 1968 and 1969.

Proprietor employment, according to the simulation model is projected to increase only slightly from 236,300 in 1963 to 252,804 in 1980. The simulated projections are above the published estimates. The reason proprietor employment changes very little is that the decreasing number of farmers is offset by a slight increase in proprietor employment for the service-type sectors.[1]

Figure 6 contains projections for the number of wage and salary workers and farm proprietors derived from the simulation model for agriculture. The published estimates were obtained from U. S. Department of Agriculture publications. The number of wage and salary workers in agriculture is expected to decrease from 26,000 in 1963 to 6,314 in 1980 according to the simulation model. This indicates the trend in mechanization of the agricultural sectors. The published data are below the projected values from 1964 through 1966 and about the same as the simulated results from 1967 to 1969. The upper portion of Figure 6 gives the projected number of farm proprietors from

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[1]Service-type sectors include: transportation, communication and public utilities; real estate, finance and insurance; services; wholesale and retail trade; and construction.

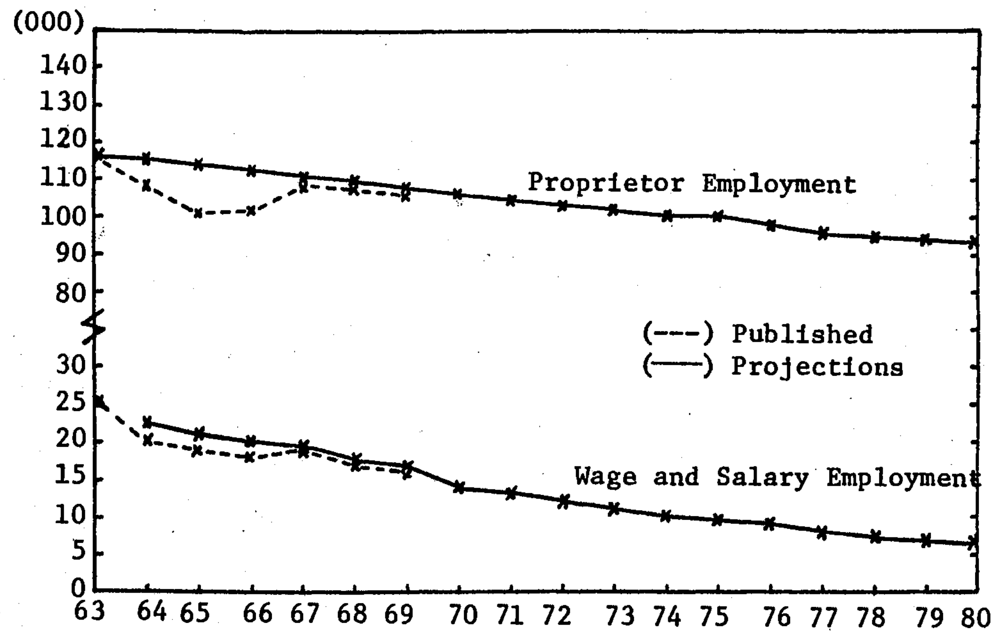

Figure 6. Proprietor Employment and Wage and Salary Employment in Agriculture, Oklahoma

1964 to 1980. The number of farm proprietors is expected to decrease from 117,500 in 1963 to 93,283 in 1980. The projected values are above the published U. S. Department of Agriculture estimates for 1964 through 1966, and quite similar for years 1967 through 1969.

Data in Figure 7 indicate very little change is expected in employment in the agricultural processing sector. In fact, wage and salary employment is expected to increase to 17,712 in 1980; an increase of only 2,212 from 1963. The simulated results are slightly higher than the published values. The results for the petroleum sector, also displayed on Figure 7, indicate a wage and salary employment increase from 7,500 in 1963 to 8,269 in 1980. The published estimates are slightly above those of the simulation model.

Wage and salary employment is expected to equal 22,646 in 1980 for machinery, as compared to 10,500 in 1963 (Figure 8). This sector is growing rapidly and the projected values fluctuate around the published estimates for 1963 through 1968. Other manufacturing represented in Figure 8 shows a substantial increase in wage and salary employment from 1963 to 1980. Wage and salary employment in 1980 is projected at 122,233 workers. The published estimates are slightly larger than the simulation projections. Wage and salary employment (Figure 9) in the mining sector is projected to decrease from 42,400 in 1963 to 39,462 by 1980. The published estimates are above the projected values for 1965 and 1966 and below for 1964, 1967, and 1968.

The activity of the five service-type sectors depends heavily on the activity of the durable and non-durable sectors. Wage and salary employment is expected to increase in all of these sectors except in the construction sector where employment first decreases and then

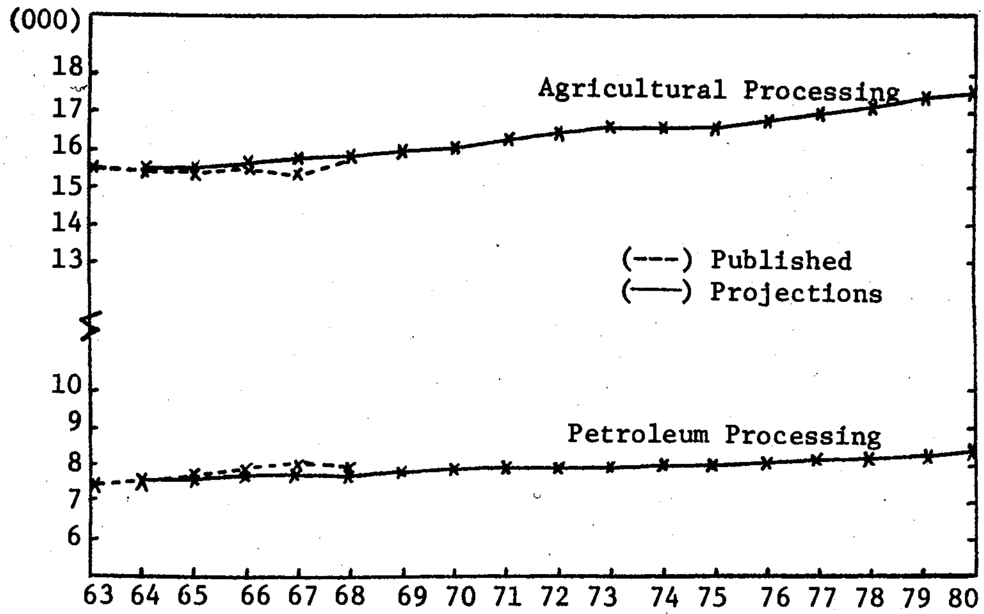

Figure 7. Wage and Salary Employment in Agricultural Processing and Petroleum Processing, Oklahoma

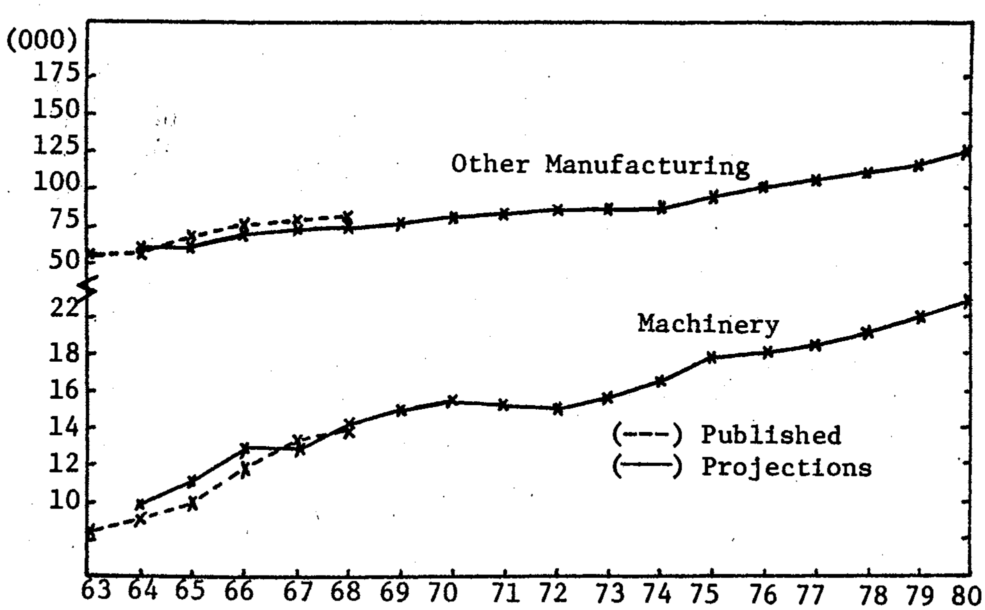

Figure 8. Wage and Salary Employment in Machinery and Other Manufacturing Sectors, Oklahoma

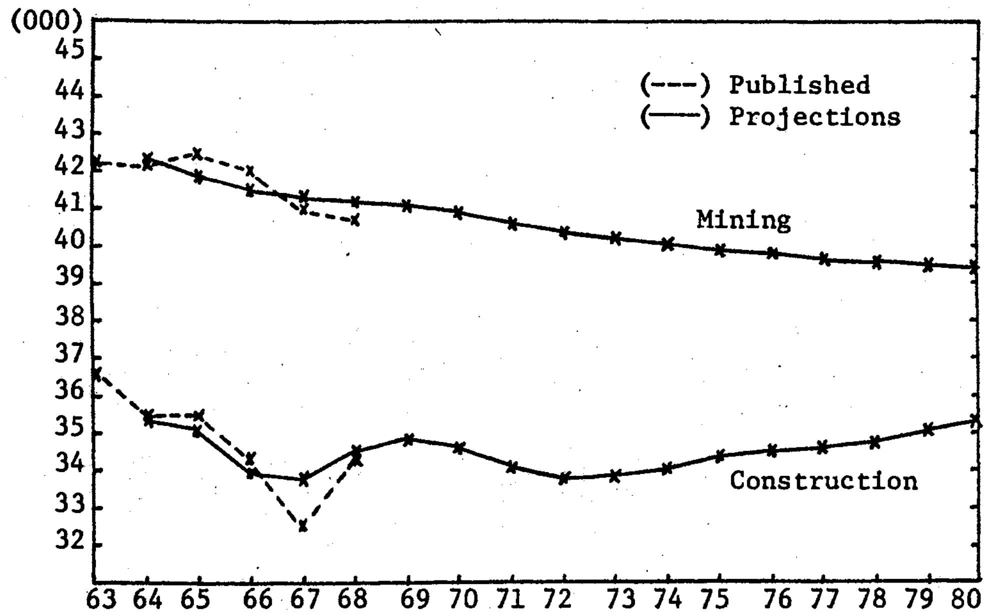

Figure 9. Wage and Salary Employment in the Mining and Construction Sectors, Oklahoma

increases (Figure 9). The cyclical demand in capital investment and the increasing technology employed in the sector account for the directional change in construction employment. The actual estimates for the construction sector fluctuate around the projected values. Wage and salary employment in the transportation, communication and public utilities sector is projected to increase from 46,000 in 1963 to 72,857 in 1980 (Figure 10). Real estate, finance and insurance projected employment is 49,431 for 1980 as compared to 29,100 in 1963 (Figure 10). Wholesale and retail trade and the services are projected to have the largest increases in wage and salary employment. In the wholesale and retail trade sector, wage and salary employment is projected to increase from 141,000 in 1963 to 223,477 by 1980 (Figure 11). Wage and salary employment in the service sector is projected to increase to 182,207 in 1980 as compared to 82,400 in 1963. In general, for the service-type sectors, the projected values are close to the published estimates as published by the U. S. Department of Labor.

Figure 12 contains employment estimates for the government sectors. Wage and salary employment is projected to increase from 142,700 in 1963 to 314,726 in 1980. The published estimates for 1963 through 1968 are very similar to the projected values.

Income Projections

Income projections are presented in Figure 13 and Tables XXVI and XXVII. Information in Figure 13 and Table XXVI is in constant 1963 prices, while Table XXVII contains income estimates in current prices. Data in Figure 13 give an overview of the aggregate income projections.

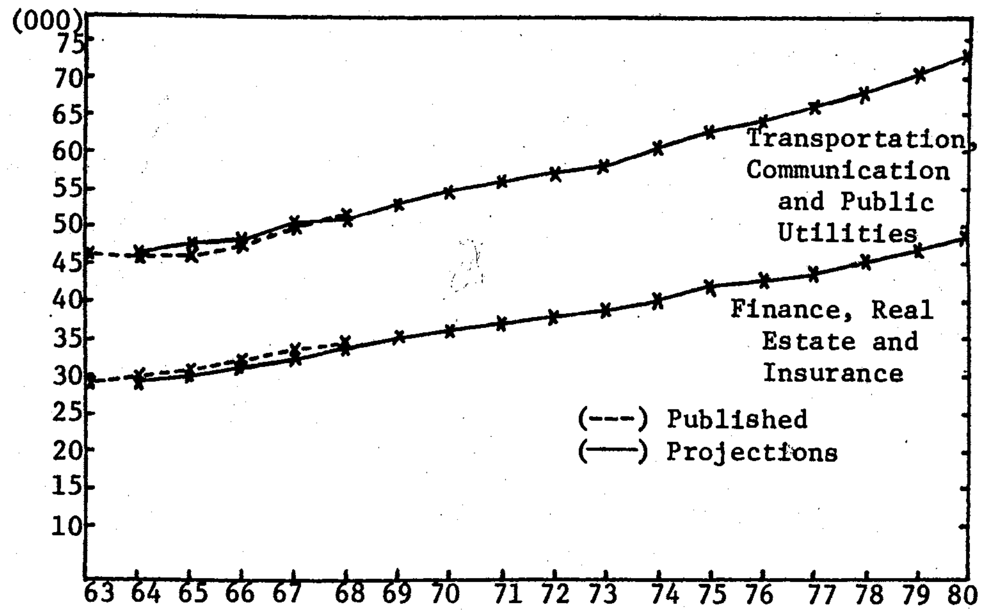

Figure 10. Wage and Salary Employment in the Transportation, Communication and Public Utilities, and Real Estate, Finance and Insurance Sectors, Oklahoma

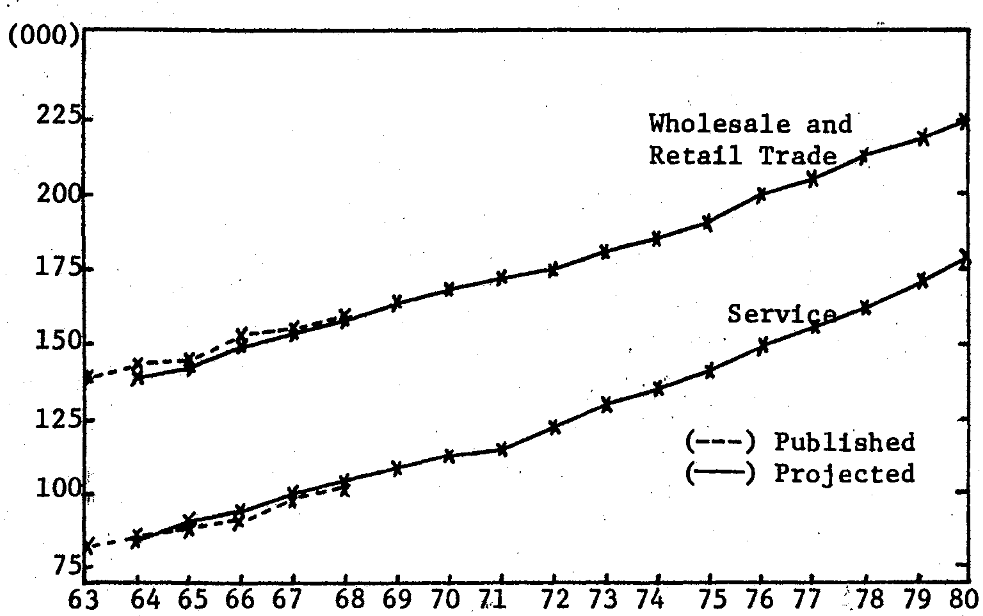

Figure 11. Wage and Salary Employment in the Wholesale and Retail Trade and Service Sectors, Oklahoma

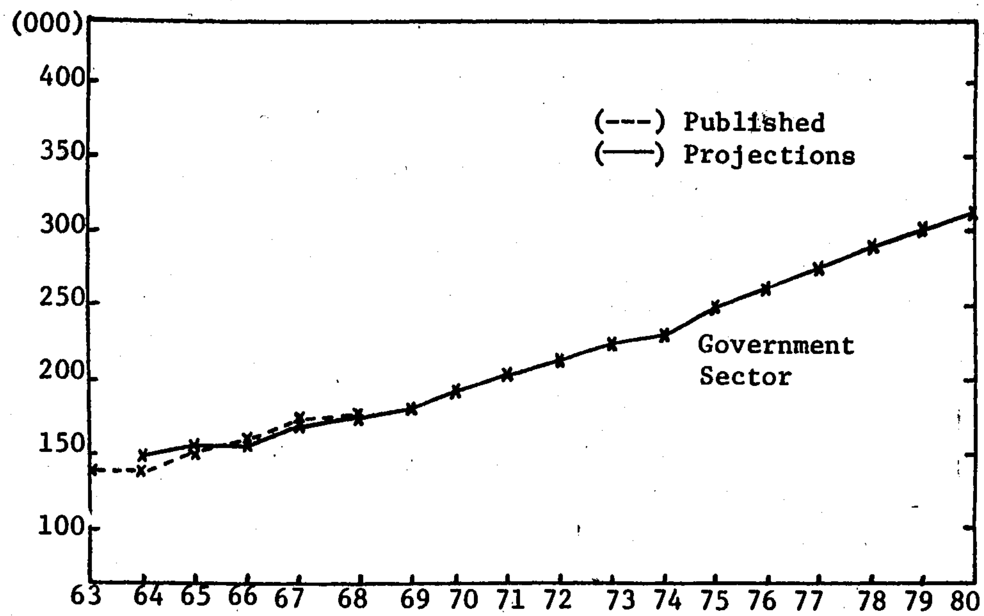

Figure 12. Wage and Salary Employment in the Government Sectors, Oklahoma

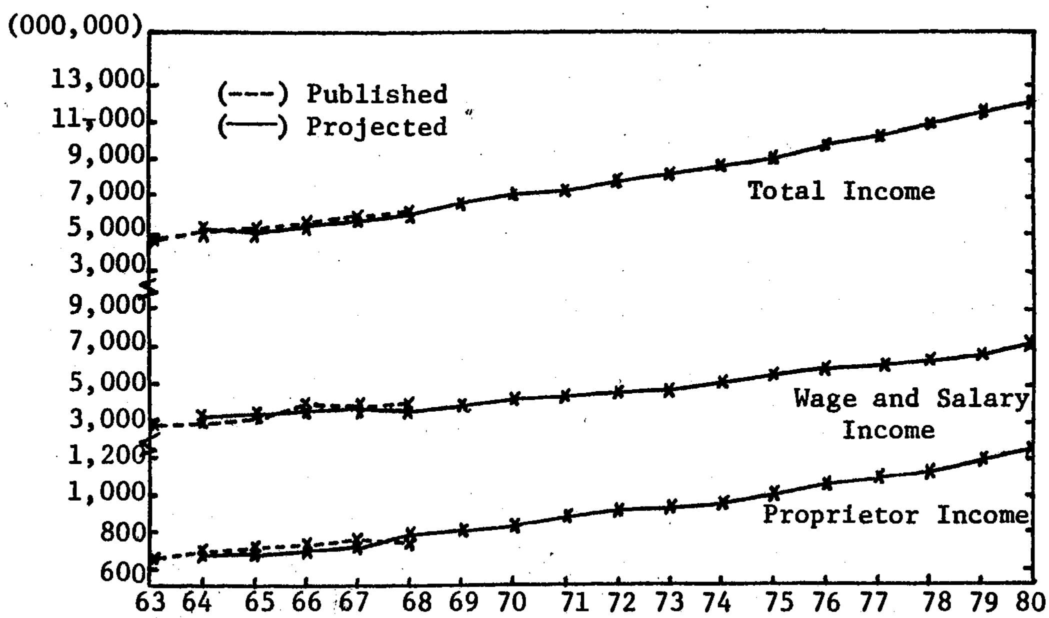

Figure 13. Total Income, Proprietor Income, and Wage and Salary Income Projections, Oklahoma

TABLE XXVI

PERSONAL INCOME, WAGE AND SALARY INCOME, AND OTHER INCOME PROJECTIONS IN CONSTANT 1963 DOLLARS FROM 1964 TO 1980, OKLAHOMA

	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Personal Income-P[a]	5,166	5,405	5,651	5,964	6,329	6,708	7,071	7,431	7,824	8,267	8,755	9,270	9,815	10,396	11,017	11,681	12,388
Personal Income-A[b]	5,143	5,471	5,786	6,105	6,368												
Wage and Salary-P	3,157	3,284	3,415	3,591	3,812	4,036	4,239	4,433	4,645	4,897	5,178	5,469	5,778	6,103	6,457	6,832	7,232
Wage and Salary-A	3,146	3,279	3,502	3,700	3,900												
Agricultural-P	32	31	29	28	27	26	25	24	22	22	21	20	19	18	18	17	16
Agricultural-A	27	26	25	28	26												
Manufacturing-P	538	561	580	612	663	713	750	779	813	862	923	983	1,045	1,107	1,179	1,256	1,339
Manufacturing-A	536	578	645	668	724												
Agricultural Processing-P	75	77	79	82	85	87	90	92	95	98	101	104	107	110	114	118	122
Petroleum-P	56	58	59	61	63	65	66	68	70	72	74	76	79	81	84	87	89
Machinery-P	64	72	82	86	96	105	109	110	112	118	129	136	143	149	157	166	176
Other Manufacturing-P	343	354	360	383	419	456	485	509	536	574	619	667	716	767	824	885	952
Mining-P	278	282	286	292	298	305	311	317	322	329	336	343	351	358	366	374	383
Mining-A	277	285	287	284	293												
Transportation, Communication and Public Utilities-P	278	287	297	311	329	346	362	377	394	413	434	456	479	504	531	558	588
Transportation, Communication and Public Utilities-A	276	282	297	310	328												
Real Estate, Finance and Insurance-P	140	145	149	156	165	174	182	188	196	206	216	227	238	250	263	276	291
Real Estate, Finance and Insurance-A	139	142	151	158	165												
Services-P	329	345	362	385	412	440	466	492	520	552	587	624	664	708	754	804	857
Services-A	327	328	347	376	411												
Wholesale and Retail Trade-P	544	554	569	596	627	658	684	707	733	764	798	833	871	911	954	999	1,045
Wholesale and Retail Trade-A	544	572	592	609	632												
Construction-P	176	180	180	186	196	205	211	216	221	229	239	249	259	269	280	292	304
Construction-A	175	182	182	180	197												
Government-P	842	899	960	1,025	1,095	1,169	1,248	1,333	1,424	1,520	1,624	1,734	1,852	1,978	2,112	2,256	2,409
Government-A	840	875	970	1,080	1,117												
Other Labor Income-P	141	152	163	174	187	201	215	231	247	265	285	305	327	351	377	404	433
Other Labor Income-A	146	157	171	177	187												
Proprietors' Income-P	694	711	728	756	789	823	852	879	908	943	981	1,020	1,063	1,108	1,156	1,206	1,259
Proprietors' Income-A	600	682	765	793	765												
Property Income-P	780	834	891	953	1,019	1,089	1,164	1,244	1,329	1,421	1,520	1,624	1,736	1,855	1,983	2,119	2,266
Property Income-A	777	854	943	988	1,018												
Transfer Payments-P	518	558	600	645	695	747	804	865	930	1,000	1,077	1,158	1,246	1,341	1,442	1,551	1,669
Transfer Payments-A	495	525	564	634	694												

[a]Projections.

[b]Published estimates.

TABLE XXVII

PERSONAL INCOME, WAGE AND SALARY INCOME, AND OTHER INCOME PROJECTIONS IN CURRENT DOLLARS FROM 1964 TO 1980, OKLAHOMA

	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Personal Income-P[a]	5,272	5,682	6,124	6,637	7,201	7,800	8,427	9,099	9,842	10,664	11,561	12,533	13,601	14,772	16,043	17,419	18,912
Personal Income-A[b]	5,220	5,657	6,145	6,697	7,259												
Wage and Salary-P	3,216	3,457	3,712	4,019	4,355	4,710	5,072	5,458	5,889	6,367	6,895	7,458	8,082	8,767	9,513	10,314	11,183
Wage and Salary-A	3,193	3,390	3,719	4,059	4,446												
Agricultural-P	33	32	31	30	29	28	27	26	25	24	24	23	22	21	21	20	20
Agricultural-A	27	27	27	31	30												
Manufacturing-P	540	586	634	694	763	832	899	969	1,052	1,148	1,255	1,370	1,499	1,643	1,802	1,973	2,158
Manufacturing-A	544	598	685	733	825												
Agricultural Processing-P	76	79	82	87	91	95	99	104	109	114	118	124	130	136	143	150	157
Petroleum-P	57	60	63	66	69	73	76	79	83	88	92	96	101	106	112	118	124
Machinery-P	65	74	85	96	108	119	127	135	147	160	176	192	209	229	251	274	298
Other Manufacturing-P	342	373	404	445	495	546	597	651	713	786	869	958	1,059	1,172	1,296	1,431	1,579
Mining-P	284	297	310	324	339	355	371	387	405	423	443	463	485	508	532	557	584
Mining-A	281	295	305	311	334												
Transportation, Communication and Public Utilities-P	283	301	321	345	371	399	426	455	487	522	561	601	646	694	744	796	850
Transportation, Communication and Public Utilities-A	280	292	315	340	374												
Real Estate, Finance and Insurance-P	143	153	163	177	192	206	222	238	255	275	295	316	338	361	386	411	438
Real Estate, Finance and Insurance-A	141	147	160	173	188												
Services-P	335	363	393	429	468	511	554	601	652	709	773	841	918	1,003	1,096	1,197	1,308
Services-A	332	339	368	413	469												
Wholesale and Retail Trade-P	555	587	624	671	721	773	824	877	935	999	1,069	1,144	1,226	1,317	1,415	1,518	1,629
Wholesale and Retail Trade-A	552	591	629	668	720												
Construction-P	179	191	199	212	227	241	254	267	283	300	320	339	361	386	412	439	468
Construction-A	178	188	193	197	225												
Government-P	864	947	1,037	1,137	1,245	1,365	1,495	1,638	1,795	1,967	2,155	2,361	2,587	2,834	3,105	3,403	3,728
Government-A	853	905	1,030	1,185	1,273												
Other Labor Income-P	145	160	176	194	213	234	258	284	313	344	379	417	458	505	556	612	673
Other Labor Income-A	148	162	182	194	213												
Proprietors' Income-P	707	747	788	840	894	952	1,009	1,069	1,136	1,208	1,287	1,371	1,464	1,566	1,676	1,795	1,922
Proprietors' Income-A	710	809	812	870	872												
Property Income-P	801	879	964	1,058	1,161	1,274	1,398	1,534	1,684	1,847	2,027	2,224	2,441	2,678	2,839	3,225	3,539
Property Income-A	789	883	1,001	1,084	1,160												
Transfer Payments-P	533	588	650	718	794	877	969	1,071	1,183	1,307	1,444	1,595	1,763	1,948	2,152	2,377	2,627
Transfer Payments-A	502	543	599	696	791												

[a]Projections.

[b]Published estimates

The solid lines represent results from the simulation model, whereas the dotted lines are estimates published in the Survey of Current Business.

The top portion of Figure 13 reveals the direction that total personal income is projected to move. Personal income is expected to increase from 4,880 million dollars in 1963 to 12,388 million dollars in 1980. The projections for 1964 through 1968 are almost identical to published estimates. The middle portion of Figure 13 indicates how wage and salary income is projected to move. It is expected to increase from 2,986 million dollars in 1963 to 7,232 million dollars in 1980. Again the published and simulated values are quite similar for the years 1964 through 1968. The bottom portion of Figure 13 indicates that proprietor income is expected to increase from 667 million dollars in 1963 to 1,259 million dollars in 1980. The published estimates were slightly higher during 1964 through 1967 and slightly lower during 1968.

Data in Table XXVI provide a complete presentation of the income projections for all sectors from the simulation model in constant dollars. Also presented are the published estimates from the Survey of Current Business for 1964 through 1968. The data on total personal income, wage and salary income, and proprietor income confirm the directional movements illustrated in Figure 13. A sector comparison of wage and salary payments illustrates the ability of the model to simulate estimates consistent with published estimates.

Wage and salary payments to agricultural workers are projected to decrease from 32 million dollars in 1964 to 27 million dollars in 1968. This compares to published estimates of 27 million dollars in 1964 and

26 million dollars in 1968. In 1980, 16 million dollars in wage and salary payments to hired agricultural workers are forecast. Wage and salary earnings in manufacturing are projected to increase from 538 million dollars in 1964 to 663 million dollars in 1968. Published estimates are 536 million dollars in 1964 and 724 million dollars in 1968. Continued expansion in manufacturing activity is projected as wage and salary payments are expected to equal 1,339 million dollars in 1980. Published and projected estimates for the mining sector are very similar. In 1964, 278 million dollars were the projected wage and salary payments as compared to a published value of 277 million dollars. The 1968 projected value is 298 million dollars as compared to the published value of 293 million dollars. Wage and salary payments are projected to equal 383 million dollars in 1980 and do not represent a substantial increase. This reflects the decreasing number of wage and salary workers in mining.

The service-type sectors have simulated wage and salary projections similar to the published estimates for 1964 through 1968. Wage and salary payments in the service-type sectors are projected to increase substantially from 1969 through 1980. The largest dollar increase is projected for the service and wholesale and retail trade sectors. Rapid growth in these sectors exemplifies the growing demand for services in the society. Payments to government workers are projected to equal 842 million dollars in 1964, 1,095 million dollars in 1968, and 2,409 million dollars in 1980. This compares with the published estimates of 840 million dollars in 1964 and 1,117 million dollars in 1968.

Other labor income, property income and transfer payments are also projected to increase substantially from 1964 to 1980. The published estimates from 1964 to 1968 are quite similar to the projected values for these income categories.

Table XXVII contains income estimates in current dollars.[2] The rate of inflation implicit in the projections is similar to that which occurred during 1963 through 1968. Personal income in current dollars is projected to increase from 5,272 million dollars in 1964 to 18,912 million dollars in 1980. In constant dollars, this compares with 5,166 million dollars in 1964 and 12,388 million dollars in 1980. Wage and salary payments are projected to increase from 3,216 million dollars in 1964 to 11,183 million dollars in 1980. In constant prices, 3,157 million dollars was projected for 1964 and 7,232 million dollars in 1980.

Proprietor income in current prices was projected at 707 million dollars in 1964 and 694 million dollars in constant prices. For 1980, income to proprietor's is projected to equal 1,922 million dollars in current prices compared to 1,259 million dollars in constant prices. Also listed in Table XXVII are published income data for 1964 through 1968 at current price levels. The projected estimates are quite similar to the published estimates.

Other Economic Projections

The economic variables presented and discussed in this section include disposable income, per capita income, gross state product,

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[2]This period had an annual inflation rate of 2.1 percent.

federal taxes and state and local government revenue. The projected values for these variables are presented in Table XXVIII.

TABLE XXVIII

PROJECTIONS OF OTHER ECONOMIC VARIABLES, OKLAHOMA, 1963 TO 1980 (CONSTANT 1963 DOLLARS)

Year	Disposable Income (1)	Per Capita Income (2)	Gross State Product (3)	Federal Revenue (4)	State and Local Government Revenue (5)
	(Million Dollars)		(Million Dollars)	(Million Dollars)	(Million Dollars)
1963	4,422	1,803	4,742	961	868
1964	4,587	1,862	5,015	995	906
1965	4,795	1,948	5,159	1,027	948
1966	5,007	2,020	5,295	1,063	992
1967	5,282	2,098	5,513	1,113	1,046
1968	5,602	2,204	5,789	1,169	1,108
1969	5,934	2,311	6,066	1,227	1,172
1970	6,249	2,420	6,302	1,280	1,235
1971	6,562	2,527	6,515	1,332	1,298
1972	6,902	2,645	6,753	1,387	1,367
1973	7,287	2,777	7,038	1,451	1,444
1974	7,712	2,922	7,360	1,522	1,527
1975	8,161	3,074	7,693	1,595	1,615
1976	8,634	3,219	8,039	1,674	1,708
1977	9,139	3,372	8,404	1,758	1,808
1978	9,678	3,534	8,793	1,847	1,914
1979	10,254	3,707	9,206	1,942	2,026
1980	10,867	3,891	9,642	2,042	2,147

Disposable income is defined as personal income minus federal personal taxes and state and local personal taxes (see equation (7.51) in Chapter VII). It is projected to increase from 4,422 million dollars in 1963 to 10,867 million dollars in 1980. Per capita income is defined as disposable income available per individual (see equation (7.7) in Chapter VII). In 1963, per capita income was $1,803. The simulation model projects per capita income in 1980 as $3,891 (1963 prices).

Gross state product for Oklahoma is presented in column (3) of Table XXVIII. It is equal to value added for the business sectors plus state and local government wage and salary payments and federal government wage and salary payments (see equation (7.46) of Chapter VII). Gross state product in Oklahoma is expected to increase from 4,742 million dollars in 1963 to 9,642 million dollars in 1980. According to the data in column (4) of Table XXVIII, federal taxes are projected to increase from 961 million dollars to 2,042 million dollars in 1980. Federal taxes collected from businesses and households include corporation taxes, personal income taxes and indirect income taxes (see equations (7.41) through (7.44) of Chapter VII). Column (5) of Table XXVIII contains state and local government revenue. The components of state and local government revenue include state personal income taxes, property taxes, federal aid, other taxes, and miscellaneous taxes (see equations (7.45) through (7.50) in Chapter VII). State and local revenue is projected to increase from 868 million dollars in 1963 to 2,147 million dollars in 1980.

CHAPTER IX

ECONOMIC IMPACT ANALYSIS USING SIMULATION

Many alternative strategies exist for planning state economic development. One stragegy may be to maximize employment using whatever means available to state development authorities. This may not be an unreasonable strategy for a state such as Oklahoma which is expected to lose 24,045 jobs between 1970 and 1980 in the two primary sectors of agriculture and mining.[1] Alternatively, a strategy may be to maximize total state income (wage and salary payments plus proprietor income) or per capita income payments. For any selected development strategy it is useful to know the total impact on employment or income from private investment in any one of the industry categories.

The procedure used for the analysis was to assume that one million dollars was invested in each industry sector in 1970. Separate simulation runs were made for each sector to determine the investment impact. The effects of that investment were measured in terms of new employment and income generated through 1980. The amount of production generated in each sector from the additional million dollar investment was determined by the capital-output ratio. The increased production was assumed exported if the sector was a net exporter and consumed in the state if the sector was a net importer. For net import sectors, the increased

[1]See Chapter X for these estimates.

production was assumed to reduce imports proportionately by all user industries.

The growth process leads to short-run, intermediate-run, or long-run impacts. During the first year, three impact effects arise due to the million dollar investment. These include: the direct effect, the indirect effect, and the capital formation effect. The direct effect measures the economic activity generated directly in the sector due to increased sector production. Indirect effects arise from direct effects. The indirect effects arise as the sector which increases production demands additional goods and services from all other sectors. In turn these sectors will increase their demands for goods from other industries. The reverberations will continue until the economy completely adjusts. All repercussions of the increased production are included in the indirect effects. Another direct impact effect arises during the first year and is referred to as the capital formation effect. This effect includes the economic activity that is generated as a result of the one million dollar capital investment in a sector. Economic activity created by capital formation is heavily associated with the construction and durable goods sectors.

The intermediate impact arises from: a direct effect, the indirect effects, an induced capacity effect, and an induced consumption effect. The direct and indirect effects resulting from sector production remain as production continues in the intermediate years. The direct effect from capital formation occurs only during the first year and then disappears. However another effect which is referred to as the induced capacity effect is created. This effect is created due to the increased demand for additional goods from all other sectors. In order to produce the additional goods other sectors need to increase their capacity. The capacity effect is largest during the first and second years following the initial change in production. The capacity effect tapers off to zero over a period of years. Another effect arising during the intermediate year is the induced consumption effect. This effect arises as consumers have more money to spend for goods and services. The induced consumption effect continues on into the long-run period.

With the capital formation effect reduced to zero in the short-run and the induced capacity effect reaching zero after a period of years, all that remains in the long-run are the direct and indirect production effects and the induced consumption effects. The long-run impact indicates the economic activity generated over a period of years from the initial production increase. The impacts can easily be converted into multipliers.

The multipliers were determined from output, employment, income, and investment data. For example, consider the calculation of the long-run employment multiplier. The direct effect was determined by first calculating the amount of output generated by a one million dollar investment. Capital-output ratios were used to determine the amount of output directly generated by the investment. Output-labor ratios were used to determine the number of man-years of employment created by the additional production. The simulation model measured the total long-run impact on employment which included the direct effect, the indirect effect, and the induced effect. Short-, intermediate, and long-run employment and income multipliers are derived and discussed in the remaining parts of this chapter.

Short, Intermediate and Long-Run Employment Multipliers

The employment impact effects and multipliers are presented in Table XXIX. Listed in column (1) are the direct employment effects for each sector. The direct effect indicates the number of men employed in sector production from a one million dollar capital investment in that sector. The largest direct effects occur in wholesale and retail trade with 226 and services with 221 men employed per million dollars of capital investment. The sectors with the smallest direct effects are in petroleum; in transportation, communication and public utilities; and in mining.

Direct and indirect employment effects are listed in column (2) of Table XXIX. These effects are computed by considering the repercussions on employment in all sectors as a result of the initial change in production. The agricultural processing sector has the largest direct and indirect effect with 491 jobs created from the initial sector production change. Construction, wholesale and retail trade, and services follow with 359, 291, and 288 jobs created, respectively. The short-run production employment multipliers are listed in column (8). These multipliers are the conventional open-model input-output employment multipliers and are computed by dividing the direct effect (column 1) into the direct and indirect effect (column 2). Each multiplier indicates the change in direct and indirect employment generated throughout the Oklahoma economy by a one unit change in production employment in the specified sector. The petroleum sector has the largest employment multiplier at 7.25. The magnitude results from the sector's large interaction with other sectors, particularly mining and manufacturing.

TABLE XXIX

SHORT, INTERMEDIATE, AND LONG-RUN EMPLOYMENT IMPACTS AND MULTIPLIERS FROM A MILLION DOLLAR INVESTMENT IN INDUSTRY CAPACITY, OKLAHOMA, 1970

	Direct Employment Effect[a] (1)	Direct and Indirect Employment Effect[a] (2)	Capital Formation Effect[a] (3)	Total Short-Run Effect[a] (4)	Total Second Year Effect[a] (5)	Total Third Year Effect[a] (6)	Total Long-Run Effect[a] (7)	Short-Run Production Employment Multiplier (8)	Short-Run Total Employment Multiplier (9)	Intermediate-Run Multiplier (Second Year) (10)	Intermediate-Run Multiplier (Third Year) (11)	Long-Run Employment Multiplier (12)
Livestock	59	140	68	208	332	258	121	2.37	3.52	5.63	4.37	2.05
Crops	111	128	75	213	301	228	80	1.24	1.92	2.71	2.05	.72
Agricultural Processing	78	491	65	556	982	901	488	6.29	7.13	12.59	11.55	6.25
Petroleum	12	87	64	151	325	255	75	7.25	12.58	27.08	21.25	6.25
Machinery	76	154	67	221	353	296	196	2.02	2.91	4.64	3.89	2.58
Other Manufacturing	82	153	68	221	356	303	257	1.87	2.60	4.34	3.69	3.13
Mining	32	68	78	146	252	181	67	2.12	4.56	7.87	5.66	2.10
Transportation, Communication and Public Utilities	24	37	59	96	177	120	40	1.54	4.00	7.37	5.00	1.66
Real Estate, Finance and Insurance	80	122	67	189	282	219	127	1.52	2.36	3.53	2.74	1.59
Services	221	288	64	352	486	442	359	1.30	1.59	2.19	2.00	1.62
Wholesale and Retail Trade	226	291	71	362	498	444	353	1.29	1.60	2.20	1.96	1.56
Construction	152	359	62	421	662	610	391	2.36	2.76	4.36	4.01	2.57

[a]Man-year equivalents.

Agricultural processing has the second largest employment multiplier at 6.29. Interpretation of this multiplier means that for each man-year directly employed in the agricultural processing sector for delivery to final demand, a total of 5.29 additional man-years are generated throughout the economy.

The direct capital formation effects of each sector are listed in column (3) of Table XXIX. These figures indicate the man-years required to produce the one million dollar capital investment for that sector. The capital formation effects are somewhat similar for all sectors with a range of 59 to 78 man-years. Total man-years resulting from capital formation and increased production are listed in column (4). The agricultural processing and construction sectors have the largest total effect with 556 and 421 man-years, respectively. The total short-run employment multipliers are listed in column (9). The multipliers are computed by dividing the direct effect (column 1) into the total direct, indirect, and capital formation effect (column 4). The total short-run multiplier indicates the change in direct, indirect and capital formation employment generated throughout the Oklahoma economy by a one unit change in production employment in that sector. The petroleum sector has the largest total short-run employment multiplier at 12.58. Interpretation of this multiplier indicates that for each man-year employed directly in increased petroleum production in 1970, a total of 12.58 man-years would be employed throughout the economy in both production and direct capital formation activities.

Intermediate-run impacts and multipliers are contained in columns (5), (6), (10), and (11) of Table XXIX. The activity generated in the short-run creates additional production demands from all other sectors.

This additional production requires additional plant capacity which is constructed in the intermediate years. Most of the additional capacity is constructed in 1971 and 1972 and tapers off to zero after a period of years. Also, occuring during the intermediate years are induced consumption effects created by increased consumer income. Man-year requirements for each year are listed in columns (5) and (6). Sectors with the largest man-year requirements are agricultural processing, construction, wholesale and retail trade, and services. The intermediate-run multipliers are listed in columns (10) and (11). They are computed by dividing the direct effect (column 1) into the intermediate effects (columns 5 and 6). Petroleum, agricultural processing, and mining have the largest intermediate-run multipliers. Each multiplier indicates the total change in employment in 1971 and 1972 resulting from a one man-year production increase in 1970.

The long-run employment impact data and multipliers are presented in columns (7) and (12) of Table XXIX. With the capital formation effect occuring during the initial year, and the capacity effects tapering off to zero during the intermediate years, all that remains in the long-run is the total production effect and induced consumption effect. Total employment generated for each sector in 1980 as a result of the increased production in 1970 is listed in column (7). Agricultural processing, construction, services, and wholesale and retail trade have the largest long-run employment requirements. Long-run employment multipliers are listed in column (12). They are computed by dividing the direct effect (column 1) into the total long-run effect (column 7). Each multiplier indicates the total employment generated in 1980 resulting from one man-year production employment in

1970. Petroleum, agricultural processing, and other manufacturing have the largest long-run employment multipliers at 6.25, 6.25, and 3.13, respectively. The long-run employment multiplier for crops is .72. The small multiplier reflects the rapid increase in technology used in the crop sector and the low amount of interaction of crops with other sectors.

The employment impacts and multipliers presented in Table XXIX measure the effect of a million dollar investment on a sector and the interaction created by the direct employment. If the strategy employed by planners is to maximize employment interaction, the short, intermediate, or long-run multipliers are useful. However, the economic variable under concern may be income rather than employment. The next section provides an analysis of the impacts on income.

Income Multipliers

Table XXX contains the income impact effects and multipliers. Direct income effects for each sector are listed in column (1). The direct income effect is the amount of income going to households as wages and salaries and proprietor income as a result of increased production from a million dollar capital investment in that sector. The service and wholesale and retail trade sectors have the largest direct income effects. For the service sector, \$1,050,000 of income is directly generated, while \$927,000 is directly generated by the wholesale and retail trade sector. Sectors with the lowest direct effect are petroleum; livestock; and transportation, communication and public utilities.

TABLE XXX

SHORT, INTERMEDIATE, AND LONG-RUN INCOME IMPACTS AND MULTIPLIERS FROM A MILLION DOLLAR INVESTMENT IN INDUSTRY CAPACITY, OKLAHOMA, 1970

	Direct Income Effect (000) (1)	Direct and Indirect Income Effect (000) (2)	Capital Formation Effect (000) (3)	Total Short-Run Effect (000) (4)	Total Second Year Income Effect (000) (5)	Total Third Year Income Effect (000) (6)	Total Long-Run Effect (000) (7)	Short-Run Income Multiplier (8)	Short-Run Total Income Multiplier (9)	Intermediate-Run Income Multiplier (Second Year) (10)	Intermediate-Run Income Multiplier (Third Year) (11)	Long-Run Income Multiplier (12)
Livestock	125	361	363	724	1,450	1,137	410	2.89	5.79	11.60	9.09	3.28
Crops	236	352	396	748	1,264	929	260	1.49	3.17	5.36	3.94	1.10
Agricultural Processing	429	1,776	357	2,133	4,516	4,213	2,380	4.10	4.97	10.53	9.82	5.55
Petroleum	102	538	349	887	1,853	1,519	590	5.27	8.69	18.17	14.89	5.78
Machinery	409	875	359	1,234	2,000	1,727	1,390	1.86	2.63	4.26	3.68	2.94
Other Manufacturing	495	886	361	1,247	2,010	1,778	1,870	1.79	2.52	4.06	3.59	3.78
Mining	223	418	413	831	1,430	1,072	450	1.87	3.73	6.41	4.81	2.02
Transportation, Communication and Public Utilities	156	222	324	546	997	695	220	1.42	3.50	6.39	4.45	1.41
Real Estate, Finance and Insurance	378	536	352	888	1,417	1,109	640	1.42	2.35	3.85	2.93	1.69
Services	1,050	1,388	340	1,728	2,513	2,312	2,090	1.32	1.65	2.39	2.20	1.99
Wholesale and Retail Trade	927	1,241	364	1,605	2,375	2,130	1,840	1.34	1.73	2.56	2.30	1.98
Construction	843	1,889	337	2,226	3,611	3,414	2,690	2.24	2.64	4.28	4.05	3.19

Direct and indirect income effects are listed in column (2) of Table XXX. These effects are determined by considering all the repercussions on income in all sectors as a result of the initial change in sector production. Construction, agricultural processing, and services have the largest direct and indirect income effects at $1,889,000, $1,776,000 and $1,388,000, respectively. The smallest direct and indirect effects are in transportation, communication and public utilities; and crops. Short-run production income multipliers are contained in column (8). These multipliers are the conventional input-output income multipliers and are computed by dividing the direct effect (column 1) into the direct and indirect effect (column 2). Each multiplier indicates the change in income generated throughout the Oklahoma economy by a one unit change in production income from delivery to final demand for the specified sector. Petroleum, agricultural processing and livestock have the largest income multipliers at 5.27, 4.10, and 2.89, respectively. The petroleum multiplier indicates that for each dollar of production income directly generated, a total of $5.27 is generated throughout the economy. Sectors with the smallest income multipliers are services and wholesale and retail trade.

The direct capital formation effect for each sector is listed in column (3) of Table XXX. These figures indicate the income generated as the result of a million dollar increase in capital investment. The amount of income generated from capital formation varies from $324,000 in the transportation, communication and public utilities sector to $413,000 in the mining sector. Total income generated in each sector from capital formation and increased production is listed in column (4). The total short-run income multipliers are listed in column (9). It is calculated by dividing the direct income effect (column 1) into the total direct, indirect, and capital formation effect (column 4). Each multiplier indicates the change in income generated throughout the Oklahoma economy by a one unit change in production income of the specified sector. Petroleum, livestock, and agricultural processing have the largest total short-run income multipliers. The multiplier for the petroleum sector indicates that for each one dollar of income directly generated in petroleum production, $8.69 is generated throughout the Oklahoma economy.

The intermediate-run impacts and multipliers are presented in columns (5), (6), (10) and (11) of Table XXX. The capacity and induced consumption effects create income in addition to the direct and indirect production effects for intermediate years. Income totals generated in 1971 and 1972 are listed in columns (5) and (6). The sectors with the largest income effects are agricultural processing, construction, and services. The intermediate-run multipliers are listed in columns (10) and (11). They are computed by dividing the direct effect (column 1) into the intermediate effects (columns 5 and 6). Petroleum, agricultural processing, and livestock have the largest intermediate-run multipliers. Each multiplier indicates the total change resulting in 1971 and 1972 from a one unit income increase in 1970.

The long-run impact data and multipliers are presented in columns (7) and (12). In 1980, only the income generated from direct and indirect production and induced consumption effect remains; the capital formation effect occurs only during the first year and the capacity effect tapers off to zero during the intermediate years. The total income generated in 1980 as a result of increased production in 1970 is listed in column (7). Construction, agricultural processing, and services have the largest amount of generated income in 1980. Long-run income multipliers are listed in column (12). They are computed by dividing the direct effect (column 1) into the total long-run effect (column 7). Each multiplier indicates the total income generated in 1980 resulting from one unit of sector income in 1970. Petroleum, agricultural processing, and other manufacturing have the largest long-run income multipliers; 5.78, 5.55 and 3.78, respectively.

The income analysis assists in evaluating alternative strategies if the goal is to maximize income generated per dollar of income arising from the specified sector. Planners may have strategies other than those presented for income and employment. For example, an alternative strategy might be to maximize income or employment with limited capital. This strategy is presented and discussed in the next section.

Alternative Strategies for State Economic Development

If the goal is to maximize employment or income with limited capital, the strategy to employ would be quite different than presented in the preceding sections. The direct investment cost per 100 jobs and per million dollars worth of income generated are presented in Table XXXI. The cost to directly employ 100 men is presented in column (1). For example, to directly employ 100 men in the mining sector, $3,125,000 (1963 prices) must be invested in the mining sector. The wholesale and retail trade sector has the lowest direct short-run investment requirements per 100 jobs. Following in second order is the service sector.

TABLE XXXI

DIRECT SHORT, INTERMEDIATE, AND LONG-RUN INVESTMENT COST PER HUNDRED JOBS CREATED AND PER MILLION DOLLARS INCOME GENERATED, OKLAHOMA, 1970

Sector	Cost Per 100 Jobs Directly Created in the Short-Run (1)	Cost Per 100 Jobs Directly and Indirectly Created in the Short-Run (2)	Cost Per 100 Jobs Created Directly, Indirectly and Induced in Long-Run (3)	Cost Per Million Dollars Income Directly Created in the Short-Run (4)	Cost Per Million Dollars Income Directly and Indirectly Created in the Short-Run (5)	Cost Per Million Dollars Income Directly, Indirectly and Induced in the Long-Run (6)
	(Thousands of Dollars in 1963 Prices)					
Livestock and Livestock Products	1,695	714	826	8,000	2,770	2,439
Crops	901	724	1,250	4,237	2,841	3,846
Agricultural Processing	1,282	204	205	2,331	563	420
Petroleum and Coal Products	8,333	1,149	1,333	9,804	1,859	1,695
Machinery, Except Electrical	1,316	649	510	2,445	1,143	719
Other Manufacturing	1,219	654	389	2,020	1,129	535
Mining	3,125	1,471	1,492	4,484	2,392	2,222
Transportation, Communication and Public Utilities	4,167	2,703	2,500	6,410	4,504	4,545
Real Estate, Finance and Insurance	1,250	830	787	2,645	1,866	1,562
Services	452	347	279	952	720	478
Wholesale and Retail Trade	443	344	283	1,079	806	543
Construction	658	279	256	1,186	529	371

The direct investment costs per 100 jobs created directly and indirectly in the short-run by industry are presented in column (2) of Table XXXI. These costs indicate the investment needed in a particular sector to create jobs for 100 men. The jobs are mainly created in the sector receiving the investment; however, employment created by the interaction of the sectors is also included, thus all sectors may witness an increase in employment. For example, consider the other manufacturing sector. If $654,000 were invested in that sector, 100 jobs would be created throughout the economy in the short-run. The agricultural processing sector has the lowest short-run investment requirement per 100 men employed throughout the economy at $204,000. Next in order are the construction, wholesale and retail trade, and service sectors.

The cost per 100 jobs created in the long-run are presented in column (3) of Table XXXI. In the long-run, employment is increased directly, indirectly, and induced. Each figure in column (3) indicates the amount of direct investment required in 1970 to increase employment throughout the economy by 100 jobs in 1980. The agricultural processing sector requires $205,000 of investment in 1970 to create 100 jobs in 1980. Following this sector are the construction, services, and wholesale and retail trade sectors.

A similar approach is taken to analyze a strategy to minimize investment per million dollars of additional income. The investment requirements by industry grouping to create one million dollars worth of income in that sector are presented in column (4) of Table XXXI. The services and wholesale and retail trade sectors have the lowest investment requirements to create one million dollars worth of sector income (wages and salaries and proprietor income) in the short-run.

Investment requirements by sector per one million dollars worth of income generated directly and indirectly are presented in column (5) of Table XXXI. Income generated indirectly from the interaction of the sectors in the economy is included in these figures. The construction and agricultural processing sectors have the lowest investment requirements to yield one million dollars worth of income throughout the economy. Investment cost per million dollars worth of income generated directly, indirectly, and induced for the long-run are presented in column (6) of Table XXXI. Again the construction and agricultural processing sectors have the lowest investment requirements to yield a million dollars income throughout the economy. In third and fourth order are services, and wholesale and retail trade.

In the short-run the sectors which require the largest amount of capital per 100 jobs directly created are petroleum and coal products; transportation, communication and public utilities; and mining. In the long-run, the same sectors have the largest investment requirements per 100 jobs created; however, the petroleum and coal products sector ranks third rather than first. This change is due to the large amount of interaction found in the petroleum and coal products sector. In the short-run, the sectors with the largest investment requirement per million dollars income are petroleum and coal products, livestock and livestock products; and transportation, communication and public utilities. In the long-run, the transportation, communication and public utilities; crops; and livestock and livestock products sectors have the largest investment costs per million dollars of income.

The preceding investment strategies do not consider the growth potential of the various sectors or the rate of return for private and social investment. The multiplier analysis indicates a maximum interaction criterion of each sector in the short, intermediate and long-run for income and employment. The minimum investment analysis (lowest sector investment per 100 jobs created or per million dollars generated) yields a minimum investment criterion for the short, intermediate and long-run periods. Neither of these criteria consider the growth potential of the sectors.

The agricultural sectors, (livestock and livestock products, and crops) agricultural processing, petroleum and coal products, and mining are slow-growth sectors, both for Oklahoma and for the U. S. The machinery and other manufacturing sectors are more growth type sectors. Construction is a cyclical sector and seriously affects Oklahoma's and the U. S.'s economy during tight money periods.[2] The remaining sectors are service-type sectors and their growth largely depends on the activity of the primary and manufacturing sectors.

For a more complete analysis, the regional data presented above should be supplemented with data on rates of return to private and social investment. For example, it would be impractical for a planning authority to push development in a sector with a high multiplier and/or a low investment cost, if the private rate of return for the industry for that location were negative. Rates of return must be positive for industry location and the higher the rate of return the easier it would

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[2]Employment and income data in Chapter VI for Oklahoma and in [116] and Survey of Current Business (various issues) from 1966-69 support these growth conclusions.

be to attract an industry to a particular location. Social rates of return for the sectors in the model can be calculated from the data in the capital account and interindustry account.[3] Private rates of return cannot be obtained from the data in the accounts.[4] Both private and social rates of return would be useful in supplementing this analysis, thus specifying a need for additional research.

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[3]Social rate of return is defined as the value added per unit of investment.

[4]Private rates of return is defined as the rate of return to the total resources invested in the project. A feasibility study would be needed to arrive at a private rate of return for a firm at a particular location.

CHAPTER X

SUMMARY, IMPLICATIONS AND LIMITATIONS

Summary

The main purpose of the study was to provide a dynamic analysis which would yield economic projections and evaluate various development strategies. Government planners who are striving to efficiently allocate scarce resources will find the analysis useful in evaluating the impacts of various governmental policies. Industrial and agricultural leaders will find the data useful in planning their investments and operations. The main objectives of the study were to develop a social accounting system and to develop a simulation model for the economy of Oklahoma. Secondary data were used to formulate the social accounting system for Oklahoma. Economic activity within the state was classified into 12 endogenous sectors and five exogenous sectors. The endogenous sectors or producing sectors included two agricultural sectors, four manufacturing sectors, one mining sector and five service-type sectors.

The social accounting system for 1963 was presented in three main sections: (1) the interindustry account; (2) the capital account; and (3) the human resource account. The interindustry account forms the core of the complete system. Connected to it are the capital and human resource account.

The interindustry section of the Oklahoma social accounting system consists of three basic parts: a transaction or flow table, a direct coefficient table, and a direct and indirect coefficient table. The transaction table is the base of the interindustry account and the other tables are derived directly from it. The transaction table is a double accounting system, as sales and purchases or each sector are included in the table. The direct coefficients reveal the direct dependence of each sector on all other sectors. The direct and indirect coefficients indicate the total change in input requirements as a result of a one dollar change in final demand. The total change includes the direct effect as well as all indirect effects resulting from the initial one dollar change in final demand.

The capital section includes eight basic parts: a capital coefficient matrix, capital-output ratios, capacity levels, capital unit matrix, capital stock matrix, inventory coefficients, investment matrix and depreciation coefficients. The capital coefficients indicate the capital goods required by the other sectors per dollar's worth of capital expenditure in that sector. Capital-output ratios were defined as the ratio of total cost of plant and equipment to output at capacity. Estimates of percent capacity operating levels for 1963 in each sector were obtained from employment data. Peak employment was assumed equal to 100 percent capacity operation.

The capital unit matrix indicates the capital goods required from all other sectors to produce one unit of output capacity in each sector. The total value of capital goods and composition are presented in the capital stock matrix. Inventory coefficients were derived that measure the amount of inventory required per unit of output. The investment matrix shows the value of capital goods and inventory from each sector needed per unit of sector investment. To complete the capital structure analysis, depreciation coefficients were estimated as the ratio of depreciation to depreciable assets.

Of vital importance in an accounting system is the human resource account. From this account, data are available on employment, income, and population for the state. Included in the employment portion are estimates of wage and salary employment and proprietor employment by sector. With employment data and the output data from the transaction table, labor-output ratios are developed. The income portion includes wage and salary and proprietor income data by sector. With the employment and income data, payment rates for wage and salary workers as well as proprietors are calculated.

The simulation model was formulated around the basic Leontief input-output system. The complete multiple-sector recursive model consists of 51 major equations. Many of the major equations were disaggregated into sub-equations; that is, having one sub-equation for each endogenous sector in the Oklahoma economy. Thus, the entire system includes over 300 equations. The model was formulated in Fortran and run on the computer at relatively low cost enabling the researchers to experiment with the model by changing variables and measuring their impact. The simulation model was run with the data from the social accounting system to obtain results on projections of state economic variables and to estimate structural parameters for the Oklahoma economy.

Implications

Economic variables projected by sector included income and employment. Total employment was projected to increase by 54 percent from 1963 to 1980, wage and salary employment by 71 percent, and proprietor employment by ten percent. The slow growth in proprietor employment results from the decline in the projections of farm proprietors. In fact, the number of farm proprietors is projected to decrease by 21 percent from 1963 to 1980. The service-type sectors during this period are projected to have an increase in proprietors, thus accounting for the net increase in all proprietors.

Wage and salary employment is projected to increase in all sectors, except in agricultural, mining, and construction. These sectors are victims of rapidly increasing technology, thus reducing the need for added employment. Of the four manufacturing sectors, wage and salary employment in agricultural processing and petroleum are expected to grow rather slowly. The agricultural processing sector is projected to have a 14 percent increase in employment from 1963 to 1980, while the petroleum sector's wage and salary employment is projected to increase 11 percent. Wage and salary employment in the machinery and other manufacturing sectors is expected to increase at a much faster rate. In the machinery sector, wage and salary employment is projected to increase 116 percent from 1963 to 1980, while in the other manufacturing sector it is projected to increase 113 percent. Employment in the service-type sectors depends heavily on the other sectors. Total wage and salary employment in the service-type sectors is projected to increase 67 percent from 1963 to 1980. The wholesale and retail trade and service sectors are projected to become increasingly important in our economy.

Income projections indicate that personal income is expected to increase 154 percent from 1963 to 1980, wage and salary income 142 percent, and proprietor income 82 percent. Wage and salary payments by sector were presented and had a pattern similar to wage and salary employment projections. Per capita income is projected to increase 116 percent from 1963 to 1980 (all growth rates in 1963 dollars).

The impact analysis consisted of measuring the effect on income and employment of a one million dollar investment in a sector. This procedure was adopted to provide planners with a criterion to use to evaluate effects of alternative development strategies. If the goal is to maximize employment with a limited amount of capital, the wholesale and retail trade, services, and construction sectors have the largest short-run direct effect. The sectors having the largest short-run total production effect (direct and indirect effects) are the agricultural processing, construction and wholesale and retail trade sectors. In the long-run the sectors which maximize employment from a given amount of capital are agricultural processing, construction, and wholesale and retail trade.

If the planner desires to maximize the number of man-years employed per man-year directly employed in production, the sector with the largest employment multipliers should be stressed. Each sector multiplier indicates the number of man-years employment generated throughout the economy by a one man-year change in production employment in that sector. The petroleum sector has the largest employment multiplier, while the employment multiplier for the agricultural processing sector is second largest in the short-run, intermediate-run and long-run. The third largest employment multiplier is found in the livestock and livestock products sector in the short-run, in the mining sector in the intermediate-run, and in the other manufacturing sector in the long-run.

Similar goals related to income are also presented. If the goal is to maximize income with limited capital, income generated by direct production is largest in the service, wholesale and retail trade, and construction sectors. Direct and indirect income effects in the short-run are largest in the construction, agricultural processing, and service sectors. In the long-run, construction, agricultural processing, and service sectors have the largest income effect. Maximization of the interaction of the income multipliers results in selecting those sectors with the largest income multipliers. Income multipliers are defined as the total income generated as a result of one dollar of income arising from delivery to final demand for any specified sector. Ranking as first and second in the short-run, intermediate-run, and long-run are the income multipliers of the petroleum and agricultural processing sectors. In third order in the short-run and intermediate-run is the livestock and livestock products sector and in the long-run is the other manufacturing sector.

Limitations

A major limitation is that the empirical results apply to an aggregate of industries within a sector and cannot be generalized for any specific industry. 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 a specific industry is to be analyzed, the coefficients would have to be adjusted to represent the production pattern of that industry.

Additional refinement is needed to improve or add relationships to the model. The accelerator principle assumed in the capital investment equation and the constant export share assumption in the export equation are limitations inherent in the model. Additional research would allow modification of these relationships and many others. Also, with more data, additional equations could be included in the model, making it more realistic in testing such strategies as state authority, industry loan programs, and tax write-off programs.

The limitations of the model directly exemplify future research needs. First, a more detailed model will provide more information concerning the growth of the Oklahoma economy. A more detailed model would involve a great deal of time and money, as primary data would have to be collected. Second, additional research is needed to study, evaluate, and improve the relationships in the model. This research would make the model more realistic and sensitive to critical issues, thus allowing for evaluation of additional programs. Third, additional research remains to be completed with the present model. For example, the impact of a negative income tax can be connected to the income and federal government equations. These equations in turn revert back to household demand and induce further changes in the model. Finally, additional research is needed to apply this model as an inter-regional model in analyzing the economy of the Ozark counties of Oklahoma. Such an analysis would indicate the economic conditions within the region, as well as how the economic conditions of the region effect or are effected by the conditions of the rest of the state. The model could project economic variables and analyze the impact of alternative planning actions. The impact of industry investment and expansion and numerous government programs (such as social capital investment in highways) could be determined from the simulation model. These results would be useful for industrial, governmental and agricultural planners. The implementation of an inter-regional model would again require a large amount of primary data. The resources involved in collecting this data might necessitate developing short cuts to minimize research costs. This too, can only be determined with additional research.

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APPENDIXES

APPENDIX A

METHODS AND SOURCES USED FOR CONSTRUCTION OF THE CURRENT ACCOUNT

The Oklahoma model consists of 12 endogenous sectors and five exogenous sectors. Each sector is defined according to the classification used by the Bureau of Labor Statistics. Appendix Table XXXII summarizes a classification of the endogenous sectors. All data refers to 1963 in current prices unless otherwise specified.

Definitions and Sources Used in Deriving the Endogenous Sectors

Sectors 1 and 2: Livestock and Livestock Products and Crops

The agricultural sectors are discussed jointly as many of the definitions and sources are similar for the two sectors. Output is defined as the value of all agricultural commodities produced on the farm in 1963, plus the value of government payments, and the rental value received. Estimates for these items are as follows:

Livestock and Livestock Products	$365,298,000
Crops	339,246,000
Government Payments	53,517,000
Farm Rental Received	28,600,000
TOTAL	$786,661,000

The value of agricultural commodities produced during 1963 on Oklahoma farms was obtained from [58] and includes:

TABLE XXXII

CLASSIFICATION OF ENDOGENOUS SECTORS, OKLAHOMA MODEL

Oklahoma Model	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 and 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) Fruits and nuts q) Other crop products
3. Agricultural Processing	a) Meat products b) Dairy products c) Canned and frozen foods d) Grain mill products e) Bakery products f) Confectionery and related products g) Beverage industries h) Miscellaneous food preparation
4. Petroleum and Coal Products	a) Petroleum refining b) Paving and roofing materials c) Petroleum and coal products, N.E.C.
5. Machinery, Except Electrical	a) Farm machinery and equipment b) Construction and like equipment c) Metalworking machinery

TABLE XXXII (Continued)

Oklahoma Model	Included in Sector
	d) Special industry machinery e) General industrial machinery f) Service industry machines g) Machinery, except electrical, N.E.C.
6. Other Manufacturing	a) Ordinance and accessories b) Apparel and related products c) Lumber and wood products d) Paper and allied products e) Printing and publishing f) Chemicals and allied products g) Rubber and plastics products h) Leather and leather products i) Stone, clay, and glass products j) Primary metal industries k) Fabricated metal products l) Electrical machinery m) Transportation equipment n) Instruments and related products o) Miscellaneous manufacturing
7. Mining	a) Crude petroleum and natural gas b) Metal mining c) Bituminous coal and lignite mining d) Nonmetallic minerals, except fuels
8. Transportation, Communication and Public Utilities	a) Local passenger transportation b) Trucking and warehousing c) Pipe line transportation d) Transportation services e) Communication f) Electric, gas and sanitary services
9. Real Estate, Finance and Insurance	a) Banking b) Credit agencies and other loan banks c) Insurance carriers d) Insurance agents, brokers and services

TABLE XXXII (Continued)

Oklahoma Model	Included in Sector
	e) Real estate f) Combined real estate, insurance, etc. g) Holding and other investment companies
10. Services	a) Hotels and other lodging places b) Personal services c) Miscellaneous business services d) Auto repair and services e) Motion pictures f) Amusements, recreation services g) Medical services h) Other professional services
11. Wholesale and Retail Trade	a) Motor vehicles and automotive equipment b) Drugs, chemicals and allied products c) Dry goods and apparel d) Groceries and related products e) Farm products f) Electrical goods g) Hardware, plumbing, heating equipment h) Machinery, equipment and supplies i) Miscellaneous wholesalers j) Building materials and farm equipment k) General merchandise l) Food m) Automotive dealers and service stations n) Apparel and accessories o) Furniture and home furnishings p) Eating and drinking places q) Miscellaneous retail stores r) Retail stores, N.E.C.
12. Construction	a) Maintenance and repair construction

Livestock and Livestock Products

Cattle and Calves		$259,259,000
Dairy Products		57,840,000
Poultry and Eggs		25,247,000
Hogs		20,094,000
Sheep and Wool		2,336,000
Other		522,000
	TOTAL	$365,298,000

Crops

Wheat		$144,789,000
Sorghum for Grain		21,830,000
Sorghum for Forage		11,480,000
Cotton Lint		49,371,000
Peanuts		19,340,000
Seeds		3,642,000
All Hay		50,700,000
Other		38,094,000
	TOTAL	$339,246,000

The amount of government payments received by farmers and farm rental income was also available in [65]. The allocation of agricultural output is as follows:

	Livestock Sector	Crop Sector
Livestock and Livestock Products	$365,298,000	
Crops		$339,246,000
Government Payments	173,000	53,344,000
Rental Received	14,829,000	13,771,000
TOTAL	$380,300,000	$406,361,000

All government payments were for crops except $173,000 which was received by farmers for wool [91]. Farm rental received was allocated by assuming each sector's share was in proportion to output of the crop and livestock sectors.

Input figures which show the dollar value of agriculture's consumption of raw materials, purchased inputs and services are more difficult to obtain. Most of the data used to derive the agricultural inputs were obtained from Oklahoma Department of Agriculture or United

States Department of Agriculture publications. Sources [58], [79], and [80] were used for various agricultural expenditures. Included in these expenditure estimates were marketing margins (charges of wholesale and retail trade, sales tax, and transportation). Marketing margins were obtained from [51]. Current operating expenses of the farmer and the amount of the marketing margin are as follows:

Purchased Input	Amount Paid By Farmer	Marketing Margin (Percent)	Margin	Amount Paid to Producer
Fuel	$35,380,000	52	$18,398,000	$16,982,000
Fertilizer	23,000,000	20	4,600,000	18,400,000
Feed	44,318,000	3	1,330,000	42,988,000
Feed (Commercial)	60,182,000	18	10,833,000	49,349,000
Livestock	73,200,000	4	2,928,000	70,272,000
Seed	4,076,000	3	122,000	3,954,000
Seed (Commercial)	9,224,000	27	2,490,000	6,734,000
Operating Expenses	49,220,000	33	16,243,000	32,977,000
Miscellaneous	61,600,000	-	-	61,600,000
Hired Labor	33,900,000	-	-	33,900,000
TOTAL	$394,100,000		$56,944,000	$337,156,000

Marketing margin indicate value of services received from wholesale and retail trade, government and transportation. Inputs purchased by the agricultural sectors are discussed below.

Sources [58] and [91] reported $70,272,000 worth of livestock purchases by farmers. The amount of crop purchases by farmers was also available in [58] and [91]. The amount of purchased commercial feed was determined as a proportion of total feed purchases using data in [79]. The commercial feed was purchased by the livestock sector from the agricultural processing sector, whereas the feed grains were purchases of the livestock sector from the crop sector. Data from [96] yielded information of crops used for seed and feed on farms where grown. A check on this estimate was available in [80]. The value of seeds purchased by farmers included grains purchased from other farmers

as well as commercial. The amount of each had to be determined since commercial sales were purchases from the agricultural processing sector and sales from other farmers where purchases from the crop sector. Data in [96] provided an estimate of the value of seed produced on the farm and used either on the farm cr sold to others for seed. The difference between the amount of seed sold to others and the total amount of seed purchased was assumed to be commercial seed. The final allocation of crops used on the farm (whether home grown or purchased) during 1963 was as follows:

	Livestock	Crops	Total
Seed (Purchased)		$3,954,000	$3,954,000
Seed (Home Grown)		7,966,780	7,966,780
Fed to Livestock (Home Grown)	$57,450,380		57,450,380
Fed to Livestock (Purchased)	42,988,000		42,988,000
TOTAL	$100,438,380	$11,920,780	$112,359,160

Agricultural inputs purchased by the livestock sector from agricultural processing include processed mill products, such as soybean oil meal and cottonseed oil meal. Value of commercial feeds purchased by the livestock sector equaled $49,349,000. Agricultural inputs purchased by the crop sector from agricultural processing included commercial seeds valued at $6,734,000.

Purchases of inputs from the sectors of petroleum, machinery, and construction were reported in [62] as operating expenses. Data in [79] yielded an estimate of purchased fuel. Information in [108] was used to estimate the amount of agricultural inputs from the construction repair and maintenance sector. The amount of operating expenses which remained was calculated and allocated to machinery:

Total Operating Expenses	$32,977,000
Less Petroleum Expenses	16,982,000
Less Repair and Maintenance Construction Expenses	7,628,000
Amount Allocated to Machinery Sector	$8,367,000

Information in [89], [90] and [108] was used to allocate petroleum and machinery inputs between the crop and livestock sectors. Data in [108] were used to distribute construction inputs between the crop and livestock sectors.

The remaining agricultural inputs reported in [91] consisted of fertilizer, miscellaneous expenses, and interest. Miscellaneous expenses included such things as interest on non-real estate debt, pesticides, ginning, electricity, telephone, transportation, wholesale and retail trade, veterinary services, insurance, and other expenses.

Marketing margins were allocated to the livestock and crop sectors as follows:

	Livestock	Crops	Total
Fuel	$ 2,673,000	$15,725,000	$18,398,000
Fertilizer		4,600,000	4,600,000
Feed Grains	1,330,000		1,330,000
Feed (Commercial)	10,833,000		10,833,000
Livestock	2,928,000		2,928,000
Seed		122,000	122,000
Seed (Commercial)		2,490,000	2,490,000
Operating Expenses	2,360,000	13,883,000	16,243,000
TOTAL	$20,124,000	$36,820,000	$56,944,000

Included in these margin totals are transportation and taxes as reported in [51]. Subtracting these charges, wholesale and retail trade costs are as follows:

	Livestock	Crops	Total
Margin Total	$20,124,000	$36,820,000	$56,944,000
Less Transportation	5,731,000	10,486,000	16,217,000
Less Taxes	2,596,000	4,750,000	7,346,000
Wholesale and Retail Trade	$11,797,000	$21,584,000	$33,381,000

Transportation costs for the agricultural sectors were estimated above. Expenditures for communication and public utilities were added to the transportation costs. The average amount spent per farm for telephone service was obtained from [93] and the number of farms having telephones was reported in [95]. Electrical charges per farm were obtained from [94] and the number of farms was obtained from [58]. Telephone and electrical charges were allocated according to output of the two agricultural sectors.

	Livestock	Crops	Total
Transportation Charges	$ 5,731,000	$10,486,000	$16,217,000
Electricity Charges	4,315,000	4,612,000	8,927,000
Telephone Charges	1,435,000	1,533,000	2,968,000
TOTAL	$11,481,000	$16,631,000	$28,112,000

The purchase of the crop and livestock sectors from the real estate, finance, and insurance sector and the service sector were estimated using [108] as a starting point. Purchases from real estate, finance, and insurance were estimated at $33,200,000, of which $17,500,000 were interest payments [58 and 91] and $13,200,000 was rent payments [58]. Services were estimated at $14,791,000 and included such things as veterinary expenses and custom work. Information was not available for mining material purchased by the agricultural sectors, thus [108] was used to arrive at the estimate of $102,000 for livestock and $1,796,000 for crops.

Other manufacturing inputs were determined as a residual. Estimated inputs to livestock from other manufacturing equaled $4,077,000 and for crops the estimate equaled $20,487,000. Other manufacturing inputs included a fertilizer expense of $18,400,000. The estimates for other manufacturing inputs were checked against that derived from

[108] and found to be very similar. Depreciation for the livestock and livestock products sector equaled $37,451,000 and for the crop sector equaled $54,688,000. Depreciation rates were estimated as the ratio of depreciation to depreciable assets. The amount of annual depreciation and depreciable assets were obtained from U. S. Internal Revenue Service sources [124].

Serivces received by farmers from the government sectors were assumed to be equal to taxes paid. Federal taxes paid were obtained from [111], [121], [122], and [124] and were as follows:

Manufacturers Excise Tax		$3,688,000
Social Security Tax		501,000
Miscellaneous Tax		494,000
	TOTAL	$4,633,000

State and local taxes were reported in [60], [61], [62], [100], and [101]. They included:

Property Tax		$29,700,000
State and Local Taxes		2,806,000
Miscellaneous Taxes		3,315,000
	TOTAL	$35,821,000

Property taxes were also estimated in [58] and [91]. Data on wages and salaries paid and income earned were available in [105] and [107]. The allocation of taxes, wages and salaries, and income was made with information from [108]. Data in [123] for Oklahoma supported these estimates. The depreciation estimate was obtained from [123] and national data from [123] were used to allocate among the crop and livestock sectors.

Sectors 3, 4, 5, and 6: Manufacturing

For this analysis, manufacturing activity was classified into four sectors: agricultural processing, petroleum and coal products, machinery (except electrical), and other manufacturing. Data sources, definitions and concepts used in deriving the data for the transaction table are presented below.

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 was obtained from [84] and [86] and are as follows:

Meat Slaughtering Plants	$117,841,000
Poultry Dressing Plants	17,846,000
Fluid Milk	85,658,000
Canned Fruits and Vegetables	10,963,000
Prepared Animal Feeds	49,850,000
Confectionery Products	8,621,000
Bottled and Canned Soft Drinks	28,813,000
Other	173,486,000
TOTAL	$493,078,000

Oklahoma's share of inventory change was assumed to be in the same proportion of Oklahoma's shipments as United States' inventory change was to United States shipments. Gross output was as follows:

Value of Shipments	$493,078,000
Value of Change in Inventory	1,800,000
TOTAL	$494,878,000

Most of the information used to arrive at the input statistics was found in the four volumes of the United States Census of Manufacturing [83], [84], [85], and [86]. Purchases made by the agricultural processing sector included raw materials, semi-finished goods, parts, components, containers, supplies, fuel and electrical energy. The expenses included the marketing margin. Data in [51] and [108] were used to distribute the final amounts to the proper sectors. The distribution of purchases made by the agricultural processing sector was as follows:

Commodity	Amount Paid By Processing Sector	Margin (Percent)	Margin	Amount Paid to Producer
Livestock and Livestock Products	$123,045,000	5	$ 4,921,000	$118,124,000
Crops	75,026,000	3	2,250,000	72,776,000
Machinery	501,000	32	160,000	341,000
Other Manufacturing	60,185,000	18	10,833,000	49,352,000
Food and Kindred Products	102,227,000	16	16,356,000	85,871,000
TOTAL	$360,984,000		$34,520,000	$326,464,000

All purchases by the agricultural processing sector from livestock and livestock products were obtained from [58], [83], [95], and [97]. Data on cattle, calves, hogs and poultry (except turkeys) purchased were obtained from [58]. Information on turkeys, sheep, and lambs were obtained from [83] and [95] while dairy products data were obtained from [58]. Purchases from the crop sector by the processing sector consisted mainly of wheat. Information on the amount of wheat, corn, oats, and barley purchased by the food and kindred products sector was available in [83]. The estimate for the other crops was obtained from data in [58]. Data were not available on purchases made from the agricultural processing industries or used by these sectors. Therefore, the coefficient from [108] was used to arrive at the estimate. The coefficient indicates how much of the sector's dollar expense goes for purchases from other industries in that sector. The coefficient was calculated as follows:

$$.17352 \times \$494,878,000 = \$85,871,000.$$

Information in [83] supports this estimate. The amount of fuel purchased by the agricultural processing sector was $1,244,000 and was obtained from [83].

Purchases by the agricultural processing industries from the remaining manufacturing sectors were more difficult to ascertain. Data in [108] were used to estimate purchases from the machinery sector. Purchases from the other manufacturing sector was obtained as a residual. The estimate was checked against sources [108] and [83] and found to be very similar. Most of the $49,352,000 purchases from the other manufacturing sectors were containers, bags, and similar inputs.

The amount spent by the agricultural processing sector for transportation, communication and public utilities was estimated at $20,213,000. Of the total margin as shown above, $16,798,000 was allocated as transportation expenses. This allocation was made with data from [108]. Data in [83] reported public utility expenses at $2,144,000. Expenditures for communication and warehousing was estimated from [108]. Final allocation was as follows:

Transportation		$16,798,000
Public Utilities		2,144,000
Communication		1,271,000
	TOTAL	$20,213,000

Coefficients from [108] were used to arrive at the amount spent by the agricultural processing sector for services from the real estate, finance and insurance sector and from the service sector. The amount spent for services from the wholesale and retail trade sector was derived from the margins discussed previously and equaled $17,722,000. The amount was consistent with an estimate arrived from [108]. Data from [108] and [83] were used to estimate the amount of services purchased from the mining and maintenance construction sector.

The amount spent for services from the government sector was assumed equal to taxes paid. Data on federal taxes were found in [111],

[121], [122], and [124] and were as follows:

Social Security		$1,088,000
Corporation Taxes		5,063,000
Other Taxes		219,000
	TOTAL	$6,370,000

State and local taxes paid were obtained from [60], [61], [62], [100], and [101]. They included:

Property Tax		$ 616,000
Social Insurance		350,000
State and Local Charges		4,287,000
Other		1,246,000
	TOTAL	$6,499,000

Sources [83], [86], and [107] were used to derive the amount paid for wages and salaries while sources [107] and [124] were used to arrive at estimates of proprietor and other income.

Petroleum and Coal Products. Output for the petroleum sector was defined as the value of production of the industries in this sector. It was estimated by adding the value of shipments and the value of inventory change. Most of the output was from petroleum refining. Breakdown of value of shipments [85] is as follows:

		Value of Shipments
Petroleum Refinery Operation		$640,620,000
Paving Mixtures and Blocks		2,826,000
Asphalt Felts and Coatings		7,201,000
Other		9,676,000
	TOTAL	$660,323,000

Oklahoma's share of inventory change was assumed to be in the same proportion of Oklahoma's shipments as United States' inventory change was to United States shipments [83]. Gross output was as follows:

Value of Shipments		$660,323,000
Value of Change in Inventory		- 416,000
	TOTAL	$659,907,000

Input statistics for petroluem processing were difficult to ascertain. United States Census of Manufacturing, [83] and [85], provided input data which was supplemented with national data from [108] to complete the analysis. The concepts used to derive each input entry are discussed below. Data were not available on purchases made by petroleum processing from the agricultural processing sector; therefore, data in [108] were used to derive the estimate of $752,000. Most of these inputs consisted of animal and vegetable additives. The amount of petroleum products which was consumed or transferred between industries was estimated at $42,467,000. This input was estimated by obtaining an estimate ($8,797,000) of fuel consumed by the sector from [83] and adding to it the movement of products between industries in the petroleum sector. From [85] an estimate ($33,670,000) was obtained for intermovement of products in the petroleum sector.

The amount of raw materials purchased from the mining sector was obtained from [85]. The estimate is the delivered cost of the raw material, thus transportation costs were subtracted to arrive at the amount paid to the mining sector. Data in [108] were used to arrive at an estimate of transportation costs. To complete the input estimate for the transportation, communication and public utility sector, the last two elements had to be estimated. The amount spent for electric energy was available in [83] and the remaining elements were estimated from [108]. The breakdown was as follows:

Transportation		$29,187,000
Electric Energy		3,636,000
Communications and Other Public Utilities		8,949,000
	TOTAL	$41,772,000

The inputs purchased from the real estate, finance and insurance sector and service sector were estimated from [108]. No state estimates were available. Inputs of maintenance and repair construction were obtained from [108]. The machinery estimate was obtained from [108]. An estimate of the cost of all goods and services is presented in [85]. Taking the total cost of all goods and services and subtracting all previous estimated input yielded an input estimate for other manufacturing and wholesale and retail trade. Data in [108] were used to determine the allocation between the two sectors. Of other manufacturing inputs, $13,026,000 were reported as the amount spent for chemical additives [85].

Data on federal taxes paid were obtained from [111], [121], [122], and [124] and included:

Social Security		$ 426,000
Corporation Taxes		10,065,000
Other Taxes		435,000
	TOTAL	$10,926,000

Sources [60], [61], [62], [100], and [101] yielded data on state and local taxes which were as follows:

Property Tax		$ 822,000
Social Insurance		137,000
State and Local Charges		2,831,000
Other		6,293,000
	TOTAL	$10,083,000

Sources [83], [86], and [107] were used to derive the amount paid for wages and salaries, while sources [107] and [124] were used to arrive at an estimate of proprietor and other income.

Machinery (Except Electrical) and Other Manufacturing. Machinery and other manufacturing are discussed jointly as many of the data sources and methods of estimating inputs are similar. Output is defined as the value of production of the industries in these sectors. The value of production was estimated by adding the value of products shipped and inventory charge. Data on value of shipments were estimated from [84] and [85]. The main products of these sectors were as follows:

Machinery Sector

Type of Machinery	Value of Shipments
Farm Machinery	$ 7,001,000
Oil Field Machinery	98,193,000
Pumps and Compressors	34,620,000
Refrigeration Machinery	16,309,000
Special Industry Machines	6,626,000
Miscellaneous Machinery	13,513,000
Other	53,141,000
TOTAL	$229,403,000

Other Manufacturing Sector

Producing Industry	Value of Shipments
Apparel and Related Products	$ 71,477,000
Printing and Publishing	88,033,000
Rubber and Plastic Products	92,798,000
Stone, Clay, and Glass Products	147,405,000
Primary Metal Products	120,004,000
Fabricated Metal Products	168,200,000
Electrical Machinery	187,294,000
Transportation Equipment	164,468,000
Other	206,596,000
TOTAL	$1,246,275,000

Inventory change for Oklahoma was assumed to be the same as that of United States' inventory change. Gross output for these two sectors was as follows:

	Machinery	Other Manufacturing
Value of Shipments	$229,403,000	$1,246,275,000
Value of Change in Inventory	+ 1,876,000	+ 5,571,000
TOTAL	$231,279,000	$1,251,846,000

Input data for these sectors were difficult to obtain and national coefficients were used to derive some of the estimates. The amount spent for petroleum and electrical energy was available in [84]. Wages and salaries paid were available from [85], while income data were obtained from [107] and [124]. Services received from the government sectors were assumed equal to taxes paid. Data from [111], [121], [122], and [124] yielded the estimate on federal taxes paid and were as follows:

	Machinery	Other Manufacturing
Corporate Taxes	$4,698,000	$23,670,000
Social Security	845,000	5,121,000
Other Taxes	204,000	1,024,000
TOTAL	$5,746,000	$29,815,000

State and local taxes were estimated from [60], [61], [62], [100], and [101], and were as follows:

	Machinery	Other Manufacturing
Property Tax	$ 288,000	$ 1,560,000
Social Insurance	272,000	1,649,000
State and Local Charges	1,321,000	6,659,000
Other	2,494,000	13,061,000
TOTAL	$4,375,000	$22,929,000

Data in [84] and [85] provided an estimate of the total cost of all materials. This total amount of material had to be allocated among the various sectors and census data were incomplete in accomplishing this; thus [108] was used to allocate the remaining inputs for these two sectors.

Sector 7: Mining

Output 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 [88] and [112]. Most of Oklahoma's mineral production consisted of the extraction of oil and gas:

Oil and Gas		$1,009,130,000
Metal Mining		10,814,000
Bituminous Coal		5,853,000
Non-metals		18,591,000
	TOTAL	$1,044,388,000
Mining Processing Included in Manufacturing		-4,884,000
Value of Output		$1,039,504,000

Purchases from the livestock, crops, and agricultural processing sectors were found to be zero from [87] and [88]. Expenditures for manufacturing goods include fuel, supplies, and machinery. Machinery expense includes all machinery, equipment and parts used for renewals or repairs. The expenditures were found in [87] and [88] and are as follows:

Machinery		$ 58,161,000
Supplies		150,702,000
Fuel		3,451,000
	TOTAL	$212,314,000

This value included market margins. Data from [108] were used to separate marketing margins from the amount paid. The results were as follows:

Commodity	Total Amount Paid	Transportation Charges	Wholesale & Retail Charges	Taxes	Amount Paid to Producer
Machinery	$ 58,161,000	$ 4,176,000	$ 8,590,000	$ 564,000	$ 44,831,000
Supplies	150,702,000	10,820,000	22,259,000	1,462,000	116,161,000
Fuel	3,451,000	248,000	510,000	33,000	2,660,000
TOTAL	$212,314,000	$15,244,000	$31,359,000	$2,059,000	$163,652,000

Deducting the margin costs determined purchases made by mining from the petroluem sector, the machinery sector, and the other manufacturing sector. The amount spent for wholesale and retail services equaled $31,359,000. Transportation, communication and public utility charges were determined from [108] and equaled $47,921,000. Of this total, [88] reported $9,442,000 spent for electric energy.

The amount purchased from the real estate, finance and insurance sector was estimated from [108] and equaled $15,123,000. The amount spent by the mining sector for services totaled $112,294,000. The majority of the expense was for research and development of oil wells. Source [108] was used to estimate finance and insurance charges. This source was also used to estimate the purchases made from the service sector. Mining industries received $101,747,000 worth of minerals from other industries in the sector [88]. These minerals were received for additional processing or for distribution. The amount spent for repair and maintenance construction was estimated from [108] and equaled $28,597,000.

Data obtained on state and local taxes paid were obtained from [60], [61], [62], [100], and [101]. Federal taxes paid were obtained from [111], [121], [122], and [124]. The amount of federal taxes paid by the mining sector was as follows:

Corporation Taxes		$18,009,000
Social Insurance		4,191,000
Other		1,383,000
	TOTAL	$23,583,000

State and local taxes consisted of:

Property Tax		$ 2,211,000
Social Insurance		1,349,000
State and Local Taxes		35,519,000
Other		4,285,000
	TOTAL	$43,364,000

Sources [105] and [107] yielded information on wages and salaries paid by the mining industry and also on proprietor income.

Sectors 8, 9, 10, 11, and 12: Services

The service sectors are discussed jointly as similar techniques were used to estimate each sector's production and inputs. Included as service sectors are transportation, communication and public utility; real estate, finance and insurance; services; wholesale and retail trade; and construction. The definition and sources used to derive the output estimate for these sectors are discussed first, then the input estimates are discussed jointly.

Output for the transportation, communication and public utility sector was assumed equal to the value of receipts received. Output had to be estimated since no source yielded the data directly. The estimate was obtained by assuming that the ratio between output in Oklahoma and in the United States was the same as employment between Oklahoma and the United States. Employment statistics were obtained from [57] and [116]. An output estimate of $961,582,000 was obtained by this procedure. The same procedure was used to estimate output for the real estate, finance and insurance sector. Output was defined as the value of receipts received for services provided by the sector. Oklahoma's employment was 1.0293 percent of the total U. S. employment in this sector. Using this percentage, an estimate of $1,034,501,000 worth of output was obtained.

For the service sector, output is the amount paid to the industries in this sector for services performed. Gross output for some services are listed in [81] and [82]. In addition to these services, medical and professional expenditures were estimated. The most accurate output estimate was derived using the employment ratio. The procedure yielded an estimate of $1,034,501,000. This estimate was substantiated by data found in [103] and [104]. For the wholesale and retail trade sector, output was defined as the value of the services performed in handling goods. 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 trade sector. Current marketing and transportation margins were not available for many of the sectors included in the model. Where current margins were available, they were not in detail as to the classification used in this model. Output was estimated from employment data found in [104] and [116]. 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. Output for the construction sector was defined as the dollar valuation of construction put in place in Oklahoma. Employment data in [116] were used to estimate sector output.

Input data at the state level for these sectors were limited, thus national coefficients in [108] were used to a large extent. Taxes paid by the service sectors were assumed equal to the value of services received. Data in [60], [61], [62], [100], and [101] yielded state and local taxes paid by the service sector, while data in [111], [121], [122], and [124] yielded estimates of federal taxes paid by these sectors. Data on wage and salary payments, proprietor income, and rent were available from [57], [105], and [107].

Explanation of the Exogenous Sectors

Federal Government

Total receipts collected in Oklahoma were used as a measure of the gross output of the federal government sector. Data were available in [111], [121], [122], and [124]. Total output by government, in contrast to the endogenous sectors of the economy, need not equal total input. Therefore, total expenditures required individual estimation. A study by Raphaelsm [120] estimated the amount of federal expenditures in Oklahoma. The composition of the federal expenditure was much more difficult to ascertain and national coefficients in [108] were used to allocate the expenditure to the various sectors.

State and Local Government

This sector included governments of 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 [101] and local data were obtained from [62]. Again, expenditures were estimated individually as output does not have to equal input. Sources [62], [98], [100], and [101] were used to arrive at the expenditure estimate of $880,536,000. Input data were also available from these sources. Other sources were wage and salary data and transfer income data from [105].

Private Capital Formation Sector

Included as output in this sector is the total amount of capital investment made by the private sectors. Data in [86] yielded estimates of the amount of capital investment in the manufacturing sectors of Oklahoma; while data in [88] provided an estimate of capital investment in the mining sector. Capital expenditures for Oklahoma for the remaining sectors were not available, therefore it was assumed that the ratio of Oklahoma's capital investment to U. S. capital investment data in [124] was the same ratio as Oklahoma output was to U. S. output. Capital coefficients constructed for Oklahoma were then used to determine the inputs needed by the private industrial sectors in Oklahoma.

Household capital investment data were obtained from [57], [113], [114], and [115]. Data in [57] yielded an estimate of construction expenditures, whereas other capital purchases were reported in [113], [114], and [115]. Data for other capital purchases were collected in a regional survey taken in 1960. Data published in [103] indicated the changes in consumption expenditures from 1960 to 1963 and these data were used to update the Oklahoma 1960 data to 1963.

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 publications [113], [114], and [115] gave per family expenditures for rural, nonrural and urban families in the Southern region.[1] Data were for the year 1960, thus data in [103] on consumer changes in purchases were used to update Oklahoma to the 1963 base year.

Expenditures for current consumption totaled $4,114,900,000. This figure was arrived at by obtaining per family figures from [113], [114], and [115] and expanding these to state totals with the use of population estimates in [45]. Then, information in [103] was used to adjust the data to represent changes in consumer spending from 1960 to 1963. Goods purchased through wholesalers and retailers totaled $1,844,086,000. Final allocation was as follows:

Livestock and Livestock Products	$ 19,514,000
Crops	25,014,000
Agricultural Processing	423,475,000
Petroleum and Coal Products	57,707,000
Machinery (Except Electrical)	4,615,000
Other Manufacturing	480,551,000
Mining	2,661,000
Wholesale and Retail Trade	830,549,000
TOTAL	$1,844,086,000

Expenditures by households for transportation, communication and public utilities were obtained from [113]. The total is allocated among the sectors as follows:

Public Utilities	$ 73,892,000
Transportation	99,333,000
Communication	37,834,000
TOTAL	$211,059,000

Information on expenditures for real estate, finance and insruance was located in [113] and equaled $178,110,000. Household's

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

expenditures for services were reported in [113] and included:

Hotels, Motels, etc.		$ 31,123,000
Laundry and Services		59,758,000
Auto Services		14,939,000
Medical Services		187,365,000
Personal Services		87,769,000
Amusements		89,637,000
	TOTAL	$470,592,000

Construction information was taken from [57]. Households paid over 1,109 million dollars in taxes. These data were obtained from [60], [61], [62], [100], and [101] for state and local taxes paid and from [111], [121], [122], and [124] for federal taxes paid. Federal taxes paid include:

Federal Income Tax		$411,086,000
Social Security Tax		117,101,000
Other		124,719,000
	TOTAL	$652,906,000

State and local taxes paid include:

Property Tax		$ 93,637,000
State and Local Charges		220,165,000
Charges and Misc.		111,978,000
Utility		15,716,000
Social Insurance		14,842,000
	TOTAL	$456,338,000

Data on wages and salaries and proprietor income were obtained from [105] and [107].

Exports

Export and import data were computed as residuals. A flow table was completed using the entries discussed above. 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 imports. The export and import figures computed in this way show only net values.

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.

APPENDIX B

TABLE XXXIII

VECTORS AND SCALARS WHICH WERE NOT PRESENTED IN THE SOCIAL ACCOUNTS

Matrix \ Sector	Lvsk., & Lvsk. Products	Crops	Agric. Proc.	Petro.	Mach.	Other Manf.	Mining	Trans., Comm. & Pub. Ut.	Real Est., Fin. & Ins.	Services	Whole-sale & Retail	Constr.
A_3	1.0087	1.0087	1.0025	1.0057	1.0102	1.0027	1.0177	1.0000	1.0047	1.0047	1.0139	1.0034
A_5	.9815	.9815	1.0336	1.0158								
A_6					.16983	.82350	.00667					
A_7								1.0442	1.0124	1.0423	1.0140	1.0000
A_8	1.0357	1.0000	1.0300	1.0171								
A_9					1.0225	1.0225	1.0225					
A_{13}	1.0404	1.0404	1.0475	1.0525	1.0461	1.1650	1.0722	1.0394	1.0170	1.0611	1.0538	1.0449
A_{14}	.9740	.9740	1.0039	1.0106	1.0873	1.0723	.9928	1.0221	1.0306	1.0461	1.0254	.9885
A_{15}	.9500	.9500	.9500	.9500	.9500	.9500	.9500	.9500	.9500	.9500	.9500	.9500
A_{16}	1.0750	1.0750	1.1930	1.1930	1.1930	1.1930	1.0870	1.1100	1.1100	1.1100	1.1100	1.1100
A_{18}	1.0550	1.0550	1.0350	1.0177	1.0163	1.0000	1.0320	1.0184	1.0117	1.0000	1.0000	1.0350
A_{20}	.1812	.1812	.9720	.9721	.9720	.9721	.8792	.9009	.6401	.6776	.8002	.7205
A_{21}	.9401	.9401	1.0015	1.0015	1.0015	1.0015	1.0018	1.0000	1.0111	1.0043	1.0002	1.0000
A_{22}	1,308	1,308	4,706	7,258	5,286	5,290	6,415	5,804	4,502	3,726	3,650	4,797
A_{23}	1.0406	1.0406	1.0230	1.0230	1.0230	1.0230	1.0246	1.0196	1.0160	1.0380	1.0147	1.0349
A_{24}	1,813	1,813	4,307	4,307	4,307	4,307	2,286	2,904	2,505	5,277	3,380	3,293
A_{25}	.2772	.5743	.1658	.1243	.3229	.3717	.4544	.4089	.4433	.5745	.5791	.3678
A_{26}	.0059	.0059	.0035	.0035	.0035	.0035	.0054	.0939	.0066	.0062	.0100	.0027

a_1	.0945	a_{12}	1.0153	a_{23}	.0072
a_2	1.0546	a_{13}	5,897	a_{24}	.0822
a_3	.9988	a_{14}	1.0217	a_{25}	.0388
a_4	1.0573	a_{15}	1.0772	a_{26}	.0094
a_5	1.0772	a_{16}	1.0758	a_{27}	1.0766
a_6	.00004	a_{17}	1.0689	a_{28}	1.0499
a_7	.9660	a_{18}	1.0724	a_{29}	.0346
a_8	.00010	a_{19}	.0391	a_{30}	.0220
a_9	.9939	a_{20}	1.0309	a_{31}	.0285
a_{10}	1.0259	a_{21}	.0064	a_{32}	.0244
a_{11}	3,602	a_{22}	.0068	a_{33}	.0060

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