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Interindustrial Structure Analysis: An Input-output Study of the St. Louis Region, 1967

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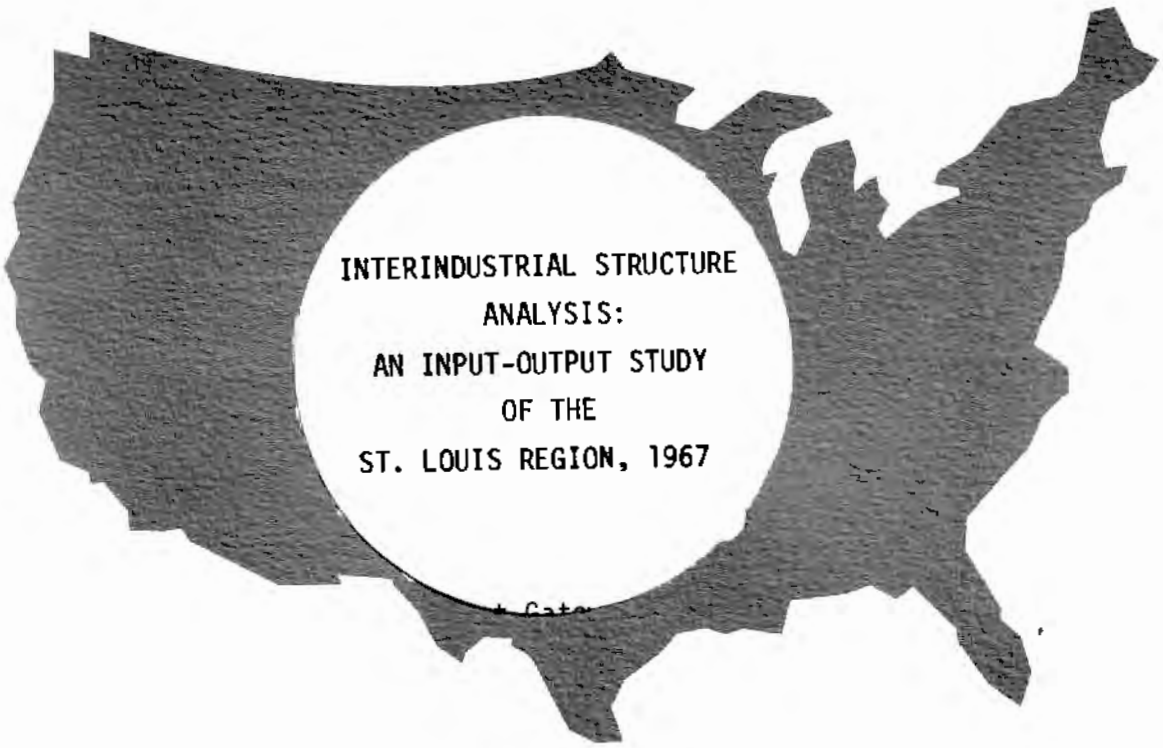

INTERINDUSTRIAL STRUCTURE ANALYSIS: AN INPUT-OUTPUT STUDY OF THE ST. LOUIS REGION, 1967

ST. LOUIS REGIONAL INDUSTRIAL DEVELOPMENT CORPORATION

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INTERINDUSTRIAL STRUCTURE ANALYSIS: AN INPUT-OUTPUT STUDY OF THE ST. LOUIS REGION, 1967

Prepared for The East-West Gateway Coordinating Council

by

Ben-chieh Liu, Project Director

St. Louis Regional Industrial Development Corporation

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PREFACE

This is a contracted study between the East-West Gateway Coordinating Council (E.W.G.C.C.) and the St. Louis Regional Industrial Development Corporation (R.I.D.C.). Originally a From-To or product flow study of the St. Louis region was required by the contract. The table resulting from this study represents the transactions of goods and services among sectors specified in the contract for a given year, in static form. This study originated from the idea of providing a better understanding of the economic structure and industrial interdependence in the region, such that public and private decision makers can be well informed on outlining their policies for regional development and growth.

Initially this study was proposed and directed by Mr. William White, former Project Director at R.I.D.C. A questionnaire was developed, a field survey conducted, and sample data were partially assembled between June and August, with the assistance of Mr. Joseph Gasparich (M.B.A. and doctoral student in Economics at Washington University); Mr. George Guernsey (Economics major at Yale University); and Miss Renee Waterhout (Sociology student at Missouri University). The author took over this project in September, 1968. Needless to say he is indebted to the above for their initial accomplishment of this project.

In order to provide more and better service for the community, the author agreed with the E.W.G.C.C. to make available to the region a completed input-output study. It identifies not only the regional product flows of goods and services by sector but also measures various direct, indirect and induced effects upon industries of any final demand change, through multiplier analysis.

The author would like to extend his gratitude to Mr. Lewis H. Siegel, Project Director at St. Louis R.I.D.C. and Joseph Gasparich, Research Associate. Mr. Siegel assisted in the completion of data collection from the survey and collected information for transportation, communication and utilities and finance, insurance and real estate sectors through personal contact with various firms, etc. Mr. Gasparich has worked as an assistant directly on this project since June. In addition to sample survey and data assembling, he has assisted the author in much painstaking work; tabulation, proof reading, etc. Without their assistance, this project might not have been completed on time.

Professors Werner Hirsch of U.C.L.A. and Floyd Harmston of Missouri University have done pioneer work for the St. Louis S.M.S.A. and the State of Missouri, respectively. The author, too, is indebted to them for their assistance. The author benefited equally from discussions with Dr. Harmston.

In addition, the author would like to express his thanks to Mr. D. Reid Ross, Executive Vice President and Mr. Charles James, Director of Economic Research at St. Louis R.I.D.C. for their administrative assistance in the process of this study. Mr. James Holderread, Industrial Specialist at R.I.D.C. has prepared the map of the St. Louis region; Mrs. Susan Echols has constantly provided her services in proof reading this report and Mrs. Betty Higgins, secretary, with her expertise, typed this report. To them, the author is grateful.

Finally, the author would like to thank those firms who have patiently completed the questionnaire and all computer work furnished by Washington University Computer Center under the author's doctoral dissertation program. With credits going to those individuals mentioned above, the author alone is responsible for the technique and methodology employed and any possible error appearing in this study.

Chapter One: Introduction

The input-output analysis was first introduced by Wassily W. Leontief and has been universally used to study the economic structure and the interdependence among industries, for a nation or region, during any given period of time. The analysis is static in its nature but is always open, in that it deals not only with the industrial relationship within the area but with that outside the area, as well. The input-output analysis is a technique introduced to better understand the economic structure and to provide a basis on which to formulate policies for any economic sector requiring policy adjustments due to changing socio-economic conditions. It has been so aptly stressed by Walter Isard that: "Of the general interdependence approaches which have been investigated, the (inter-) regional input-output approach is most prominent, both in terms of accomplishment and recognition."[1]

This technique, as explained clearly by Wassily W. Leontief, reckons with the transactions of sales and purchases that carry goods and services from manufacturer to distributor and, finally, on to consumers. It illustrates the entire procedure of economic activities through production, distribution and eventually, consumption.

"The data of input-output analysis are the flows of goods and services inside the economy that underlie the summary statistics by which economic activity is conventionally measured,"[2] said Leontief, "the technique thus ties prediction about the external configuration of the system to the indirect flows of supply and demand within."[3]

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[1]Walter Isard, Methods of Regional Analysis: An Introduction to Regional Science, M.I.T. Press, Cambridge, Massachusetts, 1963, p. 310.

[2]Wassily W. Leontief, "The Structure of Development" reprinted from Scientific American, September, 1963. W. H. Freeman & Co., San Francisco, p. 2.

[3]Wassily W. Leontief, "The Structure of the U. S. Economy," reprinted from Scientific American, April, 1965, p. 3.

In addition to analyzing the direct and indirect interdependence between input and output flows of goods and services that reflect the intersectoral balance of any economic system, the technique provides also means for analyzing income and/or employment-induced economic changes on the regional scene.

The "Interindustrial Structural Analysis: An Input-Output Study of the St. Louis Region" is the second study in a sequence of this type of study being provided for the St. Louis region. In the twelve years that have lapsed since Werner Hirsch's stimulating work of 1955[4] on the St. Louis Standard Metropolitan Statistical Area, our urban area has obviously experienced some changes in its social and economic activities. Economic structure and interdependence relationships among industries may well have been influenced by technical changes introduced during the past twelve years. This study surveyed empirically all industrial sectors in the St. Louis region and derived its data directly from firms, for the year 1967. It attempts not only to reveal the economic structure and industrial interdependence relationships in the region for 1967, i.e., a static analysis, but is also intended to compare the resulting changes in the region between 1955 and 1967. That is to say, some comparative static analysis will be made. Since this study geographically covers seven counties and one city in both the States of Missouri and Illinois, spacial comparisons between this region and other areas, such as the State of Missouri, are made, wherever possible, in order to investigate areal

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[4]Werner Z. Hirsch, "Interindustry Relations of a Metropolitan Area," in Review of Economics and Statistics, Vol. XLI-4, November, 1959, pp. 360-369. Based on this study of the St. Louis Region of 1955, many articles have been authored by him.

differentials.

Aside from being descriptive, this study is also designed to be predictive, in the sense that it attempts to analyze the impacts upon regional industries as a result of changes in exogenous forces. In other words, for any given change determined exogeneously from this linear, equalibrium model, predictions or forecast in terms of income or employment change in the industry and other industries can be traced through their respective multipliers. Multipliers derived by considering household and local government as exogeneous final demand sectors certainly differ from those derived by considering them as endogenous sectors. In order to follow Hirsch's 1955 St. Louis S.M.S.A. study and Floyd Harmston's 1963 Missouri study[5] for purposes of comparison and to analyze the interactions of induced changes from the sectors, both approaches were adopted.

Chapter Two covers the sample Survey, including the scope of geographical areas, aggregated sectors and periods of time, methodology and sampling results. Chapter Three contains relevant methodology and data sources for developing the entire model, in a rather unusually detailed form, in order that future studies of this approach can be easily and economically made. The chapter is divided into three parts: manufacturing, (13 sectors); final demand (8 sectors); and non-manufacturing industries, (8 sectors). Various hypotheses and their supporting arguments are clearly specified and tested, whenever data are available.

The St. Louis regional input-output model is designed to give as complete a structural description as possible, with proper aggregation by sectors, as contracted with E.W.G.C.C.

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[5]Floyd Harmston, An Inter-Sectoral Analysis of the Missouri Economy, 1963, School of Business and Public Administration, University of Missouri, 1968.

Chapter Four, The Structure of Regional Economy, deals with the sales and purchases relationship among sectors within the region and areas outside the region. All transactions occurring in the region, by sector, during 1967 were represented in thousand dollar units by the Interindustry Gross Flow Table. The sales distribution in relative terms. i.e., in per cent, was also provided. In addition, input coefficients per dollar of direct sales by sector were computed and included in this chapter. Together they portray a static picture of the regional economy of 1967, in which the economic structure is outlined and identified, where possible.

In addition to the descriptive interpretation and analyses by sector, this chapter attempts to compare the current economy of the region to its past economy, and to the economy of the State of Missouri, wherever possible. Reasonings and explanations are given, again, whenever possible, after each comparison is made. Thus, this chapter contains some comparative static analysis between this study and other studies of a similar nature.

Predictive studies, through income and employment multipliers, can be analyzed by means of this study. Two models were developed to supply related information on income changes of any final demand changes. Model A, taking into account consumption-income relationships, computes, in addition to direct and indirect effects, induced effects upon industries and income through changes in the final demand. Model B, without considering consumption-income relationships or setting household and local government sectors firmly outside the interindustrial framework, gives only the direct and indirect income changes resulting from any final demand change. Comparing the result of these two models, induced income change by assuming a linear, homogenous consumption-income function, is then observed. Table V-1, Direct

and Indirect Requirement Per Dollar of Exogenous Final Demand, shows all effects of final demand upon various industries, when household and local government sectors are considered as participants in the production process. Table V-2, Direct and Indirect Requirement Per Dollar of Exogenous and Endogenous Final Demand, was the basic source, from which direct and indirect income effects were calculated and the income multipliers in Model B were hence developed.

Aside from income multipliers and income changes discussed in Chapter Five, the two tables provide information, such as sectoral multipliers, which are also dealt with in the chapter. Sectoral multipliers relate final demand changes to interindustrial transactions, not to income as do the income multipliers.

In addition to technical interpretation and analysis with respect to the development of income multipliers, some illustrations were given in Chapter Five to demonstrate the usefulness of the so-called inverse matrix. Interesting readers can follow these examples to trace and to analyze the impact upon income and transactions of any final demand change. Predictions and forecasts can therefore be easily made to cope with various questions at hand.

Although empirical values of employment multipliers have not been investigated because of limited time, the theoretical arguments in developing these multipliers are prescribed in this chapter. As is planned, impacts upon employment resulting from final demand changes will be undertaken in the study that immediately follows.

A summary of important findings and theoretical and empirical limitations and difficulties involved in the completion of this study is found in the last chapter. Furthermore, suggestions for further research in the region are recommended.

For those who are not involved with research work of this type, Chapters Two and Three require little attention. Likewise, in reading the remaining chapters, statistical or mathematical statements may be skipped without harm. This study is so designed that it can hopefully accommodate a variety of readership.[6]

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[6]See A Primer of Input-Output Economics, by William H. Miernyk, Northeastern University, Boston, Mass., 1957 for a simple but excellent presentation of this input-output study.

Chapter Two: Sample Survey

I. The Scope of the Survey

Industries included in EWGCC's input-output study were specified to be two digit industries in the Standard Industrial Classification Code. Most elements in the matrix were aggregated in a form of more than two sectors according to EWGCC's specifications in the contract. The purpose of this aggregation is to avoid disclosure problems and to simplify the implementation of work due to obviously limited budget and time. By aggregating the sectors, the study loses detailed information. However, the major purposes of this study are to investigate the economic structures in the region in a broad sense for macro-economic analysis and for public and private planning on an industrial-wide basis. In addition to examining the interindustrial relationship in the region on the basis of static analysis, this study also provides information to compare the change in economic structure for the entire region as a comparative static analysis. For these purposes, choosing the two digit S.I.C. level for the development of the sample seemed to be tolerable.

The basic unit of measurement adopted in this study was employment, though it was ultimately converted to dollar values in the flow table. It was decided to attempt to sample 60% of the employment in each of the two digit S.I.C. codes. The firms with the largest employment in each industry were selected first until 60% of the employment estimated for each industry was obtained. The major source of data on employment by S.I.C. was County Business Patterns (C.B.P.), 1967. Data are given for each county and Standard Metropolitan Statistical Area (S.M.S.A.) as well.

The administrative boundary of the East-West Gateway Coordinating Council (E.W.G.C.C.) includes eight counties: St. Louis City and St. Louis County, Franklin, Jefferson and St. Charles Counties in Missouri, and Madison, Monroe and St. Clair Counties in Illinois. The city and the first six counties constitute the St. Louis S.M.S.A. Since this study is prepared for the E.W.G.C.C., the regional geographical coverage extends from the St. Louis S.M.S.A. to include Monroe County (see Appendix II-1). Total population in this region was estimated to be 2,362,278 persons or 51.3% of total residents in the State of Missouri in 1967. Of the total population in the region, 76.3% were residing on the west side of the Mississippi river or in the State of Missouri and the rest, on the east side of the river, or in the State of Illinois. In terms of employment, this region employed about 60% of the total Missouri employment in 1967.

In the questionnaire every firm was asked to report its latest available data. As expected, all firms sampled answered with 1967 data. Therefore, when government documents were used to complete the information, some of the latest relevant publications were adjusted or reestimated to bring them up to 1967 for purposes of consistency.

II. Methodology of Sampling

In 1966 the St. Louis Regional Industrial Development Corporation (R.I.D.C.) conducted an input-output survey of manufacturing industries for the St. Louis S.M.S.A. A long and detailed questionnaire was used and personal interviews were conducted among all sampled firms.

A stratified sampling method was adopted in the survey and its coverage of firms ranged from those employing one to thousands of workers. Within each stratum, a random sampling was performed. It was planned to interview fifty percent of the reporting units or 1500 establishments in the manufacturing industries within the St. Louis S.M.S.A.

In the questionnaire, both input structure data and the distribution of sales of each firm for each industry were requested in order to permit cross checking in constructing an input-output table (see Appendix II-2). However, the results of the interviews revealed the fact that firms in St. Louis know the destination of their outputs far better than the origin of their inputs, especially where regional breakdowns are required. In terms of input-output flows, information for the rows is easier to secure than information for the columns. The reason for this is, "that the bundle of inputs is usually so varied and complex that their origins are difficult even for firms involved to track down accurately."[1]

RIDC's 1968 questionnaire was designed similar to the one presented by Tiebout to cover a certain proportion of regional employment.[2] Sampling the largest firm first is biased, of course, in this specific sampling process. However, many manufacturing industries in this region have historically been dominated by some large firms. Therefore, technical relationships within industries revealed by those firms perhaps

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[1]W. Lee Hansen and Charles M. Tiebout, "An Intersectoral Flows Analysis of the California Economy," Review of Economics and Statistics, Vol. 45:4, November, 1963, p. 411.

[2]Charles Tiebout, The Community Economic Base Study, Supplementary Paper No. 16, published by Committee for Economic Development, December, 1962.

are more reliable than they otherwise would be. In addition to its simplicity, conducting a sample by this method provides an attractive advantage of cost saving. It was anticipated that both RIDC's surveys, 1966 and 1968 questionnaires, would give a combined picture in investigating the economic structures of this region.

As previous experience illustrated, emphasis of the 1968 questionnaire was placed on firms' sales distribution not their inputs. In order to get a better return, the questions on dollar values of sales and costs were stated as optional. Since our unit of measurement was employment and the table was basically designed to disclose employment coefficients and employment multipliers in this region, sampled firms needed only to give employment figures and distribution of their output by percentages. The questionnaire form was short, so that it would be easy to fill out; but it was also inclusive enough to serve our needs (see Appendix II-3).

The Metropolitan St. Louis Manufacturing Directory, which lists firms by S.I.C. code and by size and the Large Employer's Directory, which lists all employers with over 100 employees, provided the basic information needed for the mailing preparation of the survey.

Personal interviews were conducted several weeks later in order to complete questionnaires of sampled firms which did not reply or replied only in part. Others were interviewed to reexamine or reconfirm the information supplied if there was any doubt about its reliability or applicability.

Various forms were designed to code step by step, sampled results for each two digit S.I.C. industry. Employment figures and their

distribution for each firm were aggregated to obtain industrial sampling. By the same token, dollar values were also aggregated from firms which made this information available.

III. Sampling Results

The usable sample results of the 1968 survey expectedly differ, in terms of employment coverage, from the intended coverage at which the survey was aimed. Even with extra assistance through personal interviews, the goal of covering 60% of the total employment in each manufacturing industry was accomplished only in four sectors: lumber and furniture; chemical, petroleum and rubber products; primary metals; and transportation equipments. The other manufacturing industrial coverages were below this percentage, ranging from 12% to 49% with a median of 43% of total sectoral employment. However, with the 1966 survey, this percentage of employment coverage would be rather high. In some industries, the figure is higher than when the two samplings are combined.

For non-manufacturing sectors, the percentage of usable questionnaires was not as good as that in manufacturing industries. As expected, the employment coverage was relatively low, ranging from 6% in construction to 31% in transportation, communication and utilities sectors. No completely satisfactory report was received from the mining industries.

The weak part of the survey, as in the mining and construction industries, was mainly a result of the problem of disclosure. One firm, for example, in the mining industry employed more than 40% of total mining employees in the region. Various secondary sources were carefully

collected for industries for less satisfactory coverages such as annual reports of firms and accessible government files. Table I-1 shows the results of usable sample coverage of total employment in the 1968 survey for each sector.

TABLE II-1

Employment Coverage Of Usable Samples,
1968 Survey By Sector

Standard Industrial Classifications (1)	Sector (2)	Regional Employment (3)	Coverage (4)	Percentage Distribution (5)=(4)/(3)
20-21	Food, Tobacco & Kindred Products	25,240	3,021	12
22-23	Textiles & Apparel	14,258	5,630	39
24-25	Lumber & Furniture	6,274	4,265	68
26-27	Paper & Printing	22,812	8,993	39
28-29-30	Chemicals, Petroleum & Rubber	24,307	17,686	73
31	Leather Products	8,215	3,523	43
32	Stone, Clay & Glass	9,441	4,393	47
33	Primary Metals	26,157	15,658	60
34	Fabricated Metals	22,071	9,832	45
35	Machinery (Except Electrical)	19,712	2,697	14
36	Electrical Machinery	18,123	2,300	13
37	Transportation Equipment	68,577	49,900	73
19-38-39	Ordinance & Miscellaneous Manufacturing	20,161	7,252	36
01-09	Agriculture	1,316	375	28
10-14	Mining	2,316	384	17
15-17	Contract Construction	43,222	2,620	6
40-49	Transportation, Communication & Utilities	64,047	19,785	31
50-51	Wholesale Trade Services	52,210	4,461	9
52-59	Retail Trade Services	125,684	17,709	14
60-67	Finance, Insurance and Real Estate	45,923	8,868	19
70-89	Business, Personal & Other Services	126,302	29,044	13

Source: Regional Employment is obtained from County Business Patterns, Missouri and Illinois: 1967, Mid March pay period.

Chapter Three: Methodology And Data Sources

I. Manufacturing Industries

A. Determination of Total Value of Shipments

The total value of shipment for one industry reflects very closely the amount sold from this industry, or the physical transaction that actually took place. In this study, we assumed that both values were identical, if checks made from the expansion of aggregated sales from sampled firms did not show any significant difference between the two figures.

The latest data of manufacturing shipments were those for the St. Louis S.M.S.A. by sectors in 1965, published in the Annual Survey of Manufactures, 1967, by the Department of Commerce. The values of shipment from various manufacturing sectors were estimated by multiplying regional shipments (with Monroe County included) in 1965 by the employment ratio of 1967 to 1965 in that sector. All manufacturing sectoral shipments in 1967 were obtained separately by the method just described, unless otherwise specified.

The assumptions underlying this methodology are as follows:

1. Marginal productivity of labor between 1965 and 1967 in the respective sectors remained fairly constant with a relatively small change in capital stock and negligible technical progress between the two years. Therefore, the supply of output increased proportionally to the increase in labor input.

2. Demand for each sector's product increased proportionally to that of supply, as a combined effect of both domestic and outside demand increases. Inventory adjustment is hence negligible.

Except for minor adjustments, such as inventory change, total value of shipment in each sector is therefore expected to change in the same direction and with the same magnitude as the change in employment.

The value of shipments has to be adjusted because of price changes between 1965 and 1967. The difference between price changes by sector varies from one sector to another. Wholesale price indexes calculated from the Federal Reserve Bulletin, November, 1967, ranged from 1.0029 to 1.0647 between the two years.[1] By multiplying both employment and price change indexes by 1965 shipments for each manufacturing sector, estimated 1967 $hipments for each respective sector were obtained. Information for each manufacturing sector with preceedingly described data is shown in Table II-1.

Total value of shipment for lumber and furniture in 1967 was estimated separately for lumber and wood products and for furniture. The basic information on the shipment from furniture producers in the St. Louis region in 1965 was given in the Annual Survey of Manufactures. By multiplying the 1965 shipments by the percentage increase in employment in the sector (S.I.C. 25) between 1965 and 1967, we obtained an estimated dollar figure for 1967. In the lumber and wood industry (S.I.C. 24), there was no data available on shipments for the region, due to the fact that the standard error was too large for it to be useful. Therefore, the state average of shipment per employee in 1965 was computed. Again, this average figure was multiplied by regional employment in 1967 to get 1967's shipment for this industry, by assuming equal productivity of workers in this industry both in the region and the state. These figures, of course, were finally adjusted by price changes to arrive at a sectoral control total. Value of shipment in the ordinance industry (S.I.C. 19) in 1965 was not disclosed by the Annual Survey of Manufactures. The value of shipment of ordinance products in

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[1]Board of Governors of the Federal Reserve System, Federal Reserve Bulletin, November, 1967, p. 1982 and July, p. 864, Wholesale Price Summary.

TABLE III-1

Estimated Value Of Shipment For St. Louis Region,
by Manufacturing Industries, 1967

Industries (1)	S.I.C. (2)	Ratio of 1967/1967 Employment (3)	Ratio of 1967/1967 Price (4)	Shipment 1965 (5)	Estimated Shipment (6)=(3)x(4)x(5)
Food, Tobacco & Kindred Products	20-21	1.00250	1.0468	1,222,176	1,282,572
Textile & Apparel	22-23	1.00635	1.0029	190,284	192,047
Lumber & Furniture	24-25	1.14426	1.0425	70,993	84,079 (1)
Paper & Printing	26-27	1.04830	1.0401	463,988	505,904
Chemical, Petroleum & Rubber Products	28-29-30	0.97772	1.0102	1,602,448	1,582,726
Leather Products	31	1.06398	1.0604	94,712	106,859
Stone, Clay & Glass	32	0.93912	1.0255	728,331	219,898
Primary Metals	33	1.00745	1.0359	828,152	864,274
Fabricated Metals	34	1.15491	1.0359	444,762	532,100
Machinery (except Electrical)	35	1.09517	1.0647	374,680	436,887
Electrical Machinery	36	1.17282	1.0647	310,433	387,638
Transportation Equipment	37	1.14849	1.0419	2,941,269	3,519,557
Ordinance & Miscellaneous Manufacturing	19-38-39	1.55493	1.0418	132,104	293,673 (2)
Total		1.12348	1.0351	9,029,546	10,008,214

Sources:
1. Employment - County Business Pattern State Section, Mo. and Ill., 1965 and 1967 (Mid-March Pay Period).
2. Price Index - Federal Reserve Bulletin, November, 1967 and July, 1968.
3. Value of Shipment - Annual Survey of Manufactures, Mo., 1965.

Note:
(1) See explanation in the text.
(2) This figure includes total shipment from ordinance industry which was not disclosed for 1965.

1967 was estimated from federal government expenditures, and then it was added to the shipment estimation of miscellaneous manufactures.

The estimated values of shipments in 1967 have been double checked against state shipments as well as our sample survey. The assumptions held up fairly well in both directions, i.e., in expanding regional figures to compare with state figures or aggregating sampled firms' sales to compare with regional estimates, no significant discrepancy was indicated.

B. Estimation of Other Statistics

Inventory changes in terms of percentage of cost were indicated by some sampled firms. Together with dollar value of sales and costs from these firms, the firms' inventory change was estimated in dollars. Comparing these firms' employment to that of the industry, an enlarged figure for the industry was obtained, provided that sampled firms were large enough in employment size to reasonably determine the industry's inventory. Total domestic output is the sum of the value of shipment and inventory value changes.

Depreciation and other capital allowance were also indicated by some sampled firms in terms of percentage of total cost. By a method similar to that employed in estimating industrial inventory change, we can estimate depreciation and other capital consumption for the whole sector. Likewise, we can obtain sectoral expenditures such as salaries and wages, local government tax payments, etc. These estimates provide us with information for double checks against, for example, household earnings and local government revenues for each sector. The household earnings and local government revenues row cells were filled, however, by utilizing more reliable information: government publications of earnings of broad industrial sources and annual reports of government finance, discussed in detail later in the final demand sectors.

Cost of materials and labor input purchased from outside the region for each sector were stated either in terms of dollars or employment by all sampled firms in both surveys of 1966 and 1968. Therefore, expenditures on imported goods or services for each sector could be estimated in a like manner, by expanding the surveyed information to obtain the sector's imports. This figure was again compared with the counterpart data computed from cost of materials for each sector. Cost of materials for each sector in 1965 was published by the Department of Commerce in the Annual Survey of Manufactures, 1967. Cost of materials for each sector for 1967 was estimated by a method similar to that used in estimating value of shipment. With this procedure a two-way examination was possible and any necessary adjustments could more reasonably be made.

C. Distribution of Output

The value of sectoral production for the year is obtained by subtracting or adding the change in product inventory to the total value of shipment. This output at producer's price represents total transactions of this sector with the sector itself and other sectors. Any sector sells its output to two categories: one is the final demand sectors, which consume directly the output, the other is the non-final demand sectors which purchase this sector's output, not for immediate consumption, but for further production, i.e., producing something to satisfy the direct consumption of the final demand sectors. Household consumption, investment expenditures, government and net exports are considered to be final demand sectors and the rest, the non-final demand sectors.

Sales or the distribution of row vector from non-final demand sectors to final demand sectors is determined in two ways. The results obtained

from the sample survey, as will be shown later in this section, have to be compared and adjusted with the results obtained from the distribution of column vector of these final demand sectors. The column vectors of these final demand sectors were derived from other sources, independent of the sampled survey. This will be discussed in the section pertaining to the final demand sectors.

Every firm sampled in 1968 was asked to which industry its product was sold, where it was sold and how much was sold, in percentage terms. All sampled firms also released their yearly average employment. Sales distribution can certainly be converted to number of employees. Information regarding sales distribution in terms of number of employees from each firm was aggregated by S.I.C. codes. These aggregated totals by S.I.C. codes were divided by the total sampled employment in that S.I.C., thus achieving a sample percentage distribution by employment for each S.I.C. code.

In like manner, the percentage distribution of employment obtained from our sample survey for each two digit S.I.C. was multiplied by the regional employment for that S.I.C. to obtain a regional employment distribution by S.I.C. codes. The distribution by S.I.C. codes is actually the internal matrix (by row) in terms of employment. By converting employment figures into dollars of output sold from each S.I.C. category to relevant S.I.C. categories, we complete the cash flow table--sales from manufacturing industries to manufacturing and other sectors.

A matrix is filled up horizontally first in terms of sample employment for each sector concerned: each cell is the number of employee, horizontally they all add to the total sampled employment for that sector named at the left. Taking percentage distribution, each row vector can undoubtedly, easily be converted to represent regional employment distribution or product flow

distribution by sector, as long as we have sectoral control totals. This method has been employed by Hansen and Tiebout in analyzing the California economy.[2] It is closest in spirit to one developed by Professor Leven in his analysis of regional income and products accounts.[3] Traditional technical coefficients a_{ij} in orthodox input-output tables are thus replaced here by employment coefficients, e_{ij} which indicate the employment required in the regional industry i per employee in industry j. The matrix inverse can then be derived to show the direct and indirect effects of changes in an industry's employment and to estimate the direct and indirect effects of changes in an industry's final demand for its output, which was caused by any exogenous change.

D. Mathematical and Statistical Summary

Mathematically, the methodology of allocating dollar sales from manufacturing industries to manufacturing industries and other sectors can be illustrated as follows:

1. Intermediate Transactions

(a) $e_{ij}^{k} = s_{ij}^{k} \times e_{i}^{k}$

where e_{i}^{k} = total employment in 1967 employed by the sampled i th firm in S.I.C. code of k sector.

s_{ij}^{k} = percent of total sales from the sampled i th firm to j th sector, both are inside the region.

$j = 1,\ldots,k,\ldots,n$. n is total number of sectors used in the study or total number of row headings.

$i = 1,\ldots,m$, n is total number of sampled firms.

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[2] Hansen and Tiebout, op. cit.

[3] Charles Leven, "Regional Income and Product Accounts: Construction and Application," in Design of Regional Accounts, Johns Hopkins Press, Baltimore, 1961, pp. 148-195.

e_{ij}^{k} = number of employees in the sampled i th firm in the k sector that is conceptually required for that portion of output of this firm sold to the j th sector.

(b) $E_j^k = \sum e_{ij}^k \Big/ \sum e_i^k$

where E_j^k = the proportion of total sampled employment in the k sector that is conceptually corresponding to the production of that portion of output sold from the k to the j th sector.

(c) $S_j^k = S^k \times E_j^k$

where S^k = total value of sales from the k th sector in the region. This control total is obtained from published materials or estimated figures, as stated in subsection (1).

S_j^k = total value of sales from the k th sector to the j th sector in the region.

2. Final Demand Sectors

Sales from St. Louis regional manufacturing industries to sectors outside the region and other exogenous sectors, such as federal government, are computed similarly to those for the intermediate transactions, but adjusted and reconciled with figures derived for all final demand sector columns from other separate sources.

3. Results and Statistical Tests of Methodology

Table IV-3, "Interindustrial Output Distribution," indicates inter-relationships of various sectors' sales distribution. Each entry shows the percentage of sales from the regional industries named at left to the regional industries named at top. This table is the output resulting from the manipulation of equation (b) in subsection (1), which is originally the employment distribution of each industry named at left derived directly

from initial sample survey. Table IV-2, "Input Coefficients: Direct Purchase Per Dollar of Output," actually represents the employment input coefficient. Each entry shows the required employment input of each regional industry named at left to produce the total output of the industry named at top. In other words, each entry (e_{ij}, i refers to row and j to column number) would tell the number of jobs for the row industry that is related to per employee in a column industry. This table is constructed by transforming the Interindustrial Gross Flow Table, Table IV-1 which is built by employing equation (c) in subsection (1).

In completing these tables, especially the last one, we have not only assumed that homogeneity exists among labor inputs in each sampled firm, but also that weighted sample results, with the weights being each firm's employment, can represent the corresponding sector under discussion. Finally, employment and output have also been considered to be interchangeable in a linear form with the existence of high correlation between the two variables. In other words, we have assumed a linear homogeneous production function for each industry and that labor is the most important variable factor in that industry, such that changes in capital stock in each firm can be ignored. Although those assumptions are broad, they are vital and essential under the situation of unwillingness of sampled firms to disclose their dollar amounts in all accounts.

In order to examine the reliability of Table III-1, the Interindustrial Gross Flow Table, the linear homogenous relationship between labor input total output has been tested for nearly all sectors in the St. Louis region.

Setting employment as a dependent variable (for the later purpose of estimating employment multipliers resulting from the effect upon output of any dollar change in the final demand) and total output as an independent variable, simple regression has been run for each sector which has sufficient information from samples. Due to different numbers of observations (i.e., firms giving both information on employment and dollar output) among sectors and different characteristics (i.e., capacity, technology, etc.) among observations in each sector, regression results naturally differ among sectors. Simple correlation coefficients between the two variables, labor and output, ranged from as high as 0.98 in the transportation equipment sector (S.I.C. 37) to as low as 0.45 in the service sector. The correlation coefficients reflect the least degree to which we have confidence in judging the model implemented from our sample survey.

Although correlation coefficients differ from sector to sector in the region in 1967, regression coefficients of output on employment are all significant at the 5% level of confidence. Most are significant at the 1% level. That is to say, employment multipliers can be estimated through those coefficients with the probability of committing an error less than one out of every hundred times.

By considering each sector as an observation and pulling together sectoral employment and value of output, a similar test has been performed for the St. Louis region in 1967, St. Louis S.M.S.A. in 1955, and the State of Missouri in 1963. The estimated results are as follows:

St. Louis Region: $E_{67} = a_1 + b_1 X_{67}$ $r_1 = 0.62$, $t = 3.41$, D.F. = 19

$= 1.29 + 0.026 X_{67}$ ----------(1)

St. Louis S.M.S.A.: $E_{55} = a_2 + b_2 X_{55}$ $r_2 = 0.47$, $t = 2.04$, D.F. = 15

$= 1.18 + 0.047 X_{55}$ ----------(2)

State of Missouri: $E_{63} = a_3 + b_3 X_{63}$ $r_3 = 0.57$, $t = 2.95$, D.F. = 18

$= 1.53 + 0.036 X_{63}$ ----------(3)

E represents employment, X the gross output ($1,000), and a the constant. Coefficients for both the region and the state (b_1 and b_3) are statistically significant at the 1% level of confidence, while the S.M.S.A. (b_2) is only significant at the 10% level, with respect to individual degrees of freedom. In addition, the simple correlation coefficient (r) is higher for the region than that for the state and that of the state is higher than the S.M.S.A.'s. The results imply at least that the method employed in constructing our transactions flow table for the region in 1967 is much better supported than if it were used twelve years ago for the S.M.S.A., or four years ago for the State of Missouri. For the regional economy as a whole, estimates made on the basis of equation (1) would be correct ninety-nine times out of every hundred, in terms of probability.[3]

In summary, there are clearly a number of limitations to the methodology employed in this study. Most of them center upon the underlying assumptions whose adoptions apparently were attributed to insufficient reliable empirical data. The sample data for firms are subject to response errors and to biases as well.

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[3]For statistical analysis, please see any intermediate statistics text under the sections of regression analysis and student t test.

Table III-2

Gross Output and Employment By Corresponding Standard

Industrial Classification Code For St. Louis S.M.S.A. (1955), Missouri (1963) and St. Louis Region (1967)

	St. Louis S.M.S.A.[a] 1955		State Of Missouri[b] 1963		St. Louis Region[c] 1967	
S.I.C.	Output ($1,000)	Employment	Output ($1,000)	Employment	Output ($1,000)	Employment
20-21	1126209	33100	2226223	48188	1283957	25240
22-23	181522	19000	441089	36429	197447	14258
24-25	--	--	179682	12156	83890	6274
26-27	271491	22100	714920	39179	506693	22812
28-29-30	1152383	28800	1389192	55090	1584148	24307
31	148687	14900			106859	8215
32	--	--	281733	13119	219898	9441
33	426389	23600	317187	12798	851358	26157
34	223490	19900	559031	24303	535675	22071
35	233802	20100	519495	26449	439483	19712
36	202970	19900	427606	24081	386357	18123
37	878523	33000	3053295	58206	3555604	68577
19-38-39	520155	37100	317833	14967	293673	20161
01-09	--	--	1195699	3937	88291	1316
10-14	606638	14500	116003	7100	78669	2314
15-17	723890	42800	1055047	68200	922382	43222
40-49	881439	68300	2193868	114600	1481926	64047
50-51	965146	155100	1333500	93200	870227	52210
52-59			2329000	251177	1350862	125684
60-67	668002	35200	3605390	75700	1656675	45923
70-89	535940	75200	1181173	202400	1483274	126302
Total	9746676	662600	24136966	1181279	17977348	746368

[a] St. Louis S.M.S.A.: Output data used by Professor Werner Hirsch in his study, "Interindustry Relation of a Metropolitan Area," published in Review of Economics and Statistics, Vol. XLI:4 (Nov., 1959), pp. 360-369, were obtained directly from Professor Hirsch. Employment data for this study was given by Professor E. F. Terry in a private letter to St. Louis Regional Research Council. Figures in Sector 10-14 include those of S.I.C. 19, 78 & 84, which are therefore not included in respective sectors given in the table.

(OVER)

Similarly, Sector 19-38-39 includes values of S.I.C. 01, 21 and 24.

[b]Missouri State: Output data are taken from Professor Floyd K. Harmston, Missouri Economic Study, An Inter-Sectoral Analysis of the Missouri Economy, 1963, printed by the University of Missouri at Columbia, Missouri. Manufacturing employment data was obtained from the Missouri Division of Employment Security, Department of Labor and Industrial Relations. Employment for sectors 21 and 29 were not included due to the problem of disclosure. Employment data for non-manufacturing industries were obtained from Employment and Earnings Statistics, 1967, published by the U. S. Department of Labor, except agriculture from 1964 C.B.P.

[c]St. Louis Region: Output data are those presented in the Interindustrial Gross Flow Table. Employment data was obtained from the County Business Patterns, 1967.

For detailed sector classification see Table IV-6.

But the most obvious advantage of the approach outlined above, according to our experience, in general, and to professors Hansen and Tiebout, in particular, "lies in its operational simplicity."

They concluded: "Although other approaches may have certain advantages at the conceptual level, the real problem is one of generating the necessary data at a reasonable cost and on a recurrent basis so that regional economics can be more fully analyzed."[4]

II. Final Demand Sectors

A. Federal Government Column Vector

The prime source of data for the federal government sector was the Office of Economic Opportunities' (O.E.O.) Summary of Federal Programs, "A Report of Federal Programs' Impact on the Local Community" for 1967.

This report detailed federal government expenditures in each county by major functions for each governmental department and agency. Total expenditures for the St. Louis region were obtained by combining the data by function and department for the City of St. Louis and the seven surrounding counties. Each function was assigned a two digit S.I.C. code determined on the basis of what sector was the recipient of the function's expenditures.

According to the O.E.O. publication, Military Prime Contractors in the St. Louis Region, there were recipients of over $2 billion worth of expenditures by the Department of Defense in 1967. Because of this enormous amount and its obvious effects on the St. Louis area, it is certainly necessary to break prime military contracts into the major industries involved.

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[4] W. L. Hansen and Charles M. Tiebout, op. cit., p. 418.

A study for R.I.D.C. by D. N. Humphries and Associates entitled, Federal Procurement in the St. Louis Metropolitan Area, provided the information necessary to sub-classify military contract expenditures. The D. N. Humphries study listed the major companies in the St. Louis area which were recipients of prime government contracts. The total expenditures from both these reports were sufficient to use as a basis for assigning S.I.C. codes.

A check was made with the firms listed in the Humphries study to determine what their S.I.C. classification should be. In the process, it was found that several large firms have not only increased their sales to the federal government but that, due to the change in their major products, a new S.I.C. code should be assigned.

After all departmental functions and prime contractors were assigned S.I.C. codes, aggregates were accumulated to compute the federal government expenditures by sectors.

B. State Government Column Vector

No reliable data could be found from either primary or secondary sources as to the amount of state government expenditures in the St. Louis region.

It was therefore decided to allocate Missouri and Illinois expenditures to the St. Louis region on the basis of population: assuming that per capita expenditure from state government is the same within the state boundary.

Governmental expenditures for the states of Illinois and Missouri were listed by major functions in the publication, "State Government Finances for 1967" by the Department of Commerce.

Each state's expenditure by function was multiplied by the ratio of the population of the counties making up the region to the total state population.

After the two states were added together, each functional expenditure was assigned a S.I.C. code, when the code could definitely be determined by the nature of the expenditure.

State government expenditures are listed in five major categories: capital outlays, insurance benefits, interest on debt, assistance and subsidies, and current operations.

Capital outlays for construction were allocated directly to the construction sector, while those for equipment were allocated to S.I.C.s 36, 37, 19-38-39, in the ratio of the coefficient of these three sectors from the Harmston 1963 table.

Insurance benefits and payments were allocated directly to households. Interest on debt expenditures were estimated to be fifty percent to household and fifty percent to finance, insurance and real estate.

Assistance and subsidies and current operating expenditures were broken down for each department of the state government. Of the 25 sub-expenditures of current operation and assistance and subsidiaries only 10 could be allocated directly to four sectors (S.I.C. 60-67, 70-89, 15-17, and household.)

To distribute the remaining amount, $146,631, the coefficients of the Harmston table, after subtracting the coefficients of the above four sectors from Harmston's corresponding sectors, were used to arrive at a new set of distribution coefficients.

The Harmston table did not break out expenditures from state and local government, but governments' imports were in one sector. Therefore, part of the imported amount determined with the Harmston coefficient in our table was reallocated proportionally to S.I.C. sectors 40 to 89.

C. Local Government Vectors

After thorough research it was found that very little up-to-date data with a fine breakdown for 1967 was available on local government expenditures and revenue from either primary or secondary sources.

It was decided, therefore, to project local government expenditures and revenue from the latest data available, the Census of Governments, 1962 and 1957, with adjustments made by utilizing RIDC's 1964 survey of local governments and St. Louis county's 1967 tax revenues and expenditures records.

Table 12 of the Census of Governments publication gave "Local Government Finances in Individual Standard Metropolitan Statistical Areas and their Component Counties," by function. Since the S.M.S.A. did not include Madison and Franklin Counties in 1957 and 1962 these two counties' data obtained from the same census publication were added to those of the S.M.S.A.

The rate of increase in each function of and source of revenue and expenditures was computed from 1957 and 1962. From these rates of increases, including Monroe County's data, expenditures and revenues were projected by function and source for 1967 for the entire region.

Each function was then assigned a S.I.C. code, depending on which sector received the local government funds. From the functions listed in the table only the household, finance, insurance and real estate, construction, transportation, communication and utilities sectors could be determined.

In order to obtain the remaining sectors which received local government funds, the distribution pattern in Hirsch's 1955 table of St. Louis was adjusted and used.

From the total projected expenditures in 1967, household, finance, insurance and real estate, construction and transportation, communication, and utilities were subtracted. The remaining expenditures were then allocated to the other sectors, based on the ratio of these sectors in the adjusted Hirsch transaction table.

Revenues levied from each sector by local government through various taxes and other forms are estimated and adjusted mainly on the basis of the following information:

1. The 1966 input-output survey conducted by the St. Louis R.I.D.C. recorded the amount of taxes paid to local governments by firms. The estimated amount of tax paid to local governments by industry or sector is the product of the ratio of sector employment to sampled firms' employment and the amount of taxes assessed from the firms, weighted by price indexes.

2. The 1964 R.I.D.C. survey of local governments covered revenue information for various levels of local governments, municipalities, townships, etc. This survey constitutes another source for the estimation of revenues by sector.

3. Revenue data by source for St. Louis County and City were received directly from the governments. Tax revenue per employee in each sector was computed, through which revenue estimation by sector for the region was performed, with reference to regional employment in the sector.

4. The ratio of local government tax per dollar of output for the St. Louis S.M.S.A. in Hirsch's 1955 table was calculated for each sector. Similarly, the ratio of state and local government tax per dollar of output for the State of Missouri in Harmston's 1963 table was computed. These ratios provided another relevant source for double checks against revenue allocation by sector in 1967.

From the RIDC 1966 survey, revenues assessed by local government through local taxes from sampled firms and their employment were aggregated by two digit S.I.C. codes. Ratios of total employment in 1965 (from County Business Patterns) to sample employment were computed and multiplied by sample revenues of local taxes for each sector. The product is the estimated 1965 local government revenue by S.I.C., with the assumption that employment and assessed value subject to local government taxes were perfectly correlated in 1965.

These estimated 1965 revenue figures of local government were projected to 1967 by multiplying the figures by the 1967/1965 employment ratio of each sector and adjusting by price changes. Again, the previously mentioned assumption is retained here. It is certainly not valid for a single firm. However, for many firms in a sector, the difference may conceivably be washed out.

Not all of the sectors could be determined by this procedure since there were not sufficient responses to the survey for manufacturing sectors 20, 21, 24 and the non-manufacturing sectors. For these undetermined elements, Hirsch's 1955 table of this local government row vector was expanded to 1967, to arrive at some adjusted figures. The expansion was done by multiplying the ratio of our local government column total to

Hirsch's local government column total, by Hirsch's row vector dollar figures.

With all sectors' expenditures on local government taxes obtained, estimated coefficients were then computed. Those coefficients, after they had been compared with data collected from the survey of local governments, 1964, were adjusted and used to allocate the total of local government revenues in 1967, after several items had been subtracted.

Total local government revenues in 1967 were estimated by subtracting from the local government column total (local government expenditures) the intergovernment transfer payments: federal and state payments to local government. From these the household sector expenditures on local taxes were also subtracted before distributing the control total by the coefficients previously estimated. The household expenditures on local tax were estimated by multiplying Hirsch's coefficients for household by local government revenues. The assumption employed here is that the ratio of local government taxes on household properties to that on non-household properties has remained constant over the time period, 1955 to 1967. It is a proxy for the purpose of simplicity, for it is hardly possible for local government authorities to clearly distinguish between the two sources of revenue.

Sectoral revenue estimated through the above described methods was finally compared with information derived directly from St. Louis County and City revenues offices. On the basis of revenue per employee, our local government row was thoroughly checked and minor modification was performed.

D. Private Gross Investment Column Vector

1. New Capital Investment by Manufacturers

The most current data that could be found for new capital expenditures by two digit S.I.C. code for manufacturing was the Annual Survey of Manufactures, 1965.

Corresponding to the dollar value of new investment for each S.I.C. code was the number of production workers. It was decided to estimate new 1967 investment by multiplying the ratio of new capital expenditures to production workers for 1965 by the 1967 estimated production workers.

The rate of change in manufacturing employment in each sector was computed from the 1965 and 1967 County Business Patterns. The number of production workers listed in the 1965 Annual Survey of Manufactures was then projected by the rate of change computed from County Business Patterns.

The projected 1967 production employment in each sector was then multiplied by the ratio of 1965 new capital expenditures to production workers to obtain 1967 sectoral new capital investments. Here we have assumed that new capital investment per employee had remained constant from 1965 to 1967, for the sector under discussion as a whole.

The second estimate of business investment was obtained from the 1966 RIDC survey of manufacturers. Investment expenditures on goods purchased in and out of the St. Louis S.M.S.A. by sampled firms were accumulated by two digit S.I.C. code.

S.M.S.A. employment for each sector from County Business Patterns was divided by sample employment to get a multiplier for the sample total. This employment multiplier was then multiplied by sample investment in each

two digit sector. The figures so obtained give an estimate of total investment in 1965 based on sample investment and employment.

To project this investment to 1967, the ratio of employment in 1967 to employment in 1965 by two digit sector was multiplied by the 1965 estimated investment. Here again we have assumed a constant new capital investment per employee ratio.

Using the RIDC survey as a double check, total investment for manufacturing so computed was fairly close to total investment obtained from the Annual Survey of Manufactures, by using the above described method. This RIDC survey was then used as a support of the manufacturers' investment estimation as computed from the Annual Survey of Manufactures.

2. Capital Expenditure on Equipment

Since total capital expenditures included both construction (both new and maintenance) and equipment, some way had to be developed to determine the equipment sectors.

From total construction for each two digit sector, five percent was subtracted based on an estimated 20 year life. The five percent was the estimated current consumption (1967) of total construction investment, including repairing and maintenance. This was the amount entered in the cells of the transaction table across the construction row. The remaining ninety-five percent will be future consumption of present construction investment.

Subtracting the remaining 95% of construction investment from total new capital outlays obtained from the Annual Survey of Manufactures, the difference constitutes total expenditures on equipment. This total was partitioned into equipment expenditures purchased in and out of St. Louis

in accordance with the in-out ratio obtained from the RIDC 1966 survey. The expenditures on imported equipment were allocated to imports, and equipment expenditures within the region were allocated to manufacturing sectors on the basis of our 1968 survey, with adjustments made from Hirsch's coefficients for capital equipment expenditures.

E. Export and Import Vectors

1. Manufacturing Sales to Foreign Countries

From the U. S. Bureau of Census' Survey of Origin of Exports of Manufacturing Products, 1966, value of exports by two digit S.I.C. were obtained for the St. Louis S.M.S.A.

Dollar value of exports for four sectors were not given because of disclosure problems. Subtracting those sectors given from total export for the St. Louis S.M.S.A. yielded a difference of $5.4 million to be distributed to the four undisclosed sectors. Footnotes at the end of the table showed that three of these sectors were less than one million and one was between one and five million dollars.

The weighted ratio of St. Louis S.M.S.A. employment to state employment for these four sectors was used to distribute the $5.4 million of undisclosed exports. The ratio of local employment to state employment for each of these four sectors was multiplied by the amount of state expenditures in each of the four sectors. The products are assumed to be local exports to foreign countries from the sectors.

The resulting weighted dollar figures of export by these four sectors were converted into a ratio, with a sum of 100%. These four ratios were then multiplied by the $5.4 million undisclosed exports, to arrive at an estimated dollar export for these four sectors. The final dollar figures for three of

these sectors were less than one million and one was about five million. These figures are consistent with the range given in the previously mentioned footnote.

Estimated exports to foreign countries by two digit manufacturing S.I.C. code industries were multiplied by the percentage change in employment in each of these sectors between 1966 and 1967 (including Monroe County). Four sectors did not disclose employment so the ratio of total S.M.S.A. manufacturers' employment between 1966 and 1967 was used to project 1967 export figures for these four sectors. Finally, when each entry was weighted by price changes, we obtained a column vector of manufacturing exports to foreign countries.

2. Manufacturing Sales to Rest of U. S.

The question of how much of a firm's output was sold outside the region was asked in RIDC's survey conducted in both 1966 and 1968. Dollar value of output sold to outside customers was recorded in the earlier year's survey while percentage was stated in the latter. Accumulating the sampled information in this respect and expanding it by multiplying it by the ratio of sector to sampled employment, the outcomes are respectively the estimated dollar value of sectoral export for the former and, for the latter the proportion of sectoral employment that is conceptually responsible for that portion of output produced and then exported. The latter figure is then multiplied by the value of output to arrive at dollar amount of sectoral export. Of course, the difference between the total amount of output exported and that part sold to foreign countries is the export to the rest of the U. S.

3. Non-manufacturing Export Sales

Export of non-manufacturing products and services outflow to satisfy non-regional needs was estimated principally from survey results in a manner identical to the export estimated for the manufacturing industries.

The export columns are derived conventionally as residual after inter-industrial and all final demand, other than export, are subtracted from gross output for each row. The residual is the value of net export only, not gross export;[5] it is certainly less informative than if both gross export and import are presented. However, our export column represents gross values and it is divided into two parts simply because reliable information needed to do so was made available.

4. Import Row Vector

Every cell in this row is the sum of values of raw materials, products and services that are imported and used by the sector named at top as input, in the process of its production. Both RIDC surveys in 1966 and 1968 requested firms to fill out their purchases, either in dollar or in percentage form, from suppliers outside the region. This information led to the completion of this row after various adjustments and checks were made. Cost of materials have been published for each manufacturing sector in the Annual Survey of Manufactures, and cost of goods sold was made available in U. S. Business Tax Returns. These two sources, combined with the information secured directly from St. Louis Customs about values of imported goods and materials, are used to estimate total value imported by the region and, eventually, the breakdown of import by sector in reference to the surveyed results.

F. Net Inventory Adjustment Column

Inventory changes both in product and raw material were requested specifically and separately in the RIDC questionnaire used in 1966 and

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[5]As an example, see Frederick T. Moore and James W. Peterson, "Regional Analysis: An Interindustry Model of Utah," The Review of Economics & Statistics, Vol. XXXVII, No. 4, November 1955, p. 372.

the change in raw material was requested in the 1968 survey. This column, like the export column in other input-output tables, is a net residual, which takes into account both changes in raw material and product inventories. Although indirect methods of getting this kind of information from firms' annual reports were adopted, information on inventory changes in many sectors was still poor and insufficient. Even though no entry was shown in this column for many sectors, particularly non-manufacturing sectors, this does not indicate that there was no change in inventory in 1967. Rather, they were left blank due to the lack of reliable data. This shortage does not affect, in any significant form, our table, with respect to the purposes that the table is designed to serve.

G. Household Row Vector

Earnings by "broad industrial source" for 1967, from the Survey of Current Business (August, 1968) were the primary source of data for determining the household row sector.

Earnings in 1966 are listed by "broad industrial source" for the St. Louis S.M.S.A. which does not include Monroe County. Monroe County was added by multiplying Monroe's percentage of state population by each of the sources of earnings for the State of Illinois. The earnings in 1967 were estimated to be 1.055 times as much as those of 1966, because the Department of Commerce has stated that the annual average rate of change in income in the S.M.S.A. for the past seven years has been 5.5%.

Personal contributions to social insurance were listed as a separate category and were subtracted proportionally from each of the sources of income, to arrive at before-tax-income. Property income was listed separately and was added proportionally to each broad industrial source

of earnings on the assumption that property income is, on the average of each aggregation, perfectly correlated with personal income.

Earnings from all governmental sectors were taken from the governmental earnings, plus transfer payment, minus social security contributions. Similar methods were applied also to the mining, agriculture and service sectors.

The trade sector was divided between retail and wholesale by using the ratio of the products of 1960 median income and 1966 employment in the retail and wholesale sectors, respectively. The 1960 median incomes were obtained from the 1960 Census of Population. Employment and Earnings Statistics, 1966, supplied the employment information.

Manufacturing earnings were broken into two digit S.I.C. codes by utilizing information for the St. Louis S.M.S.A. published in Employment and Earnings Statistics, 1966. The number of employees were listed for each two digit S.I.C. code. The employment figures were then multiplied by average weekly earnings of production workers times 52 weeks. From these figures the distribution of manufacturing earnings was obtained which was, in turn, multiplied by the earnings from manufacturing industries for 1967 to arrive at individual sector's earnings.

H. Household Column Vector

"Consumer Expenditures and Income for St. Louis, 1960" was published by the Bureau of Labor Statistics. This is the basic source from which we distribute household expenditures. The publication listed the major categories of dollar expenditures for families in the area with average income, and the percentage change from 1950 to 1960 for each item consumed.

Assuming a linear, homogeneous consumption function existed in the region between the years 1950 to 1967, for every item consumed, the consumer expenditures in 1967 were projected by multiplying the 1960 expenditures on each item by one plus seven-tenths of the percentage increase from 1950 to 1960. Percentage distribution of all expenditures was computed for each item and S.I.C. codes were assigned to these items where they could be definitely determined without doubt. The ratios of consumed items within the same sector were aggregated. Sectoral coefficients of household expenditures so computed were compared with those of Hirsch's and Harmston's.

Some household expenditure coefficients resulting from this method are quite close to those given by Hirsch and Harmston, such as in the sectors S.I.C. 20-21, 22-23, 40-49, etc. These coefficients were therefore finalized and accepted in the distribution of household expenditures for the corresponding sectors.

We adjusted coefficients which differ considerably from those of Hirsch's, on the basis of our 1968 survey, with reference to "sales to public consumption" by sector stated in the questionnaires. This adjustment is a modification of our assumption, the linear homogeneous consumption function.

However, for those expenditures on items which could not be assigned S.I.C. codes, we relied on our assumption of the linear homogeneous consumption function since 1950. Under this assumption, those expenditures were then allocated, in line with Hirsch's coefficients, to sectors excluding those already determined, as explained above.

All the coefficients calculated, as previously described, were multiplied by the total household earnings, 1967, which were estimated in the preceeding section, household row vector, from the Survey of Current Business.

III. Non-manufacturing Sectors

A. Agriculture Row Vector

The latest data available on agricultural output in the St. Louis region was obtained by aggregating county information from the Census of Agriculture for 1964.

The total agricultural output of the St. Louis region for 1964 was projected to 1967 by using the ratio of the increase in population in this area between 1964 and 1967.

This method gave the estimated value of agricultural output in St. Louis in 1967 as $88,291,000. From this figure $180,000 was subtracted, which was the amount of federal government expenditures to the agriculture sector, as computed in determining the federal government expenditures.

The remaining $88,111,000 was then distributed to the various sectors by examining Harmston's 1963 Missouri table, with adjustments made after disregarding the federal government entry. Harmston's coefficients provide a guideline for sales allocation and RIDC's 1968 survey and earlier survey of farms in St. Louis County were used for adjustments.

B. Mining Row Vector

From the U. S. Department of Interior's Mineral Yearbook the total value of mineral output for each county in the St. Louis region was obtained for the years 1963 through 1966.

Although there was no strong trend line in output for each county, the total output for the region showed a steady increase of approximately 7% for each of the four years.

Using 1966 figures and a rate of increase of 7%, 1967 mineral output was estimated to be $78,667,502.

The total mineral output for 1967 was then allocated to the various sectors, based on the adjusted coefficients for mining from Harmston's 1963 input/output table for Missouri. Because this region produces more than half of the total mining output in the state, this application is likely unquestionable, despite the lack of reliable information due to the problem of disclosure.

C. Construction Row Vector

The primary source of data for the development of the construction sector was the Chamber of Commerce of Metropolitan St. Louis' publication, St. Louis Commerce.

These reports, compiled primarily from building permits, have a detailed breakdown of industrial, commercial and residential construction expenditures.

All non-residential construction projects of $100,000 or more are listed by name and address of the firms involved and by the type of construction, as well. The public sector breakdown shows total federal, state and local government expenditures on construction by department, function and major projects. These were adjusted and included in the column vectors of governmental expenditures.

1. Public Construction

Since the data was obtained from building permits, figures given showed construction value over the total life of the project. In order to determine the amount of the total construction cost applicable to 1967, all projects were assumed to have a five year construction period, except where otherwise stated.

All public sector departments and projects were aggregated into five major functions and divided by five, to obtain the yearly outlay for construction. These major functions were utilities, higher education, highways, urban renewal and federal public flood control.

Utilities were allocated to either the local government sector or the private sector from the listing of construction expenditure by private and public utilities.

Higher education expenditures were allocated equally to private and government sectors, as an estimate of private university expenditures in the area versus public ones. All local highways projects were allocated directly to the local governments.

Urban renewal projects were allocated 100% to the federal government, since the state governments shared no expenditures for urban renewal projects. All flood control projects were allocated to the federal government, since all such projects were handled by the Army Corps of Engineers.

2. Residential Construction

The Chamber of Commerce published lists of total residential construction for 1967. From this figure the amount of residential construction attributed to federal government through urban renewal programs was subtracted to obtain a figure for private residential construction.

Private residential construction was allocated 96% to the finance, insurance and real estate sector and 4% to the household sector. This percentage was obtained by averaging the coefficients of other input/output tables for household and finance, insurance and real estate sectors of construction, because most new residential construction has been contracted through contract with finance, insurance and real estate sectors.

3. Commercial and Industrial Construction

All of the firms listed by the Chamber of Commerce with building projects of $100,000 or more were assigned S.I.C. codes. Then the dollar amounts spent on buildings in 1967 for all firms of the same S.I.C. code were aggregated and percentage distributions were thus determined for all industrial and commercial sectors.

These coefficients were then multiplied by the remaining value of construction after the public sector and residential construction were subtracted from the total year's construction outlay. This step was necessary since not all firms listed the dollar value of this construction because of disclosure problems, their values, however, were included in the yearly total.

After the private sector was allocated by S.I.C., the public sector expenditures on construction, as explained in the allocation of government expenditure columns, were added together. For example, state government expenditures of $82,696,000 for construction in the St. Louis S.M.S.A. were obtained from the state government sector and are explained under that section.

These private sector allocations plus the amount spent by federal, state and local governments on construction give the total output of the construction sector.

Besides sales to the government sectors, 5% of all construction is assumed to be consumed (including repairing and maintenance) in that year and the remaining 95% goes to investment. It is so assumed, because most financial reports of large firms state a life span of 20-45 years for all buildings, a straight depreciation method for 20 years is therefore used. Ten years straight depreciation is assumed for household buildings and additions, thus 90% of residential construction should be considered as an investment.

D. Transportation, Communication and Utilities Row Vector

One of the unique problems existing in the regional economic analyses is the determination of the regional output of the transportation sector. Due to the spatial nature of transportation service and the relationships of revenue derived from the service, the determination becomes complicated.[6]

The output of railroads may be considered as the sum of regional expenditures and estimated profit margin. For local and suburban transit and taxicabs, total revenue received, including taxes, is the sectoral output. One half of the revenues received by trucking activities with the firm's home office located in the region is assumed to be the sectoral output. The output of water transportation is primarily the level of shipping activity in the port. From the Corps of Engineers reports we secured the basic data. Estimated functional expenditures per ton of cargo handled, general and bulk, were given by the Philadelphia study.[7] With price adjustments, we estimated the total output for water transportation for the region. From the Civil Aeronautics Board's Uniform System of Accounts and Reports for Certified Air Carriers, output data for air transportation was reconciled and computed for the region. Output of warehousing is its revenues.

The outputs of telephone communications and radio and television broadcasting were defined as they were in the Philadelphia study: total receipts including taxes. Telephone companies provided information for the former activities while reference was made to the annual reports of the Federal Communication Commission for the latter.

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[6]For detailed analysis, see Isard, Langford, Romanoff, Philadelphia Regional Input Output Study, Working Papers, Vol. II, p. 6-2. Department of Regional Science, University of Pennsylvania, 1966.

[7]Ibid., p. 6-8.

The output of the utilities firms was estimated from surveyed firms. Revenue (including taxes) per employee, reconciled with estimates of sales per customer provided the basic information for sectoral output estimation.

For sanitary and other utility systems, output was estimated from employment and payroll data from County Business Patterns, with reference to Employment and Earnings Statistics.

Again, output of this sector estimated by the preceeding described methods was compared with output estimated by utilizing information derived from S.C.B. and U. S. Business Tax Returns, as was done later in deriving that of the trade sectors. Personal interviews were performed and secondary sources were collected for necessary adjustment and reconciliation. Our survey covered firms employing about 20 thousand people or 3/10 of total sectoral employment. Allocation of this sector's output is almost entirely based on the survey's distribution.

E. Wholesale Trade Service Row Vector

1. Estimation of Gross Margin

In order to analyze the importance of service added through transactions, not gross sales but rather "gross margin" or "mark-up" should be taken into account in this sector. Except in a few special cases, wholesalers do not change the nature of the goods they sell. For the sake of simplicity, expenditures made for inventory are ignored in order to make the table comparable to the latest 1963 state table constructed by Harmston.

The Census of Business, published by the U. S. Department of Commerce, is the basic source of sales and payrolls. In the State Section, information on sales and payrolls of all covered wholesale establishments in the state

and in the S.M.S.A. were obtained. Since Monroe County had no employment figure for this sector in 1967, as stated by County Business Patterns, the S.M.S.A. data therefore represent the regional data. Annual average rates of change of sales and payrolls were calculated for the periods 1948-54, 1954-58, and 1958-63, for the state and the region, as well. An arithmetic mean of three periods was computed and used as an overall annual rate of change to arrive at estimates for 1967's sales and payrolls.

U. S. Business Tax Returns, published by the U. S. Treasury Department, Internal Revenue Service, is the basic source for business receipts, cost of goods sold, net profit and depreciations, etc. Nevertheless, this information is available only for sole proprietorships and partnerships for the state. No similar information from corporations is disclosed for the state; and for the region we have no information for any type of business. The latest data is that of fiscal year 1963.

Information for the state from business of two types, sole prorpietorship and partnership, were added for 1963 under categories mentioned perviously. In a like manner, we added relevant data for the entire nation. Ratios of the state to the nation under those categories were applied to the business of corporations, so that we have adequate information for the state's corporations. In doing so, we have assumed that in relation to the nation as a whole, the state's corporation receipts, net profit, depreciation, etc., are percentage-wise exactly the same as those of the state's sum of the other two types of business to the national figures. This assumption is, of course, vulnerable. However, in order to have relatively reliable information on such a category as net profit of business, this may be the cheaper and faster method.

Business receipts in the state obtained from U. S. Business Tax Returns certainly differ from sales obtained from Census of Business through previously stated procedures. Nonetheless, a ratio of business receipts to net profit was found from the former source. By multiplying the sales of all establishments in the sector, estimated from the latter source, by the ratio, we get a state net profit approximation for 1963 for the sector.

Payroll for 1963, estimated through using Census of Business and estimated net profit for the state, are generally considered to be the "gross margin" for Missouri wholesale trade service. They were contrasted to the "gross margin" for the sector revealed by Harmston's 1963 Missouri table. Since Harmston's estimates were secured from other detailed information with special authority given by government agencies, his estimates may be considered more accurate for the state. Comparing his household earnings to our estimated payroll and his non-household gross margin to our estimated net profits for the wholesale trade service, our estimates are rather low. The quotients of the two are 1.17 and 1.61 respectively.

Assuming that the state's ratio of net profit to sales is applicable to the region and also assuming that this ratio remained constant from 1963 to 1967, the regional net profit of 1967 was computed. It is simply the product of the ratio and the regional sales estimated from the Census of Business. Our regional figures for net profit and payrolls were as underestimated as those of our state figures. Regional payrolls and net profits for the sector were therefore adjusted and expanded 1.17 and 1.61 times respectively. The sum of these two values, $870 million, was the "gross margin" estimated for the sector in the region in 1967.

In accordance with our survey, gross margin was distributed across the board in the wholesale service row. Another assumption used here is that the amount of gross margin extracted from each sector is proportional to the value sold to the sector. Regional sales distribution from this sector in 1967 was, in general, similar to that of state sales distribution in 1963.

2. Reliability Check

Most assumptions employed in the process of obtaining regional data of sales, payrolls and net profit for this sector were checked. Various attempts have been made to test these hypotheses. The ratios of total sales in the region to those in the state have been computed. They show that more than half of the state sales were from the region, and the ratios are quite constant ranging from 54.7% in 1958 to 53.5% in 1963. Similar payroll ratios were found; they ranged from 53.3% to 58.8% between 1948 and 1963. Again, ratios of regional employment to state employment in the sector were also quite constant, around 53%. Those ratios were obtained from different government documents, such as Census of Business, County Business Patterns, and Employment Earnings and Statistics. Viewing the dominant state shares of sales, payrolls, and employment in the region and the consistency of the shares over time, our approaches of employing state ratio of net profit to sales, to estimate regional net profit, and of assuming the ratio to be constant over a period of four years are likely acceptable.

A check against our sample survey was also performed. Sector sales estimated from samples were very close to those estimated from employing annual average rate change published in Census of Business. The difference

is about 1%. This fact indicates that we are warranted in allocating gross margin according to sample sales distribution with some necessary adjustments on a prior ground.

Household earnings from this sector secured from utilizing both the Survey of Current Business and Employment and Earnings Statistics were $482.8 million, $57.2 million more than estimated salaries and wages spent by this sector. This difference is the margin for other earnings by household, which is undoubtedly acceptable for a sector with total value of sales close to $8 billion.

F. Retail Trade Service Row Vector

1. Estimation of Gross Margin

As explained in the wholesale sector section we have to use "mark-up" or "gross margin," not "gross sales," in this sector in order to study the service provided by it through its transactions. Except for some special cases like restaurants and cafeterias, retailers generally do not change the nature of the commodities they purchased for retailing. Analysis of their service provided is somewhat similar to the analysis of value added in manufacturing industries. Here again, we ignore the expenditures on inventory adjustment.

The methods adopted here for estimating sectoral gross margin are the same as those used in the wholesale sector. The means of three periods' (1948-54, 1954-58, 1958-63) average annual rates of change in sales and payrolls were computed from the Census of Business, for the St. Louis S.M.S.A. and the State of Missouri. Using this averaged time series adjusted annual rate, we estimated sales and payrolls for 1967.

The ratios of net profit to business receipts, of depreciation to business receipts, to cost of goods sold, etc., can be calculated from U. S. Business Tax Returns for 1963 for the state, with the assumptions specified in the wholesale sector.

By multiplying the first ratio by the 1963 sales, stated in the Census of Business, the product gives us estimated net profit in 1963.

Comparing 1963 state net profit of this sector to non-household gross margin of this sector in Harmston's state I/O Table of 1963, a ratio of adjustment is discovered for net profit. By the same token, comparing payroll to household gross margin we obtain a ratio of adjustment for wages and salaries. By applying the state ratios to the St. Louis S.M.S.A. and adjusting them through employment difference, we arrived at estimates of net profit, and wages and salaries for the region. The sum of these two amounts is the regional gross margin for this sector.

The gross margin is then allocated horizontally across the board to each sector according to sampled sales distribution.

2. Reliability Check

The Survey of Current Business published data on earnings by broad industrial sources. Wholesale and retail trade produced about $1,091 million in earnings in 1966 for the St. Louis S.M.S.A., or $1,099 million for the region. With an annual rate of growth of 2.6%, the earnings in these two sectors in the region should be about $1,128 million one year later.

Our estimates of 1967 payrolls for wholesale and retail trades in the region were, respectively, $426 million and $702 million. Their sum is exactly the same figure as released by S.C.B. with one year

adjustment, as mentioned in the preceeding paragraph. However, the estimates were obtained separately by utilizing the combined public sources of the Census of Business and U. S. Business Tax Returns, with the method of estimation described previously. This may be an evidence of precision of estimation, if not coincidence.

The 1967 distribution of gross margin in this sector was generally similar (though with exceptional sectors) to that of 1955 (S.M.S.A. table) and 1963 (state table). However, dollar amounts differ from sector, time and place from each other. A characteristic of retail sales is that they do not necessarily have a constant pattern traceable over time. The extent to which sales to other individual sectors fluctuate, depends on the price, technology, number of suppliers and demanders, as well as the nature of the commodity transacted. As an example, dollar value paid by Sector 31 for retail service in 1967 was less than in 1955; $554 thousand against $985 thousand. On the contrary, Sector 37 paid eleven times more for the service in 1967 than it paid in 1955, while the entire retail sector increased only 1.4 times over the period. Without further investigation, no plausible reasons can be given for the fluctuation. In other words, checking against the sales distribution in this sector is unlikely to be effective, and may be unnecessary.

Checking against the reliability of the distribution was undertaken by all means possible. One of the reasons for the payment increase of eleven times in sector 37, the transportation equipment sector, was the increased consumption of automobile and related services which have higher income and population elasticity of demand. Out of total retail sale of $3.4 billion

(our estimate based on the Census of Business was $3.3 billion), automotive sales reported by Sales Management Magazine were about 19% or $644 million. Even a small percentage increase in automotive consumption, expectedly payment for the sales service, would amount to a very large increase due to its large dollar amount of sales.

G. Finance, Insurance and Real Estate Row Vector

The finance sector consists of groups such as the Federal Reserve Bank, commercial and stock savings banks, mutual savings banks, savings and loan associations and security and commodity brokers, dealers and exchanges and services. The output for the Federal Reserve Bank is the difference between total current operating expenditures and the Federal Reserve currency expenses; for other banks, the output is the total annual operating earnings estimated from the "Annual Reports of Earnings and Dividends." For savings and loan associations, current operating income can be estimated from the Federal Home and Loan Bank Board publication, Combined Financial Statement. Total operating revenues for security and commodity brokers, dealers, exchanges and services can be estimated by multiplying the regional sector employment by the ratio of output per employee, derived from the survey.

The insurance sector is constituted of two carriers, life and non-life insurance. The latter category includes carriers engaged in accident, hospital, health, fire, casualty, title and other activities. The output of life insurance is the value of total operating and underwriting costs, inclusive of profits. Profit margin can be estimated from the information given by the Internal Revenue Service and total underwriting and operating costs, exclusive of profit, can be estimated by utilizing earned premiums,

reported by the State Insurance Commissioners. The assumption underlying this method is that perfect correlation exists between underwriting costs and premiums through the whole industry. Total premiums earned by the non-life insurance carriers in the region are considered as the value of output in the sector.

Real estate and rental activities are sometimes considered as services through which transactions take place. The output of this sector is sometimes defined as annual revenues.

Various approaches have been used in order to obtain total production of this finance, insurance and real estate sector (F.I.R.E.). Due to the fact that this sector covers too many units of dissimilar nature, to arrive at a figure of high reliability would be very costly, if not impossible. However, efforts were still made to obtain the total sectoral output through methods described previously.

Another method used to arrive at a comparable figure of sector output is a method similar to that used in deriving the wholesale trade service sector. Earnings from this F.I.R.E. group in 1966 were reported by the Department of Commerce in the Survey of Current Business. Adjusting this figure by population and price indexes, we arrived at a comparable figure for the 1967 payroll. Net profit and other related transactions for this sector in 1963 can be estimated partly through utilizing U. S. Business Tax Returns and the Census of Business for the state. The weight of adjustment can be obtained in comparison with the 1963 state table. The second element of this sector's control total or profit margin and relevant transactions for the region is thus estimated by retaining assumptions employed in the wholesale trade sector.

Allocation of this sector's service and other sales is based mainly on our 1967 survey.

H. Business, Personal and Other Services Row Vector

Significant contributions have been made to the economic growth of this region by the service sector. It has been playing an important role in the regional economy and providing an increasing quantity and variety of service to people and businesses both inside and outside the region.

This sector consists of various types of services such as hotel, motel, recreation; higher education, research and development; professional and health; repairing, etc. Obviously, establishments categorized in this sector are numerous and their sizes in terms of employment range from one person to thousands of people. It is practically impossible to sample all types of services because of the diversity of services provided the constraint of budget, and limited time. However, about one-eighth of total employment in this sector was covered in the returned survey.

The value of output of the service sector was defined as total earned business receipts, including taxes collected and paid by establishments, but excluding investment dividends, rentals and other non-business receipts. The Census of Business gives sales of all establishments of selected services. From County Business Patterns we have employment figures for those selected services. Sales per employee for each service can be obtained for every year in which the Census of Business is published. The rates of change of sales per employee over time have been computed to estimate sales per employee for 1967. Multiplying this figure by estimated regional employment in 1967 and adjusting it for price changes, the estimation of total sales in 1967 for each service is hence furnished for comparative purposes.

The methods employed in the wholesale trade sector for estimating sectoral profit margin and business receipts were used once again here to estimate 1963 Missouri business receipts and profit margin of the services sector. Finally, similar estimations for the services sector in the region for 1967 were estimated by converting state figures, through state to region ratios of employment. Adjustments were made in reference to the 1963 state table for business receipts and profit margin.

The third approach used to arrive at values of output of various service sectors was to multiply total regional employment in each sector by revenue per employee in that related sector, which was derived from the 1967 field survey.

Finally, the value of output for various service sectors, $1,483 million, was estimated for the region in 1967. For the State of Missouri, the value totalled $1,881 million in 1963. According to the surveyed distribution of services provided for various industries, the value of output was proportionally allocated.

Chapter Four: The Structure Of Regional Economy

I. General Concept of Sector

One of the purposes of this study, as indicated previously, is to analyze the economic structure of this region throughout its product flows of goods and services among sectors. All two-digit industries in the region have been aggregated into sectors under the assumption of invariability of repercussions among industries in the same sector.[1] From these sectors, the products are transacted to two categories of demanders: endogenous and exogenous. The exogenous part includes state and federal governments, investment, export plus net inventory changes. They are income determining factors whose change directly effects a region's income and is rather independently determined by forces outside the model. Conventionally they are categorized in the final demand segment. The endogenous part includes all local industries with their activities dependent on the level of regional income. Therefore, they are income determined and are responsive to any change in the final demand.

Two other final demanders, household and local government, are always treated as exogenous sectors in a national study where the economy is somewhat more closed (or is engaged in less trading with outsiders) than a small region in the nation. In a regional or interregional model, these sectors are sometimes considered to be meaningfully related to changes in endogenous industrial sectors.[2] Furthermore, Harmston has argued that: "In an open trading economy, where changes are generated quite largely outside the geographic area, their roles

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[1] For the criteria of aggregation, see Isamu Yamada, Theory and Application of Interindustry Analysis, Kinokuniya Bookstore Co., Ltd., Tokyo, Japan, 1961, pp. 16-49.

[2] Walter Isard, op. cit., p. 337, supported this argument for household sector.

as producers outweigh their roles as consumers. While they certainly represent final consumers of goods, they also represent very important parts of the production process. If one considers human beings as producers, he can think of their consumption as an input which makes them function. If they are considered as consumers, their purchases are a part of final demand."[3]

In order to determine the impact of these sectors on the regional economy, they are treated alternately as both exogenous and endogenous sectors in this study. This makes available the analyses of multipliers due to interaction of industrial sectors alone, as well as those due to interaction when endogenous final demand sectors are also taken into consideration in the production process. Induced income change, in addition to direct and indirect income changes, can thus be introduced and analyzed by varying the assumptions of consumption function employed in the model.

II. Regional Market Structure

Table IV-1, the Interindustry Gross Flow Table, shows all market transactions of goods and services from industrial and endogenous final demand sectors named at left, to industrial and all final demand sectors named at the top of the table, inside and outside the region for 1967. The gross value of these transactions were estimated to be $26,643,629,000; excluding household and local government, it amounted to $17,977,348,000. Certainly these values are much higher than the regional gross product, since output of one firm frequently is used as input by another firm. Therefore, the value of transactions includes double counted values of intermediate products. Corresponding figures for the St. Louis S.M.S.A. in 1955 were $14,354,039,000 and $9,746,676,000, and for the

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[3]Floyd K. Harmston, op. cit., p. 71 and p. 11.

TABLE IV-1

INTERINDUSTRY GROSS FLOW TABLE, ST. LOUIS REGION, 1967

(Thousands of Dollars)

For the distribution of output of an industry, read across the row for that industry.
For the composition of input to an industry, read down the column for that industry.

ST. LOUIS INDUSTRY → SALES / PURCHASES	Food, Tobacco & Kindred Prods.	Textiles & Apparel	Lumber & Furniture	Paper & Printing	Chemicals, Petroluem & Rubber Prods.	Leather Products	Stone, Clay & Glass	Primary Metals	Fabricated Metals	Machinery (except electrical)	Electrical Machinery	Transportation Equipment	Ordinance & Miscellaneous Manufacturing	Agriculture	Mining	Construction	Transportation, Communication & Utilities	Wholesale Trade Services	Retail Trade Services	Finance, Insurance & Real Estate	Business, Personal & Other Services	Subtotal:	FINAL DEMAND SECTORS: Endogenous: Household	Endogenous: Local Government	Exogenous: State Government	Exogenous: Federal Government	Exogenous: Sales to Local Investment	Exogenous: Export: Foreign Countries	Exogenous: Export: Rest Of U.S.	Net Inventory Adjustment	TOTAL PRODUCTION	Corresponding Standard Industrial Classification Code
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24								
1. Food, Tobacco & Kindred Products	64,989	140	--	128	1,603	192	80	--	--	--	--	77	385	26	--	--	1,090	4,328	28,477	--	2,565	104,080	414,515	7,712	3,123	21,026	--	8,209	723,907	+ 1,385	1,283,957	20-21
2. Textiles & Apparel	4,500	4,729	438	153	345	57	39	191	168	100	26	536	96	230	19	287	326	177	290	64	634	13,405	85,604	742	--	930	--	106	91,260	+ 5,400	197,447	22-23
3. Lumber & Furniture	245	141	3,250	1,154	160	28	57	13	63	144	204	246	52	--	2	1,081	114	100	1,324	672	1,095	10,145	13,577	3,487	--	5,524	--	--	51,346	- 189	83,890	24-25
4. Paper & Printing	18,455	1,062	658	35,262	9,348	961	1,467	517	456	405	304	5,311	4,403	101	162	3,086	7,234	4,047	51,299	7,639	19,022	171,199	36,663	6,380	968	1,394	--	1,785	287,515	+ 789	506,893	26-27
5. Chemicals, Petroleum & Rubber	5,935	317	158	1,583	83,995	1,899	285	617	760	332	949	4,589	470	63	95	479	174	8,389	4,748	32	1,899	117,768	88,924	2,107	1,334	69,503	--	35,474	1,267,616	+ 1,422	1,584,148	28-29-30
6. Leather Products	--	96	21	--	16	203	--	--	--	14	13	118	53	--	--	--	--	2,704	3,441	22	--	6,701	10,854	--	--	1,191	--	--	88,113	--	106,859	31
7. Stone, Clay & Glass	65,653	--	--	--	17,798	--	3,072	--	214	--	1,715	214	2,573	--	--	22,301	--	4,289	1,501	--	--	119,330	3,056	343	15	1,123	--	7,337	88,694	--	219,898	32
8. Primary Metals	--	--	3,371	--	1,296	--	--	10,069	15,730	13,656	20,310	52,548	17,804	43	346	26,447	3,544	864	--	--	1,469	167,497	--	908	--	1,122	--	3,242	681,505	- 12,916	851,358	33
9. Fabricated Metals	45,495	21	1,112	585	6,810	639	5	2,714	13,867	9,684	9,950	12,824	6,704	--	905	64,540	589	3,991	--	--	2,660	183,095	1,769	1,993	--	2,243	2,470	4,476	336,054	+ 3,575	535,675	34
10. Machinery (Except Electrical)	1,092	262	328	830	481	44	66	721	2,246	10,573	8,388	19,922	1,267	35	428	7,864	1,267	1,442	118	39	354	57,767	568	1,295	--	32	22,671	16,205	338,349	+ 2,596	439,483	35
11. Electrical Machinery	853	155	78	426	1,083	39	271	581	388	504	2,791	5,466	275	--	--	--	3,024	6,318	2,054	116	1,938	26,360	3,538	875	77	62,557	1,427	3,409	289,398	- 1,284	386,357	36
12. Transportation Equipment	--	--	--	84	--	--	--	619	2,076	672	83	42,234	989	--	--	--	1,834	8,823	152	--	3,375	60,941	86,619	3,852	3,839	1,827,725	80,574	80,173	1,375,834	+ 36,047	3,555,604	37
13. Ordinance & Miscellaneous Manufacturing	899	171	257	492	1,113	493	278	642	749	663	471	26,024	1,402	12	14	5,254	798	1,023	646	214	3,792	45,407	9,166	4,502	1,767	102,590	2,646	8,714	118,881	--	293,673	19-38-39
14. Agriculture	53,575	501	956	293	22	--	--	--	--	--	--	--	263	7,858	--	--	--	--	--	--	--	63,468	3,184	--	--	180	--	21,259		+ 200	88,291	01-09
15. Mining	1,223	7	62	3	2,746	2	7,302	13,787	--	--	66	406	59	2,252	1,910	33,352	2,149	--	--	--	--	65,326	--	--	--	--	936	12,407		--	78,669	10-14
16. Construction	1,623	53	--	261	481	--	241	18	168	130	16	1,124	423	--	--	75	6,627	170	1,084	17,383	1,876	32,353	3,700	97,996	82,696	87,226	618,411	--		--	922,382	15-17
17. Transportation, Communication & Utilities	58,388	7,706	8,743	19,265	56,610	3,557	20,599	25,193	10,670	6,669	7,706	43,717	8,595	2,519	12,448	16,449	155,010	17,042	30,379	54,238	58,091	623,594	627,496	21,045	21,130	5,452	6,817	176,392		--	1,481,926	40-49
18. Wholesale Trade Services	17,083	1,084	2,859	4,180	6,809	3,460	5,607	9,539	9,060	6,449	5,966	9,574	7,411	117	360	6,314	9,115	5,005	45,300	4,398	31,784	191,474	41,648	4,052	3,089	1,201	--	628,763		--	870,227	50-51
19. Retail Trade Services	5,655	9,888	4,188	2,499	3,647	554	932	2,026	6,768	9,470	878	18,980	1,013	108	324	37,513	13,171	6,295	32,731	17,683	33,245	207,568	1,012,595	1,506	3,012	1,133	1,878	123,170		--	1,350,862	52-59
20. Finance, Insurance & Real Estate	27,666	6,461	2,485	10,271	9,774	6,958	8,946	10,768	12,756	4,473	2,816	17,395	19,383	1,491	2,651	21,040	36,612	40,091	40,920	149,267	34,127	466,351	957,099	17,586	14,340	167,514	--	33,785		--	1,656,675	60-67
21. Business, Personal & Other Services	15,302	2,097	1,036	4,180	7,063	2,531	2,182	5,553	3,827	3,813	2,671	11,465	4,379	264	859	21,378	29,853	15,167	10,189	54,762	55,599	254,170	837,972	18,056	35,544	184,896	2,576	150,060		--	1,483,274	70-89
22. Subtotal	388,631	34,891	30,000	81,649	211,200	21,617	51,429	83,568	79,966	67,751	65,323	272,770	77,999	15,119	20,523	267,460	272,531	130,265	254,653	307,129	253,525											
23. Household	343,298	80,754	39,111	233,542	309,241	47,824	96,511	285,886	197,244	210,468	150,244	716,953	102,702	42,153	35,753	505,315	663,998	482,794	804,886	597,881	922,000		42,368	353,725	129,642	670,933	--	--			8,065,226	
24. Local Government	8,534	1,036	811	1,892	4,483	225	231	3,467	1,307	2,005	1,487	3,447	1,802	447	153	3,199	28,584	8,090	14,847	68,400	70,880		261,587	--	101,322	12,819	--	--			601,055	93
25. Other Exogeneous Payments	116,113	16,524	3,325	95,199	406,318	10,476	30,014	188,869	132,545	64,610	55,619	457,695	60,631	16,181	18,307	18,197	317,177	116,795	124,504	470,932	79,615		2,712,235	--	--	--	--	--				
26. Total Inside Region	856,576	133,205	73,247	412,282	931,242	80,142	178,185	561,790	411,062	344,834	272,673	1,450,865	243,134	73,900	74,736	794,171	1,282,290	737,944	1,198,890	1,444,342	1,326,020		7,254,737	548,162	401,898	3,228,314	740,406	7,063,438				
27. Total Outside Region -- Imports	427,381	64,242	10,643	94,411	652,906	26,717	41,713	289,568	124,613	94,649	113,684	2,104,739	50,539	14,391	3,933	128,211	199,636	132,283	151,972	212,333	157,254		810,489	52,893	7,035	58,026	73,192	- 6,097,453				
28. VALUE OF PRODUCTION	1,283,957	197,447	83,890	506,693	1,584,148	106,859	219,898	851,358	535,675	439,483	386,357	3,555,604	293,673	88,291	78,669	922,382	1,481,926	870,227	1,350,862	1,656,675	1,483,274		8,065,226	601,055							26,643,629	TOTAL

TABLE IV-2

Interindustrial Output: Distribution: Direct Sales Per Dollar Of Output

St. Louis Region, 1967

	Food, Tobacco & Kindred Products	Textiles & Apparel	Lumber & Furniture	Paper & Printing	Chemicals, Petroleum & Rubber Products	Leather Products	Stone, Clay & Glass	Primary Metals	Fabricated Metals	Machinery (except electrical)	Electrical Machinery	Transportation Equipment	Miscellaneous Manufacturing	Agriculture	Mining	Construction	Transportation, Communication & Utilities	Wholesale Trade Services	Retail Trade Services	Finance, Insurance & Real Estate	Business, Personal & Other Services	Subtotal	Household	Local Government	State Government	Federal Government	Sales to Local Investment	Foreign Countries	Rest of U.S.	Net Inventory Adjustment	TOTAL PRODUCTION	Corresponding Standard Industrial Classification Code
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21											
1. Food, Tobacco and Kindred Products	.0506161	.0001090	--	.0000996	.0012484	.0000495	.0000623	--	--	--	--	.0000599	.0002998	.0000202	--	--	.0008489	.0033708	.0221790	--	.0019977	.0809612	.3228418	.0060064	.0024323	.0163759	--	.0063935	.5638093	.0010786	1.0000000	20-21
2. Textiles and Apparel	.0227909	.0239507	.0022183	.0007748	.0017473	.0002886	.0001975	.0009673	.0008508	.0005064	.0001316	.0027146	.0004862	.0011648	.0000962	.0014535	.0016510	.0008964	.0014687	.0003241	.0032109	.0678906	.4335543	.0037579	--	.0047101	--	.0005368	.4621999	.0273491	1.0000000	22-23
3. Lumber and Furniture	.0029204	.0016807	.0387412	.0137561	.0019072	.0003337	.0006794	.0001549	.0007509	.0017165	.0024317	.0029324	.0006198	--	.0000238	.0128859	.0013589	.0011920	.0157825	.0080104	.0130528	.1209312	.1618428	.0413663	--	.0658481	--	--	.6120634	-.0022569	1.0000000	24-25
4. Paper and Printing	.0364224	.0029959	.0012982	.0695924	.0184490	.0018966	.0028952	.0010203	.0008999	.0007993	.0005999	.0104816	.0086896	.0001993	.0003197	.0060904	.0142768	.0079870	.1012427	.0150761	.0375414	.3378741	.0723574	.0129914	.0019104	.0027511	--	.0035228	.5674343	.0015571	1.0000000	26-27
5. Chemicals, Petroleum and Rubber Products	.0037464	.0002001	.0000997	.0009992	.0530221	.0011987	.0001799	.0003894	.0004797	.0002095	.0005990	.0028968	.0002966	.0000397	.0000599	.0003023	.0001098	.0052955	.0029971	.0000202	.0011987	.0743403	.0561336	.0013300	.0008420	.0438740	--	.0223931	.8001878	.0008976	1.0000000	28-29-30
6. Leather Products	--	.0009983	.0001965	--	.0001497	.0001996	--	--	--	.0001310	.0001216	.0011042	.0004959	--	--	--	--	.0253043	.0322013	.0002058	--	.0627082	.1015731	--	--	.0111455	--	--	.8245725	--	1.0000000	31
7. Stone, Clay and Glass	.2985611	--	--	--	.0809375	--	.0139701	--	.0009731	--	.0027990	.0009731	.0117008	--	--	--	--	.0195044	.0068258	--	--	.5426601	.0138973	.0015598	.0000682	.0051069	--	--	.4033415	--	1.0000000	32
8. Primary Metals	--	--	.0039595	--	.0015222	--	--	.0118269	.0184763	.0160402	.0238560	.0617225	.0209124	.0000505	--	.1014152	--	.0139503	--	--	--	.1967402	--	.0010665	--	.0013178	--	.0038080	.8122376	-.0151710	1.0000000	33
9. Fabricated Metals	.0849302	.0000392	.0020758	.0010920	.0127129	.0011928	.0000093	.0050665	.0258869	.0180781	.0185746	.0239398	.0125150	--	.0016894	.1204835	.0010995	.0074504	--	--	.0049656	.3418015	.0033023	.0037205	--	.0041872	.0046110	.0083558	.6273468	.0066738	1.0000000	34
10. Machinery (except electrical)	.0024847	.0005961	.0007463	.0018885	.0010944	.0001001	.0001501	.0016405	.0051105	.0240578	.0190860	.0453305	.0028829	.0000796	.0009738	.0178937	.0028829	.0032811	.0002684	.0000887	.0018054	.1314420	.0012924	.0029466	--	.0000728	.0515856	.0368728	.7698796	.0059069	1.0000000	35
11. Electrical Machinery	.0022078	.0004011	.0002018	.0011026	.0028031	.0001009	.0007014	.0015037	.0010042	.0013044	.0072238	.0141475	.0007117	--	--	--	.0078269	.0163527	.0053163	.0003002	.0050160	.0682261	.0091573	.0028674	.0001992	.1619150	.0036934	.0088234	.7490429	-.0033233	1.0000000	36
12. Transportation Equipment	--	--	.0000236	--	--	--	--	.0001740	.0005838	.0001889	.0000233	.0118781	.0002781	--	--	--	.0005158	.0024814	.0000427	--	.0009492	.0171389	.0243612	.0010833	.0010797	.5140406	.0226611	.0225483	.3869480	.0101380	1.0000000	37
13. Miscellaneous Manufacturing	.0030612	.0005822	.0008751	.0016753	.0037899	.0016787	.0009466	.0021861	.0025504	.0022576	.0016038	.0586155	.0047740	.0000408	.0000476	.0178906	.0027173	.0034834	.0021997	.0007287	.0129123	.1546168	.0312115	.0153299	.0060168	.3493341	.0090100	.0296724	.4048073	--	1.0000000	19-38-39
14. Agriculture	.6268002	.0056744	.0108278	.0033185	.0002491	--	--	--	--	--	--	--	.0890011	.0000000	--	--	.0029787	--	--	--	--	.7188498	.0360625	--	--	--	--	--	.2407833	.0022652	1.0000000	01-09
15. Mining	.0155461	.0000889	.0007881	.0000381	.0349057	.0000254	.0928192	.1752532	--	.0001409	.0000173	.0012185	.0004585	--	--	.0000813	.0071846	.0001843	.0011752	.0194962	.0020338	.0351146	.0040113	.1062423	.0896548	.0945660	.6704499	--	--	.1577114	--	1.0000000	10-14
16. Construction	.0017595	.0000574	--	.0002829	.0005214	--	.0002612	.0000195	.0001821	--	--	--	--	--	--	--	.1046003	.0114988	.0204996	.0365996	.0391996	.4207983	.4234327	.0142011	.0142584	.0036789	.0046000	--	.1190228	--	1.0000000	15-17
17. Transportation, Communication and Utilities	.0394000	.0051999	.0058997	.0129999	.0382002	.0024002	.0139001	.0170001	.0072000	.0045002	.0051999	.0295001	.0074107	.0068556	.0110017	.0085161	.0001344	.0004136	.0072555	.0104742	.0057513	.0520553	.0050538	.0365238	.2200265	.0478587	.0046562	.0035496	.0013800	--	.7225275	--	1.0000000	50-51
18. Wholesale Trade Services	.0196305	.0012456	.0032853	.0048033	.0078243	.0039759	.0064431	.0109615	.0104110	.0070103	.0006499	.0140502	.0007498	.0000799	.0002398	.0277696	.0026999	.0016997	.0104999	.0116999	.0009899	.0016001	.0127001	.0220996	.0241996	.0247000	.0901003	.0205996	.2814967	.5777228	.0106152	.0086558	.1011145	--	.0203932	--	1.0000000	52-59
19. Retail Trade Services	.0041862	.0073197	.0031002	.0018499	.0026997	.0004101	.0006899	.0014997	.0050101	.0074107	.0068556	.0110017	.0085161	.0001344	.0004136	.0072555	.0104742	.0057513	.0520553	.0050538	.0391996	.4207983	.4234327	.0142011	.0142584	.0036789	.0046000	--	.1190228	--	1.0000000	40-49
20. Finance, Insurance and Real Estate	.0166997	.0038999	.0014999	.0061997	.0058997	.0041999	.0053999	.0064997	.0076997	.0026999	.0016997	.0104999	.0016001	.0127001	.0220996	.0241996	.0247000	.0901003	.0205996	.2814967	.5777228	.0106152	.0086558	.1011145	--	.0203932	--	--	.1011680	--	1.0000000	60-67
21. Business, Personal and Other Services	.0103163	.0031137	.0006984	.0028180	.0047617	.0017063	.0014710	.0037437	.0025801	.0025706	.0018007	.0077295	.0029522	.0001779	.0005791	.0144127	.0201264	.0102253	.0068692	.0369196	.0374839	.1713563	.5649475	.0121730	.0239632	.1246539	.0077366	--	--	--	1.0000000	70-89
22. Household	.0425652	.0100126	.0048493	.0289566	.0383425	.0059296	.0119663	.0354467	.0244561	.0260957	.0186286	.0888943	.0127339	.0052265	.0043329	.0626535	.0823285	.0598611	.0997970	.0741307	.1143179	--	.0052531	.0438580	.0160741	.0831883	--	--	--	--	1.0000000	
23. Local Government	.0141983	.0017236	.0013492	.0031477	.0074585	.0003743	.0003843	.0057681	.0021745	.0033358	.0024739	.0057349	.0029980	.0007436	.0002545	.0053223	.0475563	.0134596	.0247015	.1137999	.1179259	--	.4352130	--	.1685735	.0213274	--	--	--	--	1.0000000	93

Note: Each entry shows, direct sales per dollar of output from St. Louis region industry named at left to industry named at top.
Individual items may not horizontally add to total due to rounding.

State of Missouri in 1963 were $35,025,580,000 and $24,136,966,000, respectively.[4]

In contrast to product sale (output) distribution, read across the rows, purchasing relationship (input) is recorded by reading down the columns. For example, the sector of food, tobacco and kindred products sold $64,989,000 of output to itself, $140,000 to textiles and apparel sector, $128,000 to paper and printing and so forth in 1967. In addition to its self-consumption of $64,989,000, this sector purchased $4,500,000 from the textiles and apparel sector and $245,000 from lumber and furniture, $18,455,000 from paper and printing and so forth as its inputs to produce its output of $1,283,957,000 in that year. This sector sold $104,080,000 to all non-final demand sectors in the region (row 1, column 22). Conversely, it purchased its input of $856,576,000 from all endogenous sectors in the region and $427,381,000 from industries outside the region. Empty cells represent either no value or values of less than $1,000.

Since exogenous final demand sectors are not considered in the regional production process of this model, they will be discussed first. All endogenous sectors, including household and local government will be dealt with in the sub-section thereafter.

A. Exogenous Final Demand Sectors

Exported manufacturing products from the region in 1967 were separated according to their destinations: to foreign countries and to the rest of the U. S. This kind of separation by destination was not given for exports from non-manufacturing sectors because of the lack of reliable information (see

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[4]Data for St. Louis S.M.S.A. were calculated from Werner Hirsch's transactions table which was sent to the author by him; data for the State of Missouri were estimated by Floyd K. Harmston, op. cit., p. 8.

export column). Estimated value of total export in 1967 from this region was $7,063,438,000.

Values of input purchased from markets outside the region for each sector are also shown in this table in the row of imports. The region as a whole in 1967 purchased $6,097,453,000 from outside markets. It is deliberately shown as a negative figure in the column of exports so that the value of net export can be easily observed: $965,985,000. In other words this region enjoyed a favorable trade in terms of balance of payments; net gain from trading with outside markets was about 14% of total exports. In Hirsch's model of 1955, the trade sector in the St. Louis S.M.S.A. was specified as balanced and the value estimated was $3,995,460,000 or a little less than 57% of the total export in 1967. Export from the State of Missouri in 1963 was shown in Harmston's table and the amount was estimated to be $8,526,947,000.[5]

The dependence on outside trade for a region consisting of a smaller area is usually expected to be heavier relative to a larger area, such as a state. The St. Louis region in 1967 exported about 27% of its total production of all endogenous sectors while the State of Missouri exported only 24% in 1963.

Entries under the federal government column represent the government expenditure pattern in the region, including transfer payments less social security contributions in 1967. Apparently this region's economy relies heavily on federal government's expenditure, which provides for this region an amount of basic income of $3.3 billion or more than 12% of total regional production of all endogenous sectors. This amount is about five times greater than the amount that federal government spent in the S.M.S.A. in 1955 and 34% more than that spent

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[5]For the purpose of convenience, any reference hereafter made to the St. Louis S.M.S.A. for 1955 and the State of Missouri for 1963 is referring respectively to the studies of Hirsch and Harmston, unless otherwise specified.

in the State of Missouri in 1963.

In an economic base model, all regional income is a multiple of its basic income on which all economic activities are generated. The increase in federal expenditures in both absolute amount and in its rate of change in this region certainly enlarges the community's base for growth. Consequently, economic activities in the region resulted in growth in both dimensions. The federal government spent more than half of its total expenditure in the region on transportation equipment purchases and contracts. Among both manufacturing and non-manufacturing industrial sectors, the transportation equipment sector was the largest sector in the region in terms of production. More than half of its total output was delivered to the federal government partly through contracts with the Defense Department. Twelve years ago this sector ranked next to several other sectors in terms of output produced, and the federal government spent as little as $620,000 in this sector. It is quite obvious from these facts that this region has depended considerably on federal defense procurements for its growth. The other extreme is also conceivable, i.e., how this region may be affected when disarmament policies are put into effect.

State government in 1967 contributed $409 million of basic income to this region. Twelve years ago its contribution was $141 million. Households and local governments together received more than 56% of the total in 1967 and in 1955, more than 83%.

Sales to local investment amounted to $887 million for the region in 1967. The corresponding figure shown in the Hirsch table under gross private capital formation for 1955 was higher, $915 million, and in the Harmston table for the state in 1963 was lower, $772 million. The difference between the three figures can be explained in part by the decision to change the stock of capital goods and the exact amount of those capital goods consumed during the production process

within a particular year. The decision to change and the amount consumed certainly fluctuate year by year, depending, to a large degree, on market expectations of both demanders for and suppliers of both capital and consumer goods.

Net inventory adjustment reflects the difference between goods currently produced but stocked and those previously produced but currently sold, for a particular year. Net inventory adjustment is conventionally presented in an I/O table to reveal actual production for that year. Negative signs indicate inventory depletion and positive signs, accumulation. The net inventory adjustment column in the regional table includes, for purposes of simplicity, raw materials and semi-finished goods adjustment as well.

B. Industrial Sectors

Regional market transaction among sectors shown in Table IV-1, as previously described, developed initially from the surveyed result of employment distribution within each sector. The matrix of employment distribution was constructed by methods explained in Chapter III. By multiplying respectively employment distribution ratios across the row by total production of each sector, estimated as also explained in Chapter II, the resulting matrix with proper adjustments and modification is the Interindustrial Gross Flow Table, Table IV-1.

Table IV-2, Interindustrial Output Distribution: Direct Sales Per Dollar of Output, is a by-product of Table IV-1. It portrays the relative importance, not the absolute amount, of sales from sectors named at left to sectors named at top. This matrix should be identical to that of the employment distribution matrix for sectors in which no price and other adjustment on a priori grounds were performed.

A market transaction relationship, constructed on the basis of weighted employment distribution, is generally agreeable for the region in 1967 for at least two reasons. First, the assumption of identical labor productivity

among firms within a sector is accepted at even as narrow a critical region as 1% for all sectors tested. Secondly, the simple correlation coefficients between employment and output for many sectors are higher than 0.9 (see Chapter III, sector D-3 and the following subsections for details).

1. Manufacturing Sectors

a. Food, Tobacco and Kindred Products

Interindustrial sales in the St. Louis region from this sector were negligible and made primarily to other firms within this sector and to the retail trade sector. These two sectors accounted for, respectively, 5% and 2% of total sales in 1967. Some negligible amount was sold to several other non-final demand sectors as their inputs.

Out of the total production from this sector in 1967, 91.9% was delivered to sectors other than regional industries. The region exported about 57% of its total food, tobacco and kindred products; 0.6% to foreign countries and the remainder to the rest of the U. S. A.

There were none, or a very small amount of sales to lumber and furniture, metal, machinery, mining, construction, and finance, insurance and real estate sectors. In other words, the preceeding sectors did not take any, or only took a very insignificant amount of this sector's output as their intermediate inputs.

Exports from this sector in 1955 were about 65% of its total product. This percentage declined to 56% in 1967, only slightly above the percentage of the state's exported food, tobacco and kindred products in 1963.

In 1955, household consumption accounted for 26% of this sector's output, and in 1967, 32%. Both these percentages for the region are higher than that consumption in the State of Missouri in 1963, i.e., 23%. Increased population with increased domestic household consumption, combined with increased purchases by various levels of government, resulted partly in the decline in exporting of this sector's products, in spite of the fact that this sector's output has increased 14% since 1955.

Total shipment in this sector, obtained from Annual Survey of Manufactures (A.S.M.), before price adjustment was $1,225 million. By aggregating surveyed firms by their employment and dollar value of sales, we arrived at an estimate of average sales per employee in this sector for 1967. Total sales in the sector was obtained by multiplying the average sales by the sector's employment. Total sales so obtained were $1,120 million or 92% of total shipment. This provides a percentage weight for the other estimates.

Our survey showed that 46.8% of the materials of production were purchased outside the region. The A.S.M. revealed the figure for cost of materials. By taking the product of these two figures weighted by the previously mentioned weight, we found the amount of total imports purchased by this sector. As exports for this sector declined, imports also declined. In 1955, imported materials amounted to 54% of total output; only 33.3% was attributed to imported materials in 1967. In other words, exports declined less than did imports. The region has still enjoyed a net gain in widening this economic base for growth.

b. Textile and Apparel

The survey showed that 93% of total sales of this sector were to the final demand sectors. Export to the rest of the U. S. accounted for 46% and regional households consumed 43% of the 1967 total output. The corresponding figure shown in Hirsch's 1955 study was 59%. The decline in importance of exports may be attributed to an increase in regional consumption, resulting from an increase in population and in government purchases.

The sector's sales to the final demand sectors in 1963 in the state was, according to Harmston's estimation, 91%, as compared to 93% in the St. Louis region in 1967. These figures indicate that interindustrial sales in both the region and the state have been very small.

Various checks against the reliability of the model have been painstakingly performed for sectors wherever comparable information is available. For instance, based upon the sampled firms which gave dollar amount of sales, costs and other relevant information, dollar amounts of sales inside and outside the region were computed. By the same method expenditures on variable and fixed costs of products sold were also aggregated. Multiplying the aforementioned firm information by the employment ratio of the sector to the firms, we arrive at related dollar figures for the entire sector.

The estimate of dollar sales through aggregation for this sector is quite close to estimated value of output. In addition, percentage distribution of sales and purchases inside and outside the region, obtained from employment aggregation of all samples, is almost identical to that obtained by dollar aggregation of some particular firms.

For instance, from our survey, imported materials amounted to 60% of total cost in dollar terms while the figure calculated from the employment ratio was 59%. In other words, those firms with dollar value specified could represent the whole sector. The sector's import and inventory changes were, therefore, obtained through the same method.

c. Lumber and Furniture

In this sector the furniture industry has become more important than lumber in terms of value of output. As expected, furniture export from this region has been increased partly as a result of large refrigerator producing firms' increase in production. Exports from this sector in 1955 were only 30% of total sales, but accounted for 61% in 1967. In 1963, the corresponding figure for the state was 52%.

Domestic consumption by regional residents was also high for this sector; 16% of total output. Percentage-wise the amount purchased by households from this sector ranked third among all manufacturing sectors, second only to the two mentioned in the preceeding subsections a and b. The above is true due to the nature of their products, i.e., consumer goods. However, in dollar terms, household consumption of lumber and furniture in 1967 indicated a decline as compared to that of 1955: $15.5 million against $13.6 million. Furniture is a durable consumer good. The consumption of this good shows less of a trend pattern than other non-durable goods when population increases. The whole state's consumption of lumber and furniture products in 1963 was only $24.7 million.

Sales from this sector to the leather industry show a great decline, from $3 million in 1955 to $28 thousand in 1967. Sales to rubber, plastic and leather industries together, in 1963, in the state, were also low, totalling only $777 thousand. The decline in the leather industry itself in the region, as indicated by a 6.1% decline in employment from 1955 to 1967, could be one reason for decreased input of this sector's product. One of the other reasons may be import substitution. The leather industry imported only 36% of its total input in 1955, most of the input was domestically supplied. But in 1967, more than 90% of total input used in the leather industry was obtained from outside suppliers (see Table IV-3).

Out of all sectors employed in this study, the lumber and furniture sector ranked third in terms of useful sample employment coverage; 68% of total sectoral employment was utilized (see Table II-1). From their information this sector's sales distribution was, therefore, well established.

d. Paper and Printing

Total output of this sector in 1967 showed an increase of about 90% over that of 1955. This sector, in view of its growth of product, has indicated some advantageous factors of growth existing in the region.

Sales distribution of this sector, obtained from our survey, was very satisfactory when compared with the state sales distribution in 1963. That is to say, percent distributions in the region and in the state by sector were quite similar, or that inter-industrial demand for the product in the state does not differ from that in the region.

Sales to retail trade constituted 10% of total output. The other important consuming sectors, in order of importance, were the sector

itself (7%), services and the food, tobacco and kindred products sectors. Two-thirds of this sector's output was delivered to the final demand sectors with exports amounting to 57%.

In 1955, this sector imported 33.8% of the materials used in production and exported 31.5% of its total output. In 1967, the corresponding figures rose to 38% and 57%, respectively. The states of Missouri and Washington were both net exporters of paper and printing products in 1963. More than half of their outputs were sold outside the states.[6] However, this sector in the region exported proportionally more and imported less than the State of Missouri in 1963. All of the above illustrate that this sector has been an important net exporting sector in the region.

Many of the surveyed firms in this sector reported dollar values in the questionnaire. By taking each firm's information as an independent observation, a model, by regressing output on employment was tested. Simple correlation (r) between these two variables for 1967 was higher than 0.98. The coefficient of determination (R^2) was about 0.97; in other words, employment and output in this sector, viewed through surveyed observations, was almost perfectly correlated, and about 97% of total variation in output would be explained by the variations in employment. In addition, coefficients relating employment to output for this sector are highly significant; the student t value is much greater with respect to existing degrees of freedom than the required value to warrant a judgment of a critical region less than 0.01. In terms of statistical application the use of this model is

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[6] P. J. Bourque, E. J. Chambers, J. S. Chiu, F. L. Denman, B. Dowdle, G. G. Gordon, M. Thomas, C. M. Tiebout and E. E. Weeks: The Washington Interindustry Study for 1963, Center for Urban and Regional Studies, U. of Washington, Seattle, Washington, 1966. Any reference made to

justified. The regression model for this sector, with the employment of the classic least squares technique and assumptions of normality of variable distribution and independence of explanatory variable and disturbance terms, is estimated as follows:

$$E = a + b X + e = 29.23 + 0.03437X$$

$$R^2 = 0.97, \quad t = 12.99$$

In the equation, X represents sectoral output ($1,000), E, employment and e, the disturbance or residual term; a is the constant and b the coefficient for the explanatory variable. Given the level of output for this sector, by utilizing the estimated constant and coefficient, we can estimate the employment for the sector. Assuming labor is the only variable in production, the coefficient multiplied by $\bar{X}/\bar{E}$ is the elasticity of labor with respect to output, i.e., it represents the percentage change in employment (in man-year) divided by the percentage change in output ($1,000).

e. Chemical, Petroleum and Rubber Products

This sector is one of the large exporting sectors in the region. Its sales outside the region have been constantly increasing. The region exported 78% of the total chemical, petroleum and rubber products in 1955, while in 1967 it exported 82.3% for the State of Missouri, the figure in 1963 was 58%. In spite of this, the sector's imported materials were less in 1967 than in 1955, both in

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Washington State hereafter is refering to this table and will not be footnoted for the purpose of simplification.

absolute amount and in percentage of total output. This indicates a favorable balance of trade, in this region, with the rest of the world, resulting from the operation of the industries in this sector. The resulting affect is even more worth discussing in terms of regional economic growth, because this sector produced as much total output as $1.6 billion in 1967, next only to the transportation equipment sector, among all manufacturing sectors.

Chemical industries in this region produced an overwhelming share or total output in this sector. Export of chemical products was even higher than the sectoral average: more than 90% of chemical products were shipped to outside customers.

The sector itself was the largest consumer in the region, absorbing $36.5 million or 5.3% of total output. About 0.5% of total sectoral output was sold to wholesalers; following these two sectors in importance were the retail trade, food, tobacco and kindred products, and transportation equipment sectors. The finance, insurance and real estate sectors purchased the least amount; only $32 thousand from this sector.

The 1967 survey was the basic source from which sales coefficients were computed. Sales as distributed in the Table showed no close relationship to either the 1963 state table or the S.M.S.A. table of 1955. In checking the reliability of these sales coefficients, two additional surveys were considered: (1) the 1965 I/O survey for chemical industries; and (2) the 1967 survey conducted by the Chemical Industrial Council of Greater St. Louis. As expected, the results differ in detail from survey to survey. To the extent of

sectoral aggregation, they did show many similarities. For instance, chemical products exported to outside regions were about 80% in the 1965 I/O survey and 91% in the C.I.C. survey; however, our survey shows that 82% of the total output of the whole sector (with petroleum and rubber products included), was exported.

The first phenomenon, that of having a higher percentage of export can be explained by sectoral specialization of labor in this region, as compared with the state. Output per employee of this sector for the State of Missouri was about $25,000 in 1963 and, for the region it was $65,000 in 1967, or $64,000 in terms of 1965 constant dollar (see Table IV-6). The regional figure was higher than the state even in 1955; it was $40,000. The second phenomenon, that of having a dissimilar sales distribution as compared with the state as well as the region twelve years ago, can be explained by changes in technology and prices: input and import substitutions certainly occurred in the region between the period, and their effects were so influential upon this sector such that the sales distribution of this sector within the region has been continuously changing.

Employment coverage of usable samples for this sector was the highest among all sectors surveyed in 1967, i.e., 73% of total employment (see Table II-1). The classic least squares model for this sector was also estimated on the basis of all observations with dollar information. An even higher correlation coefficient (relating output and employment) than that of the paper and printing sector was found. Additionally, the coefficient estimated for the relationship between the two variables was even statistically more significant. In other words, labor productivity among firms was extremely homogenous in this sector in 1967 and the assumption used in this study, that employment distri-

bution secured from the sample survey reflects output flows in the same sector, is theoretically as well as empirically attainable. The estimated equation is the following:

$$E = a + b X + e = 161.879 + 0.00582 X$$

$$R^2 = 0.98 \qquad t = 31.08$$

f. Leather and Leather Products

Sales to leather and leather products in 1967 were still predominantly outside the region, though the share of exports has declined since 1955: 90% against 82%, respectively. The decline may be attributed in part to the increased household consumption in the region through either or both population increase and change in propensity to consume leather products, due to rising per capita income. Domestic expenditures on leather and leather products by regional residents have increased more than four times since 1955, $10,854,000 against $2,422,000.

Sales to retail and wholesale trades were about 2.5% and 3.2% of total output. Sales inside the region to the leather and leather products sector were also negligible, i.e., 2%.

Although we sampled firms which together employed 43% of total employees in this sector in 1967, only a few firms disclosed dollar values in the questionnaire. Both the 1965 and 1967 surveys for this sector are relatively less informative than for other sectors aforementioned, with respect to dollar disclosures.

However, sales distribution in the region in 1967 was checked against Washington's 1963 table and Hirsch's 1955 table. The St. Louis survey distribution is more similar to Washington's than to Hirsch's.

No special adjustments were made for two reasons. First, domestic sales in this sector, except those to household, were of a negligible amount. Secondly, Hirsch's sectoral output in 1955 was much larger than total shipments from this sector, according to the 1965 A.S.M., i.e., $148 million against $95 million. The estimated shipment in 1967 based on employment and adjusted for price change was $101 million, still smaller than Hirsch's 1955 figure. This is partially attributed to an employment difference in this sector for the two years. Employment in 1955 totalled 14,900, as used by Hirsch, and 8,215 in 1967, as stated by the County Business Patterns. A large decline in total shipments and a time period of twelve years may certainly alter greatly the domestic sales pattern.

g. Stone, Clay and Glass

We have sampled a number of firms which together account for about 47% of total employment in this sector. The sales distribution from this sector in 1967 was quite uncomplicated. This sector exported about 43% of their total output and sold about 30% to the domestic food and related industries. An overwhelming share of this sector's sales was from the glass industry.

Sales to construction were about 10%. The construction sector was the second most important domestic demander for this sector's product. The next was chemical, petroleum and rubber products; a little more than 8%. Among all manufacturing sectors this sector had the largest domestic sales to all manufacturing industries. As manufacturing inputs this sector sold over 54% of its total output domestically in 1967.

Final demand sectors absorbed about 46% of total sales of this sector, the most important of which was export, absorbing 44%. In comparison, the State of Missouri exported 50% of total stone, clay and glass output in 1963 and all consumption by the final demand sectors accounted for only 51% in the same year. A relative low regional figure of export in this sector may be interpreted as a substitution effect: a high domestic consumption, as stated in the previous paragraph, substituted for export. A much higher interindustrial consumption was found in Washington State; all final demand sectors accounted for only 20% of total sales in 1963, one half of which was exported.

h. Primary Metals

Our survey covered firms with almost 60% of the total employment in this sector. In addition, questionnaires returned to us from these firms were filled out in detail. Therefore, the sales distribution for this sector resulting from our survey could be considered highly representative.

This sector has also been one of the important exporting sectors in the region. Of the total output produced in 1967, 81% was shipped to outside areas. Transportation equipment industries are the largest purchasers of this sector's output in the region, buying more than 6% of the total output. Construction and electrical machinery are the other two industries which consumed more than $20 million worth of primary metals produced domestically.

Compared with Hirsch's table, the value of export from this sector increased about 130% between 1955 and 1967. Relatively speaking, more than 81% of total production in 1967 was exported, as against 70%

in 1955. In terms of domestic consumption, the transportation equipment industries absorbed more than double the amount they purchased in 1955, $52,548,000 against $20,445,000.

Since many large firms in this sector are located on the Illinois side of the St. Louis region, regional sales vary greatly in dollar terms from Missouri State sales of primary metals. The state's imported primary metals could be exported from the region. Consequently, dollar transactions between this sector and other sectors in the region were much larger than those in the state. This result can also be indicated by the employment difference: the state's employment in the sector in 1967 was about 55% of that of the region, 14,462 persons as compared to 26,157 persons.

Although there were great differences in amount of sales, the sales distribution or percentages from this sector to other manufacturing industries in the region, in 1967, do not differ too much from that of the state in 1963. For instance, the rankings of the state domestic sales were transportation equipment first, machinery second and electrical machinery third, which is identical to the St. Louis rankings.

1. Fabricated Metals

Regional sales in this sector were dominated by several sectors. The construction sector purchased more than 12% of total output in 1967. Next in importance were the sectors of food and tobacco and kindred products, fabricated metals itself and transportation equipment.

A relatively high regional sale was observed in this sector. Inter-industrial use constituted more than 34% of the total output of this sector, only next to stone, clay and class sector among all manufacturing industries.

As a result of the high percentage of regional consumption, exports from this sector were low; only 64%. However, regional export in 1967 amounted to $341 million or 4 times as much as in 1955. The region exported proportionally more fabricated metals in 1967 than did the state in 1963 (59%), and also earned more money outside in 1967 than the entire state earned in 1963 through exported products ($327 million).

As exports from the region have been increasing over the period of 1955 to 1967, the precentage of total materials imported from outside as input for this sector has also shown an increase. Imported materials in 1967 were about one and one half times greater than those in 1955. Nevertheless, the increase in exports, both in absolute and relative terms, was much larger than the increase in imported materials. This sector, again shows itself to have been of great importance as a net gaining sector in enlarging the regional economic base for growth.

The simple correlation coefficient between output and employment among firms in this sector was also high for 1967. Following is the result empirically estimated for this sector, from more than forty observations. Similar interpretations applied to the sectors of paper and printing and, chemical, petroleum and rubber products are also applicable to this sector.

$$E = a + b\ X + e = 26.018 + 0.02953\ X$$

$$R^2 = 0.82 \qquad t = 13.64$$

j. Machinery (Except Electrical)

Inter-industrial sales of this sector as inputs to other regional industries in 1967 were lower than in 1955, 13% against 41%. The transportation sector was the largest domestic consumer of machinery produced in the region, about 5%. Self-consumption was also relatively high, the sector itself ranking second in domestic consumption of machinery. In other words, the multiplier for this sector is high, because the multiplier is the inverse of one minus the coefficient. Sales to local investment was high in this sector. It ranked first in all manufacturing industries. Percentage wise, the sale was even greater than the amount purchased by the transportation equipment sector.

With constant percentage sales (5% to 6%) to local industries as investment goods, the percentage of exportation of total output rose considerably. In 1967, about 81% of the total machinery products in the region were purchased by outside demanders, 4% of which were shipped to foreign countries; the corresponding figure in 1955 was a little less than one half and in 1963 was 77%, for the state.

In comparison with sales from this sector in other years, a considerable change in the interregional consumption pattern has been observed. The fluctuation in selling percentages may have resulted from the nature of durable goods and from changes in the technology of production, as well.

k. Electrical Machinery

More than 90% of this sector's total output was purchased by firms and persons outside the region and by the federal government. Literally, on a percentage basis, regional consumption of domestically produced electrical machinery has been declining since 1955. The factors responsible for this decline may be largely the effects of import and export substitution. Regional consumption of electrical machinery has certainly increased, as has the export of electrical machinery from the region.

Federal government became a very important purchaser of this sector's product. The products bought by the federal government from this region in 1955 amounted to $2.5 million. In 1967, $62.6 million of electrical machinery or 16% of total sectoral output was sold to the federal government through the expansion and development of aerospace programs. In comparison, total sales to the federal government from the state in 1963 were only $0.8 million. This fact indicates the importance and influence of government expenditures on a region's industrial growth, as well as its structure. For the sake of simplification, more than 16% of the electrical industrial capacity in this region would be idle or would have to be altered in production, if there were no aerospace program and government procurements in 1967.

Regional sales distribution was a little more complicated in 1967 than in 1955. There were no sales from this sector to retail trade in 1955; but retail trade absorbed more than one percent of its total output, in 1967. Large regional sales, other than those to retail trade, went to transportation equipment, household and transportation, communication and utility sectors, respectively. However, less than 10% of the total output of this sector was sold within the region in 1967.

1. Transportation Equipment

This sector had the least number of firms in 1967 among manufacturing industries. On the other hand, sales from this sector amounted to $3.5 billion, which indicated not only that this sector was the largest sector in manufacturing, in terms of annual sales, but also that this sector sold more than one-third of total regional shipments in all manufacturing industries in that year. In terms of employment, this sector employed less than one-fourth of the total manufacturing employees, about 22.7% or 68,577 persons (see Table II-1).

Sales distribution of this sector was more skewed toward exogenous purchases than any other manufacturing sector. More than 95% of its total output was demanded outside the region. In contrast, regional interindustrial consumption accounted for less than 2% of the total output. Among all final demand sectors, the federal government purchased more than $1.8 billion of the transportation equipment produced in the region. It is a well known fact that one regional firm has accepted the overwhelming share of federal government contracts, especially defense projects.

Exports to sectors other than the federal government were also high; over 40%. More than 2% were sold outside the U. S. A.

These figures illustrate at least five typical phenomena of the sector.

(1) Transportation equipment has been a dominating sector among all manufacturing industries in this region, in terms of manufacturing output.

(2) Labor in the transportation equipment sector has been relatively more productive than other manufacturing sectors, as far as the output/employee ratio is concerned (see Table IV-6).

(3) The size of firms in this sector has been relatively large in viewing the output/firm ratio.

(4) Compared with the state employment in manufacturing industries, the localization quotient for this sector was 1.19 for 1967. This means that the St. Louis region has more transportation equipment industries concentrated than the state as a whole, i.e., 19% higher.[7]

(5) Federal government contracts, particularly under defense projects, with this sector resulted in very large amounts of procurement from this sector. The impact of military expenditures upon this sector's production and, in turn, upon the regional economy has tended to be critical. Because this sector relies heavily on export and federal government purchases and because of the nature of specialization of this sector, it deserves some special attention.

In order to plan for a sound regional economy, we ought to know this sector's ability to sustain its growth and its vulnerability to hindered growth.

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[7]For method of calculating location quotient, see Walter Isard Methods of Regional Analysis: An Introduction to Regional Science, the M.I.T. Press, Cambridge, Mass., 1960, pp. 249-251.

Total output of this sector increased more than four times since 1955, though employment of this sector has expanded only two-fold. Exported output in 1955 was about 60%, which was approximately 20% higher than the corresponding percentage for 1967. However, together with sales to the federal government, the 1967 figure for exports was more than 95%, the counterpart figure for 1955 was only slightly more than 60%. The relevant figures for the state in 1963 were 62% for export and 21% for federal government purchases; together they constituted 83% of the state's total output.

If some of the components of the final demand, export and federal government expenditure, are considered to be the basis on which a region's economic growth depends vitally, this sector has provided a large basis for regional economic growth in St. Louis. However, there is a less optimistic side to the picture: this sector also imported a large volume of materials and goods and services as its input in production. They constituted more than 59% of total output. In other words, only about 36% of the total output of this sector sold outside the region was produced or added in the region. (Imported materials and others in 1955 constituted only 49% of that year's total output.)

An increase in inventory by this sector was indicated in 1967. This may be partly attributed to optimistic business expectations and/or a relatively full utilization of the industrial capacity.

For checking purposes, financial reports of a few large firms and other relevant data have been collected and examined. Statistical estimates obtained separately from our 1965 and 1967 surveys have

been compared. Our surveys cover firms as large as McDonnell-Douglas with employment in St. Louis of about 42,000 and some firms so small as to employ only 10 persons. Total sampled firms together employed about 73% of the sector's employees. Therefore, estimates based upon an employment distribution should be considered quite reliable.

In supporting this argument, the regression technique was once again adopted to test the relevant hypotheses. The results were highly significant in terms of both the correlation coefficient and the coefficient for the independent (or explanatory) variable. They are shown as follows:[8]

$$E = a + bX + e = 19.42 + 0.05522X$$

$$R^2 = 0.96 \qquad t = 18.81$$

m. Ordinance and Miscellaneous Manufacturing

No value of shipments for ordinance and accessories (S.I.C. 19) was disclosed for the region in 1965. The shipments in 1967 from the region were replaced by the value of total federal government expenditures contracted to the producers in these industries in 1967, under defense projects. To this value, estimated shipments of S.I.C. 38 and 39 from A.S.M. were added to arrive at a sectoral control total.

Federal government was an extremely important purchaser of this sector's product in 1967. More than one third or 35% of the total shipments of this sector was delivered to the federal government.

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[8]For a statistical interpretation, the reader is referred to sectors of paper and printing and chemical, petroleum and rubber products in this section.

The major items which the government purchased from this sector were ordinance and accessories and ammunition and rockets, under the contracts of the Department of Defense. This sector is second only to the transportation equipment sector in its portion of sales to the federal government. Purchases from the federal government certainly impose an overwhelming influence on the sector's operation.

Exports in this sector became less important in 1967 than they were in other sectors due to federal government contracts. Percentage-wise, they dropped to about 43% of total shipments in the sector, with 3% shipped to foreign countries.

Transportation equipment producing industries were the third largest purchaser. Together they accounted for more than 12% of total shipment, of which two-thirds were products by one firm and consumed by another firm in the region.

Household and construction were two other important consuming sectors. As with other manufacturing industries, this sector sold only a very small amount to the agricultural and mining sectors.

A comparison of this sector's sales between 1967 and 1955 is difficult to perform, because Hirsch's table included some other sectors, such as S.I.C. 32 in this sector. Total shipments under this category in 1955 were estimated by Hirsch to be $441 million which is one and a half times the amount we estimated for 1967.

Total shipments that we estimated for 1967 by using A.S.M.'s information are, nevertheless, somehow comparable to Harmston's estimates for the state for 1963. However, due to the component

difference in sales, the distribution would be expected to be different for the two years under consideration. For instance, federal government in 1963 purchased only $1.9 million from the state's miscellaneous manufacturing industries while its expenditures on ammunition, rocket and other military components, in the region, were as high as $80 million.

Although outside purchases of this sector's output were very high, the sector itself did not import, percentage-wise, as much material as other export-oriented sectors, such as chemical, petroleum and rubber products and food, tobacco and kindred products. About one half of the material it used for production was provided by regional sources.

2. Non-Manufacturing Sectors

a. Agriculture

Except for the mining and lumber and furniture industries, the agriculture sector produced the least in 1967 among all regional industries, only $88 million or less than 0.5% of total industrial production.

Sales distribution of this sector was simple. More than three-fifths or 61% of its total production was delivered to the food, tobacco and kindred products sector. Self-consumption ranked second in domestic consumption, about 9%. Household consumption of 4% ranked third. Therefore, more than three-fourths of this sector's production was purchased locally and export became relatively less important to the manufacturing industries.

b. Mining

Although there was no strong trend line in output for each county in the region, the total output for the region showed, as pointed out in Chapter III, a steady increase of approximately 7% since 1963. Despite the rather high rate of output growth, the output of this sector still ranked last among all sectors in the region in 1967.

Regional consumption of mineral products by other industries was extremely high; about 83% of total mining output was consumed by local industries, the figure was the highest among industries in the region. More than one half of this local consumption was delivered to the construction sector; the primary metal sector absorbed another one-fourth, and the stone, clay and glass sector,

one half of the remainder.

Export of mineral products only accounted for 16% of total output because of the high percentage of local consumption.

c. Construction

Since most construction projects were classified as investment (67%), interindustrial consumption in this sector amounted to very little, i.e., 3.5% of the total production, or the least among all sectors in the region.

Interindustrial consumption includes depreciation, repairing and maintenance allowances for all kinds of buildings and other constructions. The finance, insurance and real estate sector was the sector to which local construction sold more than one half of its value collected from all non-final demand sectors.

Governments continued to be the major customers of this sector. In 1955, all levels of government purchased 19% of total sectoral output; local, state and the federal government accounted individually for 4%, 5% and 10%. However, the counterparts in 1967 accounted for 11%, 9% and 9% respectively. With the increase in the importance of government relative to other sectors and in total output ($922.4 million as compared to $723.9 million or about 30% increase over 1955), it is conceivable that this sector's output has been depending substantially on public expenditures. For the State of Missouri in 1963, public expenditures on construction constituted more than 12% of total construction production.

As expected from the nature of investment and partly from consumption of durable goods, sales of construction production differ from year to year and place to place. Annually, its fluctuation in production depends considerably upon business expectation and geographically, by and large, upon public policy and decision, in addition to business expectations for expansion.

d. Transportation, Communication and Utilities

Households were principle consumers of this sector's products and services. As expected, household consumption of this sector's goods and services in 1967, particularly the service part, accounted for 42% of total sectoral output; percentage-wise it was about 11% higher than the state figure for 1963. An increase in household consumption certainly substituted in part for export. In 1955, the region exported about 36% of the total output in terms of both goods and services; in 1967, export contributed only 12% to the total. Self consumption of this sector was much higher in 1967 than in 1955. These results are explained by the fact that tertiary industries have been growing as per capita income in the region is increasing and the region is becoming more urbanized. Nevertheless, the rate of growth for the industries has tended to be be greater than that of income in the urban areas.

Sectors which, respectively, consumed more than 3% of total output of this sector in 1967 were food, tobacco and kindred products; chemical, petroleum and rubber; finance, insurance and real estate; and business and personal services.

e. Wholesale Trade Services

A dominant share of gross margin was applied to outside customers as they were seen in both state and regional tables. In 1967, 72% of gross margin in the region was paid by outside demanders and, in 1963, the state figure was 59%. This difference may be attributed in part, to the increased transactions of this sector with sectors within the state but outside the regional boundary.

An inversed relationship in the sales pattern in the region was observed for sales to household and the rest of the world (export). In 1955, about 62% of the total sector's service was extended to household and 9% to exportation;[8] the counterparts in 1967 were 5% and 72%, respectively. This implies some considerable reversion of both output and input structures between the two sectors.

Retail trade service and business and personal and other service sectors were the dominant domestic customers of this sector, in addition to the household sector; respectively, more than 5% and about 4% of total gross margin were extracted from them.

f. Retail Trade Service

Households apparently were the dominant customers of this sector. About 75% of retail service was provided for households.

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[8]The wholesale and retail trades were not studied separately in Hirsch's table. For purposes of simplification, all entries across the trade sector are divided equally into wholesale and retail sectors.

It was 2% higher than the region's 1955 figure and 4% higher than the state's 1963 figure. Increased population may be the major explanation for the difference in the region, and urban and rural consumption differences explain the state's lower figure.

Construction, personal and business, and the sector itself were three major demanders for retail service among all sectors except household and export. Percentage-wise, these sectors had higher shares in 1967 than their state counterparts had in 1963. This result may be used to support the argument that service consumption in the urbanized areas is always higher than in other areas.

As indicated in Chapter III, the 1967 distribution of gross margin in this sector was generally similar to that of 1955 and 1963 studies. Nevertheless, dollar transactions still differ from each other, between sector, time and place. This sector is always characterized as not having a constant sales pattern traceable over time. Sales to other individual sectors fluctuate to an extent depending on the variations in price, technological change, number of suppliers and demanders, as well as the nature of the commodity transacted.

g. Finance, Insurance and Real Estate

This sector produced the greatest output among all non-manufacturing sectors in 1967. Its sales of $1,657 million represented the second largest sector in the region, surpassed only by the transportation equipment sector. It contributed more than 9% of total industrial sales. However, in terms of employment this sector accounted for only about 6% of total

industrial employment (see Table III-2). Production per employee in this sector, ceteris paribus, was therefore relatively higher than all non-manufacturing sectors (see Table IV-6).

Most of the services and sales of this sector were provided for, or delivered to households and to the federal government. Together they demanded about 68% of total output in 1967. Although the figure is 2% lower than the counterpart in 1955 for the S.M.S.A., its dollar amount of sales in 1967 amounted to $1.1 billion which was two times that of 1955. Comparing this to the state figure for 1963, the regional figure in 1967 was 6% higher.

Self-consumption of this sector's service and product was also high, about 9% of total sales. The four remaining related service sectors consumed about 2%. Total consumption by all manufacturing sectors accounted for less than 9% of the total sales. In comparison, manufacturing industries demanded even less service and products from this sector in 1955, only about 6%. In other words, manufacturing industries technically require very little of this sector's output in their production functions.

This sector is, by and large, a service oriented sector. Depending on the education, training and experience, people engaged in activities of this sector differ substantially from one another as far as their individual productivity is concerned, holding other things constant. Therefore, the extent to which the variation in output can be explained by the variation in labor input, would be expected to be lower than the manufacturing industries. This was observed from our regression results performed for the sector's information in 1967. The value of R^2 dropped to 0.71, even though the coefficient estimated for labor input was still statistically very significant. The results are:

$$E = a + b\ X + e = 170.93 + 0.00517\ X$$

$$R^2 = 0.71 \qquad t = 4.12$$

h. Business, Personal and Other Services

When a region becomes more and more urbanized, manufacturing industries may be expected to grow at a decreasing rate or even become stagnant in terms of employment and/or value added. On the contrary, economic activities in the services sector would then grow generally at an increasing rate. Its role in the urban economy becomes more and more important over time.

"The first major finding," said Fuchs in his recently published The Service Economy, "plainly in evidence but not sufficiently appreciated, is that the balance of employment in the United States has shifted dramatically (and probably inevitably) in favor of the service industries."[9] Regional employment in this sector increased about 60% in 1967 as compared to 1955. Among all industrial sectors, this sector employed 17% of total employment in 1967; in 1955 the figure was 11%. In addition to employment shift, various services constituted 8.3% of total output produced by all sectors excluding households and local government, in 1967. The corresponding figure was only 5.5% in 1955. This increase was more pronounced because total sale of this sector was more than doubled from 1955 to 1967, regardless of price changes.

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[9]Victor R. Fuchs, The Service Economy, National Bureau of Economic Research, New York, 1968, p. 2.

Households in this sector were the dominant demander, as they were in sectors such as transportation, communication and utilities; finance, insurance and real estate. They demanded more than one half of the total services supplied in the region. Services consumed by manufacturing industries were rather small. Only the food, tobacco and kindred products sector purchased more than 1% of total services in 1967, each of the remaining manufacturing sectors purchased less than that amount.

Services rendered to customers outside the region showed a considerable decline in 1967 as compared to 1955; 19% against 10%. This may be attributed substantially to a government consumption increase, as well as increased household consumption. The federal government purchased only 2% of total services in 1955, whereas it demanded 12% in 1967. Research and development and other educational, professional and health services are major sources from which government money is attracted to the region.

As pointed out in the preceeding sector, due to the problem of sector aggregation and labor diversity within the sector, the degree to which the variation in output can be explained, holding other things constant, by the variation in labor input, declined considerably in this sector. Only 20% of the change in output was empirically observed to have been related to changes in labor input among firms in this sector, regardless of the significance of the estimated coefficient for total output. They are estimated as follows:

$$E = a + b X + e = 427.47 + 0.02237X$$

$$R^2 = 0.204 \quad t = 2.263$$

C. Endogenous Final Demand Sectors

Wages and salaries, property earnings, transfer payments less social security, and other earnings are given by sectors in the household row.

The greatest amount of household earnings was accrued to personal, business and other services sector, more than $0.9 billion or 11% of total household earnings. Retail trade and transportation equipment sectors ranked second and third, rendering about 10% and 9% of total earnings respectively.

The distribution of this row vector by sector in 1967 was generally similar to that of 1955 for the S.M.S.A. and that of 1963 for the State of Missouri. Non-manufacturing sectors, except for mining, were more important than manufacturing sectors in terms of household earnings, because labor input was not as dominant a productive factor in the latter, as in the former, sectors. Labor input has been continuously substituted by automation due to technical innovations and inventions in manufacturing industries. In turn, tertiary industries such as services, transportation, communication and utilities and finance, insurance and real estate sectors have been constantly creating jobs. The transition of the labor input from the primary to secondary and eventually to tertiary industries has been viewed as an unavoidable outcome in the process of industrialization and urbanization. The employment distribution columns in Table IV-4 support this kind of argument.

The row of local government in Table IV-1 represents estimated revenues by sector for all levels of local government. Obviously, most local government revenues are levied from individuals. Out of total local government revenues, 54% was collected from households in 1955, and 44% in 1967, despite the fact that the dollar amount of revenue collected from household was more

than doubled between the two years. Increased revenues from other sources, especially from state and federal government, explain the percentage decline. Increased population and per capita income, as well as the change in tax structure and rate, resulted in the increase in revenue volume.

Revenues collected from other sectors were proportionally quite stable over the two years. No manufacturing sector, except food, tobacco and kindred products, contributed more than 1% of the total revenue in 1967. The heavy burden, next to household, was borne by services and finance, insurance and real estate sectors; each of them paid more than 11% of the total revenues.

From the increased revenues and expenditures of local governments, it has been conceived that local governments deserve at least as much attention as do state and federal governments in the economic planning for regional development and growth.[10] This is one of the reasons that local government has been included in this study as another endogenous sector to analyze the interactions between this and other selected sectors.

III. Industrial Input Structure

Table IV-3, Input Coefficients: Direct Purchases Per Dollar Of Output, indicates the factor composition relation of each sector named at top to produce every dollar of output of that sector. Conventionally, all entries in any column reflect "technical composition" in the production of output of that column sector. In other words, each column's composition in terms of respective unit of measurement of various input factors, outlines the production function of that

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[10] Interested reader is referred to Modernizing Local Government, Committee for Economic Development, New York, 1966.

TABLE IV-3

Input Coefficients: Direct Purchases Per Dollar Of Output

St. Louis Region, 1967

	Food, Tobacco & Kindred Products	Textiles & Apparel	Lumber & Furniture	Paper & Printing	Chemicals, Petroleum & Rubber Products	Leather Products	Stone, Clay & Glass	Primary Metals	Fabricated Metals	Machinery (except electrical)	Electrical Machinery	Transportation Equipment	Miscellaneous Manufacturing	Agriculture	Mining	Construction	Transportation, Communication & Utilities	Wholesale Trade Services	Retail Trade Services	Finance, Insurance & Real Estate	Business, Personal & Other Services	Household	Local Government	Corresponding Standard Industrial Classification Code
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
1. Food, Tobacco & Kindred Products	.0506161	.0007090	--	.0002526	.0010119	.0017967	.0003638	--	--	--	--	.0000216	.0013109	.0002944	--	--	.0007355	.0049734	.0210806	--	.0017292	.0513953	.0128307	20-21
2. Textiles & Apparel	.0035047	.0239507	.0052211	.0003019	.0002177	.0005334	.0001773	.0002243	.0003136	.0002275	.0000672	.0001507	.0003268	.0026050	.0002415	.0003111	.0002199	.0002033	.0002146	.0000386	.0004274	.0106139	.0012344	22-23
3. Lumber & Furniture	.0001908	.0007141	.0387412	.0022775	.0001010	.0002620	.0002592	.0000152	.0001176	.0003276	.0005280	.0000691	.0001770	--	.0000254	.0011719	.0000769	.0001149	.0009801	.0004056	.0007382	.0016833	.0058014	24-25
4. Paper & Printing	.0143735	.0053786	.0078436	.0695924	.0059009	.0089931	.0066712	.0006072	.0008512	.0009215	.0007868	.0014936	.0149928	.0011439	.0020592	.0033456	.0048814	.0046505	.0379750	.0046110	.0128243	.0045458	.0106146	26-27
5. Chemicals, Petroleum & Rubber Products	.0046224	.0016054	.0018834	.0031241	.0530221	.0177710	.0012960	.0007247	.0014187	.0007554	.0024562	.0012906	.0016004	.0007135	.0012075	.0005193	.0001174	.0096400	.0035147	.0000193	.0012802	.0110256	.0035055	28-29-30
6. Leather Products	--	.0004862	.0002503	--	.0000101	.0018996	--	--	--	.0000318	.0000336	.0000331	.0001804	--	--	--	--	.0031072	.0025472	.0000132	--	.0013457	--	31
7. Stone, Clay & Glass	.0511333	--	--	--	.0112350	--	.0139701	--	.0003994	--	.0044388	.0000601	.0087614	--	--	.0241776	--	.0049285	.0011111	--	--	.0003789	.0005706	32
8. Primary Metals	--	--	.0401835	--	.0008181	--	--	.0118269	.0293648	.0310728	.0525679	.0147789	.0606252	.0004870	.0043981	.0286725	.0023914	.0009928	--	--	.0009903	--	.0015106	33
9. Fabricated Metals	.0354334	.0001063	.0132554	.0011545	.0042988	.0059798	.0000227	.0031878	.0258869	.0220349	.0257533	.0036067	.0228281	--	.0115038	.0699710	.0003974	.0045861	--	--	.0017933	.0002193	.0033158	34
10. Machinery (except electrical)	.0008504	.0013269	.0039098	.0016389	.0003036	.0004117	.0003001	.0008468	.0041928	.0240578	.0217104	.0056029	.0043143	.0003964	.0054405	.0085257	.0008549	.0016570	.0000873	.0000235	.0002386	.0000704	.0021545	35
11. Electrical Machinery	.0006643	.0007850	.0009297	.0008407	.0006836	.0003649	.0012323	.0006824	.0007243	.0011468	.0072238	.0015372	.0009364	--	--	--	.0012375	.0020405	.0072601	.0015205	.0000700	.0013065	.0004386	.0014557	36
12. Transportation Equipment	--	--	--	.0001657	--	--	--	.0007270	.0038754	.0015290	.0002148	.0118781	.0033676	--	--	--	.0001387	.0101387	.0001125	--	.0022735	.0107398	.0064087	37
13. Miscellaneous Manufacturing	.0007001	.0008660	.0030635	.0009710	.0007025	.0046135	.0012642	.0007540	.0013982	.0015085	.0012190	.0073191	.0047740	.0001359	.0001779	.0056961	.0005384	.0011755	.0004782	.0001291	.0025565	.0011364	.0074901	19-38-39
14. Agriculture	.0417264	.0025373	.0113958	.0005782	.0000138	--	--	--	--	--	--	--	.0008955	.0890011	--	--	--	--	--	--	--	.0003947	--	01-09
15. Mining	.0009525	.0000354	.0007390	.0000059	.0017334	.0000187	.0332063	.0161941	--	--	.0001708	.0001141	.0002009	.0255065	.0242789	.0361585	.0014501	--	--	--	--	--	--	10-14
16. Construction	.0012640	.0002684	--	.0005151	.0003036	--	.0010959	.0000211	.0003136	.0002958	.0000414	.0003161	.0014403	--	--	.0000813	.0044718	.0001953	.0008024	.0108548	.0012647	.0004587	.1630399	15-17
17. Transportation, Communication & Utilities	.0454750	.0390281	.1042198	.0380210	.0357352	.0332868	.0936752	.0295915	.0199187	.0151746	.0199452	.0122952	.0292672	.0285306	.1582325	.0178331	.1046003	.0195833	.0224886	.0327390	.0391640	.0778026	.0350134	40-49
18. Wholesale Trade Services	.0133049	.0054900	.0340803	.0082495	.0042982	.0323791	.0254981	.0112044	.0169132	.0146740	.0154416	.0026926	.0252355	.0013251	.0045761	.0068453	.0061507	.0057513	.0335341	.0026547	.0214282	.0051638	.0067414	50-51
19. Retail Trade Services	.0044043	.0500792	.0499225	.0049319	.0023021	.0051844	.0042383	.0023797	.0126345	.0215480	.0022725	.0053380	.0034494	.0012232	.0041185	.0406697	.0088877	.0072337	.0242297	.0106737	.0224132	.1255507	.0025055	52-59
20. Finance, Insurance & Real Estate	.0215474	.0327227	.0296221	.0202706	.0061698	.0651138	.0406824	.0126480	.0238129	.0101778	.0072885	.0048922	.0660019	.0168873	.0336981	.0228105	.0247056	.0460695	.0302917	.0901003	.0230078	.1186698	.0292585	60-67
21. Business, Personal & Other Services	.0119178	.0106205	.0123495	.0082495	.0044585	.0236854	.0099227	.0065225	.0071442	.0086761	.0069132	.0032244	.0149111	.0029901	.0109191	.0231769	.0201447	.0174287	.0075425	.0330553	.0374839	.1038993	.0300405	70-89
22. Household	.2673749	.4089907	.4662176	.4609142	.1952096	.4475430	.4388898	.3357999	.3682158	.4788990	.3888735	.2016402	.3497154	.4774325	.4544738	.5478370	.4480642	.5547908	.5958314	.3608921	.6215978	.0052531	.5885068	
23. Local Government	.0066466	.0052469	.0096674	.0037340	.0028299	.0021055	.0010504	.0040723	.0024399	.0045621	.0038487	.0009694	.0061360	.0050628	.0019448	.0034681	.0192884	.0092964	.0109907	.0412875	.0477861	.0324339	--	93

Note: Each entry shows direct purchases from St. Louis Region Industry named at left by industry named at top per dollar output by latter.

column sector. Although this table does not show exactly the production function of each column sector, because imported materials and products were not distributed among input sectors, it can be used to study local industrial input structure. Assuming imported inputs are distributed proportionally as local inputs, this table therefore portrays approximately production functions for all employed column sectors, given market perfection.

Labor undoubtedly was the major input in each sector. Most non-manufacturing industries relied more heavily on labor input than manufacturing industries. Expenditures on households in 1967 differed from sector to sector; proportionally they ranged from 20% in chemical, petroleum and rubber products sector to 62% of total input expenditures in the services sector. Labor input in three manufacturing sectors was found to have become proportionally less important in 1967, than in 1955; they are chemical, petroleum and rubber products; transportation equipment and miscellaneous manufactures. Percentage-wise they declined from 44% to 39%, 22% to 20% and 37% to 35%, respectively.

In contrast to non-manufacturing industries, manufacturing sectors relied more heavily on imported materials and products as their input. Imported input consisted of as high as 59% of total input in the transportation equipment sector and as low as 5% in the mining sector.

Locally supplied materials and goods by one sector consisted of (as was true for 1955 in the S.M.S.A. and 1963 in the State of Missouri) only a very small portion of total input of other sectors. For instance, in order to produce one dollar's worth of food, tobacco and kindred products, the required inputs are 5.06 cents' worth of food, tobacco and kindred products; 0.35 cents' worth of textile and apparel; 0.02 cents' worth of lumber and furniture; 1.44 cents' worth of paper and printing products and so forth, reading down column one

in Table IV-3. Only several entries in the table of 441 entries (21 x 21) showed an input requirement of more than 5 cents to produce every dollar of output, among all industrial sectors. Diagonal elements in the table are higher than most non-diagonal elements in the same column. This illustrates the production process in which more sectoral output is required as input to produce more output, relative to other inputs. The broader a sector's definition and the higher the integration in production, the more sectoral output is required to be its own input in the second round production.

Input coefficients from both the 1955 S.M.S.A. and the 1963 Missouri tables have been computed and aggregated in accordance with the 1967 regional sectoral classification. Due to the changes in technology, in price, etc. over time, substitution among imputed factors certainly took place. When comparing each sector's input coefficients from the three tables, no constant production function was observed for any sector. Once again, the food, tobacco and kindred products sector will be used as an example. In order to produce one dollar's worth of its output, it needed as its input, in 1955, 4.11 cents' worth of food, tobacco and kindred products; 0.39 of a cent worth of textile and apparel; 0.05 of a cent of lumber and furniture; 1.92 cents' worth of paper and printing and so forth. In the State of Missouri, the corresponding requirements in 1963 were 10.28 cents' worth of food, tobacco and kindred products; 0.18 of a cent of textile and apparel; 0.14 of a cent of lumber and furniture; 2.89 cents of paper and printing, and so forth.

In spite of the substitution effect, which caused the changes in the input composition, the relative importance of each variable input in any production function remained quite constant. The correlation coefficient obtained

from input coefficients comparison between the 1967 table and the 1955 table was very high (over 0.9) for almost all sectors. Similar relationships were observed from the comparison between the 1967 and the 1963 tables. This phenomenon implies that the input structure for each sector has not differed considerably over time within the region. Also, the structure in the region has been similar to that in the state, as far as the relative magnitude among variable inputs in each sector is concerned. However, this general similarity might have been greatly discounted if all input coefficients were computed at a constant price level, respectively, for each variable input, and imported materials and products were properly adjusted.[11]

The difference, in terms of direct requirement of dollar worth of output, and the similarity of relative magnitude among all inputs required to produce that amount of output, are shown in Table IV-4 for three sectors selected at random. Similar information for all sectors are available for interested readers upon request.

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[11] A more precise method of comparing input coefficients was developed by Stanislaw Czamanski in "Applicability and Limitation in the Use of National Input-Output Tables for Regional Studies," a paper presented in the Regional Science Association Meetings, November 1968, Boston, Massachusetts.

TABLE IV-4

Direct Input Composition Per Dollar Worth of Output, for Selected Sectors
for St. Louis S.M.S.A. (1955), The State of Missouri (1963) and St. Louis Region (1967)
(Input Unit: cents)

	Food, Tobacco & Kindred Products			Transportation Equipment			Personal, Business & Other Services		
	1955	1963	1967	1955	1963	1967	1955	1963	1967
20-21	4.11	10.28	5.06	--	0.01	0.02	0.92	0.27	0.17
22-23	0.39	0.18	0.35	0.88	0.02	0.02	0.18	0.71	0.04
24-25	0.05	0.14	0.02	0.14	0.01	0.01	0.04	0.14	0.07
26-27	1.92	2.89	1.44	0.18	0.01	0.15	3.79	2.23	1.28
28-29-30	0.36	0.59	0.46	0.30	0.46	0.13	2.81	0.99	0.13
31	*	--	--	0.02	--	*	0.01	--	--
32	--	0.15	5.11	--	0.09	0.01	--	0.11	--
33	0.03	--	--	2.33	0.89	1.48	--	0.07	0.10
34	3.22	2.80	3.54	1.91	0.31	0.36	0.11	0.36	0.18
35	0.03	0.12	0.09	1.35	0.57	0.56	0.36	0.50	0.02
36	0.04	0.04	0.07	0.19	0.37	0.15	*	0.45	0.13
37	0.01	--	--	10.95	0.88	1.19	0.74	1.87	0.03
19-38-39	1.92	0.04	0.07	0.88	0.33	0.73	0.52	1.01	0.26
01-09	--	32.83	4.17	--	--	--	--	--	--
10-14	--	0.08	0.10	--	0.02	0.01	--	--	--
15-17	0.30	0.24	0.13	0.47	0.20	0.03	0.16	1.80	0.13
40-49	3.09	2.96	4.55	2.12	1.75	1.23	1.11	4.11	3.92
50-51	0.52	1.12	1.33	0.19	1.00	0.27	0.28	1.56	2.14
52-59		0.89	0.44		1.14	0.53		1.26	2.24
60-67	0.29	1.54	2.15	0.22	0.51	0.49	1.79	6.86	2.30
70-89	1.40	1.48	1.19	1.56	0.69	0.32	2.22	4.59	3.75
Household	14.46	15.96	26.74	22.06	16.95	20.16	19.18	60.12	62.16
Local govt.	0.32	0.55	0.66	0.19	0.29	0.10	0.26	0.91	4.78
Input Correlation	0.944	0.506	1.00	0.910	0.996	1.00	0.969	0.994	1.00

* indicates less than 0.005 cent
Source: see text

IV. Value of Gross Regional Product

The total production shown in the Interindustrial Gross Flow Table (Table IV-1), as previously stated, does not represent net value created or added to raw materials and intermediate inputs. They are values of all transactions during the whole production process and include double counted value of various inputs. The value of the gross regional product was much smaller than total production shown in the table, it was estimated to be $9,298,856,000. It is calculated by subtracting inputs of goods and services, exclusive of human, capital and government services, from the total production. In other words, it is the sum of the value added to inputs, plus various input services employed in the production process.

The value of the gross regional product is a concept similar to that of the gross national product in a national income account analysis. Therefore, it is also possible to obtain it by another method. By subtracting all transactions between final demand and final products sectors, such as household taxes paid, transfer payment from governments, inter-governmental transactions, etc., from the total value of all final demand sectors, and adding to it the value of net export and government employees' wages and salaries we finally would arrive at the same figure as it was estimated by the aforesaid approach.[12] The result is the same if we add to personal income after taxes (equivalent to the personal consumption plus savings) all governmental expenditures and net export. It is termed gross because no deduction has been made for indirect business taxes and depreciation.

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[12] An easy example is given by John H. Chapman, Jr. and Kenneth L. Shellhammer in "The Structure of the West Virginia Economy, 1965," A Preliminary Report, West Virginia University, November, 1967, p. 5.

Table IV-5 presents the gross regional product by sector. In addition, the relative importance of each sector's contribution to the gross regional product is also shown in the table. For comparison purposes, similar statistics for the State of Missouri in 1963 are also presented.

The value of the gross state product in 1963 was 1.4 times as much as that for the 1967 gross regional product. For manufacturing sectors alone, the value for the state was only 4% more than that of the region, $3,453,340 against $3,307,806, since the region is more industrialized than the state. Sectoral contributions can be easily observed from the percentage distribution. Most manufacturing sectors contributed a higher percentage to the total value of the gross product in the region than in the state, except for textile and apparel and miscellaneous manufacturing sectors.

Personal, business and other services created a much higher value of gross product in the region relative to the state; even in terms of absolute amount of contribution, the region in 1967 was not significantly lower than that of the state in 1963. Another similar phenomenon occurred in the construction sector. These facts may be solely attributed to regional urbanization: greater consumption of services and the increased need in housing and building because of the population explosion and business expansion.

The value of the gross regional product in 1967 was $232,856,000 greater than that of the gross state product of Washington in 1963, or twice as much as that of the State of West Virginia in 1965. In comparison with the gross national product in 1967 ($789.7 billion),[13] the St. Louis region contributed 1.18% of the total G.N.P.; comparing it to the gross state product in 1967 ($16.7 billion),[14] the St. Louis region was about 55.7% of the total G.S.P.

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[13] U. S. Department of Commerce, Survey of Current Business, August, 1968, p. 9.

[14] Floyd Harmston, "Post-War Trends in the Missouri Economy" in Business and Government Review, Missouri University, Columbia, January-February issue, 1969, p. 30.

TABLE IV-5

Value of Gross Product by Sector
for St. Louis Region, 1967 and Missouri, 1963

S.I.C.	St. Louis (1967) Value of Regional Product ($1,000)	St. Louis (1967) Distribution	Missouri (1963) Value of State Product ($1,000)	Missouri (1963) Distribution
20-21	402,384	0.043	460,659	0.34
22-23	86,667	0.009	159,806	0.012
24-25	38,676	0.004	58,347	0.004
26-27	238,564	0.026	320,208	0.024
28-29-30	498,310	0.054	523,655	0.039
31	62,962	0.007		
32	101,493	0.011	122,079	0.009
33	332,420	0.036	154,902	0.012
34	223,433	0.024	217,096	0.016
35	229,349	0.025	223,699	0.017
36	163,010	0.018	198,354	0.015
37	822,655	0.088	853,286	0.064
19-38-39	107,883	0.011	161,249	0.012
Subtotal: Manufacture	3,307,806	0.356	3,453,340	0.259
01-09	46,394	0.005	652,783	0.049
10-14	52,548	0.005	73,897	0.006
15-17	499,618	0.054	495,348	0.037
40-49	942,970	0.101	1,359,353	0.102
50-51	574,654	0.062	962,120	0.072
52-59	980,336	0.105	1,680,374	0.126
60-69	964,612	0.104	2,357,903	0.177
70-89	1,207,602	0.130	1,220,499	0.091
Household workers	42,368	0.004	56,747	0.004
Local and State Government Workers	379,378	0.041	575,000	0.043
Federal Government Workers	300,570	0.032	466,671	0.035
Total	9,298,856	1.000	13,354,035	1.000

Source: Values of state product are computed from Harmston's Table 2, in Missouri Economy Study, op. cit., p. 9.

V. Comparative Structure Analysis: Output And Employment Distribution

The industrial structure in any region changes more or less over a period of time. The change can originate from various factors such as demographic (the growth and composition of the population and labor force, etc.); political (taxation and public policies, etc.) and economic (economics of scale, cost and market advantages, external economics, etc.) and so forth. This study, static in its nature, will not deal with the underlying factors and how they lead to change, because such an analysis is within the scope of a dynamic analysis. However, a comparative static study is permissible and this has been the approach discussed since the beginning of this study.

For purposes of comparison, Table IV-6, Distribution of Total Output and Employment and Production per Employee by Sector, provided information for a comparative analysis. In spite of difficulties involved with sector classification, some conslusions can be tentatively drawn from this table, which gives not only regional data for 1955 and 1967 but state statistics for 1963, as well.

Any sector with a higher percentage of output than its percentage of employment may be considered to be a sector of relative advantage in production, assuming that labor is the only scarce resource in the region and capital input is ignored. It is interesting to notice that six sectors which had relative high output per worker in 1955 also achieved a higher than average output/worker ratio in 1967, in the region. Fabricated metals in 1967 replaced construction in 1955 as the seventh sector in the region to enjoy this high ratio of output per employee. The other sectors still continue to have lower ratios than the average; these sectors were obviously service oriented and labor is more vital an input than capital in the production process.

Disregarding the price changes among sectors, the output per employee was higher in 1967 than in 1955 for all sectors of similar classifications. However, the difference between the two dollar amounts vary from sector to sector; some increased more and some less.

There was a shift in both the output and employment distribution by sector in the region, even though relative importance among sectoral distribution had remained rather constant. The most outstanding sector was transportation equipment, its output was only 9% of total production and its employment, 5% of total employment in 1955; in 1967 the corresponding figures were 20% and 9% respectively. Expectedly, the ratio of output per worker was about doubled. Another rapid but opposite change was found in the food industries, output and employment percentages declined between 1955 and 1967, with the former percentage declining much more than the latter.

In comparison with the state output and employment distribution, a divergency was disclosed. Five sectors in the state in 1963 produced more than 9% of total state production; they are finance, insurance and real estate (14.9%), transportation equipment (12.6%), wholesale trade service (9.6%), food, tobacco and kindred products (9.2%) and transportation, communication and utilities (9.1%). In the region in 1967, only transportation equipment (19.9%) and finance, insurance and real estate (9.2%) produced more than 9% of total regional production. The sectors next in importance were chemical, petroleum and rubber products, 8.8% and various services, 8.3%.

Output per worker in the region in 1967 was higher than that of the state in 1963 for all except five sectors. Except for the agriculture sector (S.I.C. 01-09), this discrepancy for the other four sectors was likely due to an underestimated employment figure, in part because of classification differences.

The absolute value of output per worker in the chemical, petroleum and rubber product sector in the region in 1967 was about 158% higher than that of the state figure in 1963. Mining industries, which had output increase of about 7% per year in the region as indicated previously in Chapter III, ranked second in terms of output per worker when this comparison is performed, i.e., about 100% higher than the state counterpart.

On the average of all industrial sectors, regional ratio of output per employee in 1967 amounted to $24,086 or 164% as much as the regional ratio in 1955 and 118% as high as that of the state ratio in 1963. Undoubtedly, these percentage differences have to be discounted by price increases, in order to reveal real increase in labor productivity, by holding other things constant.

It is very interesting to note from the table that personal and business services and retail trade service have been the two sectors with large numbers of employment and an increasing proportion of total employment but with the lowest ratios of output per worker among all industrial sectors. These phenomena are not peculiar to the region and the state; as Fuchs has observed that they are typical in the U. S. as a whole. The drastic shift of employment into the services industries was explained by a greater decline in hours worked per man in service, than in other industries and a slower increase in quality of labor and capital employed by services, than in manufacturing industries.[15]

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[15]See Victor R. Fuchs, op. cit., Chapter One: "Summary of Findings," for detailed analyses.

TABLE IV-6

Distribution of Total Output and Employment and Production per Employee by Sector
for St. Louis Region, 1967, St. Louis S.M.S.A., 1955, and the State of Missouri, 1963

S I.C.	St. Louis Region, 1967			S.I.C.	St. Louis S.M.S.A., 1955			S.I.C.	Missouri State, 1963		
	Distribution		Output		Distribution		Output		Distribution		Output
	Output	Employment	per Employee		Output	Employment	per Employee		Output	Employment	per Employee
20-21	0.071	0.034	$ 50869	20	0.116	0.050	$ 34024	20-21	0.092	0.041	$ 46198
22-23	0.011	0.019	13848	22-23	0.019	0.029	9553	22-23	0.018	0.031	12108
24-25	0.005	0.008	13371	26-27	0.028	0.033	12284	24-25	0.007	0.010	14781
26-27	0.028	0.031	22211	28-29	0.118	0.043	40013	26-27	0.030	0.033	18247
28-29-30	0.088	0.033	65172	31	0.015	0.022	9978	28-29-30			
31	0.006	0.011	13007	33	0.044	0.036	18067	31	0.058	0.047	25216
32	0.012	0.013	23291	34	0.023	0.030	11230	32	0.012	0.011	21475
33	0.047	0.035	32547	35	0.024	0.030	11631	33	0.013	0.011	24784
34	0.030	0.030	26682	36	0.021	0.030	10199	34	0.023	0.021	23002
35	0.024	0.026	22295	37	0.090	0.050	26621	35	0.022	0.022	19641
36	0.021	0.024	21318	21,24,25,30				36	0.018	0.020	17756
37	0.199	0.092	51848	32,38,39	0.053	0.056	14020	37	0.126	0.049	52456
19-38-39	0.016	0.027	14566	01-09				19-38-39	0.013	0.013	21235
01-09	0.005	0.002	67090	10-14,19,				01-09	0.050	0.003	303708
10-14	0.004	0.003	33996	79,84	0.062	0.022	41837	10-14	0.005	0.006	16338
15-17	0.051	0.058	21340	15-17	0.074	0.065	16913	15-17	0.044	0.058	15469
40-49	0.083	0.086	23138	40-49	0.090	0.103	12905	40-49	0.091	0.097	19143
50-51	0.049	0.070	16667	50-51	0.099	0.235	6222	50-51	0.055	0.079	14307
52-59	0.075	0.168	10748	52-59				52-59	0.096	0.213	9272
60-67	0.092	0.061	36075	60-67	0.069	0.053	18977	60-67	0.149	0.064	47627
70-89	0.083	0.169	11743	70-78,80-83				70-89	0.078	0.171	9294
				85-87,89	0.055	0.113	7126				
Total	1.000	1.000	24086	Total	1.000	1.000	14710	Total	1.000	1.000	20433

Source: Table III-2.

Chapter Five: Interaction And Impact Analysis

I. General Concept Of The Models

The preceeding chapter has described the beginning of interdependence among sectors in the region with respect to domestic and outside supply of inputs. The input coefficient table in that chapter releases information on input requirements of various sectors directly employed in producing one dollar of output of the sector named at top. As noted, in order to produce one dollar of food, tobacco and kindred products, about 0.46 of a cent of chemical, petroleum and rubber products is purchased in the region (column 1, row 5); but about 0.1 cent of the former product is also used to produce one dollar of the latter (column 5, row 1). The relationship shown in this table is the direct interdependence among sectors.

The more complex interdependence relationship among the sectors is found in relating them to the final demand sectors. By transposing the inversed matrix of the residuals of the input coefficient matrix subtracted from an identity matrix, we have another matrix which indicates direct and indirect requirements of output named at top per dollar delivery of output (named at left) to the final demand sectors. This matrix is conventionally called an inversed matrix, which can be obtained easily through computer work. However, structurally it represents many rounds of indirect purchases through a rather intricate process.

Each time the region makes a dollar sale of food to final demanders, people outside the region, or exports, for example, the food sector directly requires 0.46 of a cent of chemical products. But in turn, the chemical sector has to purchase domestically 0.1 of a cent of food to produce every dollar's worth of its output. This shows the indirect requirement for food in addition to that needed for the final sale (or export) of food. The amount of this indirect

requirement is 0.046 of a cent (the product of 0.46 of a cent and 0.1 cent). Only a single indirect round for a final sale of one dollar's worth of food shows that food production must be $1.00046. In order to supply the additional 0.046 of a cent of food, the food sector must buy even more chemical products. This process will continue but each round's indirect interdependence not only takes place between food and chemical sectors but also between food and other sectors and among all other sectors, as well. This effect is usually referred to as the multiplier effect. The inversed matrix mentioned above solves these direct and indirect interdependent relationships simultaneously for all sectors selected. Each entry of a row in the inversed matrix is, therefore, the total value of direct and rounded indirect requirements generated by final demands of that row.

Final demand sectors, as noted previously, are income determining factors; regional income or the level of industrial activity in the region is determined by these final demanders. In contrast, they are determined by exogenous forces and their values are taken as given in economic models dealing with industrial structure and interdependence. Therefore, when regional industrial activity is investigated with respect to the impact of change in one final demand sector, the other final demand sectors are always held constant by the condition of "ceteris paribus." A simple model in an economic base study postulates change in the export sector and analyzes its impact upon local economy, by holding constant all other final demands. Basically the hypothesis of this model is that regional economic growth vitally depends on the region's potential for and capability to export, and that the basic industries are those producing goods for export. The larger the volume of export, the larger the economic basis and the more prosperous the regional economy. In such a model, both

expenditures of consumer and investor are assumed unaffected, changes in final demand only lead to production adjustments in the specific industrial sector and those which are directly and indirectly linked to it. It is clear, therefore, that household and local government sectors are not included in the industrial production process. The inversed matrix without the two sectors' joint interaction indicates direct and indirect requirements per dollar delivery to both exogenous and endogenous final demand. Model B in the study is of this type. It is less realistic than Model A, another model investigated by this study.

Any change in the final demand for a product, for instance, a change in export-production, will basically affect other final demand sectors, such as investment and domestic consumption. The effect of this change will be twofold. Taking investment in plant and equipment, for instance, the change will directly affect investment of an export industry and indirectly, investment of other industries.

In coping with the entire impact, a complicated acceleration effect has to be incorporated. Nevertheless, in view of the scope and purpose of this study, the difficulties resulting from building this effect into the model do not warrant any trial. Hence, investment is assumed unaffected in visualizing changes in final demand and their impact upon production in Model A.

In addition, consumption expenditures, as those of investment, would also, in fact, be affected. Any change in final demand for a product changes that product's production; any change in production certainly changes labor input employed in producing that product; any change in labor input directly changes labor's income. Given the fact that current income and consumption are highly correlated, any alteration in income undoubtedly leads to adjustments in consumption expenditures. Through a specific consumption function, the alteration

in consumption expenditures results in shifts in demand schedules of various products. In turn, these shifts generate changes in production; labor input, income and so forth for successive rounds.

In order to measure these changes, or their direct and indirect effects, and induced effects by consumption adjustment, one method is to incorporate directly in the model the consumption-income relationship. "This means," as explained by Moore and Peterson, "moving the household row and column out of final demand and into the endogenous part of the model, so that the output is determined together with that of the other industries."[1]

However, consumption-income relationship has been a controversial issue in economic theory. Three hypothetical or theoretical arguments are most popular, though none of them are empirically perfect in light of time series and cross section evidence.[2] For the purpose of simplicity, a linear, homogeneous consumption function is adopted in this study. This is to assume that consumer expenditures on each commodity are perfectly correlated with income; both are changing in the same direction and varying in the same proportion.

Model A, having built in it this relationship, is thus claimed to be more realistic relative to Model B. The inversed matrix of Model A measures one more income change which is induced by consumption adjustment, besides the direct and indirect income changes; while Model B can only measure the latter of the two changes. In a like manner, input coefficient in local government row and column were also incorporated in Model A, and then the matrix was subtracted by an identity matrix. The resulting matrix was finally inversed and transposed.

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[1] Frederick T. Moore and James W. Petersen, op. cit., p. 376.

[2] They are absolute income hypothesis (Keynes), relative income hypothesis (Duesenberry) and permanent income hypothesis (Friedman and Modigliani); see Robert Ferber, "Research on Household Behavior," in Survey of Economic Theory, Vol. III, St. Martin's Press, New York, 1966, pp. 114-154, for general introduction.

Table V-1, Direct and Indirect Requirement Per Dollar of Exogenous Final Demand, contains results derived from Model A. Table V-2, Direct and Indirect Requirement Per Dollar of Exogenous and Endogenous Final Demand, represents computed information from Model B.

TABLE V-1

Direct And Indirect Requirement Per Dollar Of Exogenous Final Demand

St. Louis Region, 1967

	1 Food, Tobacco & Kindred Products	2 Textiles & Apparel	3 Lumber & Furniture	4 Paper & Printing	5 Chemicals, Petroleum & Rubber Products	6 Leather Products	7 Stone, Clay & Glass	8 Primary Metals	9 Fabricated Metals	10 Machinery (except electrical)	11 Electrical Machinery	12 Transportation Equipment	13 Miscellaneous Manufacturing	14 Agriculture	15 Mining	16 Construction	17 Transportation, Communication & Utilities	18 Wholesale Trade Services	19 Retail Trade Services	20 Insurance & Real Estate	21 Business, Peronsal & Other Services	22 Household	23 Local Government	Corresponding Standard Industrial Classification Code
1. Food, Tobacco and Kindred Products	1.0927076	.0115295	.0020097	.0283412	.0144213	.0012465	.0576868	.0026865	.0416109	.0018299	.0020381	.0084148	.0026167	.0504164	.0050452	.0111999	.1399536	.0280273	.0983625	.1319191	.0976344	.6670144	.0437966	20-21
2. Textiles and Apparel	.0485398	1.0335987	.0028626	.0211835	.0125758	.0020590	.0035930	.0016095	.0037409	.0021046	.0021684	.0096487	.0028860	.0054992	.0010231	.0112037	.1368805	.0207581	.1623643	.1583822	.1101481	.7955038	.0482475	22-23
3. Lumber and Furniture	.0627068	.0175226	1.0430889	.0288237	.0166440	.0023663	.0048372	.0452687	.0193707	.0053583	.0031386	.0131815	.0059837	.0164465	.0031598	.0152419	.2449558	.0562662	.1987983	.1979997	.1453134	1.0449794	.0676619	24-25
4. Paper and Printing	.0501646	.0099925	.0046885	1.0888096	.0148864	.0015403	.0037000	.0017919	.0050537	.0025377	.0022648	.0104637	.0031094	.0034471	.0009680	.0114269	.1416850	.0231085	.1224876	.1516214	.1135813	.8503152	.0482349	26-27
5. Chemicals, Petroleum & Rubber Products	.0242867	.0047216	.0011363	.0134539	1.0613195	.0007280	.0138060	.0018953	.0065291	.0007517	.0014375	.0048351	.0017572	.0013369	.0027916	.0057201	.0886906	.0117705	.0570515	.0679903	.0539646	.3938195	.0239532	28-29-30
6. Leather Products	.0524923	.0103221	.0025102	.0246577	.0305907	1.0035382	.0041714	.0020966	.0103013	.0012596	.0019617	.0107127	.0068380	.0028595	.0010232	.0117491	.1386260	.0477695	.1247008	.2030150	.1324257	.8587980	.0499327	31
7. Stone, Clay & Glass	.0522220	.0102130	.0025324	.0224524	.0133985	.0016501	1.0181085	.0021152	.0045131	.0013780	.0029349	.0109234	.0035010	.0028518	.0356330	.0128945	.2131891	.0414088	.1268696	.1818157	.1215976	.8811934	.0496070	32
8. Primary Metals	.0354169	.0070851	.0015456	.0106240	.0089004	.0011053	.0026204	1.0133392	.0061755	.0015168	.0017035	.0081203	.0022529	.0019319	.0174619	.0079559	.1044565	.0215288	.0856146	.1056834	.0812475	.6034632	.0355802	33
9. Fabricated Metals	.0404780	.0081203	.0018706	.0126723	.0108626	.0012994	.0034561	.0320303	1.0298405	.0050582	.0019414	.0124449	.0031674	.0022086	.0012593	.0091051	.1021400	.0295371	.1078507	.1308828	.0923462	.6858466	.0386560	34
10. Machinery (except electrical)	.0512661	.0100916	.0025501	.0158393	.0125782	.0016684	.0038066	.0345515	.0270826	1.0255186	.0026211	.0122225	.0037086	.0027979	.0014406	.0111554	.1168003	.0306207	.1418662	.1428507	.1153204	.8673511	.0491436	35
11. Electrical Machinery	.0428181	.0083753	.0023996	.0128314	.0125366	.0013808	.0077374	.0564557	.0305044	.0231871	1.0085608	.0093005	.0031142	.0023422	.0020091	.0092445	.1078717	.0290898	.1034884	.1195450	.0971147	.7298712	.0415532	36
12. Transportation Equipment	.0215844	.0043205	.0010002	.0078555	.0063103	.0007053	.0017201	.0166085	.0057136	.0062053	.0021660	1.0164922	.0083449	.0011853	.0007813	.0048146	.0561210	.0094029	.0560593	.0612834	.0484209	.3664943	.0199223	37
13. Miscellaneous Manufacturing	.0457257	.0089261	.0022020	.0293368	.0121373	.0016065	.0124300	.0640928	.0275527	.0053787	.0024096	.0129271	1.0068739	.0034813	.0025125	.0126980	.1254953	.0399931	.1087960	.1896792	.1112828	.7521057	.0486828	19-38-39
14. Agriculture	.0522898	.0130033	.0022304	.0156188	.0125947	.0015720	.0037510	.0021771	.0040581	.0013029	.0013161	.0106256	.0022603	1.1005522	.0296387	.0113474	.1392172	.0158897	.1233587	.1537059	.1121827	.8883273	.0509690	01-09
15. Mining	.0543571	.0107827	.0023936	.0183054	.0136541	.0016630	.0039683	.0070855	.0163053	.0066532	.0017399	.0113802	.0025334	.0029648	1.0261937	.0127735	.2864927	.0213141	.1332312	.1806819	.1285442	.9249145	.0535326	10-14
16. Construction	.0648017	.0127563	.0040400	.0234843	.0154788	.0020668	.0293324	.0338843	.0774102	.0102039	.0018706	.0135147	.0085649	.0035505	.0395586	1.0139212	.1566664	.0289790	.1932579	.1949149	.1592693	1.0909515	.0612186	15-17
17. Transportation, Communication & Utilities	.0525460	.0102107	.0024388	.0206603	.0119245	.0015918	.0040024	.0046341	.0049595	.0018439	.0036399	.0120583	.0029204	.0028613	.0028769	.0189322	1.2177778	.0219001	.1309114	.1618735	.1308801	.8755642	.0671806	40-49
18. Wholesale Trade Services	.0628884	.0113708	.0026616	.0215424	.0233988	.0048823	.0096304	.0035245	.0095248	.0027559	.0088496	.0221249	.0037229	.0033883	.0012987	.0138107	.1355926	1.0228008	.1427551	.1983229	.1392341	.9811624	.0612240	50-51
19. Retail Trade Services	.0868272	.0127138	.0039304	.0599165	.0188849	.0046475	.0071998	.0021069	.0058459	.0011599	.0034631	.0135516	.0032541	.0045761	.0013349	.0157401	.1526718	.0530409	1.1752266	.1999384	.1428376	1.0915873	.0679709	52-59
20. Finance, Insurance & Real Estate	.0459875	.0088630	.0027221	.0193270	.0105182	.0014187	.0038023	.0021009	.0048657	.0009417	.0013963	.0096265	.0025106	.0025139	.0015503	.0285739	.1301342	.0170906	.1193477	1.2175232	.1334802	.7704095	.0862722	60-67
21. Business, Personal & Other Services	.0716380	.0138269	.0040658	.0346631	.0174255	.0021987	.0054925	.0037746	.0079151	.0014821	.0033721	.0169294	.0058895	.0039067	.0015914	.0232936	.1802742	.0426407	.1852655	.2047561	1.1843915	1.1723093	.1099716	70-89
22. Household	.0891710	.0173040	.0037100	.0233345	.0200593	.0026830	.0062860	.0021826	.0059826	.0010412	.0020351	.0180660	.0034170	.0048610	.0013706	.0165906	.1675608	.0234482	.2082055	.2245178	.1832934	1.5313499	.0744695	
23. Local Government	.0849547	.0152241	.0093334	.0327422	.0201919	.0022040	.0105614	.0098812	.0212743	.0048644	.0034332	.0212662	.0115278	.0046103	.0076474	.1780049	.1848389	.0297205	.1778931	.2210661	.1848594	1.2174535	1.0650490	93

Note: Each entry shows, per dollar of deliveries to final demand by industry named at left (including endogenous final demand sectors, households & local government), the total dollar production directly and indirectly required from St. Louis Region Industry named at top.

TABLE V-2

Direct And Indirect Requirement Per Dollar Of Exogenous And Endogenous Final Demand

St. Louis Region, 1967

	Food, Tobacco & Kindred Products	Textiles & Apparel	Lumber & Furniture	Paper & Printing	Chemicals, Petroleum & Rubber Products	Leather Products	Stone, Clay & Glass	Primary Metals	Fabricated Metals	Machinery (except electrical)	Electrical Machinery	Transportation Equipment	Miscellaneous Manufacturing	Agriculture	Mining	Construction	Transportation, Communication & Utilities	Wholesale Trade Services	Retail Trade Services	Finance, Insurance & Real Estate	Business, Personal & Other Services	Corresponding Standard Industrial Classification Code
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
1. Food, Tobacco & Kindred Products	1.0537084	.0039758	.0003216	.0180171	.0056361	.0000771	.0548859	.0016438	.0388184	.0013308	.0011311	.0004678	.0010289	.0482907	.0043741	.0021121	.0663856	.0176887	.0075342	.0336444	.0173548	20-21
2. Textiles & Apparel	.0020837	1.0245958	.0008746	.0089269	.0021151	.0006646	.0002747	.0003982	.0004760	.0015253	.0010940	.0001982	.0010272	.0029669	.0002488	.0010184	.0493454	.0084720	.0540884	.0413452	.0145590	22-23
3. Lumber & Furniture	.0016218	.0056900	1.0404504	.0126629	.0028847	.0005342	.0004545	.0436429	.0150116	.0045802	.0017194	.0007378	.0035045	.0131169	.0021147	.0011605	.1297492	.0400799	.0565137	.0440779	.0195802	24-25
4. Paper & Printing	.0005542	.0003741	.0025848	1.0757556	.0037191	.0000500	.0001714	.0005243	.0016187	.0019319	.0011223	.0003849	.0011518	.0007428	.0001621	.0010866	.0482900	.0100126	.0067924	.0266616	.0115358	26-27
5. Chemicals, Petroleum & Rubber Products	.0012874	.0002645	.0001517	.0073852	1.0561406	.0000377	.0121628	.0012952	.0049117	.0004646	.0009054	.0001561	.0008364	.0000832	.0024078	.0006667	.0453523	.0056874	.0034480	.0100475	.0066399	28-29-30
6. Leather Products	.0023700	.0006059	.0003778	.0114562	.0193068	1.0020330	.0006010	.0008064	.0068120	.0006429	.0008056	.0005250	.0048502	.0001273	.0002013	.0011063	.0442368	.0345295	.0078364	.0767572	.0293149	31
7. Stone, Clay & Glass	.0008154	.0002458	.0003546	.0089296	.0018272	.0001058	1.0144540	.0008046	.0009595	.0007517	.0017516	.0004812	.0014756	.0000496	.0348003	.0022409	.1164220	.0278415	.0069777	.0523342	.0158612	32
8. Primary Metals	.0001899	.0002570	.0000441	.0013406	.0009692	.0000476	.0001088	1.0124287	.0037155	.0010814	.0008903	.0009582	.0008517	.0000117	.0168811	.0003965	.0381054	.0122199	.0034899	.0169433	.0087740	33
9. Fabricated Metals	.0004668	.0003626	.0001754	.0021466	.0018563	.0000974	.0006115	.0310098	1.0270741	.0045706	.0010203	.0043173	.0015906	.0000275	.0006108	.0008057	.0268222	.0189770	.0145364	.0301034	.0100481	34
10. Machinery (except electrical)	.0006626	.0002805	.0004046	.0025245	.0011873	.0001483	.0002077	.0332589	.0235797	1.0249010	.0014559	.0019422	.0017122	.0000395	.0006189	.0006174	.0215370	.0172630	.0238737	.0153899	.0112327	35
11. Electrical Machinery	.0002327	.0001190	.0005929	.0016243	.0029504	.0001016	.0047079	.0553664	.0275534	.0226666	1.0075800	.0006483	.0014325	.0000209	.0013163	.0003442	.0276979	.0178472	.0041791	.0123190	.0095178	36
12. Transportation Equipment	.0002140	.0001761	.0000989	.0022413	.0015007	.0000630	.0002040	.0160691	.0042473	.0059477	.0016752	1.0121542	.0075087	.0000204	.0004396	.0005000	.0159113	.0037679	.0062041	.0074612	.0044720	37
13. Miscellaneous Manufacturing	.0017610	.0004098	.0003030	.0177055	.0022343	.0002880	.0092758	.0629228	.0244156	.0048187	.0013883	.0039711	1.0050897	.0010849	.0017604	.0025657	.0425783	.0283435	.0063893	.0788973	.0207891	19-38-39
14. Agriculture	.0004536	.0029540	.0000290	.0019730	.0009257	.0000150	.0000615	.0008481	.0004600	.0006677	.0001215	.0000923	.0002101	1.0977267	.0287930	.0004502	.0416174	.0022019	.0024844	.0231355	.0055529	01-09
15. Mining	.0003794	.0003189	.0000985	.0040910	.0015024	.0000419	.0001244	.0056980	.0125514	.0059900	.0004953	.0004099	.0003946	.0000225	1.0253103	.0013513	.1848492	.0070575	.0073728	.0447142	.0175047	10-14
16. Construction	.0011610	.0004168	.0013451	.0067453	.0011539	.0001548	.0248090	.0322633	.0730140	.0094294	.0004060	.0005882	.0060591	.0000814	.0385290	1.0007640	.0368750	.0121843	.0448295	.0346202	.0283712	15-17
17. Transportation, Communication & Utilities	.0012176	.0002811	.0001614	.0069715	.0003516	.0000560	.0002722	.0031870	.0011348	.0011498	.0024319	.0015600	.0007512	.0000637	.0019329	.0054152	1.1207107	.0082224	.0115654	.0324621	.0251230	40-49
18. Wholesale Trade Services	.0055661	.0002642	.0001988	.0064010	.0104895	.0031623	.0055281	.0020166	.0054697	.0020346	.0075213	.0104570	.0014153	.0002638	.0003324	.0009671	.0275400	1.0076285	.0091881	.0538987	.0212692	50-51
19. Retail Trade Services	.0230556	.0003573	.0011913	.0430730	.0045233	.0027339	.0026366	.0004306	.0013369	.0003579	.0019855	.0005714	.0006879	.0011000	.0002609	.0014746	.0324659	.0361625	1.0256292	.0392660	.0116019	52-59
20. Finance, Insurance & Real Estate	.0004440	.0000863	.0005458	.0068990	.0002206	.0000655	.0003699	.0006076	.0010544	.0002220	.0002843	.0002027	.0003640	.0000321	.0005426	.0122299	.0433307	.0047565	.0140012	1.1025046	.0393677	60-67
21. Business, Personal & Other Services	.0026336	.0005028	.0008895	.0160525	.0018458	.0001410	.0003873	.0016749	.0024654	.0004724	.0017185	.0027357	.0028098	.0001461	.0001968	.0019146	.0492815	.0241068	.0252248	.0306373	1.0420125	70-89

Note: Each entry shows, per dollar of deliveries to final demand by industry named at left, the total dollar production directly and indirectly required from St. Louis region industry named at top.

As a simple illustration, when the food, tobacco and kindred sector delivers one dollar's worth of its product to the federal government, the amount of chemical, petroleum and rubber products required, directly and indirectly by all industrial sectors, is worth about 0.56 of a cent, Table V-2 (column 5, row 1). With endogenous final demand sectors included in the producing process, the product of chemical, petroleum and rubber, directly and indirectly, required amounts to 1.44 cents, as shown in Table V-1 (column 5, row 1). The required amount in Model B is 0.10 of a cent more than the direct purchase by the food sector, and it is 0.98 of a cent more in Model A. The additional amount over 0.46 of a cent is indirectly required by all producing sectors, except the food sector in the fulfullment of one dollar's worth of delivery of food products to the federal government.

For the reason just stated, all diagonal entries in both tables are larger than one dollar for each dollar's delivery to final demand from the corresponding sector: one dollar for the direct and the remainder for the indirect requirement resulting from this dollar's delivery directly to final users. It is also obvious that the food, tobacco and kindred sector requires no direct input of leather products to produce, but indirectly the sector has to use 0.12 of a cent (row 1, column 6 in Table V-1) and 0.01 of a cent (in Table V-2) of leather products to deliver one dollar's worth of food, tobacco and kindred products to final users, in Models A and B, respectively. Therefore, for any known value of final demand for any sector's product, all direct and indirect requirements by sector can be computed for both models simply by multiplying the known value by the coefficient across that sector in Tables V-1 and V-2.

II. Sectoral Multipliers and Interaction of Endogenous Final Demand

Multiplier effects can be shown in many ways. As the preceeding section has pointed out, each cell in any row in Table V-2 represents a total multiplier effect generated by one unit of final demand for that row sector's product. That sectoral multiplier has been presented in two columns in Table V-3 for the two models under discussion: one comes as a result of the interaction of the industrial sectors with one another (Model B) and the other is a result of the interaction of the industrial sector with household and local government sectors (Model A). Each figure in the first two columns of Table V-3 is the sum of the first 21 column values of the respective row in Tables V-1 and V-2. The difference between the two models is, therefore, attributable to the interaction of endogenous final demand sectors with other industrial sectors. The multiplier effect generated by this interaction again differs in magnitude from sector to sector. However the interaction in manufacturning sectors is generally less than that in the services sector because of high imported input in the former sectors and high labor input in the latter sectors.

The construction sector (sector 16) has higher multiplier effects in both models, as well as higher interaction generated by including the endogenous sectors, relative to other sectors covered in this study. Food, tobacco and kindred products (sector 1) has higher multiplier effects in both models but with lower effects of interaction. To be more precise about the effect of interaction and activity generated, the manipulation in dollar terms is demonstrated in the following for these two sectors.

TABLE V-3

Sectoral Multipliers and Interaction of Endogenous Final Demand
St. Louis Region, 1967

		Total Multiplier Effect Model A	Model B	Interaction of Endogenous Final Demand With Other Sectors
1.	Food, Tobacco & Kindred Products	1.8297	1.3784	0.4513
2.	Textiles & Apparel	1.6928	1.2163	0.4765
3.	Lumber & Furniture	2.0856	1.4399	0.6457
4.	Paper & Printing	1.7673	1.1952	0.5721
5.	Chemicals, Petroleum & Rubber Products	1.4260	1.1553	0.2707
6.	Leather Products	1.8236	1.2453	0.5783
7.	Stone, Clay & Glass	1.8822	1.2895	0.5927
8.	Primary Metals	1.5263	1.1197	0.4066
9.	Fabricated Metals	1.6386	1.1772	0.4614
10.	Machinery (except electrical)	1.7664	1.1628	0.6036
11.	Electrical Machinery	1.6899	1.1988	0.4911
12.	Transportation Equipment	1.3371	1.0909	0.2462
13.	Miscellaneous Manufacturing	1.8255	1.3170	0.5085
14.	Agriculture	1.8087	1.2108	0.5979
15.	Mining	1.9430	1.3203	0.6227
16.	Construction	2.0876	1.3538	0.7338
17.	Transportation, Communication & Utilities	1.8214	1.2250	0.5964
18.	Wholesale Trade Services	1.8441	1.1816	0.6625
19.	Retail Trade Services	1.9689	1.2319	0.7370
20.	Finance, Insurance & Real Estate	1.7643	1.2281	0.5362
21.	Business, Personal & Other Services	2.0148	1.2078	0.8070
22.	Household	1.0251		1.0251
23.	Local Government	1.2361		1.2361

Source of Interaction	Effect Distribution		Amount of Interaction ($1,000)	
	Sector 1	Sector 16	Sector 1	Sector 16
Exogenous Final Demand	1.0000	1.0000	756,650	788,333
Industry to Industry	0.3784	0.3538	286,316	278,912
Endogenous Final Demand	0.4513	0.7338	341,476	578,479
Sectoral Multiplier	1.8297	2.0876	1,384,442	1,645,724

It is clear from the above presentation that extra economic activity or local goods and services generated by total basic income from the exogenous final demand sectors in the food sector is $627,792,000 and $857,391,000 in the construction sector. As far as the basic income is concerned, the latter sector had 4% more than that of the former sector in 1967 ($788 million against $757 million). But in terms of extra economic activity generated by these two sets of basic incomes, the latter generated 37% more than the former. This difference resulted from different inter-industry relationships existing between them and other sectors.

However, a sector that generates more economic activity as compared to the other does not necessarily imply that the sector adds proportionally more value to raw materials and services employed by that sector. A sector's contribution to gross regional product need not be perfectly associated with its interdependent relationship with other sectors. Sector 16, for example, contributed $499,618,000 to the gross regional product in 1967, while sector 1 contributed $402,384,000: the former is only 24% higher than the latter (see Table IV-5).

Also another clear fact that has to be borne in mind is that the value of the multiplier effect, or interactions generated by final demands, described in this section, does not reflect the value of sales for any particular sector. A vivid illustration comes from the aforementioned two sectors. The construction sector had a higher effect in model A but about equal effect in Model B as

compared with the food sector; but effects of the two sectors in either model are higher than most of the rest of the sectors. Nevertheless, Table IV-1 shows that total sales from the construction sector in 1967 was about 72% of those from the food sector. One reason is that the food sector employed a higher percentage of imported inputs, while the construction sector did not. The rank of construction sales in 1967 was ninth among all twenty-three sectors, but this sector's multiplier effect is the highest in model A and third highest in Model B.

In comparison with the State of Missouri in 1963, almost all sector multipliers in the region in 1967 are smaller than that of the state in both models. One of the apparent reasons is that the state did not use as much imported input as did the region in the production process. Sectors comparable with this study are selected and the sectoral multipliers are computed for Hirsch's study according to the definition given by Harmston.[3] With endogenous final demand sectors included as specified in Model A, Table V-4 presents comparable sectoral multipliers from the three studies. It indicates that goods and services generated by a dollar of basic income vary, more or less, from time and place for any given sector. For instance, extra activity generated by exogenous final demand for textile and apparel products was about 70% of the amount of the final demands in 1967 in the region, about 76% in the S.M.S.A. in 1955 and 88% in the State of Missouri in 1963.

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[3]Floyd Harmston, op. cit., pp. 14-15 for Missouri sectoral multipliers.

TABLE V-4

Selected Sectoral Multipliers for the St. Louis Region, 1967, St. Louis S.M.S.A., 1955 and the State of Missouri, 1963

Sector	St. Louis Region, 1967	St. Louis S.M.S.A., 1955	Missouri State, 1963
Food, Tobacco & Kindred Products	1.8297	1.5285	N.A.
Textiles & Apparel	1.6928	1.7582	1.8750
Lumber & Furniture	2.0856	2.0084	N.A.
Leather Products	1.7673	1.8464	N.A.
Stone, Clay & Glass	1.8822	N.A.	2.4582
Primary Metals	1.5263	N.A.	2.0546
Fabricated Metals	1.6386	1.8406	1.8432
Machinery (except electrical)	1.7664	1.9164	1.9668
Electrical Machinery	1.6899	1.9484	1.8647
Transportation Equipment	1.3371	N.A.	1.4647
Mining	1.9430	N.A.	2.4471
Construction	2.0876	2.2124	2.5478
Wholesale Trade	1.8441	N.A.	2.2891
Retail Trade	1.9689	N.A.	2.2108
Finance, Insurance & Real Estate	1.7643	2.1634	N.A.
Household	1.0251	1.2486	1.5937
Local Government	1.2361	1.4566	N.A.

Sources: Figures for the St. Louis region are selected from Table V-3. Figures for the St. Louis S.M.S.A. are computed from Werner Hirsch's study, op. cit., Appendix Table 2; and the state figures are selected from Floyd Harmston's study, op. cit., pp. 14-15.

III. Income Interaction and Multipliers: Exogenous Final Demand

Table V-5, Income Interaction and Multipliers, contains calculated values of various income changes and multipliers for both Models A and B, by industrial sectors. Direct income change, as explained above, describes how much income generated in the sector named at left is directly related to one dollar delivery to the final demander of that sector's output. In short, it is the coefficient of labor input in each column sector.

If final demand for food, tobacco and kindred products was cut by one dollar, for example, this sector would directly incur an income decline of $0.276. A direct decline in this sector's income of $0.267 would in turn mean a decline in this sector's gross output of $3.745. Certainly, this direct income change differs from sector to sector for every dollar worth of final demand for the respective sectoral product. The personal, business and other services sector would directly suffer more income change than any other sector selected in this study: 62.2% of every unit decline in the final sales of services. In contrast, the chemical, petroleum and rubber products sector is the one with least direct income change with respect to the change in final demand, 19.5%. The less labor input that is required in production, the smaller their direct income change would be in responding to a given change in final demand. However, the change in gross output in the sector directly suffering income changes from final demand changes would be larger; since the change of gross output is the reciprocal of the direct income change.[4]

The direct and indirect income change, column two in Table V-5, reflects income interaction in a chain relationship and sums up all rounds of income change, directly and indirectly linked to change in final demand for a specific sector's product named at left of the table.

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[4]This is based on the assumption of a perfectly competitive market in an equilibrium model.

The direct and indirect effects on income are computed by multiplying each figure in Table V-2 across a row by the appropriate figure in the direct income change column, Table V-5, or in the household row of Table VI-3, and summing the products finally. In calculating the direct and indirect impacts of a change in food, tobacco and kindred products final demand, we add the product of 1.5371 by 0.267 to the product of 0.0040 by 0.409, to 0.0003 by 0.466, ... The sum of the twenty-one products (0.4104 + 0.0016 + 0.0001 + ...) for the first sector is 0.426, which is the figure entered in Table V-5, row 1 and column 2. By a similar manipulation, the rest of the figures in column 2 were obtained for the remaining twenty sectors.

The third column in this table shows indirect income changes, which are the difference between the first two columns described previously. Interindustry income multipliers in the fourth column show total income changes resulting from one unit of income change in the sector listed at left, due to the change of final demand for the sector's product. For example, should income in sector 1 fall by $1,000, due to a production cut, assuming all other final demand remain constant, the total income in the region would be dropped by $1,600. Literally, income multiplier is the quotient derived by dividing the direct and indirect income change by the direct income change.

Direct and indirect income change is the sum of the twenty-one products explained previously; therefore, indirectly income change does not necessarily have a certain association with the direct income change. That is to say that a sector of high direct income change effect may not have a high indirect income change effect and, in turn, may not have a high multiplier. Sector one had the highest income multiplier (1.600) in 1967 among all selected 21 sectors, but its direct income change effect ranked third from the bottom. In other words, sector one had proportionately the highest indirect income effect, as compared to its direct income effect. Nonetheless, the absolute value of the

TABLE V-5

Income Interactions and Multipliers by Sector for the St. Louis Region, 1967

Industrial Sector	Direct Income Change	Direct & Indirect Income Change	Indirect Income Change	Income Multiplier (Model B)	Direct, Indirect & Induced Income Change	Induced Income Change	Indirect & Induced Income Change	Income Multipli (Model A
1. Food, Tobacco & Kindred Products	0.267	0.426	0.159	1.600	0.667	0.241	0.400	2.498
2. Textiles & Apparel	0.409	0.497	0.088	1.215	0.796	0.299	0.387	1.946
3. Lumber & Furniture	0.466	0.670	0.204	1.438	1.045	0.375	0.579	2.343
4. Paper & Printing	0.461	0.551	0.090	1.195	0.850	0.299	0.389	1.843
5. Chemicals, Petroleum & Rubber Products	0.195	0.252	0.057	1.292	0.394	0.142	0.199	2.020
6. Leather Products	0.448	0.555	0.107	1.239	0.859	0.304	0.411	1.917
7. Stone, Clay & Glass	0.439	0.570	0.131	1.298	0.881	0.311	0.442	2.006
8. Primary Metals	0.336	0.388	0.052	1.155	0.603	0.215	0.267	1.794
9. Fabricated Metals	0.368	0.444	0.076	1.207	0.686	0.242	0.318	1.864
10. Machinery (except electrical)	0.479	0.561	0.082	1.171	0.867	0.306	0.388	1.810
11. Electrical Machinery	0.389	0.473	0.084	1.216	0.730	0.257	0.341	1.876
12. Transportation Equipment	0.202	0.238	0.036	1.178	0.366	0.128	0.164	1.811
13. Ordinance & Miscellaneous Manufacturing	0.350	0.481	0.131	1.374	0.752	0.271	0.402	2.148
14. Agriculture	0.477	0.573	0.096	1.201	0.888	0.315	0.411	1.861
15. Mining	0.454	0.596	0.142	1.313	0.925	0.329	0.471	2.037
16. Construction	0.548	0.706	0.158	1.288	1.091	0.385	0.543	1.990
17. Transportation, Communication & Utilities	0.448	0.551	0.103	1.230	0.876	0.325	0.428	1.955
18. Wholesale Trade Services	0.554	0.629	0.075	1.135	0.981	0.352	0.427	1.770
19. Retail Trade Services	0.596	0.701	0.105	1.176	1.092	0.391	0.496	1.832
20. Finance, Insurance & Real Estate	0.361	0.444	0.083	1.230	0.770	0.326	0.409	2.132
21. Business, Personal & Other Services	0.622	0.724	0.102	1.164	1.172	0.448	0.550	1.884

Source: See text.

indirect effect from this sector was no longer the highest; the third sector, lumber and furniture with a figure of 0.204 took first place. Indirect income effect or income multiplier, depends substantially upon interindustrial dependence and their interwoven relationships.

In addition to the direct and indirect income effect and the resulting income multiplier from Model B, induced income effect can be measured from Model A. When a linear, homogeneous income-consumption function is introduced into the model and households and local government sectors are set in the production process, income multipliers are greater than their counterparts in Model B. Model A measures an induced income effect resulting from changes in consumer spending, by so doing one of the critical assumptions, constant consumption expenditures in Model B, is, hence, relaxed. Literally, in order to measure the income impact of a change in final demand (see, export) upon total regional income, consumers' spendings are now allowed to react instead of being held unaffected.

Here again, the logic which appears in the front section can also be employed to illustrate the iterative process of income changes. For example, should for any reason the regional export of food products change, the production in the food industry has to be changed and income earned by people engaged in this industry is directly affected. When those people's income has changed, their consumption expenditures must be altered in accordance with their income-consumption function. The alteration in consumption expenditures leads directly to the change in the production of related consumer goods and, indirectly, other goods. The second iteration will then initiate and the change in demand is again diffused throughout the other industries in the model. In this case, the total income effect includes the direct and indirect, as well as the induced effect resulting from consumption adjustments, holding all other final demands constant.

The direct and indirect and induced income changes per dollar of change in final demand are given in column five, for each sector. In fact, they are reproduced from the household column in Table V-1. Together with direct and indirect income changes obtained in Model B, induced and indirect income changes are readily implemented for Model A. The interindustry income multiplier in Model A shows the direct, indirect and induced income change in relation to the direct one. Literally, it indicates that total income change in the region as a whole is a multiple of direct income change occurring in a sector listed at the left of the table. Therefore, it is by definition greater than its counterpart in Model B, because of the inclusion of the induced effect.

It is conceivable that the higher the indirect and induced effect in relation to the direct effect, the higher is the income multiplier. Induced effect, as indirect effect, does not necessarily differ in proportion with the direct effect among sectors. A sector showing high direct income effect may have low indirect and induced income effects and vice versa. However, it is clear from Table V-5 that direct income effect is greater than induced income effect, which in turn, is greater than the indirect effect. This means one dollar of income change directly resulted from production changes in an industry will induce less than one dollar of income change through consumption adjustment and much less through other inter-industrial relationships.

In no sector are the direct and indirect income changes resulting from a change in final demand greater than that amount of final demand, because of the nature of production. In other words, the change of gross output is always greater than the direct income change. For instance, should there be a change in final demand with a resultant direct income change of $1,000 in the services sector, the associated gross output of services would be changed in the same direction by an amount of $1,608; and total regional income by $1,164 and $1,884, in respecti models.

There were four sectors in 1967 in the region with total income effect greater than one: lumber and furniture, construction, retail trade and various services. Only in these four sectors a direct income cut by less than one dollar could lead to more than a one dollar cut in income. This only happens in Model A, due to the introduction of income-consumption interaction.

Income multiplier for any sector varies, as those of sectoral multiplier, among studies with different coverage in time and place. For purposes of comparison, and for the sake of interested readers, a number of sectors of compatible classification in both Hirsch and Harmston's studies were selected and their respective income multipliers were computed. They are contained in Table V-6.

The income multiplier analyzed the relationship between total income change and the direct income change, while the sectoral multiplier deals with industrial activities involved with all transactions. Although both are related to changes in final demand, the analytical approach and the results thereby presented are different. The employment of either analysis depends, of course, entirely upon the questions at hand to be answered. In order to be more specific about the usefulness of these two kinds of multipliers, several examples will be given in the following section for the purpose of illustration.

TABLE V-6

Income Interaction and Multipliers by Selected Sectors
St. Louis Region (1967), St. Louis S.M.S.A. (1955) and Missouri (1963)

Sector (S.I.C.)	Direct Income Change			Income Multiplier Model B			Direct, Indirect and Induced Income Change			Income Multiplier Model A		
	Region	S.M.S.A.	Missouri	Region	S.M.S.A.	Missouri	Region	S.M.S.A.	Missouri	Region	S.M.S.A.	Missouri
20-21	0.267	0.145	0.324	1.600	1.586	1.258	0.667	0.358	0.729	2.498	2.469	2.252
22-23	0.409	0.320	N.A.	1.215	1.281	N.A.	0.796	0.644	N.A.	1.946	2.013	N.A.
24-25	0.466	0.349	N.A.	1.438	1.404	N.A.	1.045	0.775	N.A.	2.343	2.221	N.A.
31	0.448	0.380	N.A.	1.239	1.237	N.A.	0.859	0.745	N.A.	1.917	1.961	N.A.
32	0.439	N.A.	0.335	1.298	N.A.	1.611	0.881	N.A.	0.982	2.006	N.A.	2.928
33	0.336	N.A.	0.308	1.155	N.A.	1.403	0.603	N.A.	0.781	1.794	N.A.	2.539
34	0.368	0.356	0.294	1.207	1.264	1.291	0.686	0.710	0.676	1.864	1.994	2.299
35	0.479	0.308	0.330	1.171	1.428	1.301	0.867	0.698	0.765	1.810	2.266	2.315
36	0.389	0.438	0.325	1.216	1.210	1.243	0.730	0.837	0.714	1.876	1.911	2.201
37	0.202	N.A.	0.170	1.178	N.A.	1.260	0.366	N.A.	0.378	1.811	N.A.	2.229
10-14	0.454	N.A.	0.379	1.313	N.A.	1.488	0.925	N.A.	1.022	2.037	N.A.	2.693
15-17	0.548	0.400	0.417	1.288	1.475	1.484	1.091	0.925	1.095	1.990	2.313	2.625
50-51	0.554	N.A.	0.482	1.135	N.A.	1.223	0.981	N.A.	1.103	1.770	N.A.	2.289
52-59	0.596	N.A.	0.506	1.176	N.A.	1.172	1.092	N.A.	1.078	1.832	N.A.	2.130
60-67	0.361	0.337	N.A.	1.230	1.484	N.A.	0.770	0.845	N.A.	2.132	2.507	N.A.

Sources: For the St. Louis regional information, see Table V-5. Information on St. Louis S.M.S.A. were computed from Werner Hirsch's study, op. cit., Table 1 and Appendix Tables 1 and 2; for the State of Missouri, they were computed from Floyd Harmston's Input Coefficient Table sent to the author by him and Tables 4 and 5 in his study, op. cit., p. 49 and p. 57.

IV. Impact Analysis: Some Illustrations

A. Exported Transportation Equipment

Sector 12, transportation equipment, exported $1,456 million in 1967 to the outside areas. If one wishes to know what the impact of this exported transportation equipment is, upon the food, tobacco and kindred products industry, textile and apparel industry, lumber and furniture industry and other industries, sectoral multipliers would answer this as follows.

Impact upon:	Model A ($ million)	Model B ($ million)
1. Food, tobacco & kindred	1,456 x 0.0216 = 31.4	1,456 x 0.0002 = 0.3
2. Textile & Apparel	1,456 x 0.0043 = 6.3	1,456 x 0.0002 = 0.3
3. Lumber & Furniture	1,456 x 0.0010 = 1.5	1,456 x 0.0001 = 0.1
All Industries	1,456 x 1.3371 =1946.8	1,456 x 1.0909 = 1588.4

Literally, the outside sales of $1,456 million in Model A would circulate the economy and produce domestically a market of $31.4 million for food, tobacco and kindred products industry, $6.3 million for textile and apparels, etc. For all industries, it generated goods and services of about $1,947 million for the regional market.

Assuming, for simplification's sake, that every impact from the export of transportation equipment are also final to each receiving sector, by employing income change and income multiplier approach, the answer would be the following income changes.

Impact upon:	Income Change ($ million) Direct	Indirect	Induced	Multiplier (Model A)
1. Food, tobacco & Kindred	31.4 x 0.267 = 8.4	31.4 x 0.159 = 5.0	31.4 x 0.241 = 7.6	8.4 x 2.498 = 21.0
2. Textile & Apparel	6.3 x 0.409 = 2.6	6.3 x 0.088 = 0.6	6.3 x 0.299 = 1.9	2.6 x 1.946 = 5.1
3. Lumber & Furniture	1.5 x 0.466 = 0.7	1.5 x 0.204 = 0.3	1.5 x 0.375 = 0.6	0.7 x 2.343 = 1.6

A change of $31.4 million in the final demand for food, tobacco and kindred products would directly lead to a change in personal income of $8.4 million, indirectly $5.0 million, and an induced change of $7.6 million. The overall income effect is $21.0 million. In a like manner, various income effects upon textile and apparel and other industries can be measured. However, the critical assumption mentioned in the preceeding paragraph has to be borne in mind, although it, in fact, may not be true; it is employed only for analytical purposes.

B. Defense Expenditures

It was stressed previously that the federal government expenditures, particularly under the contract of defense projects, had vital importance in influencing regional production and the sales of transportation equipment. The intra-sectoral multipliers also make it possible to measure the overall impact of the federal defense expenditures upon this industry, through their interrelation between this and all other industries.

Column 3 in Table V-7 shows total impact of defense expenditures upon the transportation equipment sector in 1967 measured by Model A. Based on estimated defense expenditures by sector, the total impact would amount to $1,861.8 million, which is equivalent to 52.4% of total sales made by the sector in that year ($3555.6 million, see Table IV-1).

TABLE V-7

Sectoral Impact of Federal Defense Expenditures Upon Transportation Equipment Sector, And Income Impact Upon All Related Sectors, St. Louis Region, 1967
(Amount: Million Dollars)

Industrial Sector	Estimated Defense Expenditure	Upon Transportation Equipment		Personal Income Impact	
		Multiplier	Amount Generated	Multiplier	Amount
Lumber & Furniture	4.4	0.013	0.06	1.045	4.60
Chemicals, Petroleum & Rubber	68.3	0.005	0.34	0.394	26.91
Primary Metals	1.1	0.008	0.01	0.603	0.66
Fabricated Metals	2.2	0.012	0.03	0.686	1.51
Electrical Machinery	62.5	0.009	0.56	0.730	45.63
Transportation Equipment	1826.6	1.016	1855.83	0.366	668.54
Ordinance & Miscellaneous	102.6	0.013	1.33	0.752	77.16
Business, Peronal & Other Services	11.3	0.017	0.19	1.172	13.24
Household	191.7	0.018	3.45	1.531	293.49
Total	2270.7		1861.80		1,131.74

Source: See Chapter V, Federal Government Expenditure Section for the estimation of Defense Expenditures. Sectoral multipliers are reproduced from Table V-1, Transportation Equipment Columns; Income Multiplier, from Household Column.

In economic analysis, the creation of personal income is one of the most valuable researches on which people of various fields have focused their special attention. It is worthwhile to measure the total personal income in the region in 1967, which was attributable to various basic incomes' exogenous final demands. In this case, as a sequential step of illustration, the income multipliers in Model A are utilized to measure the total income input upon various sectors attributable to defense expenditures. Table V-7, the last column, indicates that $1,131.7 million or 14% of total personal income estimated for the region, in 1967, was attributed to the defense expenditures in the region. In other words, if there were not a total federal defense expenditure of $2,270.7 million in 1967 in the region, the regional personal income would have been reduced from $8,065.2 million to $6,933.5 million.

Total personal income generated by the transportation equipment sector in 1967 was $1,245.9, the product of multiplying total final demand sales of $3,404 million by the income multiplier, 0.366. Out of which, $668.5 million or about 54% was contributed by the defense expenditures (see Table V-7). Since the transportation equipment sector contributed the largest share (15.45%) to total regional personal income in 1967 among all sectors, the importance of defense expenditures on this sector's product, in generating personal income, is apparent. As a matter of fact, it contributed 8.29% to the total personal income. Among all industrial sectors, only the construction sector contributed more than this percentage to the total personal income (i.e., 10.66%), except for, of course, the transporation equipment sector itself (see Table V-8).

C. The Relation Between Basic Income and Personal Income

Personal income has been considered as one of the most dominant indicators recording the well-being and growth of a community. Although it is better to state it in real terms to avoid price changes for the purpose of comparison, figures in current dollars will suffice for the present needs in a static I/O study.

By multiplying total personal income change, which is the column of direct, indirect and induced income change in Table V-5, by appropriate figures of total sectoral basic income, the product is the contribution of each sector's basic income to total personal income in the region. Table V-8 portrays individual shares of regional income generated by basic income by respective sectors in 1967.

Among all industrial sectors in 1967, transporation equipment has previously been noted as one of the most important contributors to the regional personal income. Its basic incomes generated more than 15% of the total in the region. Construction ranked second with a share of more than one-tenth in that year. Wholesale trade service made up 7.7%; chemical, petroleum and rubber products, 6.7%; and food, tobacco and kindred products, 6.3% of the total personal income in the region.

These rankings, of course, depend solely on two factors: the volume of basic income and the direct, indirect and induced income changes of any given sector. While the former factor, in turn, depends mostly on export and federal government procurement, the latter factor is subject to industrial interdependence in income generation. The transportation equipment sector, the one with the least value of personal income change, contributed the largest amount of federal procurement and exportation. In contrast, a vivid example comes from the construction sector. Its basic income was about 23% and 57%, respectively, of those of transportation equipment and chemicals, petroleum and rubber products but it generated about 11% of total regional personal income, or is equivalent to 70% and 160% of those generated by the two respective sectors. This is attributed to the high income change ratio exhibited by the construction sector; for every one dollar of basic income, it generated one dollar and nine cents of personal income, resulting from its high labor input and its inter-dependence with other sectors.

TABLE V-8

Basic Income, Income Multiplier And The Generation
And Distribution of Personal Income By Sector, St. Louis Region, 1967

Sector (S.I.C.)	Basic Income[1] ($000)		Personal Income Change		Personal Income ($1,000)	% of Total Income
1. Food, Tobacco & Kindred Products	$ 757,650	x	0.667	=	505,352	6.27
2. Textiles & Apparel	97,696		0.796		77,766	0.96
3. Lumber & Furniture	56,681		1.045		59,232	0.73
4. Paper & Printing	292,451		0.850		248,583	3.08
5. Chemicals, Petroleum & Rubber Products	1,375,349		0.394		541,886	6.72
6. Leather Products	89,304		0.859		76,712	0.95
7. Stone, Clay & Glass	97,154		0.881		85,593	1.06
8. Primary Metals	682,953		0.603		411,821	5.11
9. Fabricated Metals	348,818		0.686		239,289	2.97
10. Machinery (except electrical)	379,853		0.867		329,333	4.08
11. Electrical Machinery	355,584		0.730		259,576	3.22
12. Transportation Equipment	3,404,192		0.366		1,245,934	15.45
13. Ordinance & Miscellaneous Manufacturing	234,598		0.752		176,418	2.19
14. Agriculture	21,639		0.888		19,215	0.24
15. Mining	13,343		0.925		12,342	0.15
16. Construction	788,333		1.091		860,071	10.66
17. Transportation, Communication & Utilities	209,791		0.876		183,777	2.28
18. Wholesale Trade Services	633,053		0.981		621,025	7.70
19. Retail Trade Services	129,193		1.092		141,079	1.75
20. Finance, Insurance & Real Estate	215,639		0.770		166,042	2.06
21. Business, Personal & Other Services	373,076		1.172		437,245	5.42
22. Federal & State Government to Household	800,575		1.531		1,225,680	15.20
23. Federal & State to Local Government	114,141		1.217		138,910	1.72

[1]Basic incomes from the federal government including transfer payments.

D. The Relation Between Basic Income And Local Government Revenues

By the same token, the generation of local government revenues by various sector's basic income and the distribution can also be analyzed. By multiplying the local government multiplier, column 23 in Table V-1, by appropriate sector basic incomes, the product is the amount of local government revenue derived from that sector's basic income.

As they were in the determination of personal income, the amount of basic income and the relevant size of the multiplier are two factors which determine each sector's contribution to the local government revenue. It is quite obvious that figures in the two vectors, household and local government, in Table V-1, are highly correlated. That is to say, sectors having high value in one column also has high value in another. This implies that a general conclusion regarding the generation and distribution of local government revenue by sector could be drawn: those sectors of greater importance in terms of contribution in the above section would also be those in this section, because basic incomes considered by these two sectors are the same.

E. Employment Impact of Final Demand Changes

In addition to income impact of final demand changes, an input-output study can be used to analyze the employment impact of final demand changes. However, this analysis requires the establishment of an employment-production relationship.

Generally, there are two ways to approximate this relationship. One is through time series data estimation and the other by utilizing cross section information. With the assistance of regression techniques, we can run observed employment on observed output by sector over time. The coefficient or the slope so obtained may be considered as marginal propensity and it

would be used as direct impact upon employment change of a certain amount of final demand change.[5] In a similar nature, as indirect and induced income changes were computed, as described in an earlier part of this chapter, the indirect and induced employment change due to changes in final demand can also be measured from this inversed matrix.

The second method, by utilizing cross section data, was advanced by Hansen and Tiebout as mentioned at the beginning of this study. They directly allocated sector employment across the row to the final demand sectors and to various industries, according to this sector's output flow distribution. In other words, employment summed across each row equals total employment in the sector. The reader may recall the approach adopted in this study, which is similar to the Hansen and Tiebout study, but in an inverse relation in finding employment and output distribution. Table IV-2 of this study shows the initial allocation of employment in the sector named at left. Take row 1 in that table as an example: 57% of this sector's total employment is directly related to export and 8% to all industrial groups. Since total regional employment in this sector in 1967 numbered 25,240 (see Table II-2), about 14,392 employees were directly related to export and 2,019 directly related to all industrial sectors.

After the initial allocation of employment has been so obtained for each sector, employment input coefficients can be developed in the same fashion, as input coefficients developed from the transaction flow table for each column sector.

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[5]This approach was employed by Frederick T. Moore and James W. Peterson, op. cit., p. 377 and Werner Z. Hirsch, op. cit., p. 367.

Each entry would then disclose the number of jobs for the row sector that are related directly to employment in a column sector. The inversed matrix of this table can then be used to show the direct and indirect effects of changes in a sector's employment. Of course, the coefficient table was subtracted from an identity matrix before the inversion. In order to estimate the induced effect of any change in one of the final demand sectors, some other final demand sectors must be included in the endogenous segment before the subtraction and, sequentially, the inversion is performed.

The direct employment change derived from the second method can be regarded as an average propensity in the employment-production function. Employment multipliers derived from these cross section data may be biased in some economy where the measured average propensities are different from the relevant marginal propensities. However, "where the changes in values are upward, and brought about by new entries into the labor force," as argued and stressed by Hansen and Tiebout, "average propensities are the appropriate measure."[6]

Therefore, whether time series or cross data is to be implemented to investigate the employment-production function, the problem hinges on the conditions of an economy which the reader tries to analyze. In addition, whether marginal or average propensities are to be used as direct effect, sometimes also depends on the nature of the data available. Needless to say, multipliers derived from the two methods also differ because of the different values of the measured direct changes.

Due to limited time and budget, the empirical part of this employment impact analysis is omitted in this study. Nonetheless, it will be tackled later in a sequential study to follow.

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[6]W. Lee Hansen and Charles M. Tiebout, op. cit., p. 417.

Chapter Six: Summary And Conclusion

Any local economy can grow by introducing new industries and/or by expanding industries in the area. However, any of these changes in one industrial sector tend to affect numerous parameters in the private, as well as the public sector of that economy. For instance, the expansion of transportation equipment industries--the sector which ranked first in terms of total value sold and whose basic incomes generated the most personal income in 1967 in the St. Louis region--will directly lead to an increase in input purchases of goods and services for a given level of existing output. This increased purchase immediately affects prices and income and indirectly affects other industries. Changes in price and income would, in turn, change the demand for goods and services through the interrelationship between prices, income, consumption and, possibly, investment. Consequently tax receipts in the public sector cannot be unaffected. The changed receipts, in turn, affect the provision of social goods and services. Through innumerable complicated links these public and private variables are tied together. Any change will impose its effect upon one another and also respond to the second round effect.

The input-output analysis presented in this study helps anatomize the economic structure of this region in terms of sales and purchases and the interdependent relationship among all industrial sectors. In addition to providing systematic, quantitative reference schemes for discussing the existing economic conditions, it provides a means of estimating a sector's final effects under specific assumptions, with respect to exogenous changes. From income and employment changes the regional primary growth is measured. "Area input-output analysis can be a helpful tool in guiding planners of industrial development schemes," states Professor Hirsch, "It can be used to elicit support for area-wide development and to persuade members of the community to take an

active part in weighing alternative plans for their area."[1]

To be more specific, "One of the big advantages of this method," as indicated by Ross and Harmston, "is that it allows the analyst to follow the effect of a particular action through the economy and to identify the end results with the segments affected."[2]

Using models A and B of this study, one can easily allocate the activity impact through sectoral multipliers of any sectoral change in final demand, regardless of the cause of this change. This type of analysis has been thoroughly discussed in Chapter Five. Take, as an example, the expansion of the transportation equipment sector, the most dominant sector in the region, which sold 92% or $3.3 billion of its total production in 1967 to the federal government and outside customers. Hence, it contributed substantially to the favorable regional trade with outside areas. A $100 million increase in final demand for the area's transportation equipment, say, coming from federal defense spending, will result in the expansion of other sectors by the following amounts, when investment expenditure and its consequences are ignored:[3]

	($ million)		($ million)
Food, Tobacco & Kindred	2.2	Transportation Equipment	101.6
Textile & Apparel	0.4	Ordinance & Miscellaneous	0.8
Lumber & Furniture	0.1	Agriculture	0.1
Paper & Printing	0.8	Mining	0.1
Chemicals & Petroleum	0.6	Construction	0.5
Leather Products	0.1	Transportation, Communication & Utilities	5.6
Stone, Clay & Glass	0.2	Wholesale	0.9
Primary Metals	1.7	Retail	5.6
Fabricated Metals	0.6	Finance, Insurance & Real Estate	6.1
Machinery (except electrical)	0.6	Business, Personal & Other Services	4.8
Electrical Machinery	0.2	Household	36.6
		Local Government	2.0

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[1] Werner Z. Hirsch, "An Application of Area Input-Output Analysis," Papers and Proceedings of the Regional Science Association, Vol. 5, 1959, p. 89.

[2] D. Reid Ross and Floyd K. Harmston, "Input-Output Studies--As Tools for Planning," Business and Government Review, May-June, 1964. University of Missouri, p. 33.

[3] Werner Hirsch, op. cit., Table 1, p. 82 had relevant data for 1955.

Total defense expenditures on the transporation equipment sector in 1967 were estimated to be $1,827 million. Therefore, its indirect impact upon other sectors can be readily computed from the above statistics. Conversely the indirect impact upon the transportation equipment sector, of defense expenditures on other sectors, can also be measured. In 1967, defense expenditures on sectors other than transportation amounted to $444 million. Indirectly these expenditures created ~~$697~~ $715.97 million of market for the transportation sector (see Table V-7). In addition to the activity generated, personal incomes generated by the defense expenditure were also computed and presented in Table V-7. The defense expenditures generated, through multiplier effects, more than 14% of total regional personal income in 1967 ($8,065 million).

Since much has been presented to demonstrate the usefulness of this study, it may be desirable at this point to discuss some interesting findings on the characteristics of the St. Louis regional economy.

Out of total regional sales of goods and services in 1967 ($17,977 million), excluding household and local government sector, one-fifth was accounted for by the transportation equipment sector and 9% by the chemical, petroleum and rubber products sector. The agriculture and mining sectors accounted for very little; together they contributed less than 1% to the total sales. Almost all service-oriented sectors were of similar but rapidly growing importance, as was the chemical, petroleum and rubber products sector, in terms of total sales.

In terms of import-export trade, the area enjoyed a favorable balance of payment with net exports of $966 million in 1967. The chemical, petroleum and rubber products sector alone earned more than 67% of that net gain, because more than 80% of its total production was delivered outside the area. Nevertheless, the leather and leather products sector exported, percentage-wise, the most, 82% of its total production. By including sales to the federal government, the transportation equipment sector again overwhelmingly dominated;

it sold 51% and 41%, respectively, of its total production to the federal government and to outside customers, in that year. Subtracting from its sales of 92%, the imported materials, goods and services, this sector's net gain in absolute amount was even greater than total regional gain from the trade.

The federal government has had a very great influence over the regional economy; it contributed more than $3 billion to the region's basic income. However, more than 55% of this amount was paid to the transportation equipment sector and most expenditures on transportation equipment were related to defense contracts and space products. Moreover, a well-known local firm was almost solely responsible for this production.

These phenomena characterize the St. Louis economy. The potentiality for this area's economy to grow at an increasing rate therefore, probably hinges on several aforesaid factors. But the fact that the transportation equipment sector had not only the second lowest direct income effect, but very low income multipliers in both models, with respect to any change in final demand, as well, should not be overlooked. This indicates that for the same amount of final demand change, the transportation equipment sector could not add (subtract) as much income to (from) the region as those sectors with higher income multipliers. This is the main reason that Chapter Five deals only with interactions and impacts, while Chapter Four describes only the regional economic structure. The goals of economic stability and growth may not be contradictory, but for analytical purposes it may be worthwhile to dichotomize between them.

This study, like the one done by Hirsch for 1955, reveals astonishingly low household technical coefficients and multipliers for many industries. They testify to the vital dependence of this region's economy on the rest of the U. S.

This study discloses the structure of the St. Louis economy, and indicates what effects would accrue from one industry's expansion. It tells little, if anything, about which industry should be expanded or contracted. Nor does it present any social or economic advantages or disadvantages of this area which might influence industries contemplating locating in this area.

Due to its static nature the study shows no trend pattern, and any prediction or forecast made from its utilization is valid only for that "one shot" picture. Moreover, the reliability of this picture depends to a large extent upon that of the data sources. For the above reason, this study has attempted where possible, to make comparisons to other studies, in order to provide some insight into changes in the economic structure over time and their differences from area to area. Due to different sector classification among studies, structure and impact comparisons could not be made as precisely and as detailed as desired. Inaccurate and unreliable data are always the causes of a biased study and the greater the number of sectors, the higher the probability of biased results.[4] A manufacturing sector consisting of one two-digit S.I.C. code would probably be feasible and desirable for this region in view of the difficulties in data collection and possible use of this analysis.

For all service-oriented industries, an intensive field survey should be conducted, due to their diversified characteristics, even within each two-digit S.I.C. code. A stratified sampling method, in the author's opinion, serves much better than an employment percentage coverage method, starting with the larger firms. Of course, this work is highly subject to budget and time constraints.

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[4]This has been proved in many studies; for reference see William R. Bailey, "A Note on the 1947 Input-Output Study," The Review of Economics and Statistics, Vol. XLX, No. 1, February, 1968.

In order to cope with the rapid technical progress, especially in an economy with some industries employing advanced technology in production, such as St. Louis' chemical and aircraft industries, this I/O table has to be reconstructed or at least revised every five years if its costs are justifiable in relation to its benefit to the community.

As there are many empirical improvements which can be made, so too, there are many theoretical advancements that can be framed. For a better measure of income multiplier and, hence, impact analysis, a linear, but heterogeneous income-consumption function among sectors can be introduced to the model. Eventually a non-linear income-consumption function, in light of non-promotional or permanent hypotheses, may be worthwhile to try.

A further refinement that one can make is to incorporate investment theories in the study for St. Louis. Finally, the author would agree to the need for immediate initiating an inter-regional input-output study among the St. Louis region, the Kansas S.M.S.A. and the State of Missouri.

In conclusion, a simple mathematical presentation of the development of the tables used in this study is contained in Appendix VI-1.

APPENDIX II-2

1. Name of Establishment
2. Address of Establishment
   (If your firm has more than one plant, please list the address of each establishment in the St. Louis S.M.S.A.)
3. Respondent's name(s)
4. Respondent's position(s)
5. Percent of your firm's total output produced in the St. Louis Metropolitan Area _____%
6. Average monthly employment 1965 _____
7. Total wages and salaries (payroll), 1965 $_____
8. Please list the types of products which you manufacture or sell in order of importance and the wages paid to produce each product. (Please specify the products from the list given in Appendix A)

Product	Wages
a.	a. $
b.	b.
c.	c.
d.	d.
e.	e.
f.	f.
g.	g.
h.	h.

Total Wages allocated to manufacturing $_____

Total Wages allocated to:

Administrative & Central Office $ _____

Research & Development $ _____

Total Wages $ _____

9. Materials and Services (Inputs) Used in Producing Products

Type of Product Sold (Listed in Question 8) (1)	Type of Materials and Services Used in Production (Please specify for each type of product produced) (2)	Total Cost (3)	Transportation Costs of Materials that cannot be allocated by product (4)

10. Source (Geographic) of Materials and Services Used in Production

Type of Materials and Services Used in Production (From Question 9, Column 2)	Per Cent Purchased From						
	Wholesalers or Jobbers			Other Manufacturing or Processing Firms or Plants			Other
	In St. Louis SMSA	Outside St. Louis SMSA but in Mo. or Ill.*	Outside Mo. & Ill*	In St. Louis SMSA	Outside St. Louis SMSA but in Mo. or Ill.*	Outside Mo. & Ill.*	Please Specify sector & location
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)

*Please treat intra-firm shipments of materials from outside the SMSA in the same manner as you would treat purchases from another firm.

11. Sales (Value of Shipments)

Type of Product Listed in Question 8	Sales Value of Shipments (nearest $1,000)	Transportation costs of your sales that cannot be allocated by product	Per Cent Sales to									
			Households	Retail Establishments			Wholesalers, Distributors, Manufacturers, Jobbers and/or Representatives			Other Manufacturing or Processing firms			Other Please Specify Sector & Location
				In St. Louis SMSA	Outside St. Louis SMSA but in Mo. or Ill.*	Outside Mo. & Ill.	In St. Louis SMSA	Outside St. Louis SMSA but in Mo. & Ill.*	Outside Mo. & Ill.&	In St. Louis SMSA	Outside St. Louis SMSA but in Mo. or Ill.&	Outside Mo. & Ill.*	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)

*Please treat intra-firm shipments of products outside the SMSA in the same manner as you would treat sales to another firm.

12. Products Shipped to Other Manufacturing Firms or Establishments

Type of Product Sold (Listed in Question 8)	Sales to Other Manufacturing or Processing Firms					
	In St. Louis SMSA		Outside St. Louis SMSA but in Mo. or Ill.*		Outside Mo. & Ill.*	
	Purchasing Industry	Value	Purchasing Industry	Value	Purchasing Industry	Value
(1)	(2)	(3)	(4)	(5)	(6)	(7)

*If the information requested in Columns 4-7 is not available or is too difficult to obtain, please omit and continue to question 13.

13. Expenditures on Power and Energy
    a. Coal
    b. Gas
    c. Oil
    d. Electricity

14. Transportation Expenditures

Mode of Transportation (1)	Cost (2)	Per Cent of Cost * Personnel Travel (3)	Freight in (4)	Freight out (5)
Rail	$_____			
Truck				
a. Own	$_____			
b. Public Carrier	$_____			
Barge				
a. Own	$_____			
b. Public Carrier	$_____			
Air				
a. Own	$_____			
b. Public Carrier	$_____			

*If the information requested in columns 3-5 is not available or is too difficult to obtain, please omit.

15. Taxes, 1965
    a. Federal $_____
    b. State $_____
    c. Local $_____

16. Investment Expenditures of your firm in 1965

		% St. Louis SMSA	% Outside Local area
a. Plant	$_____	_____	_____
b. Equipment	$_____	_____	_____
c. Land	$_____	_____	_____

17. Inventory Change 1965 (+ increase, - decrease)
    a. Final products
    b. Raw material

Instruction on specific questions --

Question 5	Average Employment. This is the Census definition. If you have to calculate a figure it should be the average of employments during March, May, August, and November of the year used. Please include wage and salary employees in this figure.
Question 6	Wages and Salaries (payroll). This should be the definition used for Federal withholding tax calculations. It includes all compensation such as commissions, bonuses, vacation pay, etc., before deductions of taxes and other similar items.
Question 9	Materials Used in Production. Costs should be the amounts paid (after discounts and including freight charges) for materials and components actually put into production during the year. If you pick up items in your own trucks or otherwise cannot include freight charges, please indicate in the right hand column. Note that components purchased through contracts or subcontracts should be included.
Question 11	Sales (value of Shipments). Sales should be after discounts and allowances, f.o.b. plant, and excluding excise taxes and freight charges. (If freight charges cannot be excluded, or if you deliver in your own trucks, please indicate so in column 3.)

The St. Louis Standard Metropolitan Area (SMSA) includes the following counties:

1. City of St. Louis
2. St. Louis
3. Jefferson
4. St. Charles
5. Franklin
6. St. Clair
7. Madison

CONFIDENTIAL

APPENDIX II-3

PRODUCT STUDY OF THE ST. LOUIS REGIONAL AREA

NOTE: This questionnaire applies only to the establishments of your firm located in the St. Louis Regional Area:

The St. Louis Regional Area, consists of the City of St. Louis, the Missouri counties of Franklin, Jefferson, St. Charles, St. Louis, and the Illinois counties of Madison, Monroe, and St. Clair. (See map on Letterhead)

Please give information for the fiscal 1967 or most recent year for which figures are available.

These figures are for fiscal year 19____.

1. What is your average yearly employment?_____
2. Optional Question: To verify the accuracy of this study, if you do not have any objections, please give dollar figures for this question only:
   (2a) Total dollar sales_____
   (2b) Total dollar costs of goods sold_____
3. What percentage of your total yearly sales are to wholesalers?____%

In the following questions, if you sell to wholesalers, please disregard this fact and estimate where your wholesalers sell your product.

PART I: DISTRIBUTION OF SALES

4. Estimate your yearly sales between:
   (4a) Those sold within the St. Louis Regional Area. (See definition and Map) (4a) ___ ___%
   (4b) Those sold outside the St. Louis Regional Area plus to the Federal Government (4b) ___ ___%
   Total Equals 100% of Sales

5. Distribute your yearly sales outside the St. Louis Regional Area and to the Federal Government (4b) between;
   (5a) Sales to the Federal Government (5a) ___ ___%
   (5b) Sales other than Federal Government (5b) ___ ___%
   Total Equals 100% of (4b)

6. Of those yearly sales within the St. Louis Regional Area(4a), Distribute those sales;
   (6a) Directly to the consuming public (6a) ___ ___%
   (6b) To state and local governments (6b) ___ ___%
   (6c) To local firms (6c) ___ ___%
   Total Equals 100% of (4a)

7. Distribute your yearly sales to local firms (6c) between sales of
   (7a) Capital Goods (Machinery and Equipment) (7a) ___ ___%
   (7b) Non-capital Goods (7b) ___ ___%
   Total Equals 100% of (6c)

8. Distribute your yearly sales to local firms of non-capital goods (7b) among;

(8a) Agriculture, forestry and fisheries	(8a)	___ ___%
(8b) Mining	(8b)	___ ___%
(8c) Contract construction	(8c)	___ ___%
(8d) Transportation	(8d)	___ ___%
(8e) Manufacturing	(8e)	___ ___%
(8f) Retail Trade	(8f)	___ ___%
(8g) Finance, Insurance, and Real Estate	(8g)	___ ___%
(8h) Services	(8h)	___ ___%
(8i) Other (please Specify)	(8i)	___ ___%
Total Equals		100% of (7b) Sales

9. Distribute your yearly sales of non-capital goods to local manufacturing firms (8e) among;

(9a) Food and Tobacco	(9a)	___ ___%
(9b) Textiles and Apparel	(9b)	___ ___%
(9c) Lumber and Furniture	(9c)	___ ___%
(9d) Paper and Printing	(9d)	___ ___%
(9e) Chemical, Petroleum and Rubber Products	(9e)	___ ___%
(9f) Leather and Plastic Products	(9f)	___ ___%
(9g) Stone, Clay and Glass	(9g)	___ ___%
(9h) Primary Metals	(9h)	___ ___%
(9i) Fabricated Metals	(9i)	___ ___%
(9j) Machinery (except Electrical)	(9j)	___ ___%
(9k) Electrical Machinery	(9k)	___ ___%
(9l) Transportation Equipment	(9l)	___ ___%
(9m) Miscellaneous Manufacturing	(9m)	___ ___%
(9n) Other (please Specify)	(9n)	___ ___%
Total Equals		100% of (8e)

PART II: DISTRIBUTION OF COSTS AND EXPENSE

10. Distribute your total costs and expenses among;

(10a) Raw Materials Purchased (including freight charges)	(10a)	___ ___%
(10b) Semi-Finished Goods Purchased (including freight charges)	(10b)	___ ___%
(10c) Labor, Wages and Salaries	(10c)	___ ___%
(10d) Interest Costs	(10d)	___ ___%
(10e) Depreciation	(10e)	___ ___%
(10f) Power and Energy	(10f)	___ ___%
(10g) Transportation of Finished Products, F.O.B. Destination	(10g)	___ ___%
(10h) Other (please Specify)	(10h)	___ ___%
Total Equals		100% of Costs

11. Distribute your total cost of goods sold (Costs directly related to production) among:

(11a) Raw Material Purchases (including freight charges)	(11a)	___ ___%
(11b) Semi-finished goods (including freight charges)	(11b)	___ ___%
(11c) Raw Material and Semi-finished goods (from inventory)	(11c)	___ ___%
(11d) Labor, wages, and Salaries (e.g., production workers)	(11d)	___ ___%
(11e) Interest	(11e)	___ ___%
(11f) Depreciation	(11f)	___ ___%
(11g) Power and energy	(11g)	___ ___%
(11h) Other (please Specify)	(11h)	___ ___%
Total Equals		100% of Cost of Goods Sold

12. Distribute your yearly total cost of goods sold(labor, materials, and Charges) between;

(12a) Purchases and Expenditures within the St. Louis Regional Area (12a)___ ___%

(12b) Purchases and Expenditures outside the St. Louis Regional Area (12b)___ ___%

Total Equals 100% of Cost of Goods Sold

13. Please describe briefly any major changes in your firm (i.e. acquisitions, new products, reorganization, etc.) which may have changed greatly any of the above distributions as compared with 1965.

Thank you for your cooperation.

D. Reid Ross
Executive Vice President

For information or assistance concerning this form please contact:

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APPENDIX IV-1

Development Of The Tables

Table IV-1 reflects sales and purchase relationships among the twenty-one sectors which constitute the regional economy. That is to say that their transactions frame the local market structure. Table IV-3 represents the computed input coefficients from IV-1; each entry in a column of Table IV-3 is the quotient of that column entry in Table IV-1 divided by the row total of that sector.

Tables V-1 and V-2 are the transposed inversed matrixes of Table IV-3, including and excluding household and local government sectors, respectively.

Theoretically, the tables are developed as follows, where i refers to row sector and j to column.

Total sales of sector i, S_i, were distributed among sectors of j as inputs, $\sum_{j=1}^{23} X_{ij}$; and to final demand sectors, F_i.

Therefore, equation (1) represents the market sales relation of the ith sector or the row vector in Table IV-1.

$$S_i = \sum_{j=1}^{23} X_{ij} + F_i \quad \ldots \ldots (1)$$

Total purchases of input of the jth sector, P_j, is the sum of expenditures on all locally produced input, $\sum_{i=1}^{23} Y_{ij}$, and other exogenous payments, O_j.

Equation (2), therefore, indicates a column vector discribing the amount purchased by the jth sector from all sectors.

$$P_j = \sum_{i=1}^{23} Y_{ij} + O_j \quad \ldots \ldots \ldots \ldots \ldots (2)$$

Input coefficients for the jth column sector, a_{ij}, are calculated by dividing each entry in the jth column by the total sales from the appropriate row. That is:

$$a_{ij} = Y_{ij} / S_i \quad \ldots\ldots (3)$$

Therefore, Table IV-3 actually consist of the input coefficient matrix, A. Only when imported materials and goods are appropriately and adequately allocated by sector, can it be considered as a technical coefficient table.

$$\begin{bmatrix} a_{1,1} & a_{1,2} & a_{1,3} \cdots & a_{1,23} \\ \vdots & & & \vdots \\ a_{23,1} & a_{23,2} & a_{23,3} \cdots & a_{23,23} \end{bmatrix} = A$$

However, with inventory adjustment, sales equals purchases for all sectors in this static equilibrium input-output model. All outputs were either used as input in the industrial sectors or consumed by the final demand sectors. That means that we can study the economy either by tracing each sector's sales distribution or by investigating their purchases pattern. Following the sales distribution we have:

$$\begin{bmatrix} a_{1,1} \cdots a_{1,23} \\ \vdots \quad \vdots \\ a_{23,1} \cdots a_{23,23} \end{bmatrix} \begin{bmatrix} S_1 \\ \vdots \\ S_{23} \end{bmatrix} + \begin{bmatrix} F_1 \\ \vdots \\ F_{23} \end{bmatrix} = \begin{bmatrix} S_1 \\ \vdots \\ S_{23} \end{bmatrix} \quad \ldots\ldots (4)$$

or, $AS + F = S$ in matrix form. Rearranging the matrixes,

$F = (I-A)S$ and finally $F\,(I-A)^{-1} = S \quad \ldots\ldots (5)$

$(I-A)^{-1}$ represents Table V-1 before it is transposed. The transposed $(I-A)^{-1}$ links total sales to final demand by sector. It tells how many outputs are required from all sectors to satisfy the given amount of final demand for one sector's product, holding other things constant.

For a similar development in linear programming form, the Leontief statical system is well presented in the Linear Programming and Economic Analysis.[1]

[1]Robert Dorfman, Paul Samuelson and Robert Salow, Linear Programming and Economic Analysis, McGraw-Hill, New York, 1958.

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