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NEW ENGLAND AGRICULTURAL ECONOMICS COUNCIL

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MULTIREGIONAL INPUT-OUTPUT ANALYSIS[1/]

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Within the last five to ten years, the government and industry have become increasingly concerned with regional growth in the United States. The federal government is interested in the way that federal expenditures are dispersed among communities. State and local governments are becoming increasingly anxious to obtain their "fair share" of federal funds and are beginning to develop programs of their own to assist areas within their state or cities and counties. Industries are seeking information on differences between areas of the United States which might affect their location of new plants. They want to know what regional variations in the prices of inputs may significantly affect the location decision.

Fifteen years ago, Professor Leontief wrote:

> In recent years,..., the output of economic facts and figures by various public and private agencies has increased by leaps and bounds. Most of this information is published for reference purposes, and is unrelated to any particular method of analysis. As a result we have in economics today a high concentration of theory without fact on the one hand, and a mounting accumulation of fact without theory on the other. The task of filling the "empty boxes of economic theory" with relevant empirical content becomes every day more urgent and challenging.[3/]

Today, fifteen years later, the number of "economic facts and figures" seems to be multiplying at an even faster rate. This proliferation of data will continue as both government and business place more and more emphasis on the need for regional analysis. Input-output tables will be used increasingly for regional studies, since the tables provide a systematic framework for analyzing regional variations and growth.

Description of an Input-Output Table

Each national input-output table contains detailed information on the purchases of and sales by each industry within the economy. Each row of the table provides complete information on the distribution of an industry's total output to intermediate and final users within the economy. For example, from the 1958 input-output table, we learn that agriculture produced a total gross domestic output of $49.1 billion.[4/] Of this total, $41.2 billion (83.9 percent) was consumed by intermediate users before being sold in some more finished form to final users. The intermediate purchases included: $13.2 billion purchased by the agricultural industry itself, $21.1 billion by the food and

1/ This paper is a revised version of a speech given at the June 1966 meeting of the New England Agricultural Economists at the University of Rhode Island. I especially thank Robert Edelstein for his assistance in gathering the statistics presented in the paper.

2/ Harvard Economic Research Project, Cambridge, Massachusetts.

3/ Wassily Leontief, "Input-Output Economics," Scientific American (October 1951), p. 3.

4/ For this discussion, the agricultural industry is defined to include input-output sectors 1 (Livestock and Livestock Products) and 2 (other Agricultural Products) from the 1958 table: U. S. Department of Commerce, Office of Business Economics, The Survey of Current Business, Vol. 45, No. 9 (September 1965), Table 1 - Interindustry Transactions, 1958, pp. 34-35.

kindred product industry, $1.1 billion by tobacco, $1.3 billion by broad and narrow fabric industries, and $4.5 billion represent many smaller intermediate purchases by other industries. The remaining $7.9 billion was purchased by final demand units within the economy, including: private consumers, local, state, and federal governments, investors, and exporters. (The final demand total includes an increase in inventories of $1.0 billion.)

Each column of the input-output table shows the amount that any one industry in the economy purchased from each of the other industries. For example, proceeding down the column which shows the purchases by agriculture in 1958, we find that agriculture purchased $1.4 billion from agricultural services, $3.0 billion from food and kindred products, $1.2 billion from chemicals and selected chemical products, $0.9 billion from petroleum, $0.8 billion from transportation and warehousing, $2.0 billion from wholesale and retail trade, $2.1 billion from real estate and rentals, $0.8 billion from business services, etc. The final entry in the column, $20.8 billion, shows the amount of value added in the agricultural industry. This value added element can be broken into labor inputs (wages and salaries paid by the industry), capital inputs, and all other factor inputs.

To show the structure of each industry, i.e. the amount of each input required per unit of total output, each column of the input-output table is divided by the total output figure for the respective industry. The new coefficient table which results shows the direct requirements by each industry per unit of output.[5/] For example, we see from the direct coefficient table that for every dollar of gross domestic output produced in 1958 by agriculture, 2.4 cents of chemicals was purchased.

Although the national input-output table provides more information on the structure of the economy than the national income statistics, still more data are required for a regional analysis. The national input-output table itself becomes outdated as changes occur in the structure of industries. In addition, the input structure of many industries varies from one region of the country to another. For example, around Detroit, the auto industry will have a large input from the steel industry; however, in other sections of the country, the auto industry is comprised mainly of assembly plants; thus, if a regional table were constructed for New England, the amount of direct input from the steel industry into the auto industry may be infinitesimal.

General Scope of Multiregional Input-Output Analysis

Essentially, there are two approaches to a multiregional analysis using input-output:

1) Regional studies can be undertaken for each region in the economy; then, the results from the individual studies can be combined to form a national input-output table, or
2) Regional tables can be developed using the data in the national input-output tables as control totals.

5/ In order to determine what increases in purchases result from an increase in final demand for an industry's product, the economic analyst requires a table of inverse coefficients. These coefficients give the direct and indirect demand generated by a unit increase in final demand. The direct coefficients described in the text show the input structure of each industry. For a comprehensive description of the theoretical input-output system, refer to: Hollis Chenery and Paul Clark, Inter-industry Economics (New York: John Wiley & Sons, Inc., 1962).

To obtain a consistent national table, the first approach requires a high degree of co-ordination among all regional research agencies and an agreement on a common classification scheme for gathering the basic empirical data. In some places, such as the Colorado River Basin,[6] the state of Mississippi,[7] and the city of St. Louis,[8] research teams have conducted surveys to gather regional data, but extensive, comprehensive, regional surveys in each area of the country never have been attempted.[9] The second approach, where the national table provides the basic control totals, will be the basis for the remaining discussion.

A multiregional input-output model provides a framework for consistent estimations of output and employment for individual industries by region and for a simultaneous determination of the interregional transfers of goods and services. A great variety of special studies can be undertaken within the multiregional framework. One can analyze, for example, the economic impact on industries and regions within the United States of particular changes in selected components of final demand. What would be the employment impact in each industry and region of increasing government expenditures? (This particular problem will be discussed in more detail later.) The effect of changes in regional wages and profits can be traced in detail. The model also provides a basis for analyzing the transportation requirements by industry and region. For this last purpose, the trade flows should be disaggregated by mode of transport.

An even more important objective at the present time is to develop a multiregional input-output model which can be used for projections of the American economy, say, to the years 1975 and 1985. Such a model will be capable of determining the differential rates of growth in various regions over the next ten to twenty years. Two studies recently completed at the Harvard Economic Research Project illustrate how input-output can be used for multiregional analysis.

Arms Cut Study

In the first study, the economic impact of a reduction of 20 percent in military spending was assessed for each of 19 regions of the United States.[10] The basic assumption was that other final demands would increase sufficiently to keep total wages and salaries at a constant level. For the analysis, industries were separated into two groups: National and Local. The distinction was based on the fact that an economy-wide demand exists for the output of some goods, which we call National goods, while for other goods, which we call Local goods, all of the output produced within a given region

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6/ William H. Miernyk, The Elements of Input-Output Analysis (New York: Random House, 1965), 62-63.

7/ John G. D. Carden and F. B. Whittington, Jr., Studies in the Economic Structure of the State of Mississippi (Mississippi: Industrial and Technological Research Commission, 1964), Vols. I, II.

8/ Werner Z. Hirsch, "Interindustry Relations of a Metropolitan Area," The Review of Economics and Statistics, XLI (November 1959), 360-69.

9/ Various censuses, such as the Census of Manufacturers, do collect data by region, but there still is a need to obtain data which provides consistent and co-ordinated coverage of all industries.

10/ Wassily Leontief, et al., "The Economic Impact -- Industrial and Regional -- of an Arms Cut," Review of Economics and Statistics XLVII (August 1965), 217-41. The statistics quoted in this section are taken from the article.

is consumed within the same region. Transportation, trade, communications, and many service industries typically fall within the Local industry classification; furniture, aircraft, and machinery industries generally are included in the National industry category.

The actual computations were carried out in three stages. In the first stage, the total effect of the shift from a military to a non-military bill of goods was estimated, using the 1958 input-output table of coefficients. The regional distribution of the direct and indirect effects of the shift was determined in the last two stages of the computations. The change in output of National industries was apportioned as a uniform percentage change to each region. For example, the output of the aircraft industry decreased 16 percent by the hypothetical shift from military to non-military demand; then, each region which produced aircraft was assumed to reduce production by 16 percent. The reduction in absolute terms, of course, varied from one region to another.

In the last stage of the computations, the shift in the output of Local industries was distributed to regions. In addition to providing inputs to Local industries within the region, deliveries were made to National industries located within the region and to the final demand units (both civilian and military) located within the region.

For the geographic distribution of the change in output of Local industries, the input-output table was closed with respect to households. Previously, households was treated as a part of the final demand column and value added row; now, households was considered as another industry. Each coefficient in the household industry column described the amount purchased by consumers of a particular good per dollar of total wages and salaries of consumers. Each coefficient along the row described the amount of labor purchased (in terms of total wages and salaries) per unit of total output produced in each industry. The labor input varied greatly from one industry to another. The labor coefficient for the tobacco industry was .07, indicating that for each dollar of output, the tobacco industry paid only 7 cents in labor costs. Motor vehicles, on the other hand, paid about 19 cents per dollar of output.

Since the composition of military demand for goods and services was vastly different in 1958 from the composition of non-military final demand, the hypothetical decrease of 20 percent in military expenditure was compensated by an increase of only 1.8 percent in other final demands. The differences in the product mix of the two bills of goods meant that a total of $7.6 billion of additional non-military spending was required to offset the withdrawal of $6.3 billion of military demand.

For New England, the result of the hypothetical change in military expenditure can be broken down as follows:

Table I

CHANGE IN LABOR EARNINGS IN NEW ENGLAND

National industries	Gross decrease	$117.7	million
	Gross increase	-53.5	"
	Net increase	-64.2	"
Local industries	Gross increase	113.9	"
	Gross decrease	0.0	"
	Net increase	113.9	"

Source: Wassily Leontief, *et al.*, "The Economic Impact -- Industrial and Regional -- of an Arms Cut," *Review of Economics and Statistics*, XLVII (August, 1965), pp. 235-237.

Within the Local industries in New England, trade ($49.2 million), finance and insurance ($11.4 million), and medical and educational services ($11.8 million) showed the largest increases in labor earnings.

The total percentage change in output and employment for New England was -0.06 percent, while the state of California had the largest decrease in employment and output--a total of 1.9 percent. In general, those states which produced large relative quantities of aircraft, ordnance, and electronic equipment had the largest decreases in employment since these were the industries most affected by the hypothetical decline in military spending. The compensating increases in non-military final demand were concentrated in the soft consumer goods and service industries.

The arms cut study illustrates the type of analysis which is possible using multiregional input-output techniques. In this case, the entire regional analysis was carried out without explicitly determining the interregional shipments which occur among regions. For other types of regional analysis, interregional shipments often must be estimated.

Interregional Shipment Study

The second study recently completed at the Harvard Economic Research Project utilized the basic Leontief intranational input-output model just described to test alternative transportation models.11/ Although by definition the Local industries do not ship goods between regions, the interregional shipments of National goods still must be estimated. We have just described how the regional outputs for each industry can be determined by separating industries into Local and National groups. From the same basic computations, the total amount consumed by each industry within a region can be established.

In the second study, the regional production and consumption totals were assumed to be known. Then, alternative transportation models which can be incorporated within the general equilibrium input-output system were tested using actual shipment data available for fresh fruits and vegetables.12/ Comparable sets of data are published for rail and truck for the years 1960-64. These data were collected by the United States Department of Agriculture by states and for individual fruits and vegetables; thus, the models could be tested for sensitivity to aggregation.

The basic models tested included the fixed column coefficient trade model, the fixed row coefficient trade model, a gravity model and a consistent estimate of the gravity model. Chenery and Moses used the fixed column coefficient trade model in their separate efforts (Chenery for Italy and Moses for the U.S.A.) to test empirically a multiregional input-output model.13/ Moses later tried a linear programming model, but the aggregate nature of the data contributed to rather implausible empirical results.14/ Leontief has

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11/ Karen R. Polenske, "A Case Study of Transportation Models Used in Multiregional Analysis," (unpublished Ph.D. thesis, Department of Economics, Harvard University, May 1966).

12/ U. S., Department of Agriculture (USDA), Agricultural Marketing Service, Fresh Fruit and Vegetable Unloads by Commodities, States and Months, Volumes for 1960 through 1964.

13/ Hollis Chenery, "Regional Analysis," in The Structure and Growth of the Italian Economy, ed. Hollis Chenery and Paul Clark (Rome: U.S. Mutual Security Agency, 1953). Leon N. Moses, "The Stability of Interregional Trading Patterns and Input-Output Analysis," The American Economic Review, XLV (December 1955), 803-32.

14/ Leon N. Moses, "A General Equilibrium Model of Production, Interregional Trade, and Location of Industry," The Review of Economics and Statistics, XLII (November 1960), 373-97.

advocated the use of a gravity model[15] because it is designed to operate with a limited amount of factual data, and it allows for the occurrence of apparent cross-shipments, i.e. for a transfer of the same good to occur in both directions between some regions. The linear programming model was not tested specifically because it does not allow cross-hauls to exist.

The overall errors of estimation for the fresh fruit and vegetable unloads were determined for the four models. In each case, the consistent estimate of the gravity model provided the most accurate (overall) estimate of the actual fruit and vegetable unloads.

The gravity model tested in the transportation study just described can be incorporated within the multiregional input-output model in the manner described by Leontief and Strout.[16] The regional outputs and shipments then are determined simultaneously.[17]

The preceding has given a brief summary of the input-output scheme and has described how a multiregional input-output model was used to analyze specific problems such as the economic impact of an arms cut or to evaluate alternative transportation models. Input-output can be used extensively for various other types of regional analyses which are discussed in some of the input-output literature. Emphasis is placed in the remaining portion of this paper on some general problems which arise when working with multiregional input-output analysis.

Some General Problems in Multiregional Input-Output Analysis

The assembly of a consistent set of regional data is the first step in implementing a multiregional system. First, we will consider the development of a set of regional input-output coefficients.

Regional Technical Coefficients

In the past, regional output figures usually were multiplied by the national input coefficient matrix to obtain a first approximation of the regional interindustry transactions. Then,

> ...the row and column distributions for each sector were modified in the light of differences in regional productive processes, marketing practices, or product-mix.[18]

A skillful, selective modification of the national input coefficients can be accomplished for each region. The auto industry example was suggested earlier for cases where some regions only have the auto assembly plants; in such cases, little or no input of steel into the auto industry is recorded in the respective interindustry cell in the input-output table for that region.

15/ Wassily Leontief and Alan Strout, "Multiregional Input-Output Analysis," in Structural Interdependence and Economic Development, ed. Tibor Barna (New York: St. Martin's Press, Inc., 1963), Chap. 7.

16/ Ibid.

17/ The Harvard Economic Research Project is implementing the gravity model at the present time to determine regional output and shipment estimates for the United States. The model already has been implemented for Argentina. The results of the Argentina study are discussed by Mario Brodersohn, A Multiregional Input-Output Analysis of the Argentina Economy (Buenos Aires: Instituto Torcuato Di Tella, Centro de Investigaciones Economicas, October 1965), pp. 3-58.

18/ F. T. Moore and J. W. Peterson, "Regional Analysis; An Interindustry Model of Utah, 1947," Review of Economics and Statistics, XXXVII (November 1955), p. 371.

Another example is provided by the ability to differentiate the input coefficients by region for the petroleum industry.[19] There are at least three basic causes for differences in the coefficients for this industry:

1) Crude oils differ in type and quantity of fuel obtained in the distillation process. When various qualities of crude oil are distilled, the output mix varies quite widely in terms of gas, gasoline, kerosene, fuel oil, etc. The high quality crude oils yield a larger percentage of gasoline than the lower quality crudes. A cracking process (thermo or catalytic) will produce a higher gasoline yield from the low-quality crudes. Generally, refineries on the East Coast and California process the lower quality crudes and use more imported fuel oil for the processing. This has two repercussions on the input costs:

a) the value of crude oil purchases by the petroleum industry in these regions is lower.
b) The value of equipment purchases is higher.

2) Crude oils vary in sulfur content and in viscosity. In general, California crudes have larger amounts of sulfur and are more viscous than crudes processed in other parts of the country. In the California refineries, a process called "visbreaking" is used. This process requires additional capital and chemical inputs per unit of output.

3) Demand for crude oil affects the product mix. East Coast refineries are closer to imported fuel oil and to domestic coal supplies; therefore, East Coast refineries produce less fuel oil and more gasoline per unit of processed crude oil than do refineries in other parts of the country. As noted under point 1) above, the East Cost refineries then must purchase more capital equipment and chemicals (tetraethel lead), but pay less for the crude oil.

The preceding has emphasized the differences which may exist in the input structure of the petroleum industry in various regions of the country. From the distribution side, variations also are present. Industries in different regions of the country may purchase different amounts of petroleum per unit of output. For example, the use of liquid petroleum (LP) by farmers (the agricultural industry) actually varies greatly from state to state.[20]

The actual quantity used depends on the number, the average size, and the average use per annum of power machines on the farms. The purchases by farmers from the petroleum industry in the various regions should reflect the differences in the product mix of the petroleum purchases. Gasoline and fuel oil are used by farmers in greater quantities in those states farthest from oil fields. A large quantity of diesel fuel is used in the Western states for crawler tractors and in the Northern Plains states because of the larger-than-average wheel tractors. In Appalachia, 18.3 percent of the total fuel used by farmers in 1959 was kerosene. The Northeast farmers, on the other hand, used only 5.7 percent kerosene, 23.0 percent fuel oil, 67.6 percent gas with virtually no use of diesel or LP gas.[21] Such information by industry is valuable if the fuel row is disaggregated.

19/ A discussion of the changes in the national input coefficients in the petroleum industry is contained in a report by David Behling, "Projection of Input Structure for the Petroleum Refining Industry," Harvard Economic Research Project, July 1964 (Mimeo). This report is being revised at the present time. The information which follows on the petroleum inputs was obtained from discussions with David Behling.

20/ USDA, Economic Research Service, Liquid Petroleum Fuel Used by Farmers in 1959 and Related Data, Statistical Bulletin No. 344 (May 1964), pp. 2, 6.

21/ *Ibid*. footnote 10.

The final example concerns a more complete disaggregation of the agricultural column and row. Four obvious interindustry flows should be examined in greater detail for the agricultural sector: 1) fertilizer, 2) water for irrigation, 3) farm machinery, and 4) transportation.

Fertilizer: The amount and type of fertilizer needed per unit of output varies with the crop raised and the type of soil in different regions of the country. The following table shows the percent of a state's total farm commodity output (dollar output) which is tobacco (column 1), and for tobacco, the yield per acre (column 2), the number of pounds of fertilizer used per acre (column 3), and the number of pounds of fertilizer used per pound of tobacco output in 1958-59 (column 4):

Table II

SELECTED TOBACCO STATISTICS, 1958-59

STATE	TOBACCO		FERTILIZER	
	Percent of State's Total Farm (Dollar) Output	Yield per Acre (Lbs.)	Pounds per Acre	Pounds per Lb. of Tobacco Output
	(1)	(2)	(3)	(4)
Connecticut	12	1482	593	.40
Virginia	17	1641	351	.21
North Carolina	45	1723	371	.22
South Carolina	23	1725	420	.24
Kentucky	36	1532	567	.37

Source: USDA, Economic Research Service and Agricultural Research Service, Commercial Fertilizer Used on Crops and Pasture in the United States (1959 Estimates), Statistical Bulletin No. 348 (July 1964) Table 1: Fertilizer Used on all Crops, by State, 1959, pp. 11-31; USDA, Annual Report on Tobacco Statistics, 1958, Statistical Bulletin No. 247 (March 1959), Table 1: Acreage, yield per acre, by crop year, 1929-1958, Table 2: Acreage, yield per acre, crop value, by states and by classes and types of tobacco, 1951-1958, Table 3: Cash receipts from tobacco compared with total cash receipts from all farm commodities, selected states and United States, average 1951-55, annual 1956-58, pp. 1-22.

Information concerning the use of fertilizer for potato growing supports the above information that the amount of fertilizer used will vary widely from one region to another even for the same crop. Maine fertilizes 98.6 percent of its potato cropland (about 15.3 percent of its total cropland is in potatoes), while Idaho fertilizes only 8.5 percent of its total potato cropland. Maine uses 682 pounds of fertilizer (nitrogen, available phosphoric oxide, and potash) versus 166 pounds per acre in Idaho.22/

22/ USDA, Economic Research Service and Agricultural Research Service, Commercial Fertilizer Used on Crops..., op. cit., pp. 14, 17.

Water for Irrigation: Irrigation of farmland occurs mostly in Western states.23/ Input coefficients reflecting the amount of water used per unit of agricultural output then will be larger in Western states than in other sections of the country. This coefficient may change in the Northeast, however, if the drought continues.

Farm Machinery: The number of tractors per 100 farms also varies greatly from one region to another, as shown by the following figures:

Table III

NUMBER OF TRACTORS PER 100 FARMS, 1950-1955

Total United States	44
Northeast	56
East North Central	58
West North Central	55
South Atlantic	35
East South Central	32
West South Central	32
Mountain	55
Pacific	31

Source: A cooperative survey: USDA, Agricultural Marketing Service and Agricultural Research Service and U.S. Department of Commerce, Bureau of the Census, Farmers' Expenditure for Motor Vehicles and Machinery with Related Data, 1955, Statistical Bulletin No. 243 (March 1959), Table 68: Wheel Tractors: Number Kept on Farms, by Year of Manufacture, Year of Purchase and Belt Horsepower, by Geographic Region, January 1, 1956, p. 59.

The total number of tractors used will depend, of course, on the number of farms within each region.24/

The total expenditure for all farm machinery per farm in the Northeast in 1955 was 13.7 percent greater than the U. S. average.25/ This fact again illustrates the type of differences which must be reflected in regional input coefficients.

Transportation: The final illustration of differences among regions is shown by a more detailed breakdown of the transportation row (industry number 65) in the 1958 input-output table. Table IV shows the national distribution of total transportation purchases among truck, rail, warehousing, and all other transportation for 1958 for a few selected agricultural products.

23/ USDA, Basic Statistics of the National Inventory of Soil and Water Conservation Needs, Statistical Bulletin No. 317 (August 1962) pp. 1-5 and Table 29: Conservation Needs on Irrigated Cropland, pp. 146-147.

24/ Refer to source given in Table III.

25/ Ibid.

Table IV

PERCENT DISTRIBUTION BY TYPE OF TRANSPORT
OF TOTAL TRANSPORTATION PURCHASES BY
CERTAIN AGRICULTURAL INDUSTRIES

Industry	Truck	Rail	Storage and Warehousing	All Other Transportation
Meat, Poultry	82.5	11.6	6.0	0.0
Milk	98.7	1.3	0.1	0.0
Food Grain	19.0	69.4	6.6	5.0
Feed Grain	40.0	55.0	2.6	2.4
Cotton, Tobacco	29.1	36.7	34.0	.2
Oil Bearing Crops	15.0	72.3	5.4	7.3
Fruits and Vegetables	71.1	26.4	1.3	1.2
Sugar and Syrup	12.4	87.6	0.0	0.0
Other Agricultural	58.3	36.6	2.7	2.4

Source: The percentages are preliminary estimates taken from worksheets of David Behling at the Harvard Economic Research Project and are subject to revision. A more complete breakdown is being prepared at the present time.

The percentage distribution among the different modes of transportation in a region will vary from these national averages. For example, in 1960 we know that 612,423 carloads of fresh fruits and vegetables (representing 66.9 percent of total shipments) were shipped nationally by truck, but only 53.3 percent of total unloads from New England were sent by truck.26/

The difficulty in working with the transportation statistics is that comparable data for rail and truck often are unavailable. The 1963 Census of Transportation may help to eliminate some of this problem. In general, the Transportation Census indicates that more goods are hauled by truck than by rail in the Northeast compared with averages for the United States. Some figures which support this general conclusion are presented in Table V.

26/ USDA, Fresh Fruit and Vegetable Unloads . . . . 1960, loc. cit.

Table V

PERCENTAGE OF TOTAL TONNAGE FOR SELECTED COMMODITIES
SHIPPED BY MOTOR CARRIER AND PRIVATE TRUCK
UNITED STATES AND NEW ENGLAND
1963

Commodity	United States Percent	New England Percent
Canned and Frozen Foods, Other Food Products (Group 2)	39.7	67.4
Textile Mill and Leather Products (Group 4)	84.3	93.4
Basic Chemicals, Plastics, Materials, Synthetic Rubber and Fibers (Group 7)	32.9	77.6
Primary Non-ferrous Metal Products (Group 15)	44.9	74.0

Source: U. S. Bureau of Census, The Census of Transportation, 1963, (Preliminary Report) Commodity Transportation Survey: Shipper Series TC 63(p) C1, (Table 6 for each group). The group number is given in parentheses after each commodity title in the above table.

More extensive examination (along the lines just described) of the individual input coefficients for selected rows and columns of the national coefficient table can provide a second approximation for the regional interindustry transaction tables. The final step, of course, is a complete survey in each region. The Census of Manufacturers already contains a great amount of state and regional detail. Censuses for other sectors of the economy must be co-ordinated before a complete breakdown of interindustry flows by region can be established.

Regional Final Demands

The final demands also must be estimated for regions. The largest component of final demand for most industries is personal consumption expenditure. Of the $447,334,000 total final demand for all industries in 1958, personal consumption expenditures were $290,069,000 (65 percent). The individual breakdown by industry indicates that for 34 of the 80 input-output industries personal consumption expenditures composed 60 percent or more of total final demand.27/

27/ U. S. Department of Commerce, Office of Business Economics, "The Transactions Table of the 1958 Input-Output Study and Revised Direct and Total Requirements Data," Survey of Current Business, Vol. 45, No. 9 (September 1965), p. 39.

One of the best sources for material to use in estimating regional consumption is provided by the 1950 and 1960 Bureau of Labor Statistics consumer surveys. The survey data is published in great detail. For example, we learn that the Northeast spent 1/3 to 1/2 more than other regions in 1960 for items such as alcohol (including beer and ale), macaroni, and tobacco, but less than other regions for flour. The South consumed 31 cents worth of flour per urban family in one week versus 11 cents for families in the Northeast.28/

The total expenditures in 1960 for food were much higher in the Northeast than for the United States as a whole: $1495 and $1312 per urban family, respectively; however, the ratio of food expenditure to total disposal income was not so different: 21.9 percent for the United States versus 23.3 percent for the Northeast. At the same time, the Northeast spent only $16.80 per family for meals at schools versus $18.10 for the United States as a whole.29/

As has been indicated, the consumer surveys give regional information on average expenditures for quite detailed commodity groups. The BLS data can be aligned with the 83 national income personal consumption expenditure (NIPCE) classification.30/ A recent article by Nancy Simon provides the bridge between the NIPCE and the 1958 input-output sectors.31/ Thus, it is possible to obtain a first approximation of the regional breakdown of personal consumption expenditures. As additional research is done, more refined regional consumption estimation procedures will be developed.

The composition of expenditure by governments also varies from state to state. Table VI shows the variations from state to state in highway expenditures in absolute and percentage terms.

The composition of each of the other final demand columns (investment, construction, net exports, and inventory change) also must be determined for the individual states or regions in order to provide the most accurate regional analysis.

28/ Fabian Linden (ed), Expenditure Patterns of the American Family (New York: The National Industrial Conference Board, 1965), pp. 28, 52.

29/ U. S. Department of Labor, Bureau of Labor Statistics, Consumer Expenditures and Income, Urban United States, 1960, BLS Reports 237-34, 38, Supplement 3 - Part B (July 1964), p. 2.

30/ A transformation matrix is presented by H. Albert Green, "Q" Model: Personal Consumption Expenditures Submodel, U. S. Department of Agriculture, Economic Research Service, ESG Working Paper No. 4 (March 1966), pp. 30-33. Mr. Green describes in detail one method for making regional consumption estimates. The Harvard Economic Research Project is using a slightly different combination of the data to produce personal consumption expenditure estimates by states.

31/ Nancy W. Simon, "Personal Consumption Expenditures in the 1958 Input-Output Study," Survey of Current Business, Vol. 45, No. 10 (October 1965), pp. 8-10.

Table VI

TOTAL STATE EXPENDITURES AND HIGHWAY EXPENDITURES

IN NEW ENGLAND, 1958

	Total State Expenditure (Thousand $)	Total Highway Expenditure (Thousand $)	Highway As a Percent of Total State Expenditure (Percent)
Maine	119,065	51,948	43.6
Vermont	45,775	16,578	36.2
New Hampshire	61,827	24,117	39.0
Massachusetts	608,457	173,958	28.6
Rhode Island	93,552	22,384	23.9
Connecticut	294,692	97,725	33.2
New England	1,223,348	386,710	31.6
Total U. S.	18,857,116	5,531,097	29.3

Source: U. S. Bureau of the Census, Statistical Abstract of the United States: 1958, Seventy-ninth edition (Washington, D.C.: 1958), pp. 416-7.

Labor and Capital Coefficients

The 1958 national labor and capital coefficients still have not been released by the Office of Business Economics. These coefficients, however, do vary among regions, and an attempt must be made to estimate the regional value added coefficients. This again can be done by using various outside sources of information. For example, in the cotton industry (one of the 450 input-output industries in 1947):

> the extent of mechanization affects the average amount of labor per acre.... [in 1959] the statewide average was 84 man-hours per acre for Tennessee, where only 8 percent of the crop was machine picked, compared with 49 man-hours in New Mexico, where 50 percent was machine picked.32/

The labor input coefficients for the cotton industry in the two states must be adjusted to account for these differences.

32/ USDA, Farm Production Economics Division, Economic Research Service, Labor Used to Produce Field Crops, Estimates by States, Statistical Bulletin No. 346, p. 8.

Conclusion

In conclusion, in this paper we have suggested the scope of multiregional input-output analysis and have described briefly how initial estimates of the regional input-output tables can be developed from existing data sources. Every economic researcher is plagued by the changes which occur in classifications over time. In regional research, we also are concerned with the noncomparability of statistical series from different areas of the country. A need has been present and still remains to provide a unified statistical system. In general, alignments among the present statistical series are needed. Once a consistent set of regional data is available, the researcher will be able to use multiregional input-output models for many detailed investigations of the economic system.