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Multiregional Input-Output Accounts, 1977 - Volumes 5 - State Estimates of Inputs to Industries

Jack Faucett Associates, Inc.

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MULTIREGIONAL INPUT-OUTPUT ACCOUNTS, 1977. VOLUME 5. STATE ESTIMATES OF INPUTS TO INDUSTRIES

FAUCETT (JACK) ASSOCIATES, INC.
CHEVY CHASE, MD

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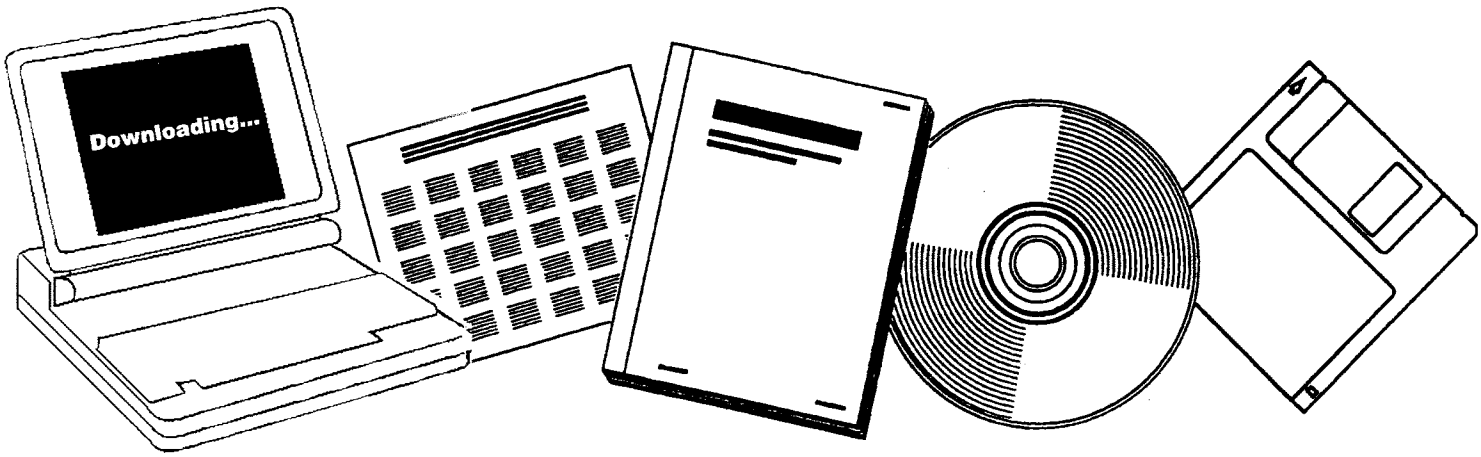

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THE MULTIREGIONAL INPUT-OUTPUT ACCOUNTS, 1977: STATE ESTIMATES OF INPUTS TO INDUSTRIES

VOLUME V

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Submitted to
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES

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Room 422F1, Hubert H. Humphrey Bldg.
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May, 1982

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16. Abstracts

The multiregional Input-Output (MRIO) accounts provide estimates for 1977 of (1) output (by industry and commodity), (2) value added, (3) intermediate uses, and (4) final uses of goods and services, by sector and state. Interregional flows balance the production and consumption of goods and services between states. The project was also supported by the Department of Commerce (Economic Development Administration), the Federal Emergency Management Administration, and the Army Corps of Engineers.

This volume explains the methodology used to develop state input data for the MRIO accounts.

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STATE ESTIMATES OF INPUTS,
TO INDUSTRIES, 1977

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Jan Trimble coordinated the development of the report. Secretarial effort was coordinated by Leila Snyder. Robert Skarr compiled the bibliographic material.

CHAPTER 1

INTRODUCTION AND SUMMARY

This report explains the methodology used to develop state input data for the Multi-Regional Input-Output (MRIO) model being prepared by Jack Faucett Associates (JFA) for the Office of the Assistant Secretary for Planning and Evaluation, Department of Health and Human Services. Data were developed for 119 sectors, MRIO sectors 1-119 as listed in Appendix C. All methods and procedures presented in the following pages will be revised as appropriate throughout the remaining stages of the model development. JFA requests that suggestions, comments, and criticisms be submitted to the authors.

Users of these data should note carefully the data limitations indicated throughout this report and should also be aware that all data are preliminary. Users are encouraged to notify cognizant JFA staff of any problems, errors or inconsistencies found upon examination of these data.

The methodologies used to develop input data are consistent with those used in developing the output data, as reported in the JFA report: State Estimates of Outputs, Employment and Payrolls, 1977. Inputs are measured in 1977 dollars in purchasers' values (excluding retail trade margins and taxes levied at the retail level).

The data development methodologies described in this study were formulated according to two primary goals:

(1) Choice of the best available data sources that will facilitate future updates of the model, and

(2) Development of procedures within the model that will minimize "manipulation" of data and thereby maintain as far as possible the integrity of the initial data sets.

In pursuit of these goals, data sets that could be expected to be available in future years were given preference. Moreover, procedures used to handle data within the model were also carefully scrutinized to avoid choices that could result in "apparent" adherence to theory or convention but in application result in the distortion of hitherto reliable data sets.

Development of Input Data

Development of 1977 input data followed two general approaches. For four categories of inputs — energy, real estate, noncomparable imports, and scrap — the availability of single data sources and/or data development techniques that were appropriate across almost all consuming industries led to separate development of data for these inputs. For other input categories, data development proceeded on an industry by industry basis.

1977 input data were available for at least a few commodities in almost every industry. In some cases, notably agriculture and manufacturing, 1977 data covered as much as 90 percent of the inputs at the national level. When 1977 input data were not available, the inputs were based on BEA 1972 input coefficients updated for prices to 1977. State-specific data on detailed inputs are severely limited but the national data were imputed to states in great sector detail, usually the four-digit SIC.

Data Source Selection

The data for this study have been selected so as to minimize difficulty in updating and to maintain the highest possible level of accuracy. Sources that could not be expected to be available for future updates were avoided. The source that provides the best "fit" with the requirements of data development within the MRIO is the quiquennial Bureau of the Census data, e.g., the Census of Manufactures, and the Census of Service Industries. Therefore, Census data were used wherever possible. When Census data were unavailable, other reliable data sources were sought.

Methodology

Three of the most important guidelines in data base development are:

- carefully defined data elements,
- consistent estimating techniques, and
- data evaluation.

Attention to these guidelines was emphasized throughout the conceptual formulation of the MRIO data base. Some of the practical applications of these principles to the development of input data are described below.

Defining Data Elements

The objectives of carefully defining data elements are: 1) a data base that can be compared with data from published sources, 2) the minimizing of estimating requirements, and 3) elimination of ambiguities in interpretation. In the MRIO data base, as explained in detail in the previous JFA report on outputs, industry sectors and other data base conventions were structured in a fashion that provided the most information to expected users, and that reflected the contents of the most comprehensive and reliable data sources.

Estimation of Missing Data

The second guideline in data base development, consistent data estimation techniques, came into play when:

- data were suppressed,
- data were available at the national but not state level,
- data were available at a more aggregate level than that required in the MRIO data base,
- primary 1977 data were unavailable.

When data were suppressed for individual states, as was frequently the case in Census data, national data were combined with state data on a related item to determine a state value. If, for example, inputs of steel to the construction industry were known for forty individual states and the U.S. total, inputs of steel to the construction industries in the remaining ten states could be estimated by distributing the residual steel inputs on the basis of cost of materials consumed by the construction industry in each of the ten states. Though estimation based on these related data items can result in error, it proved adequate if only a small portion of the total data were suppressed, e.g., less than three percent. Where larger suppressions were involved, more time consuming and accurate methods, such as development of data from supplementary sources, were warranted. In all cases, the national total of all state-level data (actual and estimated) was compared with the national total available from Census and scaling was applied to

the imputed data, if required, to reconcile the two. A similar procedure was used when no state data for inputs were available. The data items that were most commonly used in this case were state cost of materials controls published by Census for some industries, or the state output data developed previously for the MRIO by JFA.

Sometimes the Census and other data sources contained data on input categories that were more aggregate than MRIO or BEA I-O sectors. When this was the case, the aggregate number was used as a control total, and split among its component sectors using BEA's 1972 coefficients updated for price and adjusted for differences in definitions.

After exhausting all available primary sources of 1977 input data, some required data items were still missing. To fill these gaps, input data published by BEA for 1972 were price-updated and used as a guide from which the 1977 input data could be estimated. The price-updating procedure began with the development of a set of price indices at the 496-order BEA I-O detail. These were applied to the 1972 BEA 496-order BEA use table. Next, wholesale and transportation margins, identified in the BEA margin matrices, were added to the producer's values, reflecting the different treatment of these margins used in the MRIO methodology. The deflated table was then used to calculate the input of goods and services per dollar of total output less value added. The detailed methodology used for the price update and for combining the 1977 input data developed from primary sources with the price-updated BEA I-O data is outlined in Appendix A.

Data Evaluation

An important part of the development of 1977 input data was evaluation of their quality. The emphasis here was placed on identifying problems in coverage. Some primary data sources contained data on purchases of goods and services that represented only part of a BEA I-O or MRIO code, usually a four-digit SIC. Sometimes the input data were based on survey data that covered less than 100 percent of the establishments. When either of these situations occurred, the input data were examined to determine whether they could be used, directly or adjusted, in the MRIO data base. The most common technique used for evaluation was to sum all of the actual and/or estimated 1977 input data to the BEA I-O level, and compare the sums to the input value shown in the price-updated BEA matrix. If the 1977 data differed from the

updated BEA data by less than 15 percent, the 1977 data were usually accepted. If the discrepancy was greater, the input data were developed for 1972, if the same data sources were available, and compared to the BEA I-O matrix for 1972. This latter comparison proved very useful in identifying differences in commodity definitions between the data source and the BEA or MRIO conventions. It also eliminated any errors in comparison that might be introduced by the factors used when updating for prices.

Any input data whose reliability remained uncertain after these two comparisons were subjected to further analysis to determine the reason for the discrepancy. If discussions with industry analysts indicated the technical coefficient had changed in a manner that made the 1977 data reasonable, the 1977 data were used. Any remaining 1977 data — data whose utility in the MRIO data was poor or completely unknown — were discarded.

Data Quality

Input data for 1977 developed from primary data sources accounted for a large percent of total inputs to most industries. These data were developed primarily from Census sources. Where adopted into the MRIO data base without adjustment or estimation, the data are very reliable. Data from other sources were evaluated for consistency with MRIO definitions and conventions and, since they were used only if a close correlation was established, these data are also believed to be of very high quality.

When estimation or adjustment was required to distribute the data to the state level, to approximate suppressed data, or to refine the data to reflect MRIO definitions and conventions, the data quality is lessened. Where the price-updated BEA I-O data for 1972 were used, MRIO data base users should recognize two basic assumptions made in developing these data: 1) the relative price change for a given good or service is constant throughout the price-updating procedure, i.e., regardless of how the products were purchased, they were assumed to have the same price changes; and 2) each producing sector is assumed to have purchased the same mixture of goods and services as in 1972.

A discussion of data quality is included in each of Chapters 2 - 11. Further information on data quality can be found in the worksheets archived at the end of the project. Data base users should refer to these for more detail.

Report Overview

The format of this report roughly parallels the JFA report, State Estimates of Outputs, Employment, and Payrolls, 1977, facilitating comparisons of data sources and methodologies used in each sector.

Chapters 2 and 3 introduce the remaining chapters with information on certain inputs and data which, for practical or conceptual reasons, were developed separate from that developed for consuming industries. Chapter 2, "Special Input Categories," describes the development of energy, real estate, noncomparable import, and scrap inputs. Chapter 3, "Transportation Margins, Trade Margins, and Taxes," outlines the sources and methodologies used in developing the data for these important parts of the data base. Chapters 4 through 10 present the input data development techniques and findings for each of the consuming MRIO sectors. In a few cases, notably Agriculture (Chapter 4) and Transportation (Chapter 8), these chapters include discussions of the energy and/or real estate inputs. These exceptions are noted in Chapter 2 and in the chapters on consuming sectors, as required. Chapter 11 describes the treatments of secondary products and redefinitions. Finally, there are four appendices. Appendix A describes the methodology for price-updating BEA's 1972 input-output data to 1977 and for combining the results with the data developed for 1977 from primary sources. Appendix B contains procedures papers describing technical details of the assignment of margins, treatment of redefinitions, and MRIO's mathematical formulation. A complete concordance of MRIO sectors with BEA I-O sectors and 1977 SIC's appears in Appendix C. Appendix D provides a reference guide to all data sources referred to in this report.

CHAPTER 2

SPECIAL INPUT CATEGORIES

Four categories of inputs were developed separate from data on other inputs. These four input groups — energy, real estate and rental, noncomparable imports, and scrap — received special treatment either because of conceptual or data problems associated with developing them by consuming industry (energy and real estate), or because the data source used did not contain data on any other input and contained data for all purchasing industries (noncomparable imports and scrap). The methodologies used to develop these inputs are described in the following sections. Succeeding chapters exclude discussion of these inputs, except where specifically noted.

Energy Inputs

Energy input data were estimated, as much as it was possible, from basic data sources, with detailed information allowing state distributions for most energy uses. These sources included:

- the 1978 Census of Agriculture;
- the 1977 Census of Mineral Industries;
- the 1977 Census of Construction Industries; and
- the 1977 Census of Manufactures.

Data not readily available from the basic sources were developed at the national level from the National Energy Accounts: Energy Flows in the United States, 1947 through 1977 (Source 23011, hereafter referred to as the NEA). The data from the NEA were compatible with an input-output structure largely consistent with the BEA economic input-output accounting system. The NEA contains data measuring consumption of energy in purchasers' prices, by sectors, detailed fuel types, and detailed functional uses.

This discussion of data sources and methodology is divided into the following subsections:

- Agriculture (MRIO Sectors 001 - 004);
- Forestry and Fisheries (MRIO Sectors 005 - 006);
- Mining (MRIO Sectors 007 - 013);
- Construction (MRIO Sectors 014 - 019);
- Manufacturing (MRIO Sectors 020 - 084);
- Transportation (MRIO Sectors 085 - 091);
- Electric and Gas Utilities (MRIO Sectors 094 - 095);
- Commercial Sectors (MRIO Sectors 092, 093, 096 - 117);
- Personal Consumption Expenditures (MRIO Sector 150);
- Government Sectors (MRIO Sectors 118, 119, 156, 157, 158).

In as much as data in the NEA were based on a slightly different sector divisions than the MRIO, and measured only national level activities, adjustments to the data contained therein were necessary. These two concerns are discussed at the end of this section followed by a section on data quality. Note that in sections where data development in the NEA is discussed the names of sectors referred to are those employed in the NEA. A concordance between MRIO and NEA sectors is shown in Exhibit 2-1.

Agricultural (MRIO Sectors 001-004)

Data for MRIO Sectors 001, 002, 003, and 004 (the latter minus agricultural services) were taken from the 1978 Census of Agriculture (Source 03109). The reported census data covered consumption for all energy functional use categories. An estimation technique was developed in order to convert 1978 production expenditures by type of farm and by state to 1977 expenditures by product and by state. A short synopsis of this technique is included here. For a more detailed explanation see Chapter 4.

As a first step, production expenditures by type of farm had to be estimated where they were withheld to avoid disclosure. Specific estimates were made when the expenditure value suppressed represented at least five percent of the state total for that expenditure category. Where the missing values represented less than five percent of the total, the missing value was prorated to the SIC production expenditure that was not suppressed.

EXHIBIT 2-1:

CONCORDANCE OF MRIO AND NEA CODES

MRIO Sector		NEA Code	
001:	Dairy Farm Products	pt. 01000	Livestock and Livestock Products
002:	Livestock and Poultry	pt. 01000	Livestock and Livestock Products
003:	Cotton, Grain and Tobacco	pt. 02000	Other Agricultural Products
004:	Fruits, Nuts, Vegetables and Misc. Crops and Services	pt. 02000 pt. 04000	Other Agricultural Products Agricultural, Forestry, and Fishery Services
005:	Forestry Products	pt. 03000 pt. 04000	Forestry and Fishery Products Agricultural, Forestry, and Fishery Services
006:	Commercial Fishing and Trapping	pt. 03000 pt. 04000	Forestry and Fishery Products Agricultural, Foresty, and Fishery Services
007:	Iron and Ferroalloy Ores	05000	Iron and Ferroalloy Ores Mining
008:	Nonferrous Ores	06001 06002	Uranium-Radium-Vanadium Ores Nonferrous Metal Ores Mining, except Uranium-Radium-Vanadium Ores
009:	Coal	07010 07020	Anthracite Coal Mining Bituminous and Lignite Coal Mining
010:	Crude Petroleum	08001	Crude Petroleum
011:	Natural Gas and Liquids	08002 08003	Natural Gas Natural Gas Liquids
012:	Stone, Clay, Sand, and Gravel	09000	Stone and Clay Mining and Quarrying
013:	Chemical and Fertilizer Minerals	10000	Chemicals and Fertilizer Mineral Mining
014:	Residential Building Construction	pt. 11002 pt. 129xx	New Construction, excluding Oil and Gas Drilling Construction, n.e.s.
015:	Nonresidential Building Construction	pt. 11002 pt. 129xx	New Construction, excluding Oil and Gas Drilling Construction, n.e.s.
016:	Public Utility Construction	pt. 11002 pt. 129xx	New Construction, excluding Oil and Gas Drilling Construction, n.e.s.
017:	Highways and Streets	pt. 11002 pt. 129xx	New Construction, excluding Oil and Gas Drilling Construction, n.e.s.
018:	Other Construction	11001 pt. 11002 pt. 129xx	Oil and Gas Well Drilling New Construction, excluding Oil and Gas Drilling Construction, n.e.s.
019:	Maintenance Construction	12000 pt. 129xx	Maintenance and Repair Construction Construction, n.e.s.
020	Ordnance	pt. 13000	Ordnance and Accessories
021	Meat Products	pt. 14000	Food and Kindred Products
022	Dairy Products	pt. 14000	Food and Kindred Products
023	Canned and Frozen Food	pt. 14000	Food and Kindred Products
024	Grain Mill Products	pt. 14000	Food and Kindred Products
025	Bakery Products	pt. 14000	Food and Kindred Products
026	Sugar and Confectionary Products	pt. 14000	Food and Kindred Products
027	Beverages, Extracts, and Sirups	pt. 14000	Food and Kindred Products
028	Other Food Products	pt. 14000	Food and Kindred Products
029	Tobacco Products	15000	Tobacco Manufactures
030	Fabric, Yarn and Thread Mills	16000	Broad and Narrow Fabrics, Yarn and Thread Mills

EXHIBIT 2-1:

CONCORDANCE OF MRIO AND NEA CODES (cont.)

MRIO Sector		NEA Code	
031	Floor Coverings and Miscellaneous Textile Products	17000	Miscellaneous Textile Goods and Floor Coverings
032	Hosiery and Knit Goods	pt. 18000	Apparel
033	Apparel	pt. 18000	Apparel
034	Other Fabricated Textile Products	19000	Miscellaneous Fabricated Textile Products
035	Logging and Lumber	pt. 20000	Lumber and Wood Products, except Containers
036	Wood Products	pt. 20000	Lumber and Wood Products, except Containers
		21000	Wooden Containers
037	Pre-fabricated Buildings and Mobile Homes	pt. 20000	Lumber and Wood Products, except Containers
		pt. 61000	Other Transportation Equipment
038	Household Furniture	22000	Household Furniture
039	Other Furniture and Fixture	23000	Other Furniture and Fixtures
040	Paper and Allied Products	24020	Paper Mills, except Building Paper
		24990	Paper and Allied Products, except Containers, Boxes, and Paper Mills
041	Paperboard Containers and Boxes	25000	Paperboard Containers and Boxes
042	Newspapers, Periodicals and Other Printing and Publishing	26000	Printing and Publishing
043	Industrial Chemicals	27010	Industrial Inorganic and Organic Chemicals
044	Agricultural Chemicals	27020	Fertilizers
		27030	Agricultural Chemicals, n.e.c.
045	Other Chemical Products	27040	Miscellaneous Chemical Products
046	Plastics and Synthetics	28010	Plastics Materials and Resins
		28020	Synthetic Rubber
		28990	Cellulosic Man-Made Fiber, and Organic Fibers, Noncellulosic
047	Drugs	pt. 29000	Drugs, Cleaning and Toilet Preparations
048	Cosmetics and Cleaning Products	pt. 29000	Drugs, Cleaning and Toilet Preparations
049	Paint and Allied Products	30000	Paints and Allied Products
050	Petroleum Refining and Allied Products	31011	Petroleum Refining
		31012	Miscellaneous Products of Petroleum and Coal
		31990	Paving Mixtures, Blocks, Asphalt Felts and Coatings
051	Rubber and Miscellaneous Plastics	32000	Rubber and Miscellaneous Plastics Products
052	Leather and Leather Products	33000	Leather Tanning and Industrial Leather Products
		34000	Footwear and Other Leather Products
053	Glass and Glass Products	35000	Glass and Glass Products
054	Stone and Clay Products	36010	Cement, Hydraulic
		36990	Stone and Clay Products, excluding Cement, Hydraulics
055	Iron and Steel Mills and Forging	37011	Coke Oven Products
		37012	Blast Furnaces and Basic Steel, excluding Coke Oven Products
		pt. 37990	Primary Iron and Steel Manufacturing excluding Coke Oven Products

EXHIBIT 2-1:

CONCORDANCE OF MRIO AND NEA CODES (cont.)

MRIO Sector		NEA Code	
056	Iron and Steel Foundries	pt. 37990	Primary Iron and Steel Manufacturing excluding Coke Oven Products
057	Primary Nonferrous Metals and Products	38040	Primary Aluminum
		38990	Primary Nonferrous Metals Manufacture excluding Primary Aluminum
058	Metal Containers and Miscellaneous Metal Products	39000	Metal Containers
		42000	Other Fabricated Metal Products
059	Structural Metal Products	40000	Heating, Plumbing, and Fabricated Structural Metal Products
060	Screw Machine Products and Metal Stampings	41000	Screw Machine Products, Bolts, Nuts, etc. and Metal Stampings
061	Engines and Turbines	43000	Engines and Turbines
062	Farm and Lawn Equipment	44000	Farm Machinery
		pt. 61000	Other Transportation Equipment
063	Construction and Mining Equipment	45000	Construction, Mining, Oil Field, Machinery Equipment
064	Materials Handling Equipment	46000	Materials Handling Machinery and Equipment
065	Metalworking Equipment	47000	Metalworking Machinery and Equipment
066	Special Industry Machinery and Equipment	48000	Special Industry Machinery and Equipment
067	General Industrial and Other Non-electrical Machinery and Equipment	49000	General Industrial Machinery and Equipment
		50000	Machine Shop Products
068	Office and Computing Equipment	51000	Office, Computing, and Accounting Machines
069	Service Industry Machinery and Equipment	52000	Service Industry Machines
070	Electric Transmission and Electrical Industrial Equipment	53000	Electric Transmission and Distribution Equipment and Electrical Industrial Apparatus
071	Household Appliances	54000	Household Appliances
072	Electric Lighting and Wiring Equipment	55000	Electric Lighting and Wiring Equipment
073	Receiving Sets, Records and Tapes	pt. 56000	Radio, Television and Communication Equipment
074	Communications Equipment	pt. 56000	Radio, Television and Communication Equipment
075	Electronic Components	57000	Electronic Components and Accessories
076	Other Electrical Equipment	58000	Miscellaneous Electrical Machinery, Equipment and Supplies
077	Motor Vehicles and Parts	59000	Motor Vehicles and Equipment
078	Aircraft and Parts	pt. 60000	Aircraft and Parts
079	Missiles, Spacecraft and Parts	pt. 60000	Aircraft and Parts
		pt. 13000	Ordnance and Accessories
080	Aircraft, Missile and Spacecraft Propulsion Units	pt. 60000	Aircraft and Parts
081	Other Transportation Equipment	pt. 61000	Other Transportation Equipment
082	Scientific and Photographic Equipment, Watches and Clocks	pt. 62000	Professional, Scientific and Controlling Instruments, and Supplies
		pt. 63000	Optical, Ophthalmic and Photographic Equipment and Supplies

EXHIBIT 2-1:

CONCORDANCE OF MRIO AND NEA CODES (cont.)

MRIO Sector		NEA Code	
083	Medical, Dental and Optical Equipment	pt. 62000	Professional, Scientific and Controlling Instruments, and Supplies
		pt. 63000	Optical, Ophthalmic and Photographic Equipment and Supplies
084	Other Manufactured Products	64000	Miscellaneous Manufacturing
085	Railroads	65010	Railroads and Related Services
086	Local Passenger Transportation and Inter-city Bus	65020	Local, Suburban and Interurban Highway Passenger Transportation
		pt. 79009	Federal Government Enterprises
087	Motor Freight	65030	Motor Freight Transportation and Warehousing
088	Water Transportation	65040	Water Transportation
089	Air Transportation	65050	Air Transportation
090	Pipelines, except Natural Gas	65060	Pipeline Transportation
091	Transportation Services	65070	Transportation Services
092	Communications, except Radio and Television	66000	Communications
093	Radio and Television Broadcasting	67000	Radio and Television Broadcasting
094	Electric Utilities	68911	Fossil Fuel Establishments
		68912	Nuclear Establishments
		68913	Hydroelectric Establishments
		68921	Fossil Fuel Establishments
		68922	Nuclear Establishments
		68923	Hydroelectric Establishments
		68931	Fossil Fuel Establishments
		68932	Nuclear Establishments
		68933	Hydroelectric Establishments
		68941	Fossil Fuel Establishments
		68942	Nuclear Establishments
		68943	Hydroelectric Establishments
095	Gas Production and Distribution	68021	Gas Pipelines
		68022	Gas Utilities, except Gas Pipelines
096	Water and Sanitary Services	68030	Water and Sanitary Services
097	Wholesale Trade	pt. 69000	Wholesale and Retail Trade
098	Eating and Drinking Places	pt. 69000	Wholesale and Retail Trade
099	General Merchandise and Apparel Stores	pt. 69000	Wholesale and Retail Trade
100	Food, Drug and Liquor Stores	pt. 69000	Wholesale and Retail Trade
101	Automotive Dealers and Gasoline Service Stations	pt. 69000	Wholesale and Retail Trade
102	Other Retail Stores	pt. 69000	Wholesale and Retail Trade
103	Banking, Credit Agencies and Investment Brokers	pt. 70000	Finance and Insurance
104	Insurance	pt. 70000	Finance and Insurance
105	Real Estate and Rental	71000	Real Estate and Rental
106	Hotels and Lodging Place	pt. 72000	Hotels and Lodging Places, Personal and Repair Services, except Automobile Repair
107	Personal and Repair Services, except Auto	pt. 72000	Hotels and Lodging Places, Personal and Repair Services, except Automobile Repair

EXHIBIT 2-1:

CONCORDANCE OF MRIO AND NEA CODES (cont.)

MRIO Sector		NEA Code	
108	Miscellaneous Services and Advertising	pt. 73000	Business Services
109	Miscellaneous Professional Services	pt. 73000	Business Services
110	Auto Rental, Repair and Maintenance	75000	Automobile Repair and Services
111	Amusements	76000	Amusements
112	Doctors and Dentists, inc. Out-patient Care Facilities	pt. 77000	Medical, Educational Services, and Nonprofit Organizations
113	Hospitals and Nursing	pt. 77000	Medical, Educational Services, and Nonprofit Organizations
114	Other Medical and Health Services	pt. 77000	Medical, Educational Services, and Nonprofit Organizations
115	Educational Services	pt. 77000	Medical, Educational Services, and Nonprofit Organizations
116	Nonprofit Organizations	pt. 77000	Medical, Educational Services, and Nonprofit Organizations
117	Other Social Services	pt. 77000	Medical, Educational Services, and Nonprofit Organizations
118	Federal Government Enterprises except Utilities and Local Transit	78009	Federal Government Enterprises
119	State and Local Government Enterprises, except Utilities and Local Transit	pt.79009	State and Local Government Enterprises
124	Rest of World	99081	Unknown Distribution
150	Personal Consumption Expenditures	95009	Personal Consumption Expenditures
156	Federal Defense Expenditures (current and capital)	97100	Federal Government Purchases, Defense
157	Federal Government Current Expenditures (except defense)	97200	Federal Government Purchases, Others
158	State and Local Government Current Expenditures	92009	State and Local Government Purchases

This production expenditure matrix was then combined with the value of production matrix developed from Table 35 in the Census for the estimation of output and employment, by state, in the agriculture sector (see State Estimates of Outputs, Employment and Payrolls, 1977, (Source 23013).

All production expenditures and value of production for 1978 by state and type of farm were then deflated to 1977 values. Deflators for the value of production by commodity were developed from USDA sources on commodity prices or value of production. These sources were primarily crops, dairy, livestock, and poultry production reports from the Economic and Statistics Service's Crop Reporting Board (Sources 02131-4) supplemented by data from the Agricultural Statistics (Source 02001). Price data or price indexes were also used from the 1977 and 1978 Agriculture Price Reports (Source 02135) of the USDA. Composite deflators were calculated by weighting individual product indexes by product output. In most cases, deflators could be calculated in this manner by state for each Census commodity group, however, in a few cases, only a national level deflator was available.

Deflators for each production expenditure category were also developed from several sources. For all energy and petroleum product inputs except natural gas and the "other fuels" category, price data for 1977 and 1978, by state, were available from the Agricultural Price Reports. For the remaining energy expenditure categories, only national deflators were available. "Other fuels" was assumed to be mostly coal, based on energy consumption data in Energy and U.S. Agriculture: 1974 and 1978 (Source 02112). Applied across all the states, these indexes for "other fuels" and "natural gas" were taken from the 1977 Wholesale Prices and Price Indexes (Source 12106) and the Producer Prices and Price Indexes, 1978 (Source 12107).

Working from the two 1978 Census matrices now deflated to 1977 dollar values, input usage by farm commodity was imputed by calculating dollar input per dollar output intensities, by state, for each input-commodity combination. All these calculations were performed in the context of an iterative procedure. In the initial run, input intensities were calculated for the main diagonal cells of the production matrix taking total dollar inputs by farm SIC per dollar output of the primary product for that farm SIC. These input intensities were then applied across that primary product output row wherever that product was produced.

The choice of which input intensity to use for each farm product row was based upon an examination of output concentration at the national level by type of farm. For example, with grains production concentrated on cash grain farms, the input intensities for grains production on grain farms were applied across the grains output row. In this way, the input intensities of the farm SIC to which a farm commodity is primary (given SIC definitions in the agriculture sector) are controlling. As a final step, allocated inputs were then scaled to the deflated dollar input totals by type of farm given in Table 35.

The next step was to collapse the matrix across types of farms and commodities to MRIO sector levels by state. These values were then divided by deflated 1978 MRIO sector output. These coefficients applied to the 1977 total value of production data by MRIO derived from the USDA sources gave estimates of the associated 1977 dollars of energy inputs consumed in that production.

Data were then assigned to consuming sectors. It was assumed that gasoline, diesel fuel, fuel oil, LP gas, butane propane, kerosine, motor oil and grease were consumed from MRIO 050 (Petroleum Refining), while electricity was consumed from MRIO 094 (Electric Utilities), natural gas from MRIO 094 (gas production and distribution), and coal, wood, coke, etc. from MRIO 009 (Coal).

Energy data for the agricultural services portion of MRIO 004 were taken from the NEA. Heat and Power functional uses of energy for agricultural services were developed concurrently with estimates for commercial sectors discussed later in this chapter. Transportation functional uses of energy for agricultural services uses were developed concurrently with estimates for the transportation sectors and are also included in a later section of this chapter.

Forestry and Fisheries (MRIO Sectors 005-006)

Energy inputs to these sectors were developed exclusively from the NEA. In addition, the majority of the data utilized in estimating energy consumption in the Forestry and Fishery sectors were developed concurrently with the estimates for commercial sectors. Data developed separately for fisheries are included below.

Motor Gasoline

Gasoline consumption in the forestry and fishery products sector has been estimated for 1974 by the National Marine Fisheries Service of the U.S. Department of Commerce. The estimate for that year was based on a survey of sales at large marine terminals that was adjusted to account for smaller dealers. Consumption for 1977 was estimated using a 1974 coefficient in gallons of gasoline per ton of gross weight in the commercial fishing fleet and this coefficient was multiplied by the total gross weight in tons for 1977. The tonnage statistics are from the annual volume of Fishery Statistics of the United States, "Summary of Operating Units" (Source 03812).

Diesel

Diesel consumption in the fishery sector was calculated in the same manner as gasoline except that a coefficient of use per ton was estimated for both 1970 and 1974. The coefficient was allowed to change (at the annual growth rate between 1970 and 1974) to allow for differences in fuel use per ton in 1977 caused by larger tuna boats.

Motor Oil

Motor oil consumption in the fishery sector was estimated by multiplying motor gasoline and diesel use by the ratio of motor-oil-to-gasoline and motor-oil-to-diesel, respectively. Estimation of these ratios is discussed in the transportation fuels section. The results were summed to yield final estimates.

Grease

Grease consumption in the fishery sector was estimated by multiplying motor oil use by a grease-to-motor-oil ratio. Estimation of these ratios is discussed in the transportation fuels section.

Mining (MRIO Sectors 007-013)

Data for MRIO Sectors 007 - 013 were taken from the 1977 Census of Mineral Industries (Source 03106). The reported census consumption covers all energy functional use categories with the exception of the input of wet natural gas to natural gas processing plants. This input is of an intra-sector nature as MRIO 011 includes both the mining and the processing of the wet natural gas and is not shown in the MRIO.

Energy consumption data from the 1977 Census of Mineral Industries were available by energy type, by state, by two-digit SIC group. In addition data by energy type, by four-digit SIC group were available at the national level. The methodology utilized to develop estimates for MRIO energy consumption involved three steps. First, suppressed data were filled in at the state and two-digit SIC levels. Second, data was disaggregated to MRIO detail, where necessary, using national four-digit SIC data and the MRIO output measures developed previously by JFA. Third, data were assigned to consuming sectors.

Suppressed data were filled in first at the state level and then at the two-digit SIC level, by state. The method used involved developing a first estimate by allocating the unallocated portion of consumption for each fuel type based on output. These estimates were then scaled to the unallocated portion of total consumption of energy for that state or two-digit SIC within that state. Finally, the estimates were rescaled back to the unallocated portion of consumption for each fuel type.

Data were then disaggregated to MRIO detail where necessary. Since each two-digit SIC is the sum of two MRIO sectors (except MRIO 009 which is the sum of SIC's 11 and 12) this was accomplished by splitting fuel consumption, by fuel type, at the national level based on four-digit SIC consumption, dividing these consumption figures by MRIO output and then applying these ratio to MRIO output at the state level. The exceptions to this were MRIO 009 which was estimated as the sum of SIC's 11 and 12 and MRIO 010 and 011 which do not correspond to four-digit SIC's and were thus split solely on output.

Data were then assigned to consuming sectors. It was assumed that gasoline, distillate, residual and other fuels were consumed from MRIO Sector 050, Petroleum Refining. It was assumed that Electric Energy was consumed from MRIO Sector 094 (Electric Utilities), Natural Gas from MRIO 095 (Gas Production and Distribution) and Coal from MRIO 009 (Coal). Fuels not specified by kind were assumed to be consumed from the same sectors (excluding MRIO 095 Electric Utilities) in the same proportion as specified fuels.

Construction (MRIO Sectors 014-019)

Data for MRIO Sectors 014-019 were taken from the 1977 Census of Construction Industries (Source 03104). The reported census consumption covers all energy functional use categories with the exception of energy products consumed as a construction material. Data for this input were estimated from the NEA.

Energy data from the 1977 Census of Construction Industries were available by energy type and four-digit SIC group at the national level, and by fuel type at the state level. The methodology used was similar to that used for construction employment (see State Estimates of Outputs, Employment and Payrolls, 1977).

First, national level data were converted from an establishment basis (four-digit SIC) to an activity basis. This was accomplished by multiplying the ratio of purchasers' prices for each fuel type to net receipts for each four-digit SIC by the net receipts for the portion of the net receipts for each activity in that SIC. The resultant values were then summed to activity totals and divided by net receipts (for that activity) to yield ratios of fuel cost to output by activity.

Second, state estimates of fuel consumption were developed by MRIO sector. This was accomplished by multiplying the national level ratios, developed in step one, times state output, by activity, by energy product. These results were then scaled to state consumption by fuel type and summed, by activities, to yield estimates by MRIO sector.

Finally, data were assigned to producing sectors. It was assumed that gasoline, diesel fuel, lubricating oils, greases and other fuels were all consumed from MRIO 050 (Petroleum Refining), while electric energy was consumed from MRIO 094 (Electric Utilities), and natural gas from MRIO 095 (Gas Production and Distribution).

Data on the consumption of energy in construction from the NEA were used only for asphalt and road oil used as a construction material. Domestic consumption of asphalt and road oil were published in 1977, by the U.S. DOE, Energy Information Administration in Energy Data Reports, "Sales of Asphalt" (Source 06103). Asphalt consumption for paving purposes were allocated to the construction industry. The major functional use of road oil is in road construction and it has been allocated entirely to the construction sector.

Manufacturing (MRIO Sectors 020-084)

The source of data for MRIO Sectors 020-084 was the 1977 Census of Manufactures (Source 03105). The reported census consumption covers heat and power functional uses only. Data for inputs to the energy conversion process and for inputs to non-energy conversion processes were also developed from the 1977 Census of Manufactures (Source 03105). These data were developed in conjunction with the other inputs to

manufacturing sectors (see Chapter 6). Data development for the transportation functional use was developed from the NEA and is detailed in the section on transportation sectors.

Energy consumption data from the 1977 Census of Manufactures were available by energy type, by state, by three-digit SIC group. In addition, data by energy type, by four-digit SIC group were available at the national level. The methodology utilized to develop estimates for MRIO energy consumption involved three steps. First, suppressed data were filled in at the state and three-digit SIC levels. Second, data were disaggregated to four-digit SIC detail, where necessary, utilizing national data on energy consumption and state data on output (see States Estimates of Output, Employment and Payrolls, 1977). Third, data were summed to MRIO sector detail. Fourth and finally, data were assigned to consuming sectors.

Suppressed data were filled in first at the state level and then at the three-digit SIC level, by state. The method used involved developing a first estimate by allocating the unallocated portion of consumption for each fuel type based on output. These estimates were then scaled to the unallocated portion of total consumption of energy for that state or three-digit SIC within that state. Finally, the estimates were rescaled back to the unallocated portion of consumption for each fuel type.

Data were then disaggregated to four-digit SIC detail where necessary. This was accomplished by splitting fuel consumption (by fuel type at the national level based on four-digit SIC consumption), dividing these consumption figures by MRIO output and applying these ratios to MRIO output at the state level.

Data were then summed across three- and four-digit SIC groups to produce results by MRIO sectors, by state.

Finally, data were assigned to consuming sectors. Distillate, residual and other fuels were assumed to be consumed from MRIO 050 (Petroleum Refining). Electric energy was assumed to be consumed from MRIO 095 (Electric Utilities). Natural Gas was assigned to MRIO 095 (Natural Gas Production and Distribution). Coal was assigned to MRIO 009 (Coal). Coke and breeze were assigned to MRIO 055 (Iron and Steel Mills and Forging). Fuels not specified by kind were assumed to be consumed from the same sectors and in the same proportion as specified fuels (with the exception of electric energy).

Transportation (MRIO Sectors 087, 091)

This section is a description of the methods and data sources employed in the NEA to estimate fuel use for transportation in 1977. Conceptually, transportation was treated as a functional use rather than as a consuming sector, since transportation fuels, such as auto gasoline, were allocated across all consuming sectors. Thus, NEA data were used to estimate the fuel use in transportation for many non-commercial transportation sectors. In addition, NEA data were used for two commercial transportation sectors: MRIO 087 (Motor Freight) and MRIO 091 (Transportation Services). Energy use for all other commercial transportation sectors were developed independently and are discussed in Chapter 8.

The development of the highway fuel controls for gasoline, diesel and liquefied petroleum gases (LPG) are described first. Following the highway controls section are descriptions of how these fuels were allocated to consuming sectors by highway vehicle types: automobiles, trucks and non-commercial buses.

The next subsection reviews the development of fuel use for general aviation and the distribution of this fuel use across sectors.

The final subsection reviews the development of lubrication ratios and the resulting allocations of lubricating oil and grease to the various modes by sector.

Highway Fuel Controls

The data source for 1977 consumption of gasoline and diesel plus LPG (combined) was the 1977 edition of Highway Statistics (Source 14401).

The disaggregation of 1977 consumption of diesel plus LPG (combined) into its two components was derived in the following way: the quantity of LPG sold for use in internal combustion engines was obtained from the 1977 edition of Energy Data Reports, "Sales of Liquefied Petroleum Gases and Ethane," (Source 06103). Next, data on sales of LPG engine carburetors by use were obtained from the National LP Gas Association and used to estimate the proportion of LPG used for on-highway purposes. This proportion was applied to the LPG total to obtain an estimate of highway LPG, which was then subtracted from the diesel plus LPG (combined) figure to obtain the highway diesel estimate.

Automobile Fuel

Estimates of the 1977 consumption of automobile fuel were made for all sectors. All auto fuel was assumed to be gasoline.

The disaggregation of the 1977 control total to the major uses (personal, Federal government, state and local government, business) were derived by using BEA auto stock figures and estimates of average vehicle miles and miles per gallon derived from the 1977 edition of Highway Statistics (Source 14401), to obtain auto fuel by major use in each year.

The 1977 major use estimates were assigned or distributed to sectors as follows: personal was assigned to Personal Consumption Expenditures. Federal government was allocated to Federal Government Enterprises (5%), and to Federal Government Purchases (95%), using the same constant percent distribution as in the original NEA study. State and local government was assigned to State and Local Government Purchases. Business had to be distributed across all the appropriate consuming sectors, but first an independent estimate of taxi fuel was made and subtracted out of the business total, as follows: an estimate of the number of taxis in fleets in 1977 was obtained from Bobit Publishing Company. This number was then inflated approximately 17 percent to account for non-fleet cabs. Next, the series on average taxi vehicle miles (VM) per year that was developed for the original NEA study, was extended to 1977 to obtain an average taxi VM/year figure for that year. The series was extended using its average growth rate, approximately nine percent. The original VM/year series, 1947-61, was obtained from the Motor Vehicle Manufacturers Association, Automobile Facts and Figures (Source 22201). Next, the inflated number of taxis was multiplied by the average taxi VM/year figure to obtain an estimate of total taxi vehicle miles. Next, the 1977 average auto miles per gallon (MPG) figure from the 1977 edition of Highway Statistics (Source 14401) was deflated approximately ten percent to obtain a rough estimate of taxi MPG. Finally, the total VM figure was divided by the MPG figure to obtain an estimate of 1977 taxi fuel.

The taxi fuel was assigned to Local, Suburban, and Interurban Highway Passenger Transportation and subtracted from the business total to obtain 1977 residual business auto fuel for distribution to all business consuming sectors.

This residual control was distributed across all consuming sectors, using occupation by industry data. The number of employees in several occupational categories where auto travel would be particularly relevant, such as sales, managerial, and professional, were collected by industry for 1970 from U.S. Department of Commerce, Bureau of the Census, Census of Population (Source 03111), "Occupation by Industry," volume. Next, these data were weighted to take into account the relative travel intensities of the different occupational categories. Information for this purpose was obtained from FHWA, Nationwide Personal Transportation Study, Report #10, "Purposes of Automobile Trips and Travel," (Source 14403) and also from "Motor Vehicle Use Studies in Six State," in U.S. Department of Commerce, Bureau of Public Roads, Public Roads, December 1954, page 99 (Source 03901). The next step was to convert the weighted census data into the consuming sector taxonomy used in this analysis. Where necessary, disaggregaton of the census data was accomplished using total output and employment data by sector (developed for use throughout the NEA project). With this completed, the proportional distribution to consuming sectors could be calculated for 1970 and multiplied by the residual business gasoline controls to obtain estimates by detailed consuming sectors in the 1970 benchmark year.

Estimates by detailed sectors for 1977, a non-benchmark year were obtained via a computer program which extrapolated through 1977 from 1970. For 1977, the preliminary estimates were summed and then scaled to the 1977 residual business auto gasoline control. The last step was to sum the taxi gasoline estimate and the residual business gasoline allocation to the highway passenger transportation sector in order to obtain the total auto gasoline allocation for the sector.

Truck Fuels

Highway truck fuel controls for diesel fuel, gasoline, and LPG consumption were developed for and were distributed across all consuming sectors from the 1977 edition of Highway Statistics (Source 14401).

After the total truck fuel controls were obtained, the first step was to dissaggregate these into diesel, gasoline, and LPG controls. Truck diesel and LPG were each derived by subtracting the corresponding bus estimates from the highway diesel and LPG controls. Truck gasoline was obtained by subtracting the diesel and LPG (truck) estimates from the total truck fuel controls.

The rest of the analysis consisted of distributing the three truck controls to detailed consuming sectors. For Census benchmark years, the three truck fuel controls were first disaggregated among the following major uses classes: government, agriculture, personal, for-hire, contruction, manufacturing, wholesale/retail, services, forestry and lumber, mining, and utilities. The estimates by major use and fuel type were then disaggregated to detailed consuming sectors, using employment or output data. Detailed distributions for 1977 were made via extrapolation, based on trends in output and fuel to output ratios.

Data of good quality were available for 1972 from a special printout from the public use tape of the U.S. Department of Commerce, Bureau of the Census, 1972 Census of Transportation, "Truck Inventory and Use Survey" (Source 03107). A percent distribution of 1972 truck vehicle-miles by size class (very light pickup, light, medium, light-heavy, heavy-heavy) was derived from the printout. The percents were also arranged by area of operation (local, intercity, not available), fuel type (gasoline, diesel, LPG) and by major uses (agriculture, personal, for hire, construction, manufacturing, wholesale, retail, services including utilities, forestry, lumber, and mining). Additional vehicle-miles data from the published revision of the 1972 Truck Inventory and Use Survey (Source 03107) were used to break utilities out of the services major use category to form two new categories, services (excluding utilities) and utilities. The next step was to convert the percent distribution to actual vehicle-miles, as follows. Total truck vehicle miles were obtained from the 1972 Highway Statistics (Source 14401), and then government vehicle miles (aggregation of both categories) were subtracted out, yielding a residual that was then multiplied by the percent distribution to obtain vehicle-miles by size class, area of operation, fuel type and major use. MPG factors were used to convert the vehicle miles to estimates of fuel consumption.

The mpg factors were developed as a consensus of several sources including: a) worksheet estimates of the FHWA, b) U.S. House of Representatives, Final Report of the Highway Cost Allocation Study (Source 03051), and c) Jack Faucett Associates, Project Independence and Energy Conservation: Transportation Sectors (Source 23015). The fuel estimates were summed for each major use and then the major uses were aggregated and scaled to the appropriate fuel control (for gasoline, diesel, or LPG; total truck fuel minus government truck fuel).

The next major step was to disaggregate the 1972 estimates by major use and fuel type to detailed consuming sectors. The personal and wholesale/retail major use estimates were exempt from this procedure, as they were assigned to single consuming sectors. The standard output distributions (used throughout the NEA, 1958 to 1972) for the benchmark year 1972 were used as the basis for disaggregating the truck fuel estimates for the agriculture and construction major uses. Proportional distributions developed from occupational employment data were used to disaggregate the other major uses. Employment data by sector were compiled on the number of truck drivers, delivery persons, and route persons; from "Occupation by Industry" volumes of the Bureau of the Census, Census of Population in 1970 (Source 03111). These data were then updated to 1972, using the growth or decline in industry output.

The last major step was to make detailed distributions of truck fuel to consuming sectors for 1977.

The 1972 distribution of truck fuels were updated to 1977 using manual and computerized techniques. Independent estimates of government and personal truck fuels were made for 1977. From Highway Statistics (Source 14401), the total number of: a) Federal Government and b) state and local government trucks were computed. Next, estimates of average miles per vehicle were made for the same two categories and these were multiplied by the vehicle data to obtain estimates of total vehicle-miles for Federal, and state and local government trucks. The total vehicle-miles by government category were disaggregated to gasoline, diesel, and LPG. The last step was to convert the vehicle miles to fuel using the following factors: a) 10 mpg for gasoline and LPG, and b) 5 mpg for diesel (these factors were used for both government categories).

Personal truck gasoline for 1977 was estimated by extrapolating from the 1972 (benchmark) proportional allocation. No diesel fuel was allocated for personal trucks.

The estimates of government and personal truck fuels were subtracted from the total truck fuel controls on gasoline, diesel, and LPG for 1977. The residual control was then disaggregated across all the business sectors, using an extrapolating computer program. The program calculated the 1972 fuel/output ratios for each sector and fuel type and then used these as a constant multiplier of output to obtain preliminary estimates of truck fuels in 1977. The preliminary estimates were then summed and scaled to the residual business truck fuel controls for 1977.

Non-Commercial Buses

Estimates of gasoline, diesel, and LPG consumption by non-commercial buses were made for 1977 and were allocated among four consuming sectors. Control totals for school and other non-revenue buses were obtained from the 1977 edition of Highway Statistics (Source 14401).

The FHWA school and other nonrevenue total bus fuel controls were disaggregated to three major uses; private (predominantly private school buses), Federal Government, and state/local government (public school buses predominant) on the basis of the number of buses estimated for each use, from the Highway Statistics (Source 14401). The FHWA use classifications and estimates are subject to considerable error because they are vaguely defined, and FHWA has no basis other then tax data for making the distribution, but it is the best method available. The private bus fuel estimates were further disaggregated to: a) organization-owned buses and b) for-hire buses, based on vehicle miles data from the Supplementary Report of the Highway Cost Allocation Study (Source 03052). Finally, using vehicles-mile by fuel type data from the table just cited, all of the school and other nonrevenue bus fuel estimates were disaggregated between gasoline and diesel fuel (excluding Federal Government which was gasoline only.) The last step was to assign the estimates to consuming sectors. Private for-hire bus fuels were considered to be commercial bus fuels and were thus deleted. Fuels used by private organization-owned buses were assigned to Medical, Educational Services and Non-Profit Organizations. Federal government bus gasoline was assigned to Federal Government Purchases, Other (excludes defense) and state/local bus fuels were assigned to State and Local Government Purchases.

General Aviation

The control total for fuels used in general aviation are the sum of aviation gasoline and jet fuels. The source of data on aviation gasoline is the Energy Data Report 1977, "Crude Petroleum Products and Natural Gas Liquids" (Source 06103). The source of data on jet fuel consumption is the 1978 General Aviation Activity and Avionics Survey (Source 14303). The control total for both types of fuel was then allocated to major uses which were then assigned or distributed to consuming sectors.

The first step was to estimate the consumption of general aviation fuels by major use in 1977. It was decided to estimate the 1972 major uses in the original NEA study and update these to 1977 (using hours data) before making assignments or distributions to sectors.

Data on general aviation fuels consumed in 1972 could be obtained directly for major uses that were allocated exclusively to one or more sectors, but had to be estimated for major uses allocated to sectors with more than one major use allocation. The breakdown to major uses within these sectors in 1972 was estimated by determining the corresponding proportional breakdown in 1970, where major use controls were available. For the single sectors receiving allocations from aerial application, air taxi, and instruction, the difference between these quantities and the total allocation to their sectors would be the business allocation. The 1970 breakdown in the multiple sectors receiving allocations from industrial/special and other use category was determined by updating the 1964 sector allocations of these uses by output, scaling to the 1970 controls and then calculating within each sector the difference between the industrial/special and/or other allocation(s) and the total allocation to obtain business. The 1970 proportional breakdowns were calculated and applied to the total allocations in 1972 multiple use sectors. With this step completed, it was possible to determine the total fuels allocated to each major use in 1972.

The 1972 major use estimates by fuel type were updated from 1972 to 1977 by the growth rate in hours flown in each category; by aviation gasoline powered planes and by jet (turbine) powered planes. The hours for all uses except government were obtained from United States General Aviation 1959-1978 (Source 23081). The government hours were obtained from the Office of Aviation Policy at FAA. The updated fuels by use were summed and scaled to the 1977 general aviation controls.

The last step was to make sector assignments or distributions. Personal was assigned to PCE; aerial application to Agricultural Services; instruction to Educational Services; and air taxi to Commercial Air Transportation. The other major uses, business, industrial/special, other, and government were distributed to sectors by updating the 1972 sector allocations within each use category to 1977 by the growth in output, summing the updates and then scaling them to the use controls. Finally, aggregations were performed in those sectors with multiple use allocations, to obtain total allocations.

Lubricating Oils and Greases

Virtually no hard data exist on the consumption of oil and grease for transportation uses, so these estimates must be considered only rough order-of-magnitude approximations. In the treatment of both oil and grease consumption, the same procedure was followed. Several rough series of engineering ratios (gallons of oil/gallons of fuel, and gallons of lubricating grease/gallons of oil for a typical engine) were developed to deal with various broad categories of motor-powered engines, and then these time series were applied to previously estimated fuel quantities in the appropriate transportation areas to derive oil and grease consumption estimates. Most of the technique was based on conversations with authorities in the field, but some data used in the estimations were acquired from the Bureau of the Census, Current Industrial Reports series, "Sales of Lubricating and Industrial Oils and Grease" (Source 03129).

The lubricating oil/aviation gasoline (avgas) ratio (constant in all years) was developed as follows: for the period 1951 through 1954, it was possible to calculate oil/avgas ratios using oil and avgas consumption data from tables 60 and 85 (respectively) of Civil Aeronautics Board, Handbook of Airline Statistics (Source 17211), 1973 edition. These yearly ratios were then averaged to form a single ratio (0.0117). Discussion with an authority at Avco Lycoming Corporation revealed that the ratio of oil/fuel had not changed significantly since the period mentioned above. On this basis, 0.0117 was used for 1977.

The lubricating oil/jet fuel ratios were developed using information obtained from an expert at Air Research Corporation.

The lubricating oil/highway gasoline ratios were developed as follows. From a Bureau of the Census, Current Industrial Reports series entitled "Sales of Lubricating and Industrial Oils and Greases" (Source 03129), two automotive lubricating oil series were compiled: a) total sales excluding exports and Federal Government purchases, and b) Federal Government purchases, for 1977. The Federal series had to be adjusted to exclude military purchases in order to make the lubricating oil data consistent with the fuels data, as follows: ratios of civilian vehicle-miles/total vehicle-miles for Federal Government vehicles could be derived from data in General Services Administration, 1977 report entitled Federal Motor Vehicle Fleet Report (Source 17302). These were multiplied by the Federal purchases of lubricating oil, to obtain estimates of Federal

civilian lubricating oil purchases, which were then added to total lubricating oil sales (excluding exports and Federal Government) to obtain adjusted totals. The next step was to divide the adjusted total sales of automotive lubricating oil by corresponding estimates of fuel consumption. The term "automotive" as used in Current Industrial Reports (Source 03129), included all highway vehicles and, in addition, off-highway uses in agriculture, construction, and small boats. Thus, the highway fuel control had to be adjusted to include these uses. Once this was accomplished, the divisions could be made to obtain the lubricating oil/highway gasoline ratio.

The lubricating oil/highway diesel fuel ratios were developed as follows. An authority at Mack Truck, Inc., provided information on crank case sizes, oil-change intervals (miles) and add-oil intervals (miles) for diesel trucks in 1972. Using an assumed fuel mileage factor of 5 mpg, plus the lubrication information, the total consumption of both lubricating oil and fuel could be estimated for a single oil change interval (includes the oil change). Division of the former by the latter provided estimated lubricating oil/highway diesel fuel ratios for 1972. The 1972 ratio was used for 1977.

The grease/lubricating oil ratios were developed as follows. From Current Industrial Reports, "Sales of Lubricating and Industrial Oils and Greases" volumes (Source 03129), data were compiled on a) total sales of automotive and aviation greases (excluding Federal Government purchases) and b) total sales of automotive lubricating oil (excluding Federal Government purchases), for 1977. Grease/lubricating oil ratios were calculated from these data.

Electric and Gas Utilities (MRIO Sectors 094-095)

The material inputs used in the generation of electric energy were developed directly from original sources. Fuel and power uses (excluding on-highway transportation use) of energy products were developed from NEA data. On-highway use of transportation fuels by utilities is discussed in the transportation section.

The material inputs used in the generation of electric energy were developed by state for oil, coal, and gas. Data on quantities consumed by state were from the 1978 edition of Energy Data Report, "Power Production, Consumption and Capacity, Annual," (Source 06103). Data on prices for oil, gas, and coal, by state, were from the 1977 edition of Statistical Yearbook of the Electric Utility Industry (Source 22021). Quantities were multiplied by price to estimate consumption by state.

The only energy product (other than conversion inputs) for which consumption data are available for electric utilities is electric power. The Edison Electric Institute, in its Statistical Year Book of the Electric Utility Industry (Source 22021), publishes the kilowatt-hours consumed for "company use and free service" and "energy used by producers." These two categories were combined to obtain a total use of electric power by the industry. Strictly speaking, the data overstate consumption in the utility sector by the free service component. The total consumption of electricity is then distributed to each type of establishment based upon the percentage contribution of each establishment to the total amount of electricity generated.

Natural gas was the only energy product for which specific data measuring the fuel and power consumption of the gas utilities were available. These data are published by the American Gas Association in Gas Facts (Source 22011). Interdepartmental transfers were deducted from these values since these transfers are used as material inputs in the generation of electric energy in combined electric-gas utilities. In addition, natural gas used as pipeline fuel (for transportation) was also deducted so that the remainder is natural gas consumed for other purposes by the gas utilities. These data were then distributed between the gas pipeline industry and the gas utility industry, based on the miles of pipeline operated by each of these industries. The data on miles of pipeline operated are found in the American Gas Association publication, Gas Facts.

Commercial Sectors (MRIO Sectors 092, 093, 097-117)

All energy input data for commercial sectors were developed from the NEA. This section is a description of the methods and data sources employed in the NEA to estimate commercial energy consumption. Some noncommercial sectors including Forestry, Fisheries, Agricultural Services, Transportation Services, Federal Government, Federal Government Enterprises, State and Local Government and State and Local Government Enterprises are also allocated in this section. Total energy consumption by commercial industries is the sum of two components. The first, transportation use, is discussed in the section of transportation fuels and includes consumption for private fleets of trucks, autos, and buses owned and operated by commercial establishments. The second, nontransportation uses, is the subject of the present section.

The approach taken in estimating commercial consumption involved three steps. The first step was to develop a control total that approximated commercial consumption as closely as possible. Second, where existing data were sufficient, allocations to

individual sectors covered by this control were determined and subtracted from the control total. And finally, the unallocated residual was distributed on the basis of employment and building area to all sectors included in this coverage.

The following section is a detailed presentation of the methodology used in obtaining data on electricity, natural, mixed and manufactured gases, fuel oil and liquefied petroleum gas used in nontransportation commercial consumption.

Electricity

The control total for commercial consumption of electricity are from the 1977 edition of Edison Electric Institute's (EEI), Statistical Year Book (Source 22021). This total corresponds quite closely to the sum of sales to trade, communications, services, and construction excluding oil and gas well drilling, however the correspondence is not exact. For example, sales to some large commercial establishments may be reported under the industrial sales classification, while sales to some small industries concerns may be included in the commercial sales total. Also, sales to rented residential units of five households or more that are served as single customers at commercial rates are included in the commercial total. Consequently, some sales allocated to personal consumption expenditures in the present report are captured in these controls. On the whole, however, it was felt that commercial sales of electricity, as reported by the EEI, generally reflected sales to sectors mentioned above.

Consumption of electricity by the communications, radio and television, and personal consumption expenditures sectors are identifiable from existing information. Electricity consumption by the communications sector, excluding radio and television broadcasting has been estimated from data supplied by the American Telephone and Telegraph Company (AT&T). In order to estimate the total sector consumption, it was necessary to adjust upward the figures for the Bell System alone. This was done by determining the average consumption per Bell System telephone, and multiplying by the number of telephones in the United States in 1977. Statistics for the total number of phones in the nation as a whole are published in the Federal Communications Commission's Common Carrier Statistics (Source 16203). Estimates are for building services and communication energy consumption.

Consumption of electricity for transmission purposes for Radio and Television Broadcasting in 1972 was estimated by the Federal Communications Commission (FCC) and made available to Jack Faucett Associates (JFA). The only year for which the FCC made such an estimate is 1972, and its reliability is uncertain. Consumption for transmission purposes in 1977 was estimated by deriving the average number of kilowatt-hours per broadcast station in 1972, and multiplying that average by the number of broadcast stations in 1977. (The number of broadcast stations is defined as the sum of television, AM, FM, VHF and UHF stations operating during 1977.) Station operating data are published in the 1977 volume of the Broadcasting Yearbook (Source 24061).

Personal consumption expenditures for electricity are defined as including all sales to owner-occupied and rented residential units, whether individually or gang-metered. As mentioned, the FPC's commercial sales figures include a portion of these expenditures, namely, sales to rented residential units of five households or more that are served as single customers at commercial rates. Estimates of these residential sales at commercial rates are made annually by BEA, according to the methodology discussed in the personal consumption expenditure section of this report.

The individual sector allocations for communications, radio and television broadcasting, and personal consumption expenditures were summed and deducted from the EEI commercial sales total to obtain a residual control total.

This residual control total was then allocated to individual commercial and noncommercial sectors, based on the sector composition of the control quantities. This distribution is based on estimates of the floor space utilized by each sector. Estimates of floor space were developed by relating factors identifying square feet per employee to the number of employees in each sector who would be involved in indoor work, therefore requiring space conditioning.

The use of employment data, combined with square feet of building space per employee data, to obtain distributions of residual consumption was believed to provide as close an approximation of relative consumption across sectors as existing data permit. While it is fully recognized that per capita energy consumption is not uniform among consuming sectors, particularly due to differences in the energy intensiveness of various activities, sector consumption for major uses such as space conditioning and lighting is felt, in

most cases, to be linked to the number of persons engaged in economic activities in the amount of area for which building services are required.

Data on employment by sectors are developed from the Bureau of Economic Analysis, Survey of Current Business (Source 03501) and unpublished self-employment data; the Bureau of Labor Statistics Employment and Earnings (Source 12102); and the Bureau of the Census County Business Patterns (Source 03114). Square feet of floor area per employee data are from Edward A. Ide, Estimating Land and Floor Area Implicit in Employment Projections (Source 23031).

The remaining commercial data that are not assigned to sectors are summed to form a residual commercial control which is allocated to individual commercial sectors using data from the report entitled: Energy Consumption in Commercial Industries by Census Division -1974 (Source 23016), submitted by Jack Faucett Associates to the Consumption Studies Division, Department of Energy.

Natural, Mixed, and Manufactured Gases

The control totals for natural, mixed and manufactured gases are taken directly from the American Gas Association's (AGA) commercial sales figures published in the 1977 volume of Gas Facts (Source 22011). The data are compiled from an annual independent survey conducted by AGA. Representatives of AGA believe that approximately 98 percent of total gas utility sales are directly covered by this survey, with the aggregate results expanded two percent to obtain total national sales.

AGA's commercial sales cover a broad range of activities not included under the strict definition of "commercial." Besides trade, communications, and services, the total also includes sales to agriculture, forestry, and fisheries, the transportation sectors, and construction excluding oil and gas well drilling. Also, AGA includes in its commercial total the sales to rented residential units of five households or more that are served as single customers at commercial rates. As was the case for electricity, these sales are considered a part of personal consumption expenditures in the present report.

To arrive at a control total closer to the commercial sector definition and for estimating consumption by Hotels, Lodging Places, Personal and Repair Service, large volume sales reported by AGA are used to allocate sector gas consumption initially.

These data were derived from annual figures on total gas utility industry large volume sales published in Gas Facts (Source 22011). Large volume sales are defined as all gas sales to customers using more than 50 million cubic feet of gas annually.

The use of this procedure was based on two premises. First, it was assumed that the distribution of total large volume sales sufficiently reflected the distribution of total sales as to allow estimates of relative consumption among sectors. Second, since large volume sales were presented only in the aggregate and not by type of gas, it was also assumed that the composition of sector sales is comparable to that of total commercial sales (as defined by AGA).

Allocations to hotels and lodging places from the large volume sales were combined with those for dyeing and cleaning establishments to arrive at the allocation for Hotels, Lodging Places, Personal and Repair Services, Excluding Auto Repair. It is believed that these estimates provide a useful gauge of the magnitude of total sector consumption though there is no comparison to determine their quality.

Consumption of natural gas for Communications, Excluding Radio and Television Broadcasting, was estimated in a manner similar to that employed for determining electricity consumption. Information provided for nonmanufacturing use by the Bell System was used to estimate natural gas consumption per telephone. This estimate was multiplied by the number of telephones in the United States in 1977 to estimate total sector consumption.

Personal consumption expenditures for natural, mixed, and manufactured gases are defined as including all sales to owner-occupied and rented residential units, whether individually or gang-metered. As mentioned, AGA's commercial sales figures include a portion of these expenditures, namely, sales to rented residential units of five households or more that are served as single customers at commercial rates. Estimates for these residential sales at commercial rates were made for each type of gas.

The large volume sector allocations for transportation services and communication; hotels and rooming houses; laundries, cleaning and dyeing; other services; and other nonmanufacturing are summed to the commercial control total including noncommercial gas consumed for construction and transportation services. Agriculture, forestry and fisheries allocations are not included, having been previously allocated.

From this control total the allocations for Communications, Excluding Radio and Television Broadcasting; Hotels and Lodging Places; Personal and Repair Services; and Personal Consumption Expenditures are subtracted leaving a residual control total for natural, mixed and manufactured gases. This residual control total and the remaining sector allocations are distributed in the same manner as the residual control for electricity.

Fuel Oil, Distillate and Residual

As was the case with electricity and gas, it was not possible to develop a control total for strictly commercial consumption of fuel oil. However, a control covering the commercial industries, transportation services, construction (excluding oil and gas well drilling), and nonmilitary government use was calculated, based on data from the Energy Data Report, "Sales of Fuel Oil and Kerosene" (Source 06103). Distillate and residual fuel oil for heating purposes were summed to obtain the fuel oil control total. Based on discussions with individuals familiar with the operation of commercial facilities, it was assumed that, of the commercial establishments that used fuel oil in 1977, both distillate and residual fuel oil were used.

Consumption by Communications, Excluding Radio and Television Broadcasting was estimated in the same manner as for electricity and gas. Average consumption of fuel oil per telephone was calculated and multiplied by the number of telephones in the United States in 1977.

Communications, Excluding Radio and Television Broadcasting and Personal Consumption Expenditures are subtracted from the control total leaving a residual to be allocated to the remaining commercial sectors, the transportation service sectors and government. This residual was allocated utilizing the same method as detailed for electricity.

Liquefied Petroleum Gases

Data on commercial consumption of LPG were developed in line with the Interindustry Economics Division, Bureau of Economic Analysis methodology. BEA uses the Department of Energy's data for household and commercial consumption of LPG as reported in the Energy Data Report "Sales of Liquefied Petroleum Gases and Ethane" (Source

06103), and breaks out residential use as 88 percent of the combined figure. The remaining 12 percent is then assumed to cover all commercial sectors. Personal Consumption Expenditures were calculated utilizing a different method. So that LPG would not be biased by PCE estimating procedures, 12 percent of the "Retail Sales" was used as the commercial control total.

Allocations of LPG to the Communications, Excluding Radio and Television Broadcasting sector were estimated by calculating the average consumption for each telephone and them multiplying by the number of telephones in the United States for each year.

The residual LPG use was allocated to the commercial sectors utilizing the same method as detailed for electricity.

Personal Consumption Expenditures (MRIO Sector 150)

All energy consumption data for personal consumption expenditures were developed from the NEA. This section is a description of the methods and data sources employed in the NEA to estimate residential consumption of energy for 1977. The energy types covered are:

- Electricity
- Natural Gas
- Mixed Gas
- Manufactured Gas
- Fuel Oil (distillate)
- Kerosine
- Liquefied Petroleum Gases
- Coal
- Coke
- Wood

Consumption in this section refers only to the use of energy products for space conditioning, lighting, cooking, refrigeration, heat, power and electricity generation. Petroleum products used for personal transportation are included in the transportation section of this chapter. Residential use covers both individually metered dwellings and gang-metered buildings such as apartment houses.

The approach used in the estimation of residential energy consumption was to obtain a control total for household expenditures for gas, electricity and other fuels — the latter encompassing fuel oil, kerosine, liquefied petroleum gases, coal, coke, and wood. Gas expenditures were disaggregated into natural, mixed and manufactured gas expenditures, and the other fuels expenditures were disaggregated into fuel oil, kerosine, liquefied petroleum gas, coal, coke, and wood expenditures.

Gas

The gas consumed by households includes three types: natural gas-dry, manufactured gas, and mixed gas. Natural gas has been the dominant gas type in recent years, accounting for close to 100 percent of residential gas consumption in 1977.

In order to be consistent with BEA's definition of personal consumption expenditures, estimates of residential consumption of each type of gas had to be made for all residential structures, both individually metered and gang-metered. These estimates are the sum of two components.

The first of these components is sales to individually-metered dwellings and gang-metered dwellings of less than five households. The basis for estimating consumption by these units was the BEA personal consumption expenditure data for gas as published in the Survey of Current Business (Source 03501), which were based on data provided by American Gas Association (AGA) on utility industry revenues from residential customers. These revenues cover all three types of gas sold to individually-metered dwellings and gang-metered dwellings of less than five units.

The second component of personal consumption expenditures (PCE) for gas is sales to gang-metered dwellings sold at commercial rates, as estimated by BEA. These sales are added by BEA to the gas sales at residential rates to derive total household gas expenditures.

To allocate expenditures by type of gas, utility industry revenues for each type of gas were calculated as a percent ot total residential revenues. The data were obtained from Gas Facts (Source 22011) and from Historical Statistics of the Gas Utility Industry (Source 22012), Tables 110, 111, and 112, published by the American Gas Association. These percentages were then applied to the PCE data to estimate natural,

mixed, and manufactured gas expenditures in millions of dollars for gas sold at residential rates and gas sold at commercial rates.

The values for PCE are the sums of gas sold at residential and commercial rates for natural, mixed and manufactured gases.

Electricity

The value of electric energy consumed by the household sector was obtained directly from the Survey of Current Business (Source 03501), Table 2.6 (July issue). This total expenditure figure is the sum of two components. The first is the value of annual residential electric sales, as reported by the Edison Electric Institute (EEI), Statistical Year Book of the Electric Utility Industry (Source 22021), and Historical Statistics of the Electric Utility Industry (Source 22022). The data include only sales to individually-metered dwellings and to gang-metered dwellings of less than five households.

The second component is the Bureau of Economic Analysis' estimates of annual residential electric sales to gang-metered dwellings at commercial rates, which are not included in the EEI data. To estimate the commercial rate sales, BEA calculates the stock of dwellings containing five or more units, using the Census of Housing (Source 03112). Based on the assumption that a gang-metered dwelling consumes half the electricity of an individually-metered structure, BEA multiplies half the average use per residential customer times the estimated number of large gang-metered dwellings to obtain a gang-metered dwelling consumption estimate. The estimate is then multiplied by the commercial rate, as published in Edison Electric Institute, Statistical Year Book (Source 22021) and added to EEI's estimates of residential revenues for total electricity PCE.

"Other Fuels"

The basis for distributing the "other fuels," (fuel oil, kerosine, liquefied petroleum gases, coal, coke, and wood) reported in the Survey of Current Business (Source 03501) is the Bureau of Labor Statistics, Consumer Expenditure Survey, 1950, 1960, and 1973 (Source 12112). The Consumer Expenditure Survey (CES) reports the average expenditures by families (including one person families) for fuel during the reporting year. Average expenditures per household are reported in three categories: a) coal, coke, and

wood, b) fuel oil and kerosine, and c) liquefied petroleum gas. Shares of each fuel calculated from the 1950, 1960, and 1973 CES data are extrapolated for 1977.

Fuel oil and kerosine combined expenditures were separated using the Bureau of Mines data on sales for heating purposes from the Mineral Industry Surveys and the Department of Energy's Energy Data Reports "Sales of Fuel Oil and Kerosine" (Source 06103). Coal and coke combined expenditures were separated using the Bureau of Mines Minerals Yearbook (Source 10101) sales data to determine residential coke expenditures as a percent of all retail coke and coal purchased.

The National Forest Service (NFS), using Wood Energy Institute data, has estimated 1976 residential wood consumption. This estimate shows an increase in consumption from 1972, and consumption is expected to continue increasing. The consumption of wood is extrapolated from the CES and NFS estimates for 1977. The shares for 1977 are applied to the PCE "other fuels" expenditures to estimate expenditure.

Government Sectors (MRIO Sectors 118, 119, 156, 157, 158)

All energy consumption data for government sectors were developed for the NEA. This section is a description of the methods and data sources employed in the NEA to estimate energy consumption by government in 1977.

The government sectors are divided between final demand and government enterprises. Both are further disaggregated into Federal, state and local activities. Government enterprises are activities of agencies with separate accounting records that recover more than half of their operating costs from the sales of goods and services to the public. In the National Energy Accounts, the activities of publicly owned electric and gas utilities have been transferred to the electric and gas utilities industries. Public transportation systems operated by the government have been transferred to the transportation sectors.

For 1977, the Census of Manufactures (Source 03105) has included in the manufacturing industry data on fuels and power consumed the electric energy used by enterprises owned by the government but operated by private manufacturing firms. Therefore, the U.S. Department of Energy (previously the AEC or ERDA) use of electric energy for the manufacturing of fabricated nuclear products is accounted for in the industrial inorganic and organic chemicals industry.

In addition to these data, the information on consumption of several energy products by the U.S. Department of Defense is also available. Where data measuring the consumption of specific fuels by the individual government sectors are not directly available, control totals obtained from the U.S. Department of Interior, Bureau of Mines, the Federal Power Commission (both now within the Department of Energy) the Federal Highway Administration, and the American Gas Association were used to estimate government fuel consumption.

The control totals were distributed using the U.S. Department of Commerce, Bureau of Economic Analysis employment data as well as U.S. Department of Defense personnel information. Domestic consumption of energy products for the transportation and nontransportation functions by the military were based on the proportions of personnel stationed in the United States.

Fuels consumed for transportation purposes by the nonmilitary component of Federal Government final demand are discussed in the transportation section of this chapter, since the control totals for the transportation function include the nonmilitary on-road use of fuels.

Electricity

The control total measuring the amount of electric energy consumed by all segments of the government including the military was obtained from the Federal Power Commission, Annual Report (Source 17601), in the table entitled "Kilowatt-Hour Sales in Millions," in the column headed "Other." These totals were adjusted to remove electricity consumed by the transportation sector. This was done by deducting electric power used by railroads and railways, as reported in the Edison Electric Institute (EEI), Statistical Year Book of the Electric Utility Industry (Source 22021), Table 19S, "Energy Sales - Total Electric Utility Industry." The resulting total government consumption was distributed by employment to the following sectors:

- Federal Government Nondefense - Final Demand
- Federal Government Defense - Military
- Federal Government Enterprises excluding Department of Energy nuclear enrichment and fabrication installations and government operated transportation systems, and electric utilities.
- State and Local Government - Final Demand

- State and Local Government Enterprises excluding electric and gas utilities, and public transportation.

Natural Gas

Control totals measuring the purchase of natural, manufactured, and mixed gases by the government as a whole were obtained from the American Gas Association (AGA), Gas Facts (Source 22011) and other sources. Government purchases, including those of the military, were reported in terms of volume and revenue to the class of service described as "other" in the AGA publications. All volume data were reported in either millions of therms (100,000 Btu per therm) or trillions of Btu. These data were converted to cubic feet using Btu conversion factors.

Fuel Oil

While no firm data were available for the non-transportation use of fuel oil by the civilian government sectors, estimates were derived in conjunction with those for consumption by the commercial industries. For a detailed description of the estimating procedure, see the commercial industries section.

The consumption of both distillate and residual fuel oil by the military is approximated from sales data published in the Bureau of Mines, Mineral Industry Surveys, and DOE's Energy Data Reports, "Sales of Fuel Oil and Kerosene" (Source 06105). Prior to 1967, diesel fuel oil was separately published. The disaggregation of distillate fuel oil for heating and for diesel for 1977 uses the 1966 proportions.

The transportation section discusses the on-road use of diesel by the government sectors.

Coal

Data were obtained for anthracite shipments to military bases abroad from the Bureau of Mines, Minerals Yearbook (Source 10101). These are not considered exports and are therefore included under military consumption. The data are obtained by subtracting the exports of anthracite to the Netherlands and West Germany from the total exports of anthracite to those two countries.

Motor Gasoline

Motor gasoline consumed for off-highway use by both state and local governments and the military is discussed here. The transportation section of this chapter examines the nonmilitary on-road use of motor gasoline by the government.

Data measuring the consumption of motor gasoline for nonhighway uses by state and local governments were obtained from Highways Statistics (Source 14401), Table MF-21. While the table is entitled "Motor Fuel Use," the data for nonhighway use are for motor gasoline only and do not include special fuels such as diesel and LPG. The control total was then distributed between final demand by state and local governments and state and local government enterprises. Information on motor gasoline delivered to the Department of Defense was obtained from Form U502 estimated data for 1977. Since data were not available on the change in the stock of motor gasoline held by the military, deliveries were considered a measure of consumption. Domestic use was estimated by the proportion of personnel based in the United States.

Aviation Gasoline

Military consumption of aviation gasoline was determined from data compiled by the Bureau of Mines and the U.S. Department of Defense. The Bureau of Mines, Mineral Industry Surveys and DOE/EIA, Energy Data Reports, "Crude Petroleum, Petroleum Products and Natural Gas Liquids" (Source 06103), provided data on shipments for military use in the United States for 1977. As with motor gasoline, the data were converted to annual totals for calendar years and adjusted for the number of personnel stationed in the United States. The data were further adjusted by multiplying by 1.079, which was the average error found between the data from the Bureau of Mines and the U.S. Department of Defense for the years in which these two data sources overlapped.

Jet Fuel

Jet fuel consumption by the military was reported by the Bureau of Mines in the Mineral Industry Surveys, and DOE, EIA, Energy Data Reports, "Crude Petroleum, Petroleum Products and Natural Gas Liquids" (Source 06103), for 1977. Fuel imported directly was added from the footnotes in each year. To determine domestic military consumption of jet fuel, the same procedure used for aviation gasoline was followed.

NEA/MRIO Concordance

The NEA is based on a slightly different sector division than the MRIO. Thus, in order to use the NEA fuel consumption estimates a concordance between the two sectoring plans had to be established. Because both input-output tables correspond in large part with the BEA input-output accounting systems and sectors this did not prove to be an insurmountable problem. Where there was a one to one correspondance between NEA and MRIO sectors, NEA data were used as the national totals for MRIO sectors. Where two or more NEA sectors were contained within an MRIO sector, the sum of the NEA data over each of the relevant sectors were summed and used as the national totals for MRIO sectors. Where two or more MRIO sectors were contained within an NEA sector, the NEA sector totals were disaggregated based on output (see State Estimates of Output, Employment and Payrolls (Source 23013).

State Level Estimates for NEA Data

As mentioned earlier the NEA contains only national level data. State level data were estimated using a variety of methods and sources. These techniques are discussed in this section.

Gasoline Used for Transportation (Excluding Military)

Initial state estimates for transportation gasoline use by sector were developed by disaggregating MRIO totals (based on NEA data) based on output by sector, by state. These initial estimates were then scaled to state totals on gasoline consumption. As a final step these scaled estimates were rescaled back to national sector totals. Gasoline sales by state were estimated by multiplying gallons of gasoline sold by average cost per gallon. The data on gallons of gasoline sold by state are from the Yearly Report of Gasoline Sales by States, 1977 (Source 23071). Average cost per gallon data are fom State Energy Fuel Prices by Major Economic Sector From 1960-1977 (Source 06109).

Gasoline Used for Transportation (Military)

State estimates for gasoline consumed by the military were based on data supplied by the military from computer tape No. AF 82-015-S (Source 04204).

Natural Gas

State distributions of natural gas consumption are based on data from the 1977 edition of Gas Facts (Source 22011). The state distribution of natural gas consumed as personal consumption expenditures are based on revenues from residential customers as reported in Gas Facts. The distribution to states for all other sectors is accomplished by an iterative approach utilizing output and state control totals. This method is similar to that used for transportation gasoline. State control totals are based on total revenues by state after subtraction of amounts previously allocated. Total revenues are calculated as the sum of revenues from sales to ultimate customers and revenues from gas for resale. Data which were previously state allocated include those data which were taken directly from the various census, data on construction of natural gas by electric utilities for energy conversion and personal consumption expenditures for natural gas.

Electricity

State distributions for consumption of electric energy are based on data from the 1977 edition of Statistical Yearbook of the Electric Utility Industry (Source 22021). The state distribution of electric energy consumed as personal consumption expenditures are based on revenues from residential customers as reported in Gas Facts. The distribution to states for all other sectors is accomplished by an iterative approach utilizing output and state control totals. This method is similar to that used for transportation gasoline and natural gas. State control totals are based on total revenues by state after subtraction of amounts previously allocated. Total revenue is defined as sales to ultimate customers. Data which were previously state allocated include those data which were taken directly from the various censuses and data on personal consumption expenditures for electricity.

Personal Consumption Expenditures for Coal

The state distribution of personal consumption expenditures for coal was based on the sum of deliveries of anthracite, bituminous, and lignite coal by state. Data on anthracite is for "pea size and larger," used largely for residential space heating, from Energy Data Reports, "Distribution of Pennsylvania Anthracite" (Source 06103). Data on bituminous and lignite coal is for deliveries to retail dealers from Energy Data Reports, "Bituminous Coal and Lignite Distribution, January - September, 1977,: (Source 06103).

Personal Consumption Expenditures for Fuel Oil and Kerosine

The state distribution of personal consumption expenditures for fuel oil and kerosine was based on the sum of sales of distillate type heating oil and kerosine for heating. Data on numbers of barrels of each fuel sold by state were from Energy Data Reports, "Sales of Fuel Oil and Kerosene" (Source 06103). Residential retail prices per gallon for each type of fuel by state were from State Energy Fuel Prices by Major Economic Sector From 1960 Through 1977, (Source 06109).

Material Inputs to Petroleum Refineries

State estimates for consumption of energy products by refineries as an input to the energy conversion process were based on the capacity of operating petroleum refineries by state. This data was from the Energy Data Reports, "Petroleum Refineries in the United States and Puerto Rico," (Source 06103).

Inputs to Coke-Oven Plants for Energy Conversion

State estimates for consumption of inputs to coke-oven plants for the energy conversion process are based on the sum of products for oven-coke, breeze and beehive coal valued at commercial sales prices. Data for production quantities and sales values are based on data from Energy Data Reports, "Coke and Coal Chemicals, Annual," (Source 06103).

Other

State distributions for all other minor fuels and for other sectors with minor consumption values were based on output. See State Estimates of Outputs, Employment and Payrolls in 1977.

Data Quality

The quality of data for energy inputs is subject to a large degree of variance in relation to the following factors:

- the amount of data that were taken from an original data source,

- whether a data cell contains estimates resulting from withheld data or lack of detail in the original source,

and, for data used from the NEA,

- the degree to which data from the NEA were adjusted in the balancing of that table,
- the reliability of the NEA estimating techniques,
- the difficulty in mapping NEA into MRIO sectors; and
- the reliability of the method used to disaggregate the NEA national estimate to states.

Data extracted from any of the census-based publications is, for the most part, of extremely high quality. It should be cautioned, however, that most of the census data contain categories such as "other fuels" or "fuels not specified by kind" and the distribution of these categories may lead to some inaccuracies in the final data. Note that "other fuels" were assumed to be products of petroleum refining and that "fuels not specified by kind" were assumed to be proportional to all specified fuels except electricity. In addition, census data for agriculture were 1978 figures adjusted using price and quality deflators to reflect 1977 consumption. Also, census data for both agriculture and construction were converted from an establishment basis to an activity basis.

Census data on energy consumpion for all sectors contained data that was withheld to preserve the confidentiality of information for individual companies. The estimation of these data will result in a reduction in quality in most instances. In addition, energy data in both the Manufacturing and Mining census were not disaggregated to the 4-digit SIC level by state. Therefore, where this level of disaggregation was necessary, the substitute method of using national 4-digit SIC data and output measures, by state, may result in a decrease in data quality.

The NEA data are presented in an input-output format. Generally, this means that some degree of adjustments were necessary to balance data. These adjustments to

basic data will have an impact on data quality. The direction of this impact cannot be identified.

Data extracted from the NEA were developed utilizing a wide range of techniques and data sources. The quality of the data will vary accordingly. The vast number of sources and techniques precludes any detailed assessments of the particular merits or shortfalls of specific data. A review of the material presented in the previous sections on the NEA provides the best guide to the quality of the data.

The lack of a one to one correspondance between NEA and MRIO sectors negatively impacts data quality. This is especially true where one NEA sector contained two or more MRIO sectors. The division of the NEA sector controls to MRIO sectors based on output will most likely result in a decrease in data quality.

The disaggregation of NEA-based data to states may not reflect the actual distribution of energy consumption. This is particularly true where proxy measures such as capacity, shipments or output were utilized.

Inputs from the Real Estate Sectors

Data Sources and Methodology

Inputs from the Real Estate and Rental sector were estimated at the state level using the following component breakdown:

- Rents paid by business
- Rents paid by government
- Royalty payments
- Broker's commissions on sales of structures
- Management fees
- Owner and tenant occupied dwellings

Rents Paid By Business

Rental payments by business are the total of rents paid on real property by corporations, partnerships and sole proprietors. These data were available at the national level by industry from the Statistics of Income (Source 15101) published by the Internal

Revenue Service. Data on rental payments by industry are not available at the state level. Therefore, the IRS industry totals were converted to totals by MRIO sector and distributed to states based on the output measures for each sector. The conversion of IRS industry totals to MRIO totals were based on rental payments published in the 1977 Census of Manufactures (Source 03105), the 1977 Census of Mineral Industries (Source 03106), and the 1977 Census of Construction Industries (Source 03104). Where data of this kind were not available, output measures were utilized.

Rents Paid by Government

Rents paid by government were developed in the estimation of final demand and are discussed in a separate JFA report, State Estimates of Final Demand, 1977.

Royalty Payments

The control total for royalty payments was based on royalty receipts. Data for royalty receipts of persons, corporations, partnerships and sole proprietors were available in the 1977 Statistics of Income (Source 15101). Data for royalty receipts of government were from the 1979 and 1980 editions of the Budget of the U.S. Government (Source 01101). These volumes contained actual data for fiscal years 1977 and 1978. Seventy-five percent of FY 1977 receipts were added to 25 percent of FY 1978 receipts to estimate calendar year 1977 receipts.

The control total for royalties was disaggregated among sectors based on the following techniques. Royalties paid by book publishers, phonograph record manufacturers, miscellaneous publishing, newspapers, periodicals, greeting card publishers, motion picture producers, and advertisers were based on data from BEA's 1972 output workfile (Source 03509). These data were updated to 1977 based on the ratio of output in 1972 to output in 1977 for each industry. Royalties paid by mining sectors except oil and gas extraction were based on royalty payment data in the 1967 Census of Mineral Industries (Source 03106). The data were updated to 1977 based on the ratio of output in 1967 to output in 1977 for each mining industry. The source of data on royalties paid by oil and gas extraction industries was BEA's 1972 Output Workfile (Source 03509), updated based on the ratio of output in 1972 to output in 1977. The remaining royalty payments were distributed to the manufacturing industries on the basis of their royalty receipts, on the assumption that these constituted intrasector payments for patent rights. All

royalty payments were then disaggregated by state based on the output measures of their respective sectors.

Broker's Commissions on Sales of Structures

The control total for broker's commissions on sales of residential and non-residential structures, which are capitalized as part of private investment, were taken from the Survey of Current Business, National Income and Product Accounts, 1978-79: Special Supplement (Source 03501). This control total was disaggregated to the state level based on the aggregate sales price of ordinary real estate involved in measurable sales during a six-month period in 1976, by state. The source of data on aggregate sales prices was the 1977 Census of Governments (Source 03110).

Management Fees

Management Fees are an intrasector input, purchased by Real Estate from Real Estate. Management fees were developed as a residual of business receipts after broker's commissions on sales of structures were subtracted. Business receipts of real estate firms are from the Statistics of Income (Source 15101). Business receipts of corporations, partnerships and sole proprietorships classified as real estate operators and lessors of buildings by the IRS are excluded in order to avoid double counting rents paid. The national total for management fees were distributed to states based on payrolls for employees of real estate firms.

Owner and Tenant Occupied Dwellings

Rents for owner and tenant occupied dwellings are purchased as personal consumption expenditures. The purchases were developed as three separate series: owner occupied dwellings (non-farm), tenant occupied dwellings (non-farm), and farm dwellings.

The national total for imputed rental value of owner occupied non-farm dwellings is taken from the NIPA accounts as published in the Survey of Current Business, National Income and Product Accounts, 1976-79: Special Supplement (Source 03501). The rental value of owner occupied non-farm dwellings are disaggregated by state based on the total value of owner occupied dwellings by state. State level data on owner-occupied dwellings was based on median value of dwellings and number of units from the 1970

Census of Housing (Source 03112). These data were scaled to 1977 values using the ratio between 1977 and 1970 median values and units by major census region from the 1977 Survey of Housing (Source 03115).

The rental value of tenant occupied non-farm dwellings were developed using the same techniques and data sources as for owner occupied dwellings, substituting total rents paid in place of total value of dwellings. Total rents are the sum of median rents paid and number of rental units by states.

The total rental value of owner and tenant occupied farm dwellings was based on NIPA data published in Survey of Current Business, NIPA, 1976-79 (Source 03501). State level data summing to this control total were available in unpublished data from the U.S. Department of Agriculture, Economic Research Service.

Data Quality

Data quality varies considerably among components of the real estate sector. The first component, rents paid by business, is generally of high quality at the national level but suffers somewhat due to the incompatibility of the IRS and MRIO industry classifications. In addition, IRS statistics are collected on an enterprise basis rather than an activity basis. Rents paid by business are disaggregated to the state level based on output and are therefore subject to considerable error.

Royalty payments are based on actual or sample data as a control total by distribution to sectors and states are based on approximation and output respectively and thus may fail to represent actual royalty payments.

Broker's commissions are based on NIPA data at the national level but distribution to states are based on a 1976 survey of measured sales to real estate and may fail to approximate the actual distribution of broker's commissions. Management fees are calculated as a residual and prorated to states based on payrolls for real estate employees and thus represent an uncertain measure of management services.

Data on rental expenditures on owner and tenant occupied dwellings are composed of three components of varying quality. The imputed rental value of owner occupied dwellings are based on NIPA data distributed by state based on the total value of housing by state and may fail to reflect the actual distribution of implicit rental values

by state. The state distributions of rents paid by tenants is based on total contract rents by state and thus are subject to a certain degree of error. The imputed rental value of owner occupied farm dwellings and rents paid for tenant occupied farm dwelling are USDA estimates and no measure of reliability can be associated with these estimates.

Noncomparable Imports

Data Sources

The primary source of data on noncomparable imports was the Bureau of the Census' U.S. Imports for Consumption and General Imports, 1977, "IA-245" (Source 03118, hereafter referred to as "IA-245"). "IA-245" contains 1977 data on merchandise imports at their foreign port values and on the freight, insurance, and other charges (excluding duties) incurred in transporting them to the U.S. The data are available by customs district of entry, by seven digit TSUSA commodity code, and by mode of transportation (water, air, other). For purposes of the MRIO data development, the "IA-245" data were obtained by detailed SIC and by state, rather than by TSUSA code and customs district.

The data in "IA-245" were supplemented with data from other sources. The most important of these was a BEA preliminary data file, "Commodity Detail on Noncomparable Imports BEA 1977" (Source 03512, hereafter referred to as "Noncomparable Imports, 1977"). This source provides commodity detail on inputs of noncomparable imports to each of 144 of the 496 BEA sectors. Noncomparable imports are listed at both their foreign and domestic port values.

Other sources of data were BEA's preliminary workfile "1977 Analysis Input-Output Control Total Worksheets" for September 10, 1981 and January 22, 1982, and the Bureau of the Census U.S. Trade with Puerto Rico and U.S. Possessions, 1977, "FT 800" (Source 03118). Information in these sources was used to support the development of noncomparable import control totals.

Methodology

Noncomparable imports are defined in the MRIO as imports of goods and services with one or more of the following characteristics:

- there is no significant U.S. production of the good or service;
- the good or service is purchased and used outside the United States;
- the good or service is part of a group of commodities or services which is unique in expenditures and does not fit neatly into the output of any other commodity or service, such as used goods, architectural drawings, developed film, antiques, and fossils.

Noncomparable imports are grouped together at their domestic port values and shown in the MRIO data base as inputs from MRIO 120, Directly Allocated Imports, to each producing sector and final demand.

Noncomparable import data have been prepared for the MRIO data base in two formats: noncomparable imports by state of entry to the U.S., and noncomparable imports by state of use. The latter is the form required for this Task 6 effort, Development of State Estimates of Inputs to Industries. The former was developed to aid in the preparation of a transportation flow matrix during a subsequent task. The procedures used to develop both are detailed below.

Noncomparable Imports by State of Entry to the U.S.

The primary source of data on noncomparable imports by state of entry to the U.S. was the Bureau of the Census' U.S. Imports for Consumption and General Imports, 1977, "IA-245," (Source 03118) supplemented by a source containing data on trade with U.S. possessions, the Bureau of the Census' U.S. Trade with Puerto Rico and U.S. Possessions, Annual, 1977, "FT 800," (Source 03118). BEA's "Commodity Detail on Noncomparable Imports, 1977" was also used, to identify which of the import commodities in "IA-245" were noncomparable, to provide customs duties data, and to provide national noncomparable import control totals for the "IA-245" data.

Data Development

The development of data on noncomparable imports by state of entry into the U.S. began with the identification of SIC codes for noncomparable imports. BEA's "Noncomparable Imports" lists noncomparable imports by seven digit TSUSA commodity code. The "IA-245" contained data on all U.S. imports by seven digit SIC code. The TSUSA/SIC concordance in the Bureau of the Census' U.S. Foreign Trade Statistics: Classifications and Cross-Classifications, 1980, Section 6, (Source 03130) was applied to the TSUSA codes in "Noncomparable Imports," resulting in a complete list of SIC codes containing noncomparable imports.

The second step in the development of data on noncomparable imports by state of entry to the U.S. was the separation of "IA-245" data for the SIC codes identified in step one from the remaining "IA-245" import data. This completed, the state values shown for each noncomparable import were summed to the national level and compared to BEA's national noncomparable import controls at foreign port value, by type of import — a process necessitated by the possibility that seven-digit "noncomparable import" SIC codes identified by the TSUSA/SIC concordance contained both comparable and noncomparable imports. When this proved to be the case, a ratio between BEA's national noncomparable import value for a commodity and the "IA-245" value was developed at the national level and to each state. (The amount remaining after applying the ratio to each state was entered into the "IA-245" comparable imports data. For further discussion, refer to Jack Faucett Associates' report State Estimates of Final Demands -1977 (Source 23018).)

The next step involved adjusting the data for transactions with Puerto Rico and other U.S. possessions. Using the data in U.S. Trade with Puerto Rico and U.S. Possessions, 1977, "FT 800," by seven digit TSUSA commodity code, along with BEA's list of noncomparable imports by seven digit TSUSA commodity code, this step was simple and straightforward. There was only one noncomparable import, costume jewelry imported from Puerto Rico. All imports of costume jewelry from Puerto Rico were assigned to the State of Florida.

The import values used up to this point in the noncomparable imports data development were foreign port values. The values needed in the MRIO data base were the domestic port values. The final step, then, was the development of transoceanic margin data for the noncomparable imports. This was a two stage process involving 1) development of data on customs duties, and 2) development of data on other transoceanic margins.

Customs duties were not included in the "IA-245" data. BEA's "Noncomparable Imports" was the source of this information. "Noncomparable Imports" contains customs duties data by seven digit TSUSA noncomparable import commodity code for the noncomparable imports. The customs duties by TSUSA commodity were then converted to a seven-digit SIC basis using the Bureau of the Census concordance cited earlier. They were distributed to states according to each state of entry's imports of the seven-digit SIC commodity.

The second part of the transoceanic margin data development, the development of information on transoceanic transportation, insurance, and other charges (excluding duties), was accomplished using "IA-245" data. The "IA-245" contained all the required information, by state, by seven-digit SIC. Charges associated with comparable imports within certain SIC's were eliminated using the ratios between BEA's national noncomparable import value for a commodity and the "IA-245" value, prepared in the second step of noncomparable imports data development. (Again, as in step two, the amount remaining after applying the ratio to each state was entered into the "IA-245" comparable imports data.)

Customs duties and other transoceanic margins, were then added to the foreign port values for the noncomparable imports, producing the domestic port values of noncomparable imports, by state of entry and seven digit SIC, to be used in the matrix of transportation flows developed in a subsequent task.

Data Quality

The Bureau of the Census' data in "IA-245" and "FT 800" are of very good quality, as are the data in BEA's "Noncomparable Imports." The only limitation on interpretation of the data arises through the TSUSA/SIC concordance. The ratios developed by using BEA's values as national controls, though accurate at the national level, may not reflect actual state values.

Noncomparable Imports by State of Use

The primary source of data on noncomparable imports by state of use was BEA's preliminary data file "Commodity Detail on Noncomparable Imports, 1977." As stated earlier, this source provides commodity detail on inputs of noncomparable imports to

each of 144 of the 496 BEA sectors, plus an "unallocated" amount. Data are available in this source at both foreign and domestic port value.

Data Development

The development of data on noncomparable imports by state of use began with a review of the BEA data, described as "preliminary" data, for consistency and reasonableness. The 1977 values were compared to 1972 values to locate any major unexplained discrepancies. No significant users of noncomparable imports in 1972 (defined as sectors consuming over $20 million in noncomparable imports) who had no noncomparable imports shown in the 1977 data were noted.

The second step in developing the noncomparable imports by state of use data was the distribution of the unallocated noncomparable imports to using industries. The unallocated amount consists of three types of noncomparable services:

- travel by U.S. resident abroad (other than personal travel),
- fees and royalties paid to affiliated foreigners, and
- fees and royalties paid to unaffiliated foreigners.

The value of these imports, $1,581.5 million (representing both foreign and domestic port value since none of these imports are associated with custom duties or other transoceanic margins) were distributed to each producing and final demand sector in proportion to the amount of noncomparable imports it consumed in 1972. Unallocated noncomparable imports accounted for 5.3 percent of all noncomparable imports.

The final step was the allocation of noncomparable imports to states. Purchases of noncomparable imports by each industry were assigned to states according to each state's share of the using industry's cost of goods and services.

Data Quality

BEA's preliminary noncomparable imports data for 1977 are believed to be of very good quality. However, users should recognize the following when interpreting the data:

- National data were distributed to states based on cost of goods and services by using sector, and may not reflect the actual pattern.

- The unallocated noncomparable imports and margins were allocated to sectors in proportion to their 1972 purchases of noncomparable imports. This may result in under-reporting or over-reporting of noncomparable imports in some sectors.

Scrap, Used, and Secondhand Goods

MRIO sector 121, Scrap, Used, and Secondhand Goods, appears both as a "dummy" producing and a distribution sector in the 1977 MRIO accounts. This differs from the 1972 BEA treatment, where scrap appears as a commodity only, with no corresponding producing industry. In the MRIO, however, scrap production occurs mainly as a by-product of the activities of other industries, hence the scrap producing industry produces only the amount of scrap necessary to balance the supply and demand of scrap. As is the case with consumption of noncomparable imports above, the level of production and consumption of scrap is not known until the model is solved. In the post-solution step, the output of the scrap producing industry represents the amount of scrap necessary to balance supply and demand for scrap. This number will then be entered as a scrap inventory drawdown (or increase, as the case may be) in order to reset the actual value of scrap produced by the scrap producing sector to zero. (This post-solution treatment will also be necessary for noncomparable imports, for which the level of demand also is not known until the model is solved. In the post-solution step, the total demand for non-comparable imports will be inserted into the import column of final demand and the solution for output of the "dummy" sector producing non-comparable imports will be set to zero.)

In accordance with this methodology, the accounts have been constructed with both a producing and distribution sector for scrap. All consumers of scrap will buy from the scrap distribution row in the use matrix. This distribution sector in turn buys all its needs from the producing sector of scrap. Since most of the scrap demanded is generated as a by-product in other industries (and is thus entered in the scrap row of the by-product matrix), the required output of the scrap producing sector is simply the amount of the imbalance between supply and demand of scrap.

Dealings in used and secondhand goods are concentrated in the final demand columns, where transfers of such good between the PCE, investment, and government purchases columns are shown in the scrap row. Imports and exports of scrap are shown in actual

value with the appropriate sign in the import and export columns of final demand. Dealings in used and secondhand goods contained wholely within the PCE, investment or government sectors will net to zero and are not addressed.

Data for scrap production by MRIO industries were obtained from the price-updated 1972 BEA make table, which contains the percentage of 1977 industry output which is scrap. Application of these percentages to the 1977 state-level MRIO industry outputs yielded the estimates for the scrap row of the 1977 MRIO by-product matrix. Where national level controls on the scrap production of an industry were available in the 1977 Census of Manufactures, the estimated state-level values were then scaled to the national control total.

Data for scrap consumption were developed from the 1972 BEA use of commodities table by the price updating procedure described in Appendix A to the report. Scrap consumption estimates for 1977 were generated by applying the price-updated use-of-scrap coefficients to the 1977 state-level industry cost of materials data. Where available from the 1977 Census of Manufactures, actual 1977 national scrap consumption controls by manufacturing sector were then used to scale the state-level uses of scrap.

CHAPTER 3

TRANSPORTATION MARGINS, TRADE MARGINS AND EXCISE/SALES TAXES

Transportation and trade margins (including taxes) on products have been allocated to the consuming sectors of these products in most input-output tables, generally proportionate to the value of the product consumed by each sector. This procedure entails the development of a margin matrix for each transportation or trade sector. Margins that apply to each product (based on revenue detail by transportation mode and on trade mark-up by kind-of-business for wholesale and retail trade) are allocated along a row in the matrix to each consuming sector of the product. These product rows are then collapsed to a single row that represents the total input of the services of the specific transportation or trade sector to each consuming sector.

This procedure is very cumbersome when applied to state detail in an interregional input-output table, and is especially tedious in terms of the steps required to update the coefficients. These problems led to the development of a different procedure for handling these margins in the model. In this procedure, the margins are allocated to special (dummy) distribution sectors in each state, one for each product. The concepts and mechanics of this procedure are described in Appendix B.

Excise and sales taxes are assigned in two ways. Excise and selective sales taxes are allocated to the special distribution sectors within the model. General sales taxes are allocated to final demand by appropriate sectors.

Transportation Margins

Transportation margins will be derived and allocated in context with the commodity flows in the next phase of the data development. The amount of transportation revenues associated with each state-to-state flow of each product will be estimated based on the distance-of-haul and the revenues-per-ton mile associated with each flow. These margin estimates will be assigned as inputs to the distribution sector for that product in each terminating state for the commodity flow. In this way the distribution

sector's output values will include the transportation costs and will implicitly distribute a pro rata share of these costs to each consuming sector. Thus, transportation costs distributed to the consuming sectors of each product in each state will reflect an average transportation cost on the product from the several states of supply, including the intra-state transportation costs for the amount of product that is produced and consumed within the state.

Transportation revenues have been compiled for each transportation mode at the national level. These revenues will be allocated to product flows by MRIO sector — to establish national controls on the margin allocations to each state-to-state flow. Since the commodity detail is not complete for some of the modes, especially for trucking, pipeline and air, all of the steps in the allocation procedure will be done after the commodity flows are completed because the commodity flow data will provide information useful even to the initial allocation of national total revenues to products.

The development of the commodity flow data is also essential to the distribution of transportation output (and inputs) to states. The conceptual problem of identifying the state location of transportation activities that traverse states is closely tied to a principal purpose of the model in tracing the impact of activities on input requirements. Since much of the transportation equipment is mobile, inputs may be drawn from anywhere along the route, and there is no fixed location at which inputs are assembled as in the case of a factory. At best, these inputs are concentrated within a region consisting of several states. This leads to a different procedure for handling both the location of output and inputs for the transportation modes, as described below.

Data on transportation outputs and inputs have been developed at the national level. To generate input requirements by state, regional areas of operation will be defined for each mode. These regional areas will be defined to reconcile the conflicting objectives of (a) making each region large enough to cover all of the inputs to transportation associated with a particular origination, termination, or passage of traffic in a state and of (b) making the region small enough to avoid spreading input requirements to states that are not really involved. Although some inputs will be allocated entirely to the states of origin and destination, other inputs may be spread among other states of a region that is involved in a transportation movement. The distributions among states of a region will follow any available data, but it is expected that there will be considerable use of standard distribution formulas that require no region-specific data.

The final distribution of inputs to transportation across states will be substantially superior to an assumption that each user of transportation mode buys either just from its own state or from all states in proportion to base year outputs. Where the commodity is needed and from where it comes will have significant impacts on the estimation of the states where inputs are required. It must be recognized, however, that the procedure will be approximate, because little direct data are reasonably available on exactly where each kind of input to transportation between two states is needed.

As stated earlier, this procedure will be implemented in context with the development and analysis of the commodity flow and passenger flow data.[1]

Trade Margins

The output of wholesale and retail trade establishments is defined as the value of services rendered by trade operators and does not include the value of the goods passing through these establishments. It is necessary to assign these costs of trade services to the actual commodities passing through trade establishments so that the cost of trade services can be added to producer prices and be reflected in the price paid by consuming sectors. In the case of wholesale trade, producing sectors are the primary purchasers of the services rendered and the cost of wholesale trade activity is reflected in the prices paid for intermediate inputs to producing sectors. Retail trade services are primarily purchased by final demand sectors and the cost of retail services is one component of the price paid by final demand sectors. In the MRIO, wholesale margins were assigned to the distributing sectors of producing sectors and are reflected in the price paid for goods by each consuming sector. Retail margins were assigned to the final demand (consuming) sectors according to sales and to intermediate purchases of retail trade goods, where appropriate.

[1] *The only exception to this treatment is purely local transportation (transit, taxicabs, etc., part of MRIO 086) and transportation services (MRIO 091).*

Lacking the precise margin for trade services associated with each purchase by producing or final demand sectors, margins were estimated by applying the most appropriate margin rate by broad categories of goods. To estimate margins by sector and state, margin rates were developed by kind of business at the national level and applied to sales by MRIO sector at the state level. The following sections explain the procedures used to develop margin rates and to control margins to trade output by state.

Wholesale Trade

The total value of wholesale trade margins corresponds to the output of wholesale trade establishments. In the development of output data, national margins were estimated for each of the 18 three-digit wholesale SIC's by type of wholesale activity, i.e., merchant wholesalers, manufacturers' sales offices and branches, and agents and brokers, from data in the 1977 Census of Wholesale Trade (Source 03102). Merchant wholesale activity was estimated at the national level by the gross margins reported in 1977 Merchant Wholesalers, Measures of Value Produced, Capital Expenditures, Depreciable Assets and Operating Expenses (Source 03121), while national-level estimates for manufacturers' sales offices and branches and agents and brokers' commissions were built up from operating expenses as reported in the 1977 Census of Wholesale Trade. Profits for sales offices and branches and agents and brokers were estimated from IRS data and added to operating expenses to estimate the value of these services. To compute state controls, the national controls were allocated based on each state's wholesale sales as reported by Census. For a more complete discussion of the development of state wholesale trade outputs, see Chapter 12 of JFA's report State Estimates of Output, Employment and Payrolls, 1977 (Source 23013). The sum of the value of wholesale trade services by each type of operation provides the state control at the three-digit SIC (kind-of-business) level of wholesale activity.

To assign the cost of wholesale services to goods passing through wholesale trade establishments, margin rates were assigned to each of the 18 three-digit SIC's involved in wholesale activity. Lacking reliable data for the development of margin rates at the state level, rates were estimated at the national level and then applied to estimated sales at the state level. In the final step, the estimate of state wholesale margins were scaled to the state control for wholesale services.

National margin rates were developed by dividing the total wholesale margin (the sum of the margins for merchant wholesalers, manufacturers sales branches and offices, and agents and brokers) by sales-less-margin for each three-digit wholesale SIC. Since the margins charged for the sale of goods from one wholesaler to another represent an additional component of the wholesale margin, margin rates were adjusted to reflect an estimate of goods exchanged by wholesalers. As shown in Exhibit 3-1, the percent of sales to other wholesalers by three-digit wholesale SIC at the national level ranges from 17.6 to 31.3 percent as reported in the 1977 Census of Wholesale Trade. For each kind of business, the adjusted margin appearing in Exhibit 3-1 represents the implied margin rate of all goods when the percent of goods resold are assumed to incur two margins. This adjustment assumes that these goods are exchanged by wholesalers within the same kind of business, and that all customers, including other wholesalers, are charged the same rate.

Margin rates are used to estimate margins by multiplying the most appropriate margin rate by each state's production by MRIO sector, adjusted to reflect only the goods that flow into wholesale establishments. The most appropriate margin rate was determined by comparing each sector's production with the goods handled by each three-digit wholesale SIC. If a three-digit wholesale activity handled most of the products produced in a specific MRIO sector, the margin rate of the sector was assumed to equal the margin rate of the three-digit SIC. In cases where the production of an MRIO sector was handled in substantial amounts by more than one three-digit wholesaler, an average margin rate was computed. The assignment of margin rates to MRIO sectors is shown in Exhibit 3-2. The margin assignment process relied on the judgement of the analyst, guided by available data.

Lacking state-level data on the flow of goods from each producing sector into wholesale trade channels, the estimate of goods flowing into wholesale trade was developed from national data. For most manufacturing sectors, the percent of goods sold by producers to wholesalers at the national level was available by four-digit SIC based on data contained in 1977 Census of Manufactures, Subject Series, Distribution of Sales by Class of Customer (Source 03105). The percent of goods sold to wholesalers not covered by the 1977 Census of Manufactures, i.e., SIC 23: Apparel and Other Finished Products Made From Fabrics and Similar Materials, SIC 27: Printing, Publishing, and Allied Industries, and nonmanufacturing sectors were estimated using the commodity line sales associated with these categories from the 1977 Census of Wholesale Trade (Source

EXHIBIT 3-1

WHOLESALE MARGINS BY KIND OF BUSINESS

Wholesale Kind of Business SIC	Title	Gross Margin[1]	Percent of Goods Sold To Other Wholesalers[2]	Adjusted Margin[3]	Final Margin[4]
50	Wholesale Trade, Durable Goods	21.4	20.0	25.7	22.2
501	Motor Vehicles and Automotive Parts and Supplies	13.6	18.2	16.1	14.5
502	Furniture and Home Furnishings	22.4	16.1	26.0	25.9
503	Lumber and Other Construction Materials	22.7	25.3	28.4	28.2
504	Sporting, Recreational, Photographic, and Hobby Goods, Toys, and Supplies	23.4	28.2	30.0	29.1
505	Metals and Minerals, Except Petroleum	12.5	18.7	14.8	14.5
506	Electrical Goods	21.3	17.9	25.1	23.4
507	Hardware, and Plumbing and Heating Equipment and Supplies	27.6	25.2	34.6	34.2
508	Machinery, Equipment and Supplies	31.6	18.6	37.5	26.7
509	Miscellaneous Durable Goods	26.5	31.1	34.7	34.4
51	Wholesale Trade, Nondurable Goods	14.7	27.2	18.7	18.3
511	Paper and Paper Products	20.3	19.1	24.2	23.9
512	Drugs, Drug Proprietaries and Druggists' Sundries	24.2	18.4	28.8	28.8
513	Apparel, Piece Goods, and Notions	21.7	26.4	27.4	27.4
514	Groceries and Related Products	15.0	29.7	19.5	18.8
515	Farm-Product Raw Materials	6.6	31.3	8.7	8.1
516	Chemicals and Allied Products	15.7	17.6	18.5	18.3
517	Petroleum and Petroleum Products	10.0	29.7	13.0	12.6
518	Beer, Wine and Distilled Alcoholic Beverages	29.0	22.9	35.8	35.8
519	Miscellaneous Nondurable Goods	22.6	24.9	28.2	28.0

[1] *The sum of the margins for merchant wholesalers, manufacturers' sales branches and offices, and agents and brokers as a percent of sales-less-margin by kind-of-business.*

[2] *Source 03102: 1977 Census of Wholesale Trade, Subject Series, Miscellaneous Subjects, Table 1, pp.3-9 through 3-17.*

[3] *(Gross Margin)(1- Percent of Goods Sold to Other Wholesalers)+2(Gross Margin)(Percent of Goods Sold to Other Wholesalers).*

[4] *Final margin after controlling to primary output by kind of business, i.e., margins reduced for by-products produced by wholesalers.*

EXHIBIT 3-2

WHOLESALE KINDS OF BUSINESS BY MRIO SECTOR

MRIO SECTOR		WHOLESALE KIND-OF-BUSINESS	
		SIC	Title
001	Dairy Farm Products	514	Groceries and Related Products
002	Livestock and Poultry	515	Farm-Product Raw Materials
003	Cotton, Grain and Tobacco	515	Farm-Product Raw Materials
004	Fruits, Nuts, Regular and Miscellaneous Crops and Services	514	Groceries and Related Products
005	Forestry Products	519	Miscellaneous Nondurable Goods
006	Commercial Fishing and Trapping	514	Groceries and Related Products
007	Iron and Ferroalloys Ores	505	Metals and Minerals, Except Petroleum
008	Nonferrous Ores	505	Metals and Minerals, Except Petroleum
009	Coal	505	Metals and Minerals, Except Petroleum
010	Crude Petroleum	517	Petroleum and Petroleum Products
011	Natural Gas and Liquids	517	Petroleum and Petroleum Products
012	Stone, Clay, Sand and Gravel	503	Lumber and Other Construction Materials
013	Chemical and Fertilizer Minerals	516	Chemicals and Allied Products
020	Ordnance	504	Sporting, Recreational Photographic and Hobby Goods, Toys, and Supplies
021	Meat Products	514	Groceries and Related Products
022	Dairy Products	514	Groceries and Related Products
023	Canned and Frozen Foods	514	Groceries and Related Products
024	Grain Mill Products	514	Groceries and Related Products
025	Bakery Products	514	Groceries and Related Products
026	Sugar and Confectionary Products	514	Groceries and Related Products
027	Beverages, Extracts, and Sirups	514	Groceries and Related Products
		518	Beer, Wine and Distilled Alcoholic Beverages
028	Other Food Products	514	Groceries and Related Products
029	Tobacco Products	519	Miscellaneous Nondurable Goods
030	Fabric, Yarn and Thread Mills	513	Apparel, Piece Goods, and Notions
031	Floor Coverings and Miscellaneous Textile Products	502	Furniture and Home Furnishings
032	Hosiery and Knit Goods	513	Apparel, Piece Goods, and Notions
033	Apparel	513	Apparel, Piece Goods and Notions
034	Other Fabricated Textile Products	502	Furniture and Home Furnishing
035	Logging and Lumber	503	Lumber and Other Construction Materials
		509	Miscellaneous Durable Goods

EXHIBIT 3-2

WHOLESALE KINDS OF BUSINESS BY MRIO SECTOR (cont.)

MRIO SECTOR		WHOLESALE KIND-OF-BUSINESS	
		SIC	Title
036	Wood Products	503	Lumber and Other Construction Materials
037	Pre-fabricated Buildings and Mobile Homes	503	Lumber and Other Construction Materials
038	Household Furniture	502	Furniture and Home Furnishings
039	Other Furniture and Fixtures	502	Furniture and Home Furnishings
040	Paper and Allied Products	511	Paper and Paper Products
041	Paperboard Containers and Boxes	511	Paper and Paper Products
042	Newspapers, Periodicals and Other Printing	519	Miscellaneous Nondurable Goods
043	Industrial Chemicals	516	Chemicals and Allied Products
044	Agricultural Chemicals	519	Miscellaneous Nondurable Goods
045	Other Chemical Products	516	Chemicals and Allied Products
046	Plastics and Synthetics	516	Chemicals and Allied Products
047	Drugs	512	Drugs, Drug Proprietaries, and Druggists' Sundries
048	Cosmetics and Cleaning Products	512	Drugs, Drug Proprietaries, and Druggists' Sundries
		516	Chemicals and Allied Products
049	Paint and Allied Products	519	Miscellaneous Nondurable Goods
050	Petroleum Refining and Allied Products	517	Petroleum and Petroleum Products
051	Rubber and Miscellaneous Plastics	50	Durable Goods
		51	Nondurable Goods
052	Leather and Leather Products	513	Apparel, Piece Goods and Notions
053	Glass and Glass Products	50	Durable Goods
		51	Nondurable Goods
054	Stone and Clay Products	503	Lumber and Other Construction Materials
055	Iron and Steel Mills and Forging	505	Metals and Minerals, Except Petroleum
056	Iron and Steel Foundries	505	Metals and Minerals, Except Petroleum
057	Primary Nonferrous Metals and Products	50	Durable Goods
058	Metal Containers and Miscellaneous Metal Products	50	Durable Goods
059	Structural Metal Products	50	Durable Goods
060	Screw Machine Products and Metal Stamping	50	Durable Goods

EXHIBIT 3-2

WHOLESALE KINDS OF BUSINESS BY MRIO SECTOR (cont.)

MRIO SECTOR		WHOLESALE KIND-OF-BUSINESS	
		SIC	Title
061	Engines and Turbines	508	Machinery, Equipment and Supplies
062	Farm and Lawn Equipment	508	Machinery, Equipment and Supplies
063	Construction and Mining Equipment	508	Machinery, Equipment and Supplies
064	Materials Handling Equipment	508	Machinery, Equipment and Supplies
065	Metalworking Equipment	508	Machinery, Equipment and Supplies
066	Special Industry Machinery and Equipment	508	Machinery, Equipment and Supplies
067	General Industry and Other Non-electric Machinery and Equipment	508	Machinery, Equipment and Supplies
068	Office and Computing Equipment	508	Machinery, Equipment and Supplies
069	Service Industry Machinery and Equipment	507	Hardware, and Plumbing and Heating Equipment and Supplies
070	Electric Transmission and Electrical Industrial Equipment	506	Electrical Goods
071	Household Appliances	506	Electrical Goods
072	Electric Lighting and Wiring Equipment	506	Electrical Goods
073	Receiving Sets, Records, and Tapes	506	Electrical Goods
074	Communications Equipment	506	Electrical Goods
075	Electric Components	506	Electrical Goods
076	Other Electrical Equipment	501	Motor Vehicles and Automotive Parts and Supplies
		506	Electrical Goods
		508	Machinery, Equipment and Supplies
077	Motor Vehicles and Parts	501	Motor Vehicles and Automotive Parts and Supplies
078	Aircraft and Parts	508	Machinery, Equipment and Supplies
079	Missiles, Spacecraft and Parts	508	Machinery, Equipment and Supplies
080	Aircraft, Missile and Spacecraft and Propulsion Units	508	Machinery, Equipment and Supplies
081	Other Transportation Equipment	508	Machinery, Equipment and Supplies
082	Scientific and Photographic Equipment, Watches and Clocks	504	Sporting, Recreational, Photographic, and Hobby Goods, Toys and Supplies
		508	Machinery, Equipment and Supplies
		509	Miscellaneous Durable Goods
083	Medical, Dental and Optical Equipment	508	Machinery, Equipment and Supplies
084	Other Manufactured Products	50	Durable Goods
121	Scrap	50	Durable Goods

03102). Sales for these goods, less margins, were expressed as a percent of goods produced by corresponding MRIO sectors, and were used to estimate wholesale sales at the state level. In the final step, the estimated margins by MRIO producing sector by state are scaled to the state controls for wholesale establishments.

Retail Trade

Retail trade margins are equal to the sum of the output of retail trade establishments, with output defined to exclude the cost of goods passing through retail merchants. Retail trade margins were estimated at the national level from purchases data contained in the Current Business Report "1977 Retail Trade, Annual Sales and Purchases, Year-end Inventories, and Accounts Receivable by Kind of Retail Store" (Source 03119) for each of the 41 three-digit SIC's in retail trade. The margin amount was calculated as sales (from the Census of Retail Trade, Source 03101), less purchases plus beginning inventories less ending inventories. Margins were computed for each state by three-digit SIC (kind-of-business) from the national margins and allocated to states based on state sales by kind-of-business. For a more complete discussion of the development of state retail trade outputs, see Chapter 14 of JFA's report State Estimates of Output, Employment and Payrolls, 1977.

Margins were assigned by state to the sales of goods to final demand and intermediate purchasers using margin rates by four-digit SIC developed by the Bureau of Economic Analysis (BEA). BEA developed these rates from published and unpublished Census data in the development of their preliminary "1977 Analysis Input-Output Control Total Worksheets." The margin rates were computed by expressing the gross margin for each four-digit retail SIC as a percent of sales at the national level. The assignment of margin rates to the goods of each producing sector was an inexact procedure guided by available data and the judgement of the analyst. Data considered in the determination of markup rates included merchandise line sales as reported in the 1977 Census of Retail Trade (Source 03101), product line detail listed in the Standard Industrial Classification Manual, 1972 (Source 01106), and commodity purchases used to develop final demand purchases from retail trade (see JFA report State Estimates of Final Demand, 1977.)

Wherever possible, a producing sector was assigned the margin of the four-digit kind-of-business observed to most closely specialize in the type of goods produced by the sector. For example, MRIO Sector 071, Household Appliances, produces goods sold in

Department Stores (SIC 5311), Variety Stores (SIC 5331), Household Appliance Stores (SIC 5722) to name a few. The margin rate used, however, was the rate of Household Appliance Stores (SIC 5722), since this rate most precisely reflects the rate that would be expected to be charged for appliances wherever sold. Where the output of a producing sector was sold primarily through broad product-line establishments such as hardware, department or grocery stores, the rate assigned was the rate of the retail establishment judged to handle most of the goods being produced.

In a few cases, more than one margin was used. For example, in Sector 027, Beverage, Extracts, and Sirups, a weighted average of two margins was used to reflect separately the sales of soft drinks and related products versus alcoholic beverages. The kind of business appropriate for alcoholic beverages was liquor stores, while the business associated with the sale of soft drinks was grocery stores. Exhibit 3-3 shows the margins assigned to each MRIO sector by kind-of-business. Sectors not appearing in the table show no sales to the Personal Consumption Expenditures category or show so few sales relative to production that it was assumed that sales to PCE represent goods purchased directly from producers or through wholesale channels.

To compute estimated margins, the margin rates are multiplied by state purchases-less-retail-sales-taxes in final demand and by purchases of intermediate users where appropriate. The final results are scaled, by state, to the totals of retail establishment output developed previously by JFA.

Data Quality

The reliability of the estimates of retail and wholesale trade margins is severely limited by a lack of data on the cost-of-goods sold at the state level. While the methods used to estimate trade margins provide an adequate measure of trade services within the MRIO, the user should realize that the margins and underlying margin rates within the model represent only an estimate of the average margins charged at the national level for a wide variety of products. Limitations on the accuracy of margins include:

1. The margin rates and the controls for trade margins for all types of trade activity were estimated based on national data on margins, cost-of-goods-sold, and/or operating expenses and profits of trade operators. The national controls were allocated to states based on sales. All state estimates, therefore, reflect the assumption that the ratios of gross margins-to-sales are constant across all states.

EXHIBIT 3-3:
RETAIL MARGINS BY MRIO SECTOR

MRIO SECTOR		RETAIL KIND-OF-BUSINESS		
		SIC	Title	Margin Rate[1]
001	Dairy Farm Products	5451	Dairy Product Stores	32.7
002	Livestock and Poultry	5411	Grocery Stores	22.2
004	Fruits, Nuts, Vegetables, and Misc. Crops and Services	5431	Fruit Stores and Vegetable Markets	32.7
005	Forestry Products	5261	Retail Nurseries, Lawn and Garden Supply Stores	33.9
012	Stone, Clay, Sand and Gravel	5211	Lumber and Other Building Materials Dealers	28.4
013	Chemical and Fertilizer Minerals	5261	Retail Nurseries, Lawn and Garden Supply Stores	33.9
020	Ordnance	5941	Sporting Goods Stores and Bicycle Shops	35.9
021	Meat Products	542	Meat and Fish Markets, Including Seafoods	32.7
022	Diary Products	5451	Dairy Product Stores	32.7
023	Canned and Frozen goods	5411	Grocery Stores	22.2
024	Grain Mill Products	5411	Grocery Stores	22.2
025	Bakery Products	546	Retail Bakeries	56.7
026	Sugar and Confectionary Products	5441	Candy, Nut and Confectionary Stores	32.7
027	Beverages, Extracts, and Sirups	5921	Liquor Stores	23.0
028	Other Food Products	5411	Grocery Stores	22.2
029	Tobacco Products	5993	Cigar Stores and Stands	33.4
030	Fabric, Yarn and Thread Mills	5949	Sewing, Needlework and Piece Good Stores	33.4
031	Floor Coverings and Miscellaneous Products	5713	Floor Covering Stores	40.1
032	Hosiery and Knit Goods	5631	Women's Accessory and Specialty Stores	64.8
033	Apparel	5651	Family Clothing Stores	43.7
034	Other Fabricated Textile Products	5714	Drapery, Curtain and Upholstery Stores	40.7
		5719	Misc. Home Furnishing Stores	40.7
036	Wood Products	5251	Hardware Store	32.6
037	Pre-fabricated Buildings and Mobile Homes	5271	Mobile Home Dealers	26.7
038	Household Furniture	5712	Furniture Stores	40.1

[1] *The margin rates were calculated as gross margin/sales at the national level.*

EXHIBIT 3-3:

RETAIL MARGINS BY MRIO SECTOR (cont.)

MRIO SECTOR		RETAIL KIND-OF-BUSINESS		
		SIC	Title	Margin Rate[1]
039	Other Furniture and Fixtures	5712	Furniture Stores	40.1
040	Paper and Allied Products	5411	Grocery Stores	22.2
041	Paperboard Containers and Boxes	5311	Department Stores	40.9
042	Newspapers, Periodicals and Other Printing and Publishing	5963	Direct Selling Establishments	34.2
045	Other Chemical Products	5251	Hardware Stores	32.6
047	Drugs	5912	Drug Stores and Proprietary Stores	31.1
048	Cosmetics and Cleaning Products	5912	Drug Stores and Proprietary Stores	31.3
049	Paint and Allied Products	5231	Paint, Glass, and Wallpaper Stores	33.9
050	Petroleum Refining and Allied products	5541	Gasoline Service Stations	19.9
051	Rubber and Miscellaneous Plastics	5531	Auto and Home Supply Stores	34.6
052	Leather and Leather Products	5661	Shoe Stores	43.9
053	Glass and Glass Products	5231	Paint, Glass and Wallpaper Stores	33.9
054	Stone and Clay Products	5719	Misc. Home Furnishing Stores	40.7
058	Metal Containers and Miscellaneous Metal Products	5251	Hardware Stores	32.6
059	Structural Metal Products	5251	Hardware Stores	32.6
060	Screw Machine Products and Metal Stampings	5251	Hardware Stores	32.6
061	Engines and Turbines	5531	Auto and Home Supply Stores	34.6
062	Farm and Lawn Equipment	5261	Retail Nurseries, Lawn and Garden Supply Stores	33.9
065	Metalworking Equipment	5251	Hardware Stores	32.6
066	Special Industry Machinery and Equipment	5251	Hardware Stores	32.6
067	General Industrial and Other Non-electrical Machinery and Equip.	5531	Auto and Home Supply Stores	34.6
068	Office and Computing Equipment	5943	Stationary Stores	33.4
069	Service Industry Machinery and Equipment	5722	Household Appliance Stores	30.3
070	Electrical Transmission and Electrical Industrial Equipment	5251	Hardware Stores	32.6

[1] *The margin rates were calculated as gross margin/sales at the national level.*

EXHIBIT 3-3:

RETAIL MARGINS BY MRIO SECTOR (cont.)

MRIO SECTOR		RETAIL KIND-OF-BUSINESS		
		SIC	Title	Margin Rate[1]
071	Household Appliances	5722	Household Appliances Stores	30.3
072	Electric Lighting and Wiring Equipment	5251	Hardware Stores	32.6
073	Receiving Sets, Records and Tapes	5733	Music Stores	35.1
074	Communications Equipment	5732	Radio and Television Stores	30.9
075	Electronic Components	5732	Radio and Television Stores	30.9
076	Other Electrical Equipment	5531	Auto and Home Supply Stores	34.6
077	Motor Vehicles and Parts	5531	Auto and Home Supply Stores	34.6
078	Aircraft and Parts	5599	Automobile Dealers, n.e.c.	24.6
081	Other Transportation Equipment	5271	Mobile Home Dealers	26.7
		5551	Boat Dealers	24.6
		5571	Motorcycle Dealers	24.6
082	Scientific and Photograph Equipment, Watches and Clocks	5944	Jewelry Stores	42.0
		5945	Hobby Toy and Game Shops	35.9
		5946	Camera and Photographic Equipment	35.9
084	Other Manufactured Products	5251	Hardware Stores	32.6
		5941	Sporting Goods Stores and Bicycle Shops	35.9
		5943	Stationery Stores	35.9
		5944	Jewelry Stores	42.0
		5945	Hobby Toy and Game Stores	35.9
		5949	Sewing, Needlework and Piece Good Stores	33.4

[1] *The margin rates were calculated as gross margin/sales at the national level.*

2. The margin rates, developed from the margin amounts by kind-of-business categories, were applied to sales in a largely subjective process. Though the assignment of markup rates to producing sectors was guided by available data, a considerable amount of judgement by the analyst was also required.

Excise and Sales Taxes

The numerous taxes that are levied on producer output and consumer purchases account for a varying proportion of the difference between producers' and purchasers' prices across MRIO sectors. As seen in Exhibit 3-4, many taxes are incorporated explicitedly in the model to facilitate ease in updating and to provide the user with actual data on tax collections. Taxes are built into the model at the level that supports the most accurate assignment of the tax. For example, manufactures' excise taxes are levied on the manufacturer and thus are passed on to purchasers of the goods for both intermediate uses and final demand (except government purchases). Therefore, manufacturers' excise taxes are assigned to manufacturers' distribution sectors within the model and included in the price paid by all purchasers. The tax amounts that are allocated to government purchases are balanced by a negative flow before final scaling to the control total for each category of manufacturer's excise taxes. The treatment of each tax and the development of appropriate control totals are described below.

Federal Excise Taxes

Federal excise taxes shown in Exhibit 3-4 are assigned to the distribution sector of the MRIO that produces the good or service taxed. The amount of collections for alcohol, tobacco, and manufacturers' excise taxes, by MRIO sector and four-digit SIC, are shown in Exhibit 3-5. The amount of tax assigned to each sector was developed from the 1977 and 1978 Commissioner of Internal Revenue: Annual Report (Source 15102), in accordance with the methodologies used by BEA in their 1972 table (see Definitions and Conventions of the 1972 Input-Output Study, Source 03503). Lacking specific data on the unallocated sum of $15.8 million, this sum is prorated according to the distribution of other Federal excise taxes.

Within the MRIO, the taxes assigned to each producing sector are allocated based on sales. Since Federal, state and local governments are exempted from Federal excise taxes, a special procedure was used to prevent the inappropriate assignment of taxes to

EXHIBIT 3-4:

EXCISE AND SALES TAXES AND CUSTOMS DUTIES, 1977
(millions of dollars)

Tax	Collections
Federal Excise Taxes[1]	
Alcoholic Beverages	5,387.4
Tobacco	2,382.0
Manufacturers' Excise	6,203.4
Retailers' Excise (aviation diesel fuel, etc.)	493.6
Telephone and Telegraph	1,665.4
Air Transportation	1,112.3
Miscellaneous and Unclassified Excise Taxes	514.3
Total Federal Excise Taxes	17,758.4
Custom Duties[2]	5,647.0
State Excise and Selective Sales Taxes	
Alcoholic Beverages[3]	2,204.7
Tobacco[3]	3,576.4
Motor Fuels[3]	9,308.0
Public Utility Sales[4]	2,536.7
Insurance Receipts[4]	2,518.5
Other[4]	2,193.7
Total State Excise and Selective Sales Taxes	22,338.0
Local Selective Sales Taxes[5]	
Alcoholic Beverages	147.8
Tobacco	131.9
Motor Fuels	75.9
Public Utilities Sales	1,846.5
Other	685.0
Total Local Selective Sales Taxes	2,887.1
State General Sales Taxes[3]	32,816.5
Local General Sales Taxes[5]	5,656.5
Total Taxes Shown	86,690.1

[1] *U.S. Department of the Treasury, Commissioner of Internal Revenue Annual Report, 1977 and 1978 (Source 15102). Taxes shown include an unknown amount of collections in Puerto Rico.*

[2] *U.S. Customs Service, Customs Today, FY 1977, (Source 15301), Customs USA FY 1980 (Source 15302).*

[3] *Bureau of the Census, Quarterly Summary of State and Local Tax Revenues, Oct.-Dec. 1977 (Source 03117)*

[4] *Bureau of the Census State Government Tax Collections 1977, 1978 (Source 03117). Values shown are an average of FY 1977 and FY 1978 data.*

[5] *Bureau of the Census Governmental Finances, 1976-77, 1977-78, (Source 03117). Values shown are an average of FY 1977 and FY 1978 data.*

EXHIBIT 3-5:

FEDERAL ALCOHOL, TOBACCO, AND MANUFACTURERS' EXCISE TAXES, BY SECTOR, 1977

(millions of dollars)

TAX	MRIO	SIC	Collections
Alcoholic Beverages	27: Beverages, Extracts and Sirups	2082	1,384.6
		2084	340.2
		2085	3,662.6
Tobacco	29: Tobacco Products	2111	2,346.0
		2121	34.6
	40: Paper and Allied Products	2621	1.4
Manufacturers'	20: Ordnance	3482	19.8
		3484	41.0
	50: Petroleum Refining and Allied Products	2911	4,349.4
		2992	104.3
	51: Rubber and Misc. Plastics	3011	831.7
	58: Misc. Metal and Misc. Metal Products	3493	1.6
	60: Screw Machine Products and Metal Stampings	3451	1.9
		3465	11.1
	61: Engines and Turbines	3519	11.7
	67: General Industrial and Other Non-electrical Machinery and Equipment	3592	1.7
	76: Other Electrical Equipment	3691	1.7
		3694	3.3
	77: Motor Vehicles and Parts	3711	315.0
		3713	163.4
		3714	131.9
		3715	175.2
	84: Other Manufactured Products	3949	22.8
	(unallocated)		15.8

Sources: *Commissioner of Internal Revenue Annual Report, 1977 and 1978 (Source 15102) and Definitions and Conventions of the 1972 Input - Output Study (Source 03503).*

purchases from these sectors when taxes were assigned via the distribution sectors within the MRIO. For convenience, the total taxes collected by sector will be augmented by the amount of taxes that are associated with Federal, state and local government purchases. This amount will be cancelled out by corresponding negative entries in the appropriate government columns in final demand.

Retailer's excise taxes are levied on diesel and special motor fuels and on non-commercial aviation fuels. These taxes were assigned to the distribution sector of MRIO 050 according to the specific products taxed. The state distribution of these taxes is shown in Exhibit 3-6.

Data on diesel and special motor fuel taxes by state were available from the 1977 Highway Statistics (Source 14401). Data for the non-commercial aviation fuel tax were developed as a national total and allocated to states proportionally to consumption of aviation gasoline by state. The national total was available in the 1977 and 1978 Commissioner of the Internal Revenue Annual Report (Source 15102). Consumption of aviation gasoline was published in the 1978 State Energy Data Report (Source 06105).

National totals for telephone and telegraph and air transportation excises were also available from the IRS annual reports (Source 15102). Data for toll, telephone, telegraph, radio and cable service excise taxes were developed as a national total, and allocated to states proportionally to output in MRIO Sector 092: Communications, except Radio and Television. Air transportation excise taxes were allocated to states proportionally to the output of Sector 089: Air Transportation.

Lacking reliable state and sector data, miscellaneous and unclassified excise taxes were not allocated explicitedly in the model.

Customs Duties

Customs duties on comparable imports were developed with final demands. The reader is referred to the JFA report State Estimates of Final Demands, 1977 for an explanation of the methodology.

Customs duties on noncomparable imports were developed and treated according to the procedures described in Chapter 2 of this report.

EXHIBIT 3-6:

FEDERAL RETAILERS EXCISE TAXES, 1977
(millions of dollars)

States	Diesel and Special Motor Fuel Taxes $ Millions	Non-Commercial Aviation Fuel Tax $ Millions
AL	9.5	0.5
AK	1.7	1.1
AZ	7.0	1.0
AR	7.1	0.7
CA	37.9	4.5
CO	4.9	0.7
CT	3.7	0.3
DE	0.9	0.2
DC	0.8	0.0
FL	13.7	3.1
GA	14.5	0.9
HI	0.6	0.5
ID	2.1	0.4
IL	22.5	0.2
IN	18.3	0.7
IA	9.4	0.5
KS	6.3	0.6
KY	7.4	0.3
LA	8.4	0.7
ME	1.9	0.2
MD	5.1	0.3
MA	5.6	0.5
MI	13.0	1.1
MN	8.3	0.5
MS	6.2	0.4
MO	12.6	0.4
MT	3.7	0.2
NE	5.1	0.5
NV	2.4	0.5
NH	0.9	0.1
NJ	11.7	0.3
NM	5.0	0.3
NY	11.6	7.9
NC	12.5	0.7
ND	2.2	0.3
OH	25.5	1.0
OK	8.9	0.9
OR	7.1	0.5
PA	26.4	0.8
RI	0.9	0.4
SC	6.6	0.5
SD	2.2	0.3
TN	13.7	0.1
TX	36.7	3.1
UT	3.4	0.3
VT	0.9	0.0
VA	11.2	0.6
WA	7.1	0.8
WV	3.7	0.1
WI	10.2	0.3
WY	3.4	0.6
US	452.4	41.1

State and Local Excise and Selective Sales Taxes

State excise and selective taxes include taxes levied on alcoholic beverages, tobacco, motor fuels, public utilities sales, insurance, and "other," as shown in Exhibit 3-4. Local selective sales taxes are levied on alcoholic beverages, tobacco, motor fuels, and public utility sales and "other" are also shown in Exhibit 3-4. State taxes shown as "other" are combined with general sales taxes for distribution by MRIO sector and state (see below). Local taxes shown as "other" have not been allocated in the model because there are no reliable data on these taxes by state and sector.

State distributions for each specified type of tax are shown in Exhibit 3-7. It should be noted that the state distributions of local taxes differ considerably from the local tax totals shown in Exhibit 3-4. Final scaling will adjust these values, as required. Within each state, the taxes are assigned to distribution sectors of producing MRIO sectors in proportion to output as follows:

Tax	MRIO Sector	
Alcoholic Beverages	27:	Beverages, Extracts and Sirups
Tobacco	29:	Tobacco Products
Motor Fuels	50:	Petroleum Refining and Allied Products
Public Utility Sales	094:	Electric Utilities
	095:	Gas Production and Distribution
Insurance Sales	104:	Insurance

Assignment to these sectors effectively assigns the tax to all users in proportion to sales of relevant commodities. Again, since state and local taxes are not paid by government sectors, total taxes are augmented and balanced by corresponding negative entries (see Federal Excise Taxes).

State and Local General Sales Taxes

The state totals for state and local general sales taxes and "other" state selective sales taxes are shown in Exhibit 3-8. The treatment of state and local general sales taxes differ from excise and selective sales taxes because these taxes are primarily associated with sales to final demand. The sales tax exempt status offered businesses allow, for the most part, purchases by businesses to avoid payment of these taxes. For this reason, general sales taxes are assigned entirely within final demand. It is clear that this treatment to a small extent misallocates taxes. For example, businesses do routinely pay general sales taxes on meals and lodging. However, the advantages of this

EXHIBIT 3-7

STATE AND LOCAL EXCISE AND SELECTIVE SALES TAXES
BY STATE, 1977
(millions of dollars)

	ALCOHOLIC BEVERAGES		TOBACCO		MOTOR FUELS		PUBLIC UTILITIES		INSURANCE
	State[1]	Local[2]	State[1]	Local[2]	State[1]	Local[3]	State[4]	Local[2]	State Only[4]
AL	70.4	16.9	80.4	7.8	167.7	21.2	107.8	.2	52.6
AK	8.0	-	4.8	.2	22.5	1.9	1.4	.3	9.1
AZ	16.5	-	35.4	-	115.9	-	16.1	12.2	22.3
AR	16.8	.3	48.4	-	121.8	.2	-	12.7	22.6
CA	129.5	-	265.5	6.0	834.7	-	15.9	242.2	355.2
CO	20.0	-	41.1	-	103.7	-	.8	16.2	29.5
CT	24.9	-	75.6	-	161.0	-	111.7	5.7	47.7
DE	4.4	-	12.5	-	32.7	-	9.2	-	8.1
DC	10.6	-	11.7	-	22.8	-	46.6	-	15.4
FL	209.7	-	207.7	-	394.0	-	65.8	228.8	86.0
GA	82.0	43.7	75.4	-	251.8	-	-	28.2	84.4
HI	17.3	-	10.4	-	33.3	12.3	32.3	5.0	14.7
ID	6.6	-	8.1	-	46.1	-	1.1	.9	12.5
IL	78.6	26.1	161.2	12.7	410.3	19.9	385.5	130.4	92.0
IN	30.2	-	68.3	-	266.5	-	-	-	47.8
IA	13.8	0.8	46.6	-	135.5	-	-	1.9	33.4
KS	20.7	-	32.3	-	125.5	-	0.4	14.1	26.7
KY	15.0	-	22.0	0.3	167.0	-	-	2.7	50.0
LA	46.4	2.8	58.0	-	178.9	-	16.1	14.2	55.2
ME	24.8	-	24.3	-	55.8	-	13.5	-	9.7
MD	28.2	.1	53.8	.5	193.9	-	55.0	49.6	59.1
MA	77.7	-	142.9	-	202.2	-	-	-	99.7
MI	80.3	-	138.2	2.1	426.0	2.3	-	30.4	90.8
MN	56.0	-	84.8	-	202.7	-	86.2	14.8	50.2
MS	24.8	3.5	30.8	0.3	136.1	5.5	-	8.3	28.8
MO	23.3	-	80.1	19.0	213.3	-	0.5	115.1	49.7
MT	9.8	-	11.5	-	45.9	-	4.5	-	12.0
NE	11.1	-	22.7	-	92.2	-	-	4.4	16.4
NV	10.7	-	11.1	-	30.4	0.4	1.2	5.2	8.3
NH	4.1	-	26.7	0.4	42.1	-	2.1	-	9.3
NJ	53.2	0.8	170.6	-	297.8	-	52.8	305.5	71.7
NM	7.1	-	13.6	0.1	67.0	-	5.6	4.2	14.2
NY	150.1	-	335.2	59.3	495.9	7.1	416.8	-	189.9
NC	89.5	-	19.8	0.5	296.8	-	152.1	-	80.1
ND	8.1	0.1	8.7	-	31.1	-	1.8	0.3	7.0
OH	71.3	0.7	200.5	-	403.3	-	254.2	-	106.2
OK	36.1	-	53.8	-	127.3	-	4.2	17.1	43.7
OR	8.5	-	22.9	-	93.8	2.9	1.2	15.3	26.4
PA	105.2	1.2	250.9	-	519.0	-	296.9	-	128.8
RI	7.5	-	24.0	-	41.1	-	29.2	-	10.7
SC	76.7	-	26.0	-	151.9	-	18.7	-	30.3
SD	7.6	-	9.3	-	37.2	-	.3	-	8.4
TN	43.1	33.8	68.8	-	196.4	-	10.1	1.8	49.1
TX	151.8	-	292.1	-	440.1	-	129.8	85.6	137.4
UT	5.3	0.1	7.8	-	56.1	-	1.1	8.2	13.1
VT	13.0	0.2	9.4	0.2	23.4	-	9.1	-	4.8
VA	86.8	-	18.2	12.8	272.8	-	82.0	101.3	62.4
WA	70.1	-	58.9	0.6	207.8	-	73.1	48.7	33.3
WV	21.4	-	28.3	-	84.7	-	-	4.4	21.9
WI	41.5	-	84.2	0.2	174.8	-	63.1	-	36.4
WY	1.8	-	4.8	-	27.9	-	-	1.2	2.8
US[5]	2,204.7	130.9[6]	3,578.4	123.2[6]	8,317.8	81.7[6]	2,847.8	1,632.2[6]	2,517.8

[1] Quarterly Summary of State and Local Tax Revenue, Source 03117. Represent CY 1977 values.

[2] Table 8: Capacity and Effort Measures, State Rankings and Percent Distribution of Taxes of State and Local Governments by Type of Tax, 1977; Tax Wealth in Fifty States (Source 08201). Above values calculated by subtracting State tax amount (above) from the total for State and local governments given in the publication.

[3] The larger of the local government motor fuel tax from the amounts shown in Governmental Finances 1977-78 (Source 03117) or Tax Wealth in Fifty States (Source 08201). The later calculated as in footnote 2 above.

[4] Table 4: State Government Sales and Gross Receipts Tax Revenue, State Government Tax Collections (Source 03117) 1977 and 1978. Values shown represent an average of FY 77 and FY 78 data.

[5] Columns may not add due to rounding.

[6] Different data sources were used to develop the state-level amount of local taxes than were used for the national totals in Exhibit 3-4. The amounts shown above will be scaled to equal the national Census totals in Exhibit 3-4.

EXHIBIT 3-8:

GENERAL SALES AND OTHER TAXES,
BY STATE, 1977
(millions of dollars)

	State General Sales and Gross Receipts[1]	"Other" Selective State Sales Taxes[2]	Local General Sales Taxes[3]
AL	466.4	22.7	151.3
AK	-	22.6	33.1
AZ	538.5	7.9	109.7
AR	269.4	13.2	0.7
CA	4,564.5	149.4	981.8
CO	374.1	7.5	221.8
CT	615.7	52.7	-
DE	-	6.8	-
DC	147.6	31.4	-
FL	1,499.8	116.9	1.2
GA	740.4	-	100.8
HI	352.1	-	-
ID	111.0	0.4	-
IL	1,938.8	102.2	420.5
IN	1,069.5	0.1	-
IA	361.6	0.3	-
KS	340.4	0.4	14.1
KY	498.3	112.3	-
LA	527.2	29.6	364.5
ME	178.8	1.2	-
MD	541.5	139.8	-
MA	478.3	207.0	-
MI	1,409.5	25.5	-
MN	502.4	78.8	3.1
MS	506.1	1.2	-
MO	647.9	-	139.3
MT	-	2.5	-
NE	227.3	7.6	23.9
NV	122.2	90.1	21.1
NH	-	34.9	-
NJ	969.5	29.4	-
NM	295.4	17.3	11.7
NY	2,366.9	130.4	1,787.3
NC	545.0	21.1	147.1
ND	101.0	2.8	-
OH	1,234.5	22.1	94.7
OK	222.0	40.7	151.1
OR	-	5.0	-
PA	1,638.8	28.2	-
RI	142.9	3.6	-
SC	440.6	14.9	-
SD	107.8	13.4	11.8
TN	787.3	40.1	208.4
TX	1,782.3	392.3	324.7
UT	241.9	-	47.6
VT	33.4	22.5	-
VA	457.7	68.1	154.7
WA	1,219.9	5.9	117.2
WV	459.5	70.6	-
WI	634.8	0.3	-
WY	105.8	-	13.3
US	32,816.5	2,193.7	5,656.5

Columns may not add due to rounding.

[1] *Table 3: Collections of State Taxes, Fourth Quarter of 1977 and Prior Periods, Quarterly Summary of State and Local Tax Revenue (Source 03117). Values shown are 1977 CY values.*

[2] *Table 4: State Government Sales and Gross Receipts Tax Revenue: 1978, State Government Tax Collections, 1977 and 1978 (Source 03117). These entries represent the sum of taxes collected for parimutuals, amusements and other miscellaneous taxes collected, averaged over the FY 1977 and FY 1978 data.*

[3] *Table 5: Government Revenue by Source and Level of Government, Governmental Finances 1976-77 and 1977-78. (Source 03117). Values shown represent an average of FY 1977 and FY 1978 data.*

treatment in ease in updating are believed to considerable outweigh the loss in accuracy that may occur from the misallocation of general sales taxes that are paid by businesses.

Computation of the amount of state sales tax by MRIO sector was based on information contained in the State Tax Handbook 1977 and 1978 (Source 24051). The descriptions of general sales taxes levied on sales of goods and services by state within this publication were used to estimate sales tax collections, by sector. The rates identified were applied to final demand expenditures by state and sector to estimate the amount of tax collection for each sector. These estimates were scaled to the amount of total collections by state from the Quarterly Summary of State and Local Tax Revenue (Source 03117) and shown in Exhibit 3-8.

Available data were scarce in the development of local sales collection data. Where information was not available on the products or services taxed by local sales taxes, these taxes were distributed within a state according to the distribution by sector of state sales taxes.

The taxes identified in Exhibit 3-8 as "other" selective sales taxes include taxes collected for paramutuals, amusements and other miscellaneous goods and services. Lacking information on the specific MRIO sectors associated with these taxes, they were distributed to sectors within a state according to the distribution of state sales taxes described above.

Data Quality

The data on Federal excise and state selective sales taxes are from high quality sources and may be expected to accurately represent tax collections for 1977. The assignment of Federal excise taxes to states according to sales, however, may be slightly less reliable to the extent that prices paid for specific goods varies across states and excise taxes may be levied by quantity.

The data developed for local selective sales taxes by state were developed from several data sources. To make these data more creditable, they were scaled to Census national totals.

While at the state level, collections data for state and local retail sales taxes are quite reliable, the distribution of these taxes to MRIO sectors within a state was subject to the availability of state and local sales tax information, which was not complete across all states. Subsequently, the amount of sales tax allocated to MRIO's within a state may not be representative of actual sales taxes levied, by sector. Information on local sales taxes were far less reliable than information available for state sales taxes.

CHAPTER 4

AGRICULTURE, FORESTRY AND FISHERIES

MRIO Sectors:

001: Dairy Farm Products
002: Livestock and Poultry
003: Cotton, Grain and Tobacco
004: Fruits, Nuts, Vegetables, and Miscellaneous Crops and Services
005: Forestry Products
006: Commercial Fishing and Trapping

As shown in Exhibit 4-1, this group of MRIO sectors includes all of SIC major groups:

01: Agricultural Production — Crops;
02: Agricultural Production — Livestock;
07: Agricultural Services (excluding SIC 074, Veterinary Services);
08: Forestry, and
09: Commercial Fishing, Hunting and Trapping.

Data Sources and Methodology

Overview of Input Data

A variety of sources and methods were used to estimate 1977 input data for the agricultural, forestry and fishery sectors in each state. These different methods and data resources are described below. Approximately 35 percent of the inputs to each of MRIO sectors 001 - 004 were estimated from 1977 data. An additional 55 percent was developed using 1978 data. The remaining inputs are based on 1972 BEA coefficients updated to reflect 1977 prices. All inputs to MRIO Sectors 005 and 006, and to the agricultural services subsector of MRIO 004 were developed from updated coefficients. Forty-five percent of all inputs were available in state-level detail.

EXHIBIT 4-1

MRIO CONCORDANCE WITH 1977 SIC CODES

Sectors 001, 002, 003, 004, 005, 006: Agriculture, Forestry and Fisheries

MRIO Sector	BEA I-O Code		1977 SIC
001: Dairy Farm Products	10100	Dairy Farm Products	0241, pt. 0191, pt. 0259, pt. 0291
002: Livestock and Poultry	10200	Poultry and Eggs	025 (excluding pt. 0259), pt. 0191, pt. 0219, pt. 0291
	10301	Meat Animals	021 (excluding pt. 0219), pt. 0191, pt. 0259, pt. 0291
	10302	Miscellaneous Livestock	027, pt. 0191, pt. 0219, pt. 0259, pt. 0291
003: Cotton, Grain and Tobacco	20100	Cotton	0231, pt. 0191, pt. 0219, pt. 0259, pt. 0291
	20201	Food Grains	pt. 011, pt. 0191, pt. 0219, pt. 0259, pt. 0291
	20202	Feed Grains	pt. 011, pt. 0139, pt. 0191, pt. 0219
	20203	Grass Seeds	pt. 0139, pt. 0191, pt. 0219, pt. 0259, pt. 0291
	20300	Tobacco	0132, pt. 0191, pt. 0219, pt. 0259, pt. 0291

EXHIBIT 4-1 (cont'd)

MRIO CONCORDANCE WITH 1977 SIC CODES

Sectors 001, 002, 003, 004, 005, 006: Agriculture, Forestry and Fisheries

MRIO Sector	BEA I-O Code		1977 SIC
004: Fruits, Nuts, Vegetables, and Miscellaneous Crops and Services	20401	Fruits	pt. 017, pt. 0191, pt. 0219, pt. 0259, pt. 0291
	20402	Tree Nuts	0173, pt. 0179, pt. 0191, pt. 0219, pt. 0259, pt. 0291
	20501	Vegetables	0134, pt. 0119, pt. 0139, 0161 pt. 0191, pt. 0219, pt. 0259, pt. 0291
	20502	Sugar Crops	0133, pt. 0191, pt. 0219, pt. 0259, pt. 0291
	20503	Miscellaneous Crops	pt. 0119, pt. 0139, pt. 0191, pt. 0219, pt. 0259, pt. 0291
	20600	Oil Bearing Crops	0116, pt. 0119, pt. 013, pt. 0173, pt. 0219, pt. 0259, pt. 0291
	20701	Forest Products	pt. 018, pt. 0191, pt. 0219, pt. 0259, pt. 0291
	20702	Greenhouse & Nursery Services	pt. 018, pt. 0191, pt. 0219 pt. 0259, pt. 0291, pt. 07 (excluding 074)*
005: Forestry Products	30000		0811-4; 091, 097
006: Commercial Fishing & Trapping	40000		092, 0254, 085

Indicates those industries in which there was a change in composition between the 1972 and 1977 SIC's.

Purchased Inputs: Census-Derived

Selected production expenditures in 1978 by type of farm (i.e., SIC) and by state were available from the 1978 Census of Agriculture (Source 03109) in Table 35 of each state volume. These expenditures included:

- purchased livestock and poultry (inter- and intra-state)
- purchased livestock and poultry feeds (including commercially mixed formula feeds)
- animal health costs
- purchased seeds, bulbs, plants, and trees
- purchased commercial fertilizer
- other purchased agricultural chemicals (including lime)
- purchased gasoline, diesel fuel, LP gas, butane, and propane, fuel oil, natural gas, kerosene, motor oil and grease, electricity, and other fuels (wood, coal, and coke)
- customwork, machine hire, and rental of machinery and equipment
- contract labor
- hired farm labor (the treatment of this input is described in State Estimates of Outputs, Employment and Payrolls, 1977)

The development of input data by state for MRIO Sectors 001, 002, 003, and 004 (the latter minus agricultural services) began with the estimation of suppressed data on production expenditures by type of farm. Estimates were made when the expenditure value suppressed represented at least five percent of the state total for that expenditure category. Where the missing values represented less five percent of the total, the missing value was prorated to the total production expenditure for each SIC that was not suppressed.

Next, production expenditures were combined with the value of production matrix developed from Table 35 in the Census for the estimation of output and employment, by state, in the agriculture sector (see State Estimates of Outputs, Employment and Payrolls, 1977). All production expenditures and value of production for 1978 by state and type of farm were then deflated to 1977 values. Deflators for the value of production by commodity were developed from USDA sources on commodity prices or value of production. These sources were primarily crops, dairy, livestock, and poultry production reports from the Economic Statistic Service's Crop Reporting Board (Sources 02131-4) supplemented by data from the Agricultural Statistics

(Source 02001). Price data or price indexes in the USDA's 1977 and 1978 Agriculture Price Reports (Source 02135) were also used. Composite deflators were calculated by weighting individual product indexes by product output. In most cases, deflators could be calculated in this manner by state for each Census commodity group; however, in a few cases, only a national level deflator was available.

Deflators for each production expenditure category were also developed from several sources. For all energy and petroleum product inputs except natural gas and the "other fuels" category, price data for 1977 and 1978, by state, were available from the Agricultural Price Reports.[1] National level deflators for customwork and machine hire and contract labor were also published in this source. State-specific indexes for hired farm labor were derived from data in the Economic Indicators of the Farm Sector: State Income and Balance Sheet Statistics, 1979 (Source 02111). For all the remaining expenditure categories covered by the Census, only national deflators were available. Price indexes for these items were taken from the 1977 Wholesale Prices and Price Indexes (Source 12106) and the Producer Prices and Price Indexes, 1978 (Source 12107), and applied to all states.

Working from the two 1978 Census matrices now deflated to 1977 dollar values, input usage by farm commodity was imputed by calculating dollar input per dollar output coefficients, by state, for each input-commodity combination. All these calculations were performed in the context of an iterative procedure. In the initial run, input coefficients were calculated for the main diagonal cells of the production matrix taking total dollar inputs by farm SIC per dollar output of the primary product for that farm SIC. These input coefficients would then be applied across the output row for the particular primary product wherever that product was produced.

The choice of which input coefficient to use for each farm product row was based upon an examination of output concentration at the national level by type of farm. For example, with grains production concentrated on cash grain farms, the input coefficients for grains grown on grain farms were applied across the grains output row. In this way, the input coefficients of the farm SIC to which a farm commodity is primary

[1] *Data published in Energy and U.S. Agriculture: 1974 and 1978 (Source 02112) indicated that the Census expenditure category of "other fuels" was most likely coal.*

(given SIC definitions in the agriculture sector) are controlling. Exhibit 4-2 illustrates the correspondance followed between type of farm and farm commodity. As a final step, allocated inputs were then scaled to the deflated dollar input totals by type of farm given in Table 35.

Input coefficients were calculated differently in subsequent iterations. Once some value of input had been allocated to a main diagonal cell, the input coefficients for that cell (i.e., within that cell) were then used as the controlling coefficient to be applied across the farm commodity row. As before, however, all inputs were scaled to the deflated dollar input totals by type of farm.

In some cases, certain input-commodity combinations derived with this procedure did not make "agricultural sense" (e.g., fertilizer usage for livestock production or purchased feed for vegetable production). These combinations occurred where inputs to secondary product production were attributed to a primary product for that type of farm. In these cases the input allocation was restricted to "realistic" input-commodity combinations, setting some input coefficients to zero and leaving the remaining value for that input to be allocated to the other commodities produced on that type of farm.

Two other special procedures were also involved in the estimation of these input intensities. A check of input coefficients by state relative to U.S. input coefficients assumed to represent average values revealed several significant outliers. For example, in several states large production values were associated with little or no hired farm labor, indicating significant self-employed farm production labor. In these cases, either the U.S. level coefficient for that type of farm was substituted (if the input value = 0) or a statistical procedure ("Windsorizing") was included to collapse the outliers to be either no less than half or no more than twice the U.S. input intensity.

A special procedure was also developed to handle the adjustment for inputs associated with soybeans production. Treated as an isolated step, the inputs associated with soybean production were calculated separately using the input coefficients for grain production on cash grain farms. Once calculated, the results were later subtracted from the inputs allocated to the grains output row and added to the inputs allocated to the other products comprising MRIO 004.

EXHIBIT 4-2

TYPE OF FARM - FARM COMMODITY CORRESPONDANCE
USED IN INPUT INTENSITY SELECTION

COMMODITY	TYPE OF FARM
Grains	Cash Grain
Cotton	Cotton
Tobacco	Tobacco
Field Crops, Hays	Sugar, Potato, Hay, and Other Field Crops
Vegetables and Melons	Vegetable and Melons
Fruits and Nuts	Fruits and Nuts
Nursery and Greenhouse	Horticultural Specialty
Other Crops	Sugar, Potato, Hay, and Other Field Crops
Poultry	Poultry and Eggs
Dairy	Dairy
Cattle and Calves	All Livestock
Hogs and Pigs	All Livestock
Sheep and Lambs	All Livestock
Other Livestock and Livestock Products	Animal Specialty
Soybeans	Cash Grain

The final step was to collapse the matrix across types of farms and commodities to MRIO sector levels by state following the concordance shown in Exhibit 4-1. The result was dollar input usage for 18 expenditure categories by MRIO, and by farm product. These values were then divided by deflated 1978 output by MRIO. These coefficients applied to the 1977 total value of production data by MRIO derived from the USDA sources finally gave estimates of the associated 1977 dollars of inputs invested in that production. BEA I-O codes were then assigned to these values and common I-Os within each state summed.

Motor Vehicle Repair and Non-Fuel Operation Costs

Motor vehicle (i.e., auto, truck, and other farm machinery) repair and non-fuel operation costs were reported at the U.S. level by the USDA in Farm Production Expenditures for 1977 (Source 02137). The 1978 Census of Agriculture, reported numbers-of-motor-vehicles data by state and type of farm in Table 35. Using these two sources motor vehicle repair and operation costs were split by state and type of farm. The expenditure categories added to the Census-derived input matrix included:

- auto tires and tubes;
- auto repair and replacement parts;
- auto license and registration fees;
- auto insurance;
- truck repair;
- truck tires;
- truck license and registration fees;
- truck insurance;
- tractor repair and parts;
- other farm machinery repair and parts.

These categories were first broken down into their component parts using 1972 proportions derived from USDA unpublished worksheets (Source 02117). Each component was then assigned a BEA I-O code and a MRIO code. All auto, truck, and tractor costs were distributed by state in proportion to the number of autos, trucks, and tractors, respectively, by type of farm reported by Census. After determining the total of other farm machinery reported by Census, other farm machinery repair and operation costs were also split in this manner.

Purchased Inputs: USDA Data Only

Farm Production Expenditures for 1977 (Source 02137) provided 1977 production expenditures for several other categories not covered in the 1978 Census of Agriculture. These inputs included the following:

- building maintenance and repair;
- cotton ginning and grazing fees expenses;
- livestock and dairy product marketing costs;
- costs for small hand tools and miscellaneous hardware;
- irrigation costs;
- costs for binding materials, containers, litter and bedding, and dairy cleaning supplies;
- fire, wind, hail, and Federal crop insurance;
- expenses for telephone, office equipment, farm management services, accounting services, and for fees and dues.

Different expenditures were distributed by state and by MRIO in different ways. Each method, however, was based on unpublished worksheets from the USDA (Source 02117) showing the distribution of these expenditures in 1972 by BEA I-O agriculture sectors. For example, these worksheets showed that expenses for binding materials were limited to BEA I-O 20202: Feed grains. The U.S. total expenditure on binding materials in 1977, therefore, was prorated to the states according to the output of feed grains in 1977 by state. This represents an input to MRIO 003. Similarly, livestock container and marketing costs were limited to BEA I-O 10301: Meat animals, indicating that these U.S. 1977 total expenditures should be split in proportion to 1977 state meat animal outputs. Litter and bedding, dairy cleaning supplies, dairy containers, and dairy product marketing expenses were distributed in proportion to the output of MRIO 001: Dairy products.

For cotton ginning and grazing fee expenses, actual state-specific expenditures in 1977 were available. Cotton ginning costs, an input to only MRIO 003 (BEA I-O 20100), were reported in Charges for Ginning Cotton, 1977 (Source 02118). Grazing fee costs, an input to only MRIO 002 (BEA I-O 10301), were taken from Public Land Statistics, 1977 (Source 10201). BEA I-O codes were then assigned to all these categories.

For the remaining USDA expenditure categories, a method was developed using 1972 distributions and 1972 BEA I-O sector outputs reported in the unpublished worksheets applied to 1977 output. First, a 1972 coefficient matrix was calculated by distributing

the 1972 expenditures for these inputs across BEA I-O sectors, summing I-O sectors to MRIO levels, and then finally dividing through by 1972 output by MRIO sector. This 1972 coefficient matrix by MRIO sector was then used to weight 1977 output by MRIO and by state to derive dollar input estimates for these remaining categories. These estimates were then scaled across states to the U.S. 1977 expenditure totals and assigned to BEA I-O rows. Irrigation cost was treated separately in this scaling process. State irrigation cost controls estimates were calculated by distributing U.S. total irrigation costs according to the number of acres irrigated by state according to the 1978 Census of Agriculture, and then scaling to the state value.

Nonpurchased Feed and Seed

Not all feed and seed consumed for agricultural production is purchased. For some feed and seed crops, a portion of the amount produced is consumed directly on the farm for the planting of subsequent crops or for the feeding of livestock. This represents an internal flow of inputs within and between MRIO agricultural sectors.

The values of nonpurchased seed and feed produced and used on the farm in 1977 were developed from various USDA Crop Production Reports (Source 02131). From these sources, state specific on-farm consumption figures were available on the following crops: corn, wheat, rice, hay, rye, sorghum, oats, barley, cottonseed, alfalfa seed, timothy seed, red clover seed, potatoes, sweat potatoes, flaxseed, peanuts, soybeans, lespedeya seed, dry edible beans, and dry edible peas. Data on milk produced and fed to calves came from USDA's Milk and Dairy Product Report: Milk (Source 02134). In some cases, the value of this on-farm consumption was reported directly; in others, it was estimated based on reported quantities valued at the price received by farmers for these products.

To distribute the imputed values of this nonpurchased feed and seed to MRIO sectors, distribution information contained in the 1972 USDA unpublished worksheets was again used (Source 02117). USDA no longer reports the distribution of on-farm consumption for crops used both for seed and feed. Therefore, 1977 on-farm consumption figures for these crops were split between usage for seed versus feed according to the percentages reported on the 1972 worksheets. USDA analysts consulted stated that this would probably lead to relatively small errors. Then, as before, a 1972 input coefficient matrix was calculated by first distributing the 1972 values for these inputs (assigned specific BEA I-O codes) across BEA I-O sectors, summing I-O sectors to MRIO sectors,

and then finally dividing through by 1972 output by MRIO sector. This 1972 coefficient matrix was then used to weight 1977 output by MRIO and by state to derive dollar input estimates for these nonpurchased input categories. These estimates were then scaled to the 1977 input values for these crops by state across all MRIOs.

Imputed values for other nonpurchased inputs such as animal workpower and manure were not calculated.

This left 46 out of 496 BEA I-O rows providing inputs to the agricultural sectors not covered by the combination of USDA and Census production expenditure data. For these remaining I-Os, input estimates were derived from 1972 BEA coefficients updated to reflect 1977 prices.

Forestry, Fishery, and Agricultural Service Inputs

Data on production expenditures in the forestry (MRIO 005), commercial fishing and trapping (MRIO 006), and agricultural services (part of MRIO 004) sectors were found to be unavailable or limited in coverage. Gross estimates of forestry management costs were possible on a functional or activity basis by region and for some states, but data sources were lacking as to the material inputs and their costs for these activities. Current fishery expenditure data were not available except on a very specific regional and fleet basis and in limited detail (e.g., Texas Gulf shrimp fleet total operating cost). Similarly, the 1978 Census of Agriculture: Agricultural Services volume does report some state-specific data on energy expenditures in this subsector, however, the Census does not cover other expenditure categories for this subsector.

As a result, cost of materials estimates for these sectors were developed from a 1977 input coefficient matrix based on the 1972 BEA use matrix updated to reflect 1977 prices. This required disaggregating and then reaggregating the BEA I-O matrix to match the MRIO concordance. In the agriculture sector, this meant spliting BEA I-O sector 3.0000: Forestry and Fishery Products into two sectors and I-O 4.0000: Agricultural, forestry, and fishery services into three sectors. This was accomplished by splitting the rows (output) and columns (inputs) of the 1972 use matrix with entries greater than $10 million (in producer's prices) according to producing and consuming I-O, SIC, and other information contained in the 1972 BEA I-O output file (Source 03509). Subsector percentage splits developed in this way were then used to reaggregate the 1977 input coefficient matrix to MRIO or 496 I-O sector detail from which 1977 input usage forecasts for these sectors could be calculated.

Data Quality

1. Approximately 35 percent of the inputs to MRIO Sectors 001 - 004 (the latter minus agricultural services) were estimated from 1977 data. These were largely national level, aggregate expenditure categories for all farming which were broken down into their component parts (assignable to specific BEA I-O rows) using known 1972 component proportions for these same categories available from USDA unpublished worksheets. All nonpurchased inputs were scaled to 1977 state control totals reported in USDA Crop Production Reports as production grown and used on the farm.

2. The distribution of 1977 input data across MRIO sectors was based on 1972 USDA coefficients weighted by 1977 MRIO output. These national level 1972 coefficients were applied to each state's output by MRIO.

3. Approximately 55 percent of the inputs to MRIO sectors 001 - 004 (the latter minus agricultural services) were estimated from 1978 data, by state, (deflated to 1977 dollars), in the Census of Agriculture. This was establishment-based data which was then imputed to a product basis.

4. The remaining 10 percent of all inputs (46 out of 496 BEA I-O rows) to MRIO sectors 001 - 004 and all of the inputs to MRIOs 005 and 006 and the agricultural services portion of MRIO 004, were estimated from 1972 BEA use matrix coefficients updated to reflect 1977 prices. These national coefficients were applied across all states.

5. Use of the updated 1972 BEA coefficients required disaggregating and re-aggregating I-O 3.0000: Forestry and Fishery Products, and I-O 4.0000: Agriculture, Forestry and Fishery Services to match the MRIO concordance. Information contained in the 1972 BEA output work file was analyzed to determine the appropriate splits, or, lacking BEA data, input values were split in proportion to 1977 output for the components of these I-Os.

CHAPTER 5

MINING

This chapter discusses the development of 1977 input data for these MRIO sectors:

- 007: Iron and Ferroalloy Ores
- 008: Nonferrous Ores
- 009: Coal
- 010: Crude Petroleum
- 011: Natural Gas and Liquids
- 012: Stone, Clay, Sand, and Gravel
- 013: Chemical and Fertilizer Minerals

This group of MRIO sectors includes all of major SIC groups:

- 10: Metal Mining
- 11: Anthracite Mining
- 12: Bituminous Coal and Lignite Mining
- 14: Nonmetallic Mineral Mining

Overview of Sources, Methodology, and Findings

The sources of the majority of the input data for the mining sectors were the 1977 Census of Mineral Industries, "Industry Series" (Source 03106), and data collected in Census' MA-131 survey and published in Census of Manufactures "Selected Materials Consumed" (Source 03105). The national data published in these two sources were disaggregated to states with the help of information published in Census of Mineral Industries, "General Summary" (Source 03106).

A substantial portion of the inputs to mining are energy and real estate inputs, developed as discussed in Chapter 2. The data development described in this chapter produced data on 18 to 57 percent of the 1977 inputs. Coverage of the data development efforts is as shown below:

MRIO Code	Inputs of Energy, Real Estate, Noncomparable Imports, and Scrap in 1977 (Percent Of Total Inputs)	Other Input Data Developed for 1977[1] (Percent Of Total Inputs)
007	50	42
008	24	54
009	20	57
010	42	18
011	42	18
012	36	48
013	38	34

Price-updated data from BEA's 1972 input-output table were used to fill in gaps in the 1977 data.

Methodology

General Procedure

The following subsections outline the general procedure used in developing the mining inputs. The discussion is an overview, highlighting primarily the commonalities in input data development methodology. Detail on each MRIO sector is provided later in the chapter.

Development of National Controls

Input data development began at the four-digit SIC level with data published in Tables 4 and 7 of the Census of Mineral Industries "Industry Series" (Source 03106, hereafter referred to as "Industry Series"). Data were typically available, at the national level, for the following categories of inputs:

- Minerals received for preparation
- Service industry inputs
- Parts
- Explosives

[1] *Excluding updated BEA data.*

- Unprocessed ammonium nitrate
- Steel mill shapes and forms
- Round or hewn wood products and stumpage
- Communications
- Equipment rentals.

For MRIO's 012 and 013 — Stone, Clay, and Glass, and Chemicals and Fertilizers — no additional input data were available. For the remaining sectors, the above categories of inputs were supplemented with data in the Census of Manufactures "Selected Material Consumed" (Source 03105, hereafter referred to as "Selected Materials"). "Selected Materials" data are collected from surveys of all but the smallest mining establishments, for the following SIC's: 1011, 1021, 1211, 1311, and 1321. The input patterns for these SIC's (which represent only parts of MRIO sectors) were applied to other SIC's in the MRIO sector.

Next, a check was made on the accuracy of the data by summing the four-digit SIC data to the BEA level and comparing it to the price-updated BEA coefficient matrix. (Chapter 1 describes the standards used to evaluate these data.) The purpose of the check was to identify areas where the goods or services listed in the Census data probably either undercovered or overcovered the value that should be used in the MRIO data. (The first problem could occur because the Census data were published at the four-digit SIC level and did not specify all expenditures. In other words, at the BEA I-O level, when a BEA I-O industry contained more than one SIC and Census did not publish data all SIC's included, the input data developed herein at the BEA level were subject to undercoverage. The second problem, overcoverage, could occur when the expenditure listed in Census had been capitalized, either partially or totally, by the industry.)

The results of the two comparisons showed that all data in the "Industry Series" were usable, but that a few of the 1977 inputs developed from "Selected Materials" were too unreliable to be used in the data base. The acceptable 1977 data, which represented 60 to 92 percent of the inputs, (including energy, real estate, noncomparable imports, and scrap), were entered into a data base where they were combined with the price-updated BEA matrix, producing a national matrix of inputs to the mining industries by BEA sector. This could then, after making the secondary product and other adjustments discussed in Chapter 11, be distributed to MRIO sectors.

Development of State Data

The input data were distributed initially to states based on each state's "cost of supplies and services" (output less value added) for each mining industry. Where state specific data on inputs were available, these data were substituted for the estimate that had been made as a result of the distribution. The input categories for which state specific data were sometimes available were:

- Service industry inputs
- Communications
- Equipment rental

Adjustments to the distribution were also made where information in Census of Mineral Industries, "General Summary" made it possible to identify what types of mining activities, by four-digit SIC, took place in each state. As a result, for example, all of the inputs to SIC's 1111 and 1112, Anthracite Mining and Services, were assigned to Pennsylvania (where all SIC 1111 and 1112 activity takes place.) The remaining inputs to coal mining, MRIO 009, in Pennsylvania were then adjusted to sum to the state control (output less value added).

MRIO 007: Iron and Ferroalloy Ores

MRIO 007, Iron and Ferroalloy Ores, includes:

BEA I-O	SIC
5.00	1011
	1061

Data were available for both SIC's 1011 and 1061 in the Census of Mineral Industries for all but one of the categories of inputs listed above in General Procedure. The exception was "round or hewn wood products and stumpage." However, data for this category of input and others listed below were available for SIC 1011, Iron Ore, as follows:

- Bentonite and other clay nonmetallic minerals
- Industrial chemicals
- Tires and tubes
- Gray iron foundry products
- Iron and steel forgings
- Nonferrous metal mill shapes and forms.

The expenditures on each of these input categories by SIC 1061, Ferroalloy Ores Except Vanadium, were estimated by:

1) assuming inputs to SIC 1061 followed a pattern similar to that of SIC 1011, and
2) imputing the input coefficients developed for SIC 1011 for these additional categories of inputs to SIC 1061.

No instances of undercoverage or overcoverage were established when these data were compared to the 1972 BEA matrix updated for prices to 1977.

No primary state data on specific inputs were available for MRIO 007. The national data were distributed to states on the basis of each state's cost of materials and services for MRIO 007.

MRIO 008: Nonferrous Ores

MRIO 008, Nonferrous Ores, includes:

BEA I-O	SIC
6.01	1021
6.02	1031, 1041, 1044, 1051, 1081, 1092, 1094, 1099

Data were available in the Census of Mineral Industries for all the categories of inputs listed above in General Procedure, with one exception: expenditures on "round or hewn wood products and stumpage" were not published for SIC 1051. This small input value was assumed to have the same relationship to total expenditures on goods and services in SIC 1051 as it had in the remainder of the sector.

Additional primary input data were available in "Selected Materials Consumed" for SIC 1021 in the input categories listed below:

- Chemical reagents
- Tires and tubes
- Lime and dead-burned dolomite
- Steel casting and forgings
- Nonferrous mill shapes and forms
- Drill bits and reamers
- Chemicals and allied products

- Stone, clay, glass, and concrete products
- Primary metals, nec
- Fabricated metal products,
- Metal scrap

Expenditures on each of these input categories by the remaining SIC's in MRIO 008 were estimated by:

1) assuming inputs to the remaining SIC's follow a pattern similar to that of SIC 1021, and
2) imputing the input coefficients developed for SIC 1021 for these additional categories of inputs to SIC's 103, 104, 105, 108, and 109.

No instances of undercoverage or overcoverage were established when these data were compared to the 1972 BEA matrix updated for prices to 1977.

State data were available in the Census of Mineral Industries, "Industry Series" for three categories of inputs:

- service industry inputs,
- communications, and
- equipment rental

for two states for SIC 1021 and for one state each for SIC's 1031 and 1092. These data were not used directly in the state data base, however, since the output of each of these SIC's in the states where supplementary data were available did not represent total MRIO 008 output in the state. Instead, the primary state data were used to examine for consistency the state inputs developed by distributing the national coefficients to states on the basis of each state's cost of supplies and services.

MRIO 009: Coal

MRIO 009, Coal, includes:

BEA I-O	SIC
7.00	1111
	1112
	1211
	1213

Data were available in the Census of Mineral Industries for all the categories of inputs listed above in General Procedure. The Census of Mineral Industries also published data on inputs of roof bolts for all four SIC's.

"Selected Materials Consumed" contains data for SIC 1211 on inputs of:

- Fiber and brattice cloth
- Tires and inner tubes
- Rubber and plastic products
- Concrete products
- Measuring, analyzing, and controlling instruments; photographic, medical, and optical goods; watches and clocks
- Electrical machinery, equipment, and supplies
- Electrical industrial apparatus, n.e.c.
- Wire rope, cable, spring, and other fabricated wire products
- Fabricated metal products, n.e.c.
- Primary metal products, n.e.c.
- Chemicals and allied products

Expenditures on each of these categories of inputs by SIC 1111, Anthracite Mining, were estimated by:

1) assuming inputs to SIC 1111 followed a pattern similar to that for SIC 1211, and
2) imputing the input coefficients developed for SIC 1211 for these inputs to SIC 1111.

Input patterns for SIC's 1112 and 1213, the coal mining services sectors, were believed to be too dissimilar to the input pattern for SIC 1211 to warrant using SIC 1211's input coefficients.

The input data for the four coal SIC's were summed to the BEA/MRIO level and compared to the 1972 BEA coefficients updated for prices to 1977. No instances of undercoverage or overcoverage were established.

State data were available in the Census of Mineral Industries for many states for:

- service industry inputs
- communications, and
- equipment rentals.

These data were incorporated directly into the state mining input data base. In addition, since all anthracite mining and mining services are performed in Pennsylvania, all inputs to SIC's 1111 and 1112 were assigned to that state. The remaining inputs, (i.e., inputs to SIC's 1211 and 1213 other than the three categories listed above) were distributed to the states in proportion to their cost of supplies and services for these two SIC's.

MRIO 010: Crude Petroleum and MRIO 011: Natural Gas and Liquids

MRIO 010, Crude Petroleum and MRIO 011, Natural Gas and Liquides include:

BEA I-O	SIC
8.00	1311
	1321

The development of input estimates for these two MRIO sectors was performed simultaneously since data specific to the individual MRIO sectors were not available in Census or other publications, but were available in combination. Data were available for both SIC's 1311 and 1321 in the Census of Mineral Industries for all of the categories of inputs listed above in General Procedure. Additional primary input data were available in "Selected Materials Consumed" for SIC 1311 in the input categories listed below:

- Industrial chemicals
- Drilling fluids
- Cement
- Valves and pipe fittings
- Drill bits and reamers
- Water purchased
- Chemicals and allied products, n.e.c.
- Fabricated metal products, except machinery and transportation equipment, n.e.c.
- Power driven hand tools

Expenditures on each of these input categories by SIC 1321 were estimated by:

1) assuming inputs to the remaining SIC's follow a pattern similar to that of SIC 1311, and
2) imputing the input coefficients developed for SIC 1311 for the above inputs to SIC 1321.

No instances of undercoverage or overcoverage were established when these data were compared to the 1972 BEA matrix updated for prices to 1977.

State data were available in the Census of Mineral Industries, "Industry Series," for many states for three categories of inputs:

- Service industry inputs
- Communications
- Equipment rental

These data were incorporated directly into the state mining input data base. The remaining inputs of the above three categories of inputs were distributed to states that had no state specific data in the Census of Mineral Industries according to their share of the cost of supplies and services for MRIO's 010 and 011. Inputs other than the three listed above were also distributed to states based on their cost of supplies and services for MRIO's 010 and 011.

MRIO 012: Stone, Clay, Sand, and Gravel

MRIO 012, Stone, Clay, Sand, and Gravel, includes:

BEA I-O	SIC
9.00	1411
	1422, 1423, 1429
	1442, 1446
	1452, 1453, 1454, 1455, 1459
	1481
	1492, 1496, 1499

Data were available in the Census of Mineral Industries for all the categories of inputs listed above in General Procedure, with the exception of "round or hewn wood products and stumpage," a commodity which is not used in the Stone, Clay, Sand, and Gravel industry. The Census of Mineral Industries also published data on use of "rubber and plastics products, including tires and tubes" for SIC's 1411-1446. The input coefficient for this input, developed by summing the input data for SIC's 1411-1446 and dividing by the cost-of-goods-and-services value for these SIC's, was assigned also to SIC's 1452-1499. No data on inputs to MRIO 012 were published in the 1977 "Selected Materials Consumed."

The input data for MRIO 012 was summed to the BEA/MRIO level and compared to the 1972 BEA coefficients updated for prices to 1977. No instances of undercoverage or overcoverage were identified.

State data were available in the Census of Mineral Industries for:

- service industry inputs
- communications, and
- equipment rental

for SIC's 1422, 1423, 1429, 1442, 1446, 1455, and 1499. Where 1) most of a state's output of MRIO 012 was known to be in one or more of these six SIC's and 2) state data were available for these SIC's, the data for the above three categories of inputs were incorporated directly into the state input database. The state data which were not incorporated directly were used to examine for consistency the state inputs developed by distributing the national coefficients to states on the basis of each state's cost of supplies and services.

MRIO 013: Chemical and Fertilizer Minerals

MRIO 013, Chemical and Fertilizer Minerals, includes the following BEA I-O and SIC categories:

BEA I-O	SIC
10.0	1472
	1473
	1474
	1475
	1476
	1477
	1479

Data were available in the Census of Mineral Industries for most SIC's for most of the categories of inputs listed above in General Procedure for MRIO 013. The primary exception was "round or hewn wood products and stumpage," which is not a significant input to this industry. In addition, estimates of "explosives" and "unprocessed ammonium nitrate" were not published for SIC 1477 or 1479, and a value for "steel mill shapes and forms" was not published for SIC 1479. These inputs were assumed to have the same relationship to total expenditures on goods and services in SIC's 1477 and 1479 as they had in the remainder of the sector. (No data on inputs to MRIO 013 were published in the 1977 "Selected Materials Consumed.")

No instances of undercoverage or overcoverage were established when these data were compared to the 1972 BEA matrix updated for prices to 1977.

Primary state level data were available in the Census of Mineral Industries for SIC 1474 for one state, Utah. Since Utah represents only a small portion of SIC 1474's output and since not all of Utah's MRIO 013 output is contained in SIC 1474, the state data were not used directly in the model. Inputs were distributed to states using the national input vector, and thus do not vary from state to state.

Adjustments to Coverage and Redefinitions

There were no redefinitions to or from any MRIO mining sector. Two activities of the sector received by-product treatments, however: $2,294.8 million of production of liquified petroleum gases were treated as a by-product of MRIO 050: Petroleum Refining and Allied Products in MRIO 011: Natural Gas and Liquids. $808.8 million of production of natural sodium, borate, and potassium salts processed at the mine site were treated as a by-product of MRIO 043: Industrial Chemicals in MRIO 013: Chemical and Fertilizer Minerals.

Data Quality

The national level data developed for 1977 are very reliable, as are the state-specific data on equipment rental, service industry inputs, and communications. The quality of the remaining state data estimated for 1977 are unknown as the technical coefficients may vary more between states than the estimation techniques used here permit.

Where updated BEA data were used, the quality of the data is unknown.

CHAPTER 6

CONSTRUCTION INPUTS

Methodology

The inputs to the 1977 MRIO Construction Industries are based on the 1972 BEA I-O input vectors. BEA provides input vectors for 33 new construction activities and 17 maintenance activities. These 50 input vectors were adjusted for relative price changes from 1972 to 1977, and were then normalized. The vectors were not based on the total output of an activity, but were based on the value of total intermediate inputs (TI). (It should be noted that the phrase "total intermediate inputs" has the same meaning as the phrase "cost of materials and services.")

In some cases, the input vectors had to be weighted before being applied to the 1977 data. These weights were required in order to account for the definitional differences between the 1972 BEA I-O activities and the 1977 Census activities. (The MRIO data is based on Census activities.) In most cases where weighting was required, a weighted average of two or more input vectors was used. In several cases, however, the Census data were adjusted so that the MRIO activities were defined to agree with the BEA I-O activities. The application of the BEA input vectors to the specific Census/MRIO activities is described in a following section, and the weights applied to each vector are summarized in Exhibits 6-3 and 6-4 at the end of this chapter.

An "activity" is a particular type of construction, such as "single family residential buildings" or "highways and streets." The Census provides data for 37 activities, for both new construction and maintenance. For new construction, the 37 Census activities are aggregated to five MRIO sectors. For maintenance, the 37 Census activities are aggregated to one MRIO sector. The relationship between MRIO sectors, Census activities and BEA activities is shown in Exhibit 6-1 (New Construction) and Exhibit 6-2 (Maintenance).

EXHIBIT 6-1:

MRIO 014-018: NEW CONSTRUCTION ACTIVITIES: MRIO-CENSUS-BEA CONCORDANCE

MRIO Sector	Census Activities	Description	BEA Activities
014		RESIDENTIAL	
	1	Single Family	11.0101 - Residential, 1 Unit; 11.0105 - Additions and Alterations
	2	Apartments	11.0102 - Residential, 2-4 Units; 11.0103 - Garden Apts.; 11.0104 - High-Rise Apts.; 11.0105 - Additions and Alterations
015		NONRESIDENTIAL	
	3	Other Residential	11.0106 - Hotels and Motels; 11.0107 - Dormitories
	5	Industrial	11.0201 - Industrial Bldgs; 11.0203 - Warehouses
	6	Office, Bank	11.0202 - Office Buildings
	7	Stores, Garages	11.0204 - Garages and Service Stations; 11.0205 - Stores and Restaurants
	8	Amusement	11.0209 - Other Nonfarm Buildings
	9	Religious	11.0206 - Religious Buildings
	10	Educational	11.0207 - Educational Buildings
	11	Hospital	11.0208 - Hospitals and Institutional Buildings
	12	Other Nonresidential	11.0209 - Other Nonfarm Buildings
016		PUBLIC UTILITY	
	25	Transmission Lines	
		Power	Combined with Census Activity 31
		Communication	11.0301 - Telephone and Telegraph Facilities
	28	Subways and Railroads	11.0302 - Railroads; 11.0308 - Local Transit Facilities
	29	Railroads	Combined with Census Activity 28
	31	Electric Utilities	11.0303 - Electric Utility Facilities
	27	Pipelines	
		Gas	11.0304 - Gas Utility Facilities
		Oil	11.0305 - Petroleum Pipelines
	26	Sewer, Water Mains	11.0306 - Water Supply Facilities; 11.0307 - Sewer System Facilities
	33	Sewage, Water Treatment	11.0306 - Water Supply Facilities; 11.0307 - Sewer System Facilities
017		HIGHWAYS AND STREETS	11.0400 - Highways and Streets
	14	Highways, Streets	
	19	Bridges and Elevated Highways	
	20	Tunnels	
018		OTHER CONSTRUCTION	
	4	Farm Buildings	11.0502 - Farm Service Facilities
	15	Swimming Pools	11.0507 - Other Nonbuilding Facilities
	16	Airports	11.0507 - Other Nonbuilding Facilities
	17	Parking Areas	11.0507 - Other Nonbuilding Facilities
	18	Fencing	11.0507 - Other Nonbuilding Facilities
	21	Dams, Reservoirs	11.0507 - Other Nonbuilding Facilities
	22	Marine Construction	11.0507 - Other Nonbuilding Facilities
	23	Harbors, Ports	11.0507 - Other Nonbuilding Facilities
	24	Conservation, Development	11.0506 - Conservation and Development Facilities
	30	Heavy Industrial Facilities	11.0507 - Other Nonbuilding Facilities
	34	Oilfields	11.0504 - Petroleum, Natural Gas, and Solid Mineral Exploration
	35	Other Nonbuilding	11.0507 - Other Nonbuilding Facilities
	37	Construction NSK	11.0507 - Other Nonbuilding Facilities
	39	Drilling	11.0503 - Petroleum and Natural Gas Well Drilling
	40	Mining	11.0508 - Access Structures for Solid Mineral Development

EXHIBIT 6-2:

MRIO 019: MAINTENANCE ACTIVITIES: MRIO-CENSUS-BEA CONCORDANCE

Census Activities	Description	BEA Activities
1	Single-family Residential	12.0100 - Residential Buildings
2	Apartment Buildings	12.0100 - Residential Buildings
3	Other Residential Buildings	12.0201 - Other Nonfarm Buildings
5	Industrial Buildings and Warehouses	12.0201 - Other Nonfarm Buildings
6	Office and Bank Buildings	12.0201 - Other Nonfarm Buildings
7	Stores, Restaurants, Garages	12.0201 - Other Nonfarm Buildings
8	Amusement, Recreational Buildings	12.0201 - Other Nonfarm Buildings
9	Religious Buildings	12.0201 - Other Nonfarm Buildings
10	Educational Buildings	12.0201 - Other Nonfarm Buildings
11	Hospitals and Institutions	12.0201 - Other Nonfarm Buildings
12	Other Nonresidential Buildings	12.0201 - Other Nonfarm Buildings
4	Farm Buildings	12.0203 - Farm Service Facilities
14	Highways and Streets	12.0214 - Highways and Streets
19	Bridges and Elevated Highways	12.0214 - Highways and Streets
20	Tunnels	12.0214 - Highways and Streets
24	Conservation and Development	12.0213 - Conservation and Development Facilities
25	Communication Transmission Lines	12.0204 - Telephone and Telegraph Facilities
26	Sewer and Water Mains	12.0209 - Water Supply Facilities; 12.0210 - Sewer Facilities
27	Pipelines	
	Gas	12.0207 - Gas Utility Facilities
	Oil	12.0208 - Petroleum Pipelines
28	Subways and Railroads	12.0205 - Railroads; 12.0211 - Local Transit Facilities
31	Electric Utilities	12.0206 - Electric Utility Facilities
33	Sewage and Water Treatment Plants	12.0209 - Water Supply Facilities; 12.0210 - Sewer Facilities
34	Oilfields	12.0215 - Petroleum and Natural Gas Wells
15	Swimming Pools	12.0216 - Other Nonbuilding Facilities
16	Airports	12.0216 - Other Nonbuilding Facilities
17	Parking Areas	12.0216 - Other Nonbuilding Facilities
18	Fencing	12.0216 - Other Nonbuilding Facilities
21	Dams and Reservoirs	12.0216 - Other Nonbuilding Facilities
22	Marine Construction	12.0216 - Other Nonbuilding Facilities
23	Harbors and Ports	12.0216 - Other Nonbuilding Facilities
30	Heavy Industrial Facilities	12.0216 - Other Nonbuilding Facilities
35	Other Nonbuilding Construction	12.0216 - Other Nonbuilding Facilities
37	Construction, NSK	12.0216 - Other Nonbuilding Facilities

The total intermediate inputs, or cost of materials and services, must be estimated for each activity at the national level before the BEA activity-based input vectors can be used. Total intermediate imputs are known only for each MRIO at the national level. The best available data concerning total intermediate inputs are found in the 1972 I-O tables. The use of this data to estimate total intermediate inputs by activity at the national level for 1977 is explained below. The methodology set forth below also describes the use of the MRIO level total intermediate inputs as control totals, and describes the distribution of inputs to the states.

In general, the methodology for estimating inputs is as follows:

- At the national level, for each activity, the total intermediate inputs were determined as follows. For each activity, the national level output was multiplied by a ratio of total intermediate inputs/output, yielding a preliminary estimate of total intermediate inputs. The ratios of total intermediate inputs/output were based on the 1972 BEA I-O tables. These preliminary estimates of total inputs at the activity level were then scaled to accord with previously determined MRIO level total inputs. The MRIO level total intermediate inputs were found by deducting value added from output. Value added at the MRIO level was determined in task three (Development of Value Added Estimates by MRIO Sector by State, 1977, Preliminary Report, Task Three, December 1, 1981).

- The appropriate input vector was then applied to each of the activities' total intermediate inputs, as determined above. This provided an estimate of inputs by activity at the national level. The application of these input vectors is described in detail below.

- For each activity, the national level inputs were then distributed to the states proportionate to the states' output for that activity. This yielded a preliminary estimate of inputs by activity for each state. Within each state level MRIO sector, these preliminary estimates were then scaled to agree with previously determined MRIO level input control totals. The input control totals were found by deducting value added from output. (Value added by MRIO sector at the state level was also determined in Task 3.)

For each activity, output is the sum of the following components:

- Net receipts, derived from the 1977 Census of Construction Industries (Source 03104) (see State Estimates of Outputs, Employments and Payrolls, 1977, Preliminary Report, Tasks One and Two, Chapter 4).

- Force-account construction (FAC), derived from various sources (see description in Appendix D of this report).

- Architectural and engineering fees, derived from estimates by Mr. George Roff, Bureau of the Census, for a paper entitled "Comparison of the 1977 Census of Construction Industries and the Value of New Construction Put in Place Series," (Source 03126), prepared by Mr. Alan I. Blum, Construction Statistics Division, Bureau of the Census.

Application of BEA Input Vectors to National Level Total Inputs

Once the total intermediate inputs (TI) by activity have been determined, the appropriate input vector is then applied to TI to determine the detailed inputs. In some cases, the input vectors had to be modified in order to account for differences between BEA classifications and Census/MRIO classifications. The application of the 1972 BEA input vectors to the 1977 MRIO output data is discussed below. The following notation is used throughout this chapter.

Notation:

TI_i = Total intermediate inputs, in millions of dollars, associated with activity i.

$[11.0000]$ = BEA input vector, normalized and price updated.

$[Inputs_i]$ = Vector of inputs associated with activity i. (Coefficients based to TI.)

It should also be noted that in the following discussion the weights representing output are in millions of dollars.

New Construction

MRIO 014, Activity 1 - Residential, Single Family

The measures of output, value added, and total inputs associated with MRIO 014, activity 1, are comparable to those associated with two BEA activities: new residential one-unit structures (11.0101), and part of new residential additions and alterations (11.0105). (Part of additions and alterations is also associated with apartment buildings). The total intermediate inputs for activity 1 must be divided between residential structures and additions and alterations before the BEA input vectors can be used. The publication Residential Alterations and Repairs, C50-77-5, May 1978 (Source 03122) gives the dollar value of additions and alterations for both single-family and multifamily structures. The total intermediate inputs associated with new residential single-family structures and with additions and alterations to residential single-family structures is assumed to be proportional to the output of each type of construction.

Given the total intermediate inputs for each type of construction, the input vectors can now be used to determine the detailed inputs. The following formula is an expression for all the intermediate inputs associated with residential single-family construction:

$$*[\text{Inputs}_1] = (TI_1 - \text{Add}_1)\ [11.0101] + (\text{Add}_1)\ [11.0105]$$

.... where Add_1 represents the total intermediate inputs associated with additions and alterations to single-family residential structures. Add_1 = 11,868 (4511/7468.8) = $7168 million.

MRIO 014, Activity 2 - Apartment Buildings

The input pattern associated with MRIO 014, activity 2, is a combination of those associated with four BEA activities: new residential 2-4 unit structures (11.0102), new residential garden apartments (11.0103), new residential high-rise apartments (11.0104), and part of new residential additions and alterations (11.0105). Although data is available on 1977 additions and alterations, the 1977 mix of 2-4 units, garden, and high-rise apartments is not available. Therefore, the input vectors are weighted proportionate to the 1972 total intermediate inputs, as given in BEA's I-O tables.

** The weights applied to the BEA input vectors for all the new construction activities are summarized in Exhibit 6-3, at the end of Chapter 6.*

The inputs for apartment buildings are determined by the expression:

$$\left[\text{Inputs}_2\right] = \frac{1402.1}{9628.5}\ (TI_2 - Add_2)\ \left[11.0102\right] + \frac{6186.3}{9628.5}\ (TI_2 - Add_2)\ \left[11.0103\right] + \frac{2040.1}{9628.5}\ (TI_2 - Add_2)\ \left[11.0104\right] + (Add_2)\ \left[11.0105\right]$$

.... where 1402.1, 6186.3, and 2040.1 represent the 1972 total inputs for 2-4 unit, garden, and high-rise apartments, respectively; 9628.5 is the sum of these inputs; and Add_2 represents the total inputs associated with additions and alterations to apartment buildings. Add_2 = 1732 (4511/7468.8) = $1046 million.

MRIO 015, Activity 3 - Other Residential Buildings

The input pattern associated with MRIO 015, activity 3, is a combination of those associated with two BEA activities: new hotels and motels (11.0106), and new dormitories (11.0107). Since separate data are not available for hotels and motels and dormitories, the inputs for activity 2 are weighted using 1972 proportions.

The inputs for other residential buildings can be expressed as:

$$\left[\text{Inputs}_3\right] = \frac{1120.8}{1343.3}\ (TI_3)\ \left[11.0106\right] + \frac{222.5}{1343.3}\ (TI_3)\ \left[11.0107\right]$$

.... where 1120.8 and 222.5 represent the 1972 total inputs for hotels and motels and for dormitories, respectively; 1343.3 is the sum of these inputs.

MRIO 015, Activity 5 - Industrial Buildings and Warehouses

The input pattern associated with MRIO 015, activity 5, is a combination of those associated with two BEA activities: new industrial buildings (11.0201), and new warehouses (11.0203). Since separate data are not available for industrial buildings and warehouses, the inputs for activity 5 are weighted using 1972 proportions.

The inputs for industrial buildings and warehouses are determined by the expression:

$$\left[\text{Inputs}_5\right] = \frac{3106.2}{4201.0}\ (TI_5)\ \left[11.0201\right] + \frac{1103.8}{4210.0}\ (TI_5)\ \left[11.0203\right]$$

.... where 3106.2 and 1103.8 represent the 1972 total inputs for industrial buildings and warehouses, respectively; 4210.0 is the sum of these inputs.

MRIO 015, Activity 6 - Office and Bank Buildings

The input pattern associated with MRIO 015, activity 6, is comparable to that associated with one BEA activity: new office buildings (11.0202). The inputs for office and bank buildings can be expressed as:

$$\left[\text{Inputs}_6\right] = (\text{TI}_6)\ \left[11.0202\right]$$

MRIO 015, Activity 7 - Stores, Restaurants, and Garages

The input pattern associated with MRIO 015, activity 7, is comparable to that associated with two BEA activities: new garages and service stations (11.0204), and new stores and restaurants (11.0205). Since separate data are not available for each of these activities, the total inputs for activity 7 will be weighted using 1972 proportions.

The inputs for stores, restaurants and garages are determined by the expression:

$$\left[\text{Inputs}_7\right] = \frac{396.5}{3800.9}\ (\text{TI}_7)\ \left[11.0204\right] + \frac{3404.4}{3800.9}\ (\text{TI}_7)\ \left[11.0205\right]$$

.... where 396.5 and 3404.4 represent the 1972 total inputs for garages and service stations and for stores and restaurants, respectively; 3800.9 is the sum of these inputs.

MRIO 015, Activity 8 - Amusement and Recreational Buildings

There is no BEA activity comparable to the Census/MRIO activity of amusement and recreational buildings. Rather, BEA included such buildings in the activity of new other nonfarm buildings (11.0209). Therefore, the input pattern for other nonfarm buildings will be applied to the total inputs of activity 8.

The inputs for amusement and recreational buildings can be expressed as:

$$\left[\text{Inputs}_8\right] = (\text{TI}_8)\ \left[11.0209\right]$$

MRIO 015, Activity 9 - Religious Buildings

The input pattern associated with MRIO 015, activity 9, is comparable to that associated with one BEA activity: new religious buildings (11.0206). The inputs for religious buildings are therefore given by the expression:

$$[\text{Inputs}_9] = (\text{TI}_9)\ [11.0206]$$

MRIO 015, Activity 10 - Educational Buildings

The input pattern associated with MRIO 015, activity 10, is comparable to that associated with one BEA activity: new educational buildings (11.0207). The inputs for educational buildings are determined by the expression:

$$[\text{Inputs}_{10}] = (\text{TI}_{10})\ [11.0207]$$

MRIO 015, Activity 11 - Hospitals and Institutional Buildings

The input pattern associated with MRIO 015, activity 11, is comparable to that associated with one BEA activity: new hospital and institutional buildings (11.0208). The inputs for hospitals and institutional buildings are thus determined by the expression:

$$[\text{Inputs}_{11}] = (\text{TI}_{11})\ [11.0208]$$

MRIO 015 Activity 12 - Other Nonresidential Buildings

The input pattern associated with MRIO 015, activity 12, is comparable to that associated with one BEA activity: new other nonfarm buildings (11.0209). The inputs for other nonresidential buildings are thus determined by the expression:

$$[\text{Inputs}_{12}] = (\text{TI}_{12})\ [11.0209]$$

MRIO 016, Activity 25 - Communication Transmission Lines

The input pattern associated with MRIO 016, activity 25, is comparable to that associated with one BEA activity: new telephone and telegraph facilities (11.0301). The Census category that includes communication transmission lines also includes

power transmission lines. The ouput, total inputs, etc., associated with power transmission lines has been deducted from the Census transmission lines category and added to the Census electric utility category. Thus, both MRIO activities - transmission lines and electric utilities - are now comparable to the BEA activities.

The inputs for communication transmission lines are determined by the expression:

$$\left[\text{Inputs}_{25}\right] = (\text{TI}_{25}) \left[11.0301\right]$$

MRIO 016, Activity 28 - Subways and Railroads

The input pattern associated with MRIO 016, activity 28, is a combination of those associated with two BEA activities: new railroads (11.0302), and new local transit facilities (11.0308). Separate output data at the national level for these two categories is provided by the Census. This output data will be used to weight the total inputs for activity 28.

The inputs for subways and railroads are given by the expression:

$$\left[\text{Inputs}_{28}\right] = \frac{277}{1086} (\text{TI}_{28}) \left[11.0302\right] + \frac{809}{1086} (\text{TI}_{28}) \left[11.0308\right]$$

.... where 277 and 809 represent the 1977 output for railroads and subways, respectively; 1086 is the sum of these outputs.

MRIO 016, Activity 26 - Sewer and Water Mains

The input pattern associated with MRIO 016, activity 26, is a combination of those associated with two BEA activities: new water supply facilities (11.0306), and new sewer system facilities (11.0307). The Census has two activities dealing with sewer and water facilities: sewer and water mains; and sewage and water treatment plants. In the BEA classification system, all the water facilities are combined in one activity while all the sewer facilities are combined in another. In order to apply the BEA input vectors, it is necessary to estimate the proportion of sewer mains and the proportion of water mains included in activity 26. The Value of New Construction Put in Place in the United States, 1964 to 1980, 630-805 (Source 03122) provides separate output data for sewer facilities and water facilities. These measures of output will be used to weight the total inputs.

The inputs for sewer and water mains are determined by the expression:

$$\left[\text{Inputs}_{26}\right] = \frac{1810}{7184} \left(\text{TI}_{26}\right) \left[11.0306\right] + \frac{5374}{7184} \left(\text{TI}_{26}\right) \left[11.0307\right]$$

.... where 1810 and 5374 represent the output of water supply facilities and sewer system facilities, respectively; 7184 is the sum of these outputs.

MRIO 016, Activity 27 - Pipelines

Activity 27a - Gas Utilities
Activity 27b - Petroleum Pipelines

The input pattern associated with MRIO 016, activity 27, is comparable to that associated with two BEA activities: new gas utility facilities (11.0304), and new petroleum pipelines (11.0305). However, because the state distributions of these two types of pipelines are radically different from one another, and because the input vectors are also quite different, a weighted input vector was not used. Rather, separate estimates of output, value added, and total intermediate inputs were made for gas utilities and for petroleum pipelines. The appropriate BEA input vector was then applied to the estimated total intermediate inputs for each.

The inputs for gas utilities and for petroleum pipelines, respectively, are determined by the following expressions:

$$\left[\text{Inputs}_{27a}\right] = \text{TI}_{27a} \left[11.0304\right]$$

$$\left[\text{Inputs}_{27b}\right] = \text{TI}_{27b} \left[11.0305\right]$$

MRIO 016, Activity 31 - Electric Utilities

The input pattern associated with MRIO 016 activity 31, is comparable to that associated with one BEA activity: new electric utility facilities (11.0303). The Census activity for electric utilities does not include power transmission lines. In order to use the BEA input vectors, the output, total inputs, etc., associated with power transmission lines has been added to the Census electric utility data, and deducted from the communication and power transmission lines activity. Therefore, the BEA and MRIO electric utility activities are comparable.

The inputs for electric utility facilities are determined by the expression:

$$\left[\text{Inputs}_{31}\right] = (\text{TI}_{31}) \left[11.0303\right]$$

MRIO 016, Activity 33 - Sewage and Water Treatment Plants

The input pattern associated with MRIO 016, activity 16, is a combination of those associated with two BEA activities: new water supply facilities (11.0306), and new sewer system facilities (11.0307). Using the 1977 measures of output as weights, the inputs for sewage and water treatment plants are determined by the expression:

$$*\left[\text{Inputs}_{33}\right] = \frac{1810}{7184} (\text{TI}_{33}) \left[11.0306\right] + \frac{5374}{7184} (\text{TI}_{33}) \left[11.0307\right]$$

MRIO 017, Activity 14 - Highways and Streets

Activity 19 - Bridges and Elevated Highways
Activity 20 - Tunnels

State-specific data was available for some inputs to highway construction. These inputs account for about 57 percent of the total inputs. The remaining 43 percent of the cost of materials was based on the 1972 BEA input vector for BEA activity 11.0400 - new highways and streets. The state-specific inputs were based on Highway Construction Usage Factors for Construction Materials, 1976-77-78 (Source 14402), compiled by the Federal Highway Administration. These material inputs, and their percent of total inputs, are shown below:

Material	Percent of Total Inputs
Aggregates	13.16
Lumber	1.00
Timber Piling	.16
Explosives	1.30
Bituminous	8.16
Petroleum Products	5.32
Concrete Pipe	1.96
Clay Pipe	.18
Cement	10.54
Steel Pipe	1.50
Miscellaneous Steel	1.56
Structural Steel	6.60
Reinforcing Steel	5.78
Total	57.22

For a more complete discussion of sewer and water facilities, see the discussion of MRIO 016, activity 26 - sewer and water mains.

For each input listed above, the Highway Construction Usage Factors provided usage factors in terms of units (usually tons) per million dollars of construction cost. These factors were multiplied by the value of highway construction, in millions of dollars, performed in the respective states. This yielded an estimate, in tons, of the amount of each material used in each state. These amounts were then multiplied by a state or regional price as quoted in various 1977 issues of Engineering News-Record (Source 24013).

MRIO 018, Activity 4 - Farm Buildings

The input pattern associated with MRIO 018, activity 4, is comparable to that associated with one BEA activity: new farm service facilities (11.0502). The inputs for farm buildings are determined by the expression:

$$[\text{Inputs}_4] = (\text{TI}_4)\ [11.0502]$$

MRIO 018, Activity 24 - Conservation and Development

The input pattern associated with MRIO 018, activity 24, is comparable to that associated with one BEA activity: new conservation and development facilities (11.0506). The inputs for conservation and development facilities are given by the expression:

$$[\text{Inputs}_{24}] = (\text{TI}_{24})\ [11.0506]$$

MRIO 018, Activity 34 - Oilfields

The input pattern associated with MRIO 018, activity 34, is comparable to that associated with one BEA activity: new petroleum, natural gas, and solid mineral exploration (11.0504). The inputs for oilfields are determined by the expression:

$$[\text{Inputs}_{34}] = (\text{TI}_{34})\ [11.0504]$$

MRIO 018, Activity 39 - Petroleum and Gas Drilling

The input pattern associated with MRIO 018, activity 39, is comparable to that associated with one BEA activity: new petroleum and natural gas well drilling (11.0503). The inputs for petroleum and gas drilling are determined by the expression:

$$[\text{Inputs}_{39}] = (\text{TI}_{39})\ [11.0503]$$

MRIO 018, Activity 40 - Mining

The input pattern associated with MRIO 018, activity 40, is comparable to that associated with one BEA activity: access structures for solid mineral development (11.0508). The inputs for mining are determined by the expression:

$$\left[\text{Inputs}_{40}\right] = (\text{TI}_{40}) \left[11.0508\right]$$

MRIO 018, Other Construction Activities

The remaining activities included in MRIO 018 do not have a specific counterpart in the BEA classification system. Rather, they are included with BEA's other new nonbuilding facilities (11.0507). The input vector for other new nonbuilding facilities will be applied to the sum of the total intermediate inputs from the following MRIO 018 activities.

Activity 15 - Swimming Pools
Activity 16 - Airports
Activity 17 - Parking Areas
Activity 18 - Fencing
Activity 21 - Dams and Reservoirs
Activity 22 - Marine Construction
Activity 33 - Harbor and Port Facilities
Activity 30 - Heavy Industrial Construction
Activity 35 - Other Nonbuilding Construction
Activity 37 - Construction, NSK

The inputs for these "other" categories can be expressed as:

$$\left[\text{Inputs}_{\sum_{\text{other}}}\right] = \sum_{\text{other}} (\text{TI}) \left[11.0507\right]$$

Maintenance and Repair (MRIO 019)

Activity 1 - Single-family Residential Buildings
Activity 2 - Multifamily Residential Buildings

The input pattern associated with the sum of activities 1 and 2 is comparable to that associated with one BEA activity: maintenance and repair, residential (12.0100). The inputs for the maintenance and repair of single-family and multifamily residential buildings are given by the expression:

$$*\left[\text{Inputs}_{1+2}\right] = (TI_1 + TI_2) \left[12.0100\right]$$

The input pattern associated with the sum of maintenance activity 3 plus activities 5 through 12 is comparable to that associated with one BEA activity: maintenance and repair of other nonfarm buildings (12.0201). These activities are:

Activity 3 - Other Residential Buildings
Activity 5 - Industrial Buildings and Warehouses
Activity 6 - Office and Bank Buildings
Activity 7 - Stores, Restaurants, and Garages
Activity 8 - Amusement and Recreational Buildings
Activity 9 - Religious Buildings
Activity 10 - Educational Buildings
Activity 11 - Hospitals and Institutions
Activity 12 - Other Nonresidential Buildings

The inputs for these nine activities are given by the expression:

$$\left[\text{Inputs}_{3,5-12}\right] = (TI_3 + TI_5 + TI_6 \ldots + TI_{12}) \left[12.0201\right]$$

MRIO 19, Activity 4 - Farm Buildings

The input pattern associated with activity 4 is comparable to that associated with one BEA activity: maintenance and repair of farm service facilities (12.0203). The inputs for the maintenance of farm buildings are determined by the expression:

$$\left[\text{Inputs}_4\right] = (TI_4) \quad 12.0203\right]$$

The weights applied to the BEA input vectors for all the maintenance activities are summarized in Exhibit 6-4, at the end of Chapter 6.

MRIO 019, Activity 14 - Highways and Streets
MRIO 019, Activity 19 - Bridges and Elevated Highways
MRIO 019, Activity 20 - Tunnels

The input pattern associated with the sum of activities 14, 19, and 20 is comparable to that associated with one BEA activity: maintenance and repair of highways and streets (12.0214). The Census data for bridges (activity 19) and tunnels (activity 20) have been combined into activity 19, which now becomes bridges and tunnels. This was done because the Census combines these two activities when reporting data at the state level. The inputs for the maintenance of highways, streets, etc., are determined by the expression:

$$\left[\text{Inputs}_{14,19,20}\right] = (TI_{14} + TI_{19} + TI_{20}) \left[12.0214\right]$$

MRIO 019, Activity 24 - Conservation and Development

The input pattern associated with activity 24 is comparable to that associated with one BEA activity: maintenance and repair of conservation and development facilities (12.0213). The inputs for the maintenance of conservation and development facilities are given by the expression:

$$\left[\text{Inputs}_{24}\right] = (TI_{24}) \left[12.0213\right]$$

MRIO 19, Activity 25 - Communication Transmission Lines

The input pattern associated with activity 25 is comparable to that associated with one BEA activity: maintenance and repair of telephone and telegraph facilities (12.0204). As is the case with new construction, the Census activity that includes maintenance of communication transmission lines also includes maintenance of power transmission lines. To facilitate the use of BEA's input vectors, the data associated with power transmission lines has been deducted from activity 25 and added to activity 31 (electric utilities). Thus, both MRIO activities -- transmission lines and electric utilities -- are comparable to BEA activities.

The inputs for the maintenance of communication transmission lines are determined by the expression:

$$\left[\text{Inputs}_{25}\right] = (TI_{25}) \left[12.0204\right]$$

MRIO 019, Activity 26 - Sewer and Water Mains

The input pattern associated with activity 26 is a combination of those associated with two BEA activities: maintenance and repair of water supply facilities (12.0209), and maintenance and repair of sewer facilities (12.0210). As explained in the section on new construction, the Census (and MRIO) has two activities dealing with sewer and water facilities: sewer and water mains (activity 26) and sewage and water treatment plants (activity 33). BEA, however, combines all the water facilities into one activity and all the sewer facilities into another. Therefore, the two BEA input vectors must be weighted before being applied to the Census/MRIO data. The weights were provided by the 1972 I-O tables.

The inputs for the maintenance of sewer and water mains are determined by the expression:

$$\left[\text{Inputs}_{26}\right] = \frac{540.5}{821.2}\,(\text{TI}_{26})\,\left[12.0209\right] + \frac{280.7}{821.2}\,(\text{TI}_{26})\,\left[12.0210\right]$$

.... where 540.5 and 280.7 represent the total intermediate inputs in 1972 for water and sewer facilities, respectively; 821.2 is the sum of these inputs.

MRIO 019, Activity 27 - Pipelines

Activity 27a - Gas Utilities
Activity 27b - Petroleum Pipelines

The input pattern associated with activity 27 is comparable to that associated with two BEA activities: maintenance and repair of gas utility facilities (12.0207), and maintenance and repair of petroleum pipelines (12.0208). However, because the state distributions of these two types of pipelines are radically different from one another, and because the input vectors are also quite different, a weighted input vector was not used. Rather, separate estimates of output, value added, and total intermediate inputs were made for gas utilites and for petroleum pipelines. The appropriate BEA input vector was then applied to the estimated total intermediate inputs.

The inputs for gas utilites and for petroleum pipelines, respectively, are determined by the following expressions:

$$[\text{Inputs}_{27a}] = (\text{TI}_{27a})\ [12.0207]$$
$$[\text{Inputs}_{27b}] = (\text{TI}_{27b})\ [12.0208]$$

MRIO 019, Activity 28 - Subways and Railroads

The input pattern associated with activity 28 is a combination of those associated with two BEA activities: maintenance and repair of railroads (12.0205), and maintenance and repair of local transit facilities (12.0211). Although separate national level output data is available for subways and railroads in the 1977 Census, this data is not complete. It does not include force-account maintenance, which, in the case of railroads, accounts for most of the total maintenance. Furthermore, there is no reliable data for force-account maintenance of subways. Therefore, the inputs for activity 28 will be weighted proportionatly to the 1972 total intermediate inputs for railroads and subways.

The inputs for railroads and subways are determined by the expression:

$$[\text{Inputs}_{28}] = \frac{649.2}{690.3}\ (\text{TI}_{28})\ [12.0205] + \frac{42.1}{690.3}\ (\text{TI}_{28})\ [12.0211]$$

.... where 649.2 and 42.1 represent the 1972 total intermediate inputs for railroads and subways, respectively; 690.3 is the sum of these inputs.

MRIO 019, Activity 31 - Electric Utilities

The input pattern associated with activity 31 is comparable to that associated with one BEA activity: maintenance and repair of electric utility facilities (12.0206). The inputs for the maintenance of electric utilities are determined by the expression:

$$[\text{Inputs}_{31}] = (\text{TI}_{31})\ [12.0206]$$

MRIO 019, Activity 33 - Sewage and Water Treatment Plants

The input pattern associated with activity 33 is a combination of those associated with two BEA activities: maintenance and repair of water supply facilities (12.0209), and maintenance and repair of sewer facilities. As previously explained, the Census (and MRIO) has two activities dealing with sewer and water facilities: sewer and water

mains (activity 26) and sewage and water treatment plants (activity 33). BEA, however, combines maintenance of all the water facilities into one activity and maintenance of all the sewer facilities into another. Therefore, the two BEA input vectors must be weighted before being applied to the Census/MRIO data. The weights were provided by the 1972 I-O tables.

The inputs for the maintenance of sewage and water treatment plants are given by the expression:

$$\left[\text{Inputs}_{33}\right] = \frac{540.5}{821.2} \; (TI_{33}) \left[12.0209\right] + \frac{280.7}{821.2} \; (TI_{33}) \left[12.0210\right]$$

.... where 540.5 and 280.7 are the 1972 total intermediate inputs for the maintenance of water supply and sewer facilities, respectively; 821.2 is the sum of these inputs.

MRIO 019, Activity 34 - Oilfields

The input pattern associated with activity 34 is comparable to that associated with one BEA activity: maintenance and repair of petroleum and natural gas wells (12.0215). The inputs for this category are given by the expression:

$$\left[\text{Inputs}_{34}\right] = (TI_{35}) \left[12.0215\right]$$

Other Maintenance Activities

Activity 15 - Swimming Pools
Activity 16 - Airports
Activity 17 - Parking Areas
Activity 18 - Fencing
Activity 21 - Dams and Reservoirs
Activity 22 - Marine Construction
Activity 23 - Harbors and Ports
Activity 30 - Heavy Industrial Construction
Activity 35 - Other Nonbuilding Construction
Activity 37 - Construction, NSK

The above activities do not have a specific counterpart in the BEA classification system. Rather, they are included with BEA's maintenance and repair of other nonbuilding facilities (12.0216). The dollar value of total inputs for these activities will be summed, and the input vector for other nonbulding facilities will be applied to this sum. Thus, the inputs for these "other" categories can be expressed as:

$$\left[\text{Inputs}_{\sum_{\text{other}}}\right] = \sum_{\text{other}} (\text{TI}) \left[12.0216\right]$$

EXHIBIT 6-3:

SUMMARY OF WEIGHTS APPLIED TO BEA INPUT VECTORS - NEW CONSTRUCTION

MRIO Sector	Census Activities	Description	Weights and BEA Input Vectors
014		RESIDENTIAL	
	1	Single Family	$(1 - Add_1)$ 11.0101 + (Add_1) 11.0105
	2	Apartments	$(.146)(1-Add_2)$ 11.0102 + $(.642)(1 - Add_2)$ 11.0103 + $(.212)(1 - Add_2)$ 11.0104 + (Add_2) 11.0105
015		NONRESIDENTIAL	
	3	Other Residential	(.834)11.0106 + (.166)11.0107
	5	Industrial	(.739)11.0201 + (.261)11.0203
	6	Office, Bank	11.0202
	7	Stores, Garages	(.104)11.0204 + (.896)11.0205
	8	Amusement	11.0209
	9	Religious	11.0206
	10	Educational	11.0207
	11	Hospital	11.0208
	12	Other Nonresidential	11.0209
016		PUBLIC UTILITY	
	25	Transmission Lines	
		Power	
		Communication	11.0301
	28	Subways and Railroads	(.255)11.0302 + (.745)11.0308
	29	Railroads	Included with Activity 28
	31	Electric Utilities	11.0303
	27	Pipelines	
		Gas	11.0304
		Oil	11.0305
	26	Sewer, Water Mains	(.252)11.0306 + (.748)11.0307
	33	Sewage, Water Treatment	(.252)11.0306 + (.748)11.0307
017		HIGHWAYS AND STREETS	
	14	Highways, Streets	
	19	Bridges and Elevated Highways	
	20	Tunnels	
018		OTHER CONSTRUCTION	
	4	Farm Buildings	11.0502
	15	Swimming Pools	11.0507
	16	Airports	
	17	Parking Areas	
	18	Fencing	
	21	Dams, Reservoirs	
	22	Marine Construction	
	23	Harbors, Ports	
	24	Conservation, Development	11.0506
	30	Heavy Industrial Facilities	11.0507
	34	Oilfields	11.0504
	35	Other Nonbuilding	11.0507
	37	Construction NSK	11.0507
	39	Drilling	11.0503
	40	Mining	11.0508

Add_1 in this table is the ratio of (inputs for additions and alterations, single family)/(total inputs, single family).

Add_2 is the ratio of (inputs for additions and alterations, apartments)/(total inputs, apartments).

In each case, the expression above must be multiplied by TI_i, i = activity.

EXHIBIT 6-4:

SUMMARY OF WEIGHTS APPLIED TO BEA INPUT VECTORS - MAINTENANCE

Census Activities	Description	Weights and BEA Input Vectors
1	Single-family Residential	12.0100
2	Apartment Buildings	12.0100
3	Other Residential Buildings	12.0201
5	Industrial Buildings and Warehouses	
6	Office and Bank Buildings	
7	Stores, Restaurants, Garages	
8	Amusement, Recreational Buildings	
9	Religious Buildings	
10	Educational Buildings	
11	Hospitals and Institutions	
12	Other Nonresidential Buildings	
4	Farm Buildings	12.0203
14	Highways and Streets	12.0214
19	Bridges and Elevated Highways	
20	Tunnels	
24	Conservation and Development	12.0213
25	Communication Transmission Lines	12.0204
26	Sewer and Water Mains	(.658) 12.0209 + (.342) 12.0210
27	Pipelines	
	Gas	12.0207
	Oil	12.0208
28	Subways and Railroads	(.940) 12.0205 + (.060) 12.0211
31	Electric Utilities	12.0206
33	Sewage and Water Treatment Plants	(.658) 12.0209 + (.342) 12.0210
34	Oilfields	12.0215
15	Swimming Pools	12.0216
16	Airports	
17	Parking Areas	
18	Fencing	
21	Dams and Reservoirs	
22	Marine Construction	
23	Harbors and Ports	
30	Heavy Industrial Facilities	
35	Other Nonbuilding Construction	
37	Construction, NSK	

In each case, the expression above must be multiplied by TI_t, t = activity.

CHAPTER 7

MANUFACTURING

MRIO Sectors: 020 through 084

A complete concordance of manufacturing sectors with BEA I-O sectors and SIC categories appears in Appendix C.

The inputs for manufacturing sectors were compiled in a two-step procedure, due to the extent of the available data. Although all material inputs were available from Census at the national level, the inputs of purchased services were completely lacking. In addition, some of the materials consumed data were suppressed due to disclosure problems and some were not specified by kind of material. It was therefore necessary to compare these 1977 Census data with the 1972 BEA inputs in order to determine the completeness of the 1977 Census data. Thus, the two-step procedure involved aligning the 496-order BEA sectors with the MRIO sectors, computing the input coefficients and compiling the Census data into comparable BEA sectors. The following section describes how the 1977 material input data were compiled.

Data Sources and Methodology

Data Sources

Inputs to the manufacturing sectors are derived for the most part from the materials consumed data collected in the 1977 Census of Manufactures (Source 03105). These data account for approximately 85% of materials consumed in manufacturing on the average (excluding fuels) and are tabulated for each SIC four-digit manufacturing industry at the national level. These data have been imputed to the state level based on four-digit industry output for each state. (Arrangements have been made with the Bureau of the Census to tabulate the materials consumed data at the state level for a cost of approximately $86,000, but the cost of this tabulation has not yet been funded. Disclosure problems would largely be overcome by aggregating the data to MRIO codes at the state level.) The source for the 1977 "cost of materials" control totals for manufacturing industries is the 1977 Census of Manufactures, Industry Series, Table 7,

(03105, hereafter referred to as "Industry Series"). In addition, data were obtained from the 1977 Census of Manufactures, "Selected Materials Consumed", Subject Series, MC77-SR-11, Section I, Tables 1 and 3-7, and Section II (03105).[1] Included in Section II of this Census report are expenditures by selected four-digit SIC industries on certain inputs that could be used to disaggregate the unspecified subtotals given in the "Industry Series."

Energy inputs were obtained from the 1977 Census of Manufactures. These data were available for SIC four-digit industries at the national level, and generally for two-digit industries at the state level. Detail is available for each type of fuel, generally for both quantity and delivered values. An extensive estimating procedure was employed to distribute the state two-digit data to MRIO industries in each state, while insuring that the state control totals for each fuel type, and national totals for industries, were preserved. The details of the procedure are described in Chapter 2 of this report.

With a few exceptions the remaining inputs to manufacturing were estimated by applying the 1972 BEA I-O coefficients, updated to reflect relative price changes between the output of the industry and each input over the period 1972-77. The procedure for this update is described in Appendix A. The problems and procedures employed in merging the input data estimated by applying the BEA coefficients with the 1977 input data in each sector are described below.

Methodology

Material input data for each of the four-digit SIC manufacturing industries were compiled in purchasers' values from Table 7 of "Industry Series" (Source 03105). Since, in some industries, the data contained in Table 7 contained a large amount of unspecified material inputs, the various tables in "Selected Materials Consumed" were used to determine whether additional detailed information could be obtained. All such additional data were then inserted into the original data compilation. Each of the materials consumed in an industry was assigned to an MRIO sector according to the first four digits of the seven-digit product codes used in the report. There was a problem involved in merging the 1977 materials consumed data with the data estimated from the price-updated 1972 coefficients in cases where the coverage in the materials consumed data was not complete.

[1] *The source of the data published in "Selected Materials Consumed" was a Census survey, MA131, "Consumption of Materials, Parts, Containers, and Supplies During 1977."*

The analysis that was required to overcome the merging problem described above lead to a very detailed and tedious examination of the two sets of data for each BEA industry. The objective was to insure that the 1977 data represented complete coverage for an MRIO-coded input. If only part of the input items encompassed by the MRIO code was represented in the 1977 data, it was necessary to adjust the data for full coverage, or simply to substitute the BEA data on the assumption it represented full coverage. Since it was desirable to include as much actual 1977 data as possible, if a significant fraction of the input value was represented in the 1977 data, the value of other items was added based on the disaggregated data estimated from the 1977 coefficients in BEA sector detail. If the fraction covered by the 1977 data was minor, then the value was suppressed and the total amount of the input was based on the data estimated from the 1972 coefficients since it was impractical to identify the covered amount in the 1972 coefficients. This was an extremely tedious process that required considerable judgment on the part of the analyst based on a knowledge of the inputs to the industry and the conventions of the coding in the 1977 materials consumed data collected and tabulated by the Bureau of the Census.

As a practical matter, all the inputs to each sector were first estimated (and inserted in the data files) based on the 1972 coefficients. The 1977 data, adjusted as required, were then substituted for all entries to which they were applicable. Since this substitution was done by a computer program, it was necessary to be extremely careful that partial data for 1977 was not allowed to "override" 1972-based data that represented full coverage.

It is difficult to estimate the percentage of total material inputs that is represented by 1977 data after the merging of the two sets of data since part of the 1977 data was necessarily replaced in the merging process. However, it is believed that this "loss" in merging was not substantial and that the 1977 data probably represent in excess of 75% of the material inputs (excluding fuels) in the final data.

In general, the principal inputs to each industry are covered by the materials consumed data, and less important inputs are estimated based on the 1972 coefficients. In almost no cases does the 1977 materials consumed data consistently cover a given input in all industries across-the-board; coverage from materials consumed data generally depends on the importance of that input to each industry. However, items are selected for coverage by Census based on blocks of industries; e.g., major metal shapes and forms

are consistently covered in the metal fabricating, machinery, and metal equipment industries, even though specific metals may not be important in a specific industry. The one exception is scrap inputs for which detailed and comprehensive data were reported for almost all industries. Scrap data for each four kinds of scrap (metal, textile, glass, and other) were included in Census of Manufactures' Industry Series, Table 7 (03105), under the product codes #999806 through #999825. Additional scrap information was obtained from "Selected Materials Consumed" survey, where scrap data were coded as #90001 for metal scrap and #90002 for other than metal scrap. The scrap data were collected, with no estimation involved, and were allocated to their consuming industries and respective MRIO sectors. The total scrap costs tabulated for about 60 industries amounted to over $6.5 billion, with metal scrap representing almost 96 percent of all scrap.

Data on sales for resale were extracted from Table 3a in "Industry Series" at the four-digit SIC level. In the MRIO framework, costs of resale were allocated to the intrasector transaction and the differences of value-of-resale less cost-of-resale were treated as wholesale trade activity taking place in the manufacturing industry and were hence treated as secondary products (see Chapter 11 for a complete discussion of secondary products).

It is important to note that the Census materials consumed data contained data for all imports. However, since the noncomparable imports are in a separate row in the MRIO framework, it was necessary to identify all noncomparable import products, remove them from the materials data and assign them to the noncomparable import row. This was achieved by using information obtained from "Commodity Detail on Non-Comparable Inputs, BEA 1977," (Printout, Source 03512).

Dividing BEA Sectors into MRIO Sectors

When MRIO sectors were more detailed than BEA I-O sectors, the input coefficients for the BEA I-O sector had to be divided among the MRIO sectors before the updated coefficients could be used. This division was necessary for one BEA manufacturing sector: 60.0400 (Aircraft and Missile Manufacturing). BEA Sector 60.0400 was split into two sectors, MRIO 078 Aircraft and Parts, and MRIO 079 Missiles, Spacecraft and Parts using the BEA worksheet data file on microfilm (Source 03509). For every entry to BEA 60.0400 that was over $10 million, the detailed SIC split based on purchaser's values was obtained from the microfilm. Entries of less than $10 million were deemed minor and therefore were split based on output values of the two sectors. The 60.0400 row split was carried out in a similar fashion.

Computation of the Input Coefficients

It was necessary to rebase the input coefficients in the price-updated BEA table. First, the dollar input entries for materials consumed (i.e., inputs from MRIO's 1-84, 94, 95, 120, 121) were summed and coefficients derived based on those sums. Next, the value added control was subtracted from the output total to give cost of materials and services. The cost of materials was then subtracted, leaving a cost of services control. The entries in MRIO sectors 85-93, 96-119, 122-125 (inputs of services) were summed and coefficients calculated. These two sets of coefficients were then weighted by the proper state control totals in order to derive the 51 state input tables. These tables were summed to the national input table and the 1977 national input data above were inserted into the national table. The national input coefficients were then re-computed and re-weighted by the state data to derive the 51 state input tables.

Data Quality

The major portion (estimated in excess of 75 percent) of the manufacturing input data is deemed reasonably reliable as the data were collected from the 1977 Census and the MA-131 special survey results published in "Selected Materials Consumed." Since these data were imputed to the state level using materials control totals as weights by detailed industry (BEA I-O detail), and since technological relationships at this level of detail are not expected to vary substantially, the imputed state data should be fairly reliable.

The fuels data are deemed more reliable since state data were used (albeit at more aggregated industry levels) and reconciled with more detailed industry data at the national level.

The weakest data of course are those based on the 1972 coefficients, but fortunately these are estimated at less than 25% of the total material inputs and generally reflect items of less interest in the model results.

CHAPTER 8

TRANSPORTATION

MRIO Sectors:

- 085: Railroads
- 086: Local passenger transportation and intercity bus
- 087: Motor freight
- 088: Water transportation
- 089: Air transportation
- 090: Pipelines, except natural gas
- 091: Transportation services

Introduction and Overview of Inputs

The MRIO transportation sectors include all commercial transportation of freight and passengers, with the exception of natural gas transmission, which is included in the gas utilities sector (MRIO 095). As shown in Exhibit 8-1, most of the transportation sectors concord with a single two-digit SIC industry. The exceptions to this involve the assignment of certain activities in SIC 47 to MRIO sectors other than Transportation Services (MRIO 091), as follows: SIC 4784, Fixed Facilities for Handling Motor Vehicle Transportation, N.E.C.[1], is assigned to MRIO 119 (State and Local Government Enterprises, Except Utilities and Local Transit). SIC 4789, Transportation Services, N.E.C., are assigned to MRIO sectors as follows: "sleeping and dining car operations not performed by railroads" are assigned to MRIO 085 (Railroads), and "stockyards that do not buy, sell or auction livestock" are assigned to MRIO 087 (Motor Freight). The remaining SIC 4789 activities are assigned to MRIO 091.

This chapter provides a summary of the sources and methods employed in the development of 1977 inputs, including energy inputs, for the transportation sectors. At the national level values of inputs were developed from primary 1977 data, where

[1] *Toll roads, bridges, and tunnels.*

EXHIBIT A-1

MRIO CONCORDANCE WITH 1977 SIC CODES

Sectors 085, 086, 087, 088, 089, 090, 091: Transportation

MRIO Sector	BEA I-O Code		1977 SIC	
085: Railroads	650100	Railroads and Related Services	40	Railroad Transportation
			474	Rental of Railroad Cars
			pt. 4789	Transportation Services, N.E.C.
086: Local Passenger Transportation and Intercity Bus	650200	Local and Suburban Transit and Interurban Highway Passenger Transportation	pt. 41	Local and Interurban Passenger Transit
	790100	Local Government Passenger Transit	pt. 41	Local and Interurban Passenger Transit
087: Motor Freight	650300	Motor Freight Transportation and Warehousing	42	Trucking and Warehousing
			pt. 4789	Transportation Services, N.E.C.
088: Water Transportation	650400	Water Transportation	44	Water Transportation
089: Air Transportation	650500	Air Transportation	45	Air Transportation
090: Pipelines, Except Natural Gas	650600	Pipelines, Except Natural Gas	46	Pipelines, Except Natural Gas
091: Transportation Services	650701	Freight Forwarders and Other Transportation Services	471	Freight Forwarding
			4723	Arrangement of Transportation of Freight and Cargo
			4782	Inspection and Weighing Services
			4783	Packing and Crating
			pt. 4789	Transportation Services, N.E.C.
	650702	Arrangement of Passenger Transportation	4722	Arrangement of Passenger Transportation

available. The remaining inputs were developed at the national level using the 1972 BEA input coefficients, updated for changes in relative prices to 1977. Development of data from the price-updated coefficients are described in Appendix A.

Inputs for maintenance construction of railroads and petroleum pipelines were distributed to states based on available data for these location-specific activities. The state distribution of other inputs to transportation are more transitory in nature and are linked to the transportation flows within and among states. These inputs will be distributed to states in conjunction with the development of interregional flows as part of the final stages of MRIO development.

The major inputs to MRIO Transportation Sectors 085-090 are:

- energy — coal, petroleum products, electricity, and natural gas;
- maintenance and repair inputs — vehicle parts, purchased maintenance and repair services; and
- insurance and communications inputs to air transportation.

The inputs to MRIO 091 (Transportation Services) differ from other transportation sectors because this industry provides only services related to transportation, as opposed to actual modal transportation service. The four leading inputs to MRIO 091 in 1972 were purchases from real estate, insurance, banking, and miscellaneous business service sectors. Due to the sparcity of data on inputs to MRIO 091, no inputs were developed from primary data for this sector (price-updated BEA coefficients are used instead) with the exception of energy inputs which were developed from the National Energy Accounts (NEA, Source 23011).

Data Sources and Methodology

Energy Inputs

The value of energy inputs to transportation in 1977 was estimated for all seven MRIO transportation sectors, primarily using the following general procedure.

1. Estimates of the physical quantities of energy products consumed by the transportation sectors by functional use in 1977 were compiled from the National Energy Accounts (Source 23011).

2. A sector-specific, wholesale[1] purchasers' price for each of the energy products consumed was developed where available from regulary published (usually Federal) sources.

3. Where regulary published price data were not available, the estimated purchasers' value from the National Energy Accounts data base was used as the estimated value.

4. The values of energy products consumed by sector were grouped according to their producing MRIO sector, and summed if necessary, as follows:

MRIO Producing Sector		Energy Products
050:	Petroleum refining and allied products	Motor gasoline, diesel fuel, LPG,[2] distillate fuel oil, residual fuel oil, lubricating oil, grease, aviation gasoline, jet fuel.
009:	Coal	Coal
094:	Electric utilities	Electricity
095:	Gas production and distribution	Dry natural gas

The procedures summarized above were employed in estimating most of the value of energy consumed by MRIO's 085, 086, 088, 089, and 090. For both MRIO 087, Motor Freight, and MRIO 091, Transportation Services, only National Energy Accounts estimates of the purchasers' value of energy products consumed were utilized because other approaches to estimate data did not provide reliable results. In the case of Motor Freight, an attempt was made to estimate the motor fuel inputs (gasoline, diesel, LPG) using the latest version of the 1977 Census of Transportation, Truck Inventory and Use Survey (Source 03107) tape (developed by System Design Concepts, Inc., for FHWA).

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[1] *A wholesale price is typically what any average size transportation company would actually pay for energy products.*

[2] *Liquefied Petroleum Gases.*

When preliminary computer runs revealed many nonresponses to the survey questions needed for the estimating process,[1] it was concluded that accurate, cost-effective estimates could not be obtained using the Census data. In Transportation Services (MRIO 091), analysis of 1972 BEA I-O inputs to BEA I-O Sector 650700 did not show energy to be a significant input. Thus, no primary research was considered worthwhile for these energy inputs, and purchasers' values from the National Energy Accounts were used. The methodology used to develop NEA estimates of the energy inputs to MRIO 087 and MRIO 091 can be found in Chapter 2.

Energy Inputs to Railroads (MRIO 085)

The energy inputs to railroads involve three MRIO energy sectors; MRIO 009-Coal, MRIO 050-Petroleum Refining and Allied Products, and MRIO 094-Electric Utilities. Most of the energy inputs were developed using the general procedure outlined earlier in this chapter. Additional details on the original sources of physical quantity data and how they were used in developing the NEA physical quantity estimates, energy product price data, and supplemental sources and methods are provided below.

Most of the data on the physical quantities of energy products consumed by railroads are derived from Interstate Commerce Commission (ICC) sources. The most significant functional use of energy in this sector is in locomotives, and virtually all of this is represented by diesel fuel oil, with smaller quantities of electricity and coal. Quantities of diesel fuel and coal consumed by locomotives and rail motorcars of Class I line-haul railroads in 1977 were obtained from unpublished ICC worksheet F1, Schedule 571. Physical quantities used in Class I line-haul railroads were inflated to include Class II and switching and terminal companies using the numbers of locomotives in each category of railroad (from unpublished ICC tables for 1977).

The ICC is also the primary source of data on the physical quantities of energy consumed for non-locomotive functional uses. The total Class I line-haul railroad consumption of energy products (for all functional uses except corporate automobiles, and for all energy products except aviation gasoline and jet fuel) were published in Table 70 of Part I of Transport Statistics through 1963. Energy products covered

[1] *Annual miles, MPG, engine type (gasoline, diesel, LPG).*

included coal, residual fuel oil, distillate fuel oil (including diesel) and gasoline. Several techniques were devised in order to extrapolate to 1977. Non-locomotive distillate (including diesel) consumption was indexed to sector output (from the BLS 154 Sector Output Series). Residual oil consumption was indexed on data published in Table 3 of Energy Data Reports (Source 06103), "Sales of Fuel Oil and Kerosine." Likewise, coal consumption was indexed forward on a coal consumption series published in Energy Data Reports. Non-locomotive gasoline consumption (excluding corporate auto) was indexed to 1977 on the inflated locomotive diesel consumption estimates (documented above).

Within the non-locomotive distillate (including diesel) category, a further breakdown was made in 1977 data for pricing. By subtracting the NEA estimate of truck diesel consumption[1] from total non-locomotive distillate consumption, a residual quantity was obtained which was assumed to represent Number Two Heating Oil.

After estimating the physical quantities of energy inputs by consuming sector and energy product it was necessary to obtain price data to estimate the cost of the physical quantities of energy products consumed. The value of locomotive and truck diesel fuel consumed by the railroad sector was estimated using the cost per gallon of diesel fuel oil consumed by Class I locomotives in 1977, from the 1979 Yearbook of Railroad Facts (Source 22051). The prices of motor gasoline[2] (leaded premium) and residual fuel oil were obtained from the Monthly Energy Review (Source 06102). A sector-specific price for coal was obtained from National Transportation Statistics (Source 14101), September 1980, Table 31.

In order to account for the value of most other functional uses of energy in the railroad sector, the purchasers' values of the following energy product/functional uses were compiled from the NEA data base: auto gasoline, truck LPG, and all uses of lubricating oil and grease. Summary documentation of these estimates can be found in Chapter 2.

Electricity use by railroads was estimated using a somewhat different procedure. The total value of electricity purchased by the railroad sector was estimated in two major

[1] *Truck diesel fuel consumption estimating techniques are summarized in Chapter 2.*

[2] *Used in estimating the value of consumption for uses other than corporate auto; mostly trucks.*

steps: 1) estimation of the value of electricity purchased for yard switching and train power, and 2) estimation of the value of electricity purchased for nonmotive uses. Details are provided below.

The costs of electricity purchased for yard switching and train power by Class I line-haul railroads were obtained from Transport Statistics, Part I, Table 10. These data were inflated to account for Class II and switching and terminal companies. The factor used to inflate Class I line-haul was formed by dividing total operating expenses of the railroad industry by total operating expenses of Class I line-haul. The operating expense data were obtained from Table 83-D of Transport Statistics, Part I.

The value of electricity purchased by railroads for nonmotives uses was estimated using the electricity consumption control total[1] from the NEA. The NEA residual commercial electricity consumption control was distributed across the relevant consuming sectors, including railroads, as follows. The distribution was based on the estimated square feet of building space utilized in each NEA sector, estimated using sector employment data from the MRIO data base multiplied by estimates of square feet/employee by sector from Estimating Land and Floor Area Implicit in Employment Projections (Source 23031). The consumption of commercial electricity in KWH's by railroads was computed by dividing the proportion of estimated square footage in the railroads sector by the total KWH's for all the sectors receiving commercial electricity allocations. Electricity consumed by railroads was converted to dollars using the revenues per KWH from "small light and power" customers of all electric utilities (computed from data in Tables 22S and 36S of the Statistical Yearbook of the Electric Utility Industry for 1977 (Source 22021) which was multiplied by the estimated KWH's of railroads. This value of nonmotive electricity consumption was added to electricity purchased for yard switching and train power to obtain the total electricity input value.

Energy Inputs to Local Passenger Transportation and Intercity Bus (MRIO 086)

Energy inputs to MRIO 086, Local Passenger Transportation and Intercity Bus, are purchased from three MRIO energy producing sectors (050, 094, and 095). Most of the

[1] *From NEA, Table 3-7-2, see Chapter 6.*

data were developed using the general procedure outlined in the energy inputs overview section of this chapter. Additional details on the original sources of physical quantity data (and how they were used in developing NEA physical quantity estimates) and energy product price data are provided below.

The data development began with the selection of a control total on the physical consumption of all motor fuel by commercial buses (i.e., local transit and intercity buses combined) for 1977, obtained from Table VM-1 of Highway Statistics (Source 14401), 1977. In the NEA, this quantity was further broken down between local transit and intercity buses, and within these two categories, disaggregated to fuel types (gasoline, diesel, and LPG), as follows:

- The consumption of gasoline, diesel, and LPG (propane) by local transit buses (excluding for-hire buses) was developed by fuel from Table 17 of Transit Fact Book (Source 22081), 1977-1978 edition.

- Consumption of gasoline and diesel fuel by for-hire school buses was developed in the NEA by procedures described in Chapter 2.

- The sum of local transit bus fuel data was subtracted from the Highway Statistics control used in the NEA, yielding an estimate of total intercity bus fuel consumption. This amount was disaggregated between diesel fuel and gasoline[1] on the basis of information provided by the American Bus Association.

Taxi consumption of gasoline was estimated using the following procedures:

- estimate the number of taxis;
- estimate average miles driven per taxi, then multiply this figure by the number of taxis to obtain total vehicle-miles (VM);
- estimate average miles per gallon (mpg) for taxi travel; and
- divide taxi VM by taxi mpg, yielding an estimate of taxi gasoline consumption.

[1] *LPG (propane) is not believed to be used by any intercity buses.*

The numbers of taxis was estimated using a two-step approach. First, an estimate of the number of taxis in fleets was obtained from Bobit Publishing Company (publishers of Automotive Fleet (Source 24071)). Second, this figure was inflated to account for non-fleet taxis using information provided by the Federal Highway Administration. The average miles driven per taxi in 1977 was estimated via extrapolation from 1975, using one-half the compound annual decline rate computed from data for 1973 and 1975, from Taxicab Operating Characteristics (Source 23041), Table S-1. Average mpg for taxi travel was approximated by deflating average mpg for all autos (from Table VM-1 of Highway Statistics, 1977 edition) by ten percent to reflect a greater proportion of urban driving.

Additional auto gasoline use in this sector consists of consumption for general company-owned (or company-reimbursed) auto travel.[1] Distribution of this category of auto gasoline was made to all sectors in the economy represented in the NEA. Summary procedures for this distribution are included in Chapter 2.

Another essential use of energy in this sector is of electricity for the propulsion of transit vehicles (such as subway cars) and for the general light and power needs of the sector. Consumption of electricity by transit vehicles is quantified in Table 17 of Transit Fact Book, 1977-1978 edition. Consumption of electricity for general light and power uses by MRIO 086 was automatically estimated as part of the procedure employed in estimating the value of general purpose electricity consumption by the railroads sector (MRIO 085). For details, see the previous section, Energy Inputs to Railroads (MRIO 085).

The next step was to assemble price data to convert the energy product consumption data to value data. The price of all bus consumption of gasoline (local and intercity) was assumed to be a tank-wagon price, plus state and local taxes, per gallon. The averages of these two subcomponents were obtained from the State Physical Unit Price Database (Source 06110). Separate diesel fuel prices were developed for intercity and local buses. The price of diesel fuel for intercity buses was taken from Bus Facts (Source 22211), 1981 Edition. This price represents the cost (including taxes) to Class I intercity carriers of bus fuel. Because virtually all of the buses operated in Class I are large diesel-powered units, it was assumed that the bus fuel price presented in Bus Facts was essentially a diesel fuel price. A price for local transit bus diesel fuel was

[1] *Non-taxi autos.*

constructed as follows. The price (excluding taxes) of No. 1 diesel fuel to local transit bus systems was obtained from the American Public Transit Association (APTA). Next, the average state and local taxes on diesel fuel purchased by Class I intercity bus companies in the U.S. was computed from Bus Facts, 1981 Edition. The average taxes were added to the price from APTA (which excludes taxes) to obtain a total wholesale purchasers' price. The price of LPG purchased for local transit buses was estimated using a retail price to the industrial sector from the State Physical Unit Price Database.

Two different prices were used to convert the auto gasoline consumption data to value data. These prices were applied separately to non-taxi-auto and taxi consumption. Taxi consumption was further disaggregated between "own-pump" and "service station" to estimate prices. For taxi gasoline obtained from taxi company-owned pumps, the same price as for local transit bus gasoline was used (see above). For taxi gasoline purchased from service stations and for non-taxi auto gasoline, the retail price from State Physical Unit Price Database was used. Additional discussion of the breakdown of taxi gasoline between own-pump and service station (for pricing) follows.

A special analysis was performed to break out taxi gasoline consumption to own-pump and service station sources. The results show that an estimated 67 percent of taxi gasoline consumption is from company-owned pumps. The procedures employed in the analysis are outlined below:

- Operators with 15 or more cabs were assumed to have their own pumps (Source: International Taxicab Association).

- "Own-pump" operators were assumed to have been charged a tank-wagon price for gasoline in 1977 (Source: International Taxicab Association).

- Average employment per taxicab was estimated as 1.92 employees in 1977 (extrapolated from 1975 average, published in Table S-1 of Taxicab Operating Characteristics).

- If the minimum employment by cab companies operating their own-pump equals 15, then minimum employment for own-pump companies equals 29 (1.92 x 15).

- Based on employment data by size class in SIC 412 (taxicabs), from County Business Patterns (Source 03114), 67 percent of employment in the industry is in establishments with 29 or more employees (assuming an even distribution of employment across the 20-49 employee size class).

- Assuming equal fuel consumption per taxi industry employee, it is concluded that 67 percent of taxi gasoline consumption is from company-owned pumps.

The energy value data documented above were supplemented by additional purchasers' value data from the NEA data base for the following energy products/functional uses: lubricating oil and grease; truck gasoline and diesel fuel; aviation gasoline and jet fuel; dry natural gas; and fuel oil not specified by kind (for heating). Summary documentation on the development of the above data can be found in Chapter 2 of this report.

Energy Inputs to Water Transportation (MRIO 088)

The energy inputs to MRIO 088, Water Transportation, are purchased from four MRIO energy sectors (050, 009, 094, and 095). All of these energy consumption value estimates were developed using the general procedure outlined in the energy inputs overview section of this chapter. Additional details on the original sources of physical quantity data (and how they were used in developing NEA estimates) and energy product price data are provided below.

The most significant use of energy in this sector is of distillate and residual fuel oils for vessel bunkering purposes. A very small quantity of coal was still being used in 1977 for this same purpose. The consumption (by vessels) figures for all three of these energy products are compiled or derived from data published in the Energy Data Reports (Source 06103) series. Of the three fuels, consumption data for two of these were taken directly from the Energy Data Reports (EDR) series. Coal is from EDR, "Bituminous Coal and Lignite Distribution, Quarterly", January-September 1977 and October-December 1977 editions. Residual fuel oil is from EDR, "Sales of Fuel Oil and Kerosine in 1978," Table 3. The total sales of marine distillate[1] is reported in EDR,

[1] *Including diesel.*

"Sales of Fuel Oil and Kerosine," Table 2, but these sales do not include all of the diesel fuel oil purchased by commercial fishing fleets though the actual magnitude of this undercoverage is unknown. To augment the EDR data on the quantity of distillate fuel oil consumed by the Water Transportation sector (MRIO 088), one-half of the NEA estimate of diesel fuel consumption by commercial fishing[1] was added to the figure from EDR yielding a revised figure on total marine distillate. The total NEA value for commercial fishing diesel fuel was subtracted to obtain distillate consumption by MRIO 088.

The second step in the general procedure was to use price data to convert the physical quantities documented above to dollar values. The price of coal was obtained from National Transportation Statistics (Source 14101), September 1980, Table 31 (used price paid by railroads). The prices for distillate and residual fuel oils consumed in vessels were assumed to equal U.S. average nominal prices to the industrial sector, from the State Physical Unit Price Database.

The values developed using the methods and sources documented in the previous paragraphs were supplemented by purchasers' values from the NEA data base for the following energy products/functional uses: lubricating oil and grease; auto gasoline; truck gasoline, diesel and LPG; aviation gasoline and jet fuel; fuel oil, not specified by kind (for heating); dry natural gas; and electricity. Summary documentation on the development of these NEA purchasers' values can be found in Chapter 2.

Energy Inputs to Air Transportation (MRIO 089)

The energy inputs to air transportation are purchased from three MRIO energy sectors (050, 094, and 095). In the development of these energy consumption values, methods in addition to those of the NEA were employed. Details are provided below.

Jet fuel alone accounts for 95.7 percent of the value of the total energy inputs to the sector, and 33.9 percent of the total intermediate inputs to the sector. Besides jet fuel, a small quantity of aviation gasoline was consumed in commercial aircraft in 1977, and other energy products were used for autos, trucks, and in buildings. Sources and methods used to develop the dollar values of consumption by MRIO 089 are summarized below.

[1] *Summary documentation for this estimate is included in Chapter 2.*

Controls on the consumption of jet fuel and aviation gasoline (avgas) by all aviation (both commercial and general aviation) were computed from data in Table 13 of Energy Data Reports (Source 06103), "Crude Petroleum, Petroleum Products, and Natural Gas Liquids: 1977." Next, estimates of jet fuel and avgas consumed by general aviation aircraft, from 1978 General Aviation Activity and Avionics Survey (Source 14303), were subtracted from the controls. The residual quantities obtained do not yet represent consumption by MRIO 089, however, because air taxis (small aircraft used in nonscheduled service or scheduled commuter service) must be included in the sector, but are also included in the general aviation survey data cited above. Therefore, estimates of air taxi fuels (compiled or derived from NEA worksheet data[1]) were added back in to obtain fuels consumption figures for aircraft in MRIO 089. The NEA figure for air taxi avgas was adjusted to account for the difference between the estimate of general aviation avgas reported in Energy Data Reports[2] and that published in the 1978 General Aviation Activity and Avionics Survey.

The next major step was to use jet fuel and avgas prices to convert the physical unit data on commercial aircraft fuels consumption to dollar values. Retail prices (excluding taxes) for both jet fuel and avgas were obtained from the September 1981 edition of the Monthly Energy Review (Source 06102).

The values of fuels consumed by commercial aircraft were supplemented by additional purchasers' values from the NEA data base for the following energy products/functional uses in the Air Transportation sector: lubricating oil and grease; auto gasoline; truck gasoline, diesel, and LPG; fuel, not specified by kind (for heating); dry natural gas; and electricity. Summary documentation of the development of these NEA purchasers' values can be found in Chapter 2.

Energy Inputs to Pipelines, Except Natural Gas (MRIO 090)

The energy inputs to MRIO 090 are purchased from three MRIO energy sectors (050, 094, and 095). All energy consumption estimates were developed using the general procedure outlined in the energy inputs overview section of this chapter. Additional details on the methods employed in developing estimates in physical units for the NEA and on the sources of energy product price data are provided below.

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[1] *Summary documentation for general aviation energy consumption can be found in Chapter 2.*

[2] *Used as control in the NEA.*

No data are available on the actual physical consumption of energy products for pumping crude oil and petroleum products through pipelines. The NEA procedures for estimating the consumption of dry natural gas, diesel fuel, and electricity for pumping are summarized below.

- Total ton-miles transported by petroleum pipelines in 1977 was compiled from Transportation Facts and Trends (Source 22221), Quarterly Supplement for April 1980.

- An estimate of the total BTU[1] requirement per ton-mile (TM) for pumping petroleum, as well as a percent distribution of BTU's to the three energy products used for pumping power, was obtained from Project Independence and Energy Conservation: Transportation Sectors (Source 23015).

- The BTU requirement per TM for pumping was multiplied by the total TM for petroleum pipelines, yielding the total BTU's required for pumping in petroleum pipelines during 1977. This figure was then multiplied across the percent distribution to dry natural gas, diesel fuel, and electricity, yielding BTU's of each of these products.

- The BTU's of dry natural gas and diesel fuel were converted to physical units using standard conversion factors.

- A special conversion factor (heat rate) for BTU's of electricity used in petroleum pipelines in 1972 was obtained from the Project Independence report cited above. This factor was indexed forward to 1977 on a heat rate series from the 1975 and 1977 editions of the Statistical Year Book of the Electric Utility Industry (Source 22021), Table 41S, and subsequently divided into electricity BTU's, yielding KWH.

The next major step was to develop dollar values for the energy products consumed in pumping activities. The price for dry natural gas was assumed to equal the nominal retail price to the industrial sector, U.S. average, from the State Physical Unit Price

[1] *British Thermal Unit.*

Database (Source 06110). In order to get a price for diesel fuel that would include taxes, the price of diesel fuel to Class I intercity bus companies was used as an approximation, from Bus Facts (Source 22211), 1981 Edition. The price of electricity was computed from revenue and KWH data for the Commercial and Industrial-Large Light and Power service class, from Statistical Year Book of the Electric Utility Industry, Table 36S and Table 22S. The prices of the three products were used to convert the physical units to dollar values.

The values of energy products consumed for pumping power were supplemented by additional purchasers' values from the NEA data base for the following energy products/functional uses in the petroleum pipelines sector: auto gasoline; lubricating oil and grease; aviation gasoline and jet fuel, fuel oil, not specified by kind (for uses other than pumping); dry natural gas (for uses other than pumping); and electricity (for uses other than pumping). Summary documentation of the development of these values can be found in Chapter 2.

Maintenance and Repair Inputs

The maintenance and repair inputs to transportation in 1977 that could be estimated from primary data (and were accepted as being of adequate quality) are represented by the following transactions in the MRIO model.

Producing MRIO Sector		Consuming MRIO Sector	
019:	Maintenance construction	085:	Railroads
077:	Motor vehicles and parts	087:	Motor freight
081:	Other transportation equipment	088:	Water transportation
078:	Aircraft and parts	089:	Air transportation
080:	Aircraft, missile, and spacecraft propulsion units	089:	Air transportation
019:	Maintenance construction	090:	Pipelines, except natural gas

For the purpose of documentation, the above transactions are discussed by consuming MRIO transportation sector in the sections that follow.

Maintenance and Repair Inputs to Railroads (MRIO 085)

The total value of maintenance construction work on railroad way and structures (both force-account and contract, combined) was estimated for 1977 at both the national and state levels. The national control on the value of railroad maintenance construction in 1977 is from Yearbook of Railroad Facts (Source 22051), 1979 edition, and it represents total expenditures by railroads to maintain their way and structures. The national control was distributed to states on the basis of railroad mileage by state in 1977, from Yearbook of Railroad Facts, 1979 Edition.

Maintenance and Repair Inputs to Motor Freight (MRIO 087)

Approximately 80 percent of the transactions between MRIO 077, Motor Vehicles and Parts, and MRIO 087, Motor Freight, are accounted for by the value of purchased vehicle parts. The value of vehicle parts purchased by the Motor Freight sector[1] in 1977 was estimated from primary data at the national level, and then inflated to account for remaining inputs from MRIO 077 using the BEA updated 1977 coefficients. Additional details are provided below.

According to our estimates, 57.8 percent of the value of vehicle parts purchased by MRIO 087 is accounted for by the purchases by Class I Common Carriers of General Freight in Intercity Service, as reported in Table 5 of Transport Statistics (Source 16111), 1977, Part II. Coupled with the value of all operating expenses for this carrier group (from the same source), the means of estimating the value of vehicle parts for other carrier groups was devised, as follows. The ratio of vehicle parts expense to total operating expense was developed using the above data for Class I Common Carriers of General Freight in Intercity Service and then multiplied by the total operating expenses of each of the following motor freight carrier groups:

- Class I Common Carriers of Other Than General Freight in Intercity Service;
- Class I Contract Carriers in Intercity Service;
- Class I Household Goods Carriers in Intercity Service;

[1] *In terms of I-O, this is the transaction between BEA 590302 (MRIO 077) and BEA 650300 (MRIO 087).*

- Class I Carriers in Local Service; and
- Class II Carriers of Property in Intercity Service.

With the exception of Class II Carriers of Property in Intercity Service, the total operating expenses of the carriers listed above were obtained from Tables 11, 12, 13, and 19 in Transport Statistics, Part II. Total operating expenses for Class II carriers were obtained from the Interstate Commerce Commission. The result of the above procedure was estimates of vehicle parts purchases by each carrier group. These were summed to obtain a total. As part of the initial data development process, the same procedure was employed to estimate the value of vehicle parts purchased by the nonregulated motor carriers as well. In conjunction with the vehicle parts analysis, expenses for purchased repair services were also analyzed, revealing the fact that the nonregulated motor carriers purchased proportionately nearly eight times as much repair service (from outside vendors) as did Class I Common Carriers of General Freight in Intercity Service. This led to the conclusion that virtually all of the repairs on nonregulated trucks are performed outside the trucking establishments; thus, virtually all of the vehicle parts would be purchased by the repair establishments. On this basis, the estimated value of vehicle parts purchased by nonregulated carriers was not included in the total for MRIO 087.

Maintenance and Repair Inputs to Water Transportation (MRIO 088)

The transactions between Other Transportation Equipment (MRIO 081) and Water Transportation (MRIO 088) primarily consist of the value of repairs and conversions performed on commercial water transportation vessels by establishments in BEA I-O Sector 610100, Ship Building and Repairing, one segment of MRIO 081. The total value of repairs and conversions of nonmilitary ships by U.S. ship building and repairing establishments is reported in the Annual Report of the Shipbuilders Council of America (Source 22231). However, this value does not represent the desired transaction between BEA 610100 and MRIO 088 because it includes the value of repairs and conversions to ships that are owned and operated by the transportation divisions of non-transportation companies (oil tankers are a good example.) Within non-transportation companies, only their water transportation subsidiaries which have a separate corporate identity are included in MRIO 088. Due to a lack of primary data for 1977 which would indicate what proportion of the total repairs and conversions were performed on vessels in MRIO 088, the following technique was used to estimate the value of this work in

1977. The value of total non-military ship repairs and conversions in 1977 was divided by the corresponding value for 1972 to form an update factor which was subsequently multiplied by the 1972 BEA I-O transaction between BEA sectors 610100 and 650400 (same as MRIO 088). The resulting estimated value of repairs and conversions on vessels in MRIO 088 was inflated to include the other inputs from MRIO 081 using the BEA updated 1977 coefficients.

Maintenance and Repair Inputs to Air Transportation (MRIO 089)

A control was developed from primary data on the aggregate value of 1977 purchases from MRIO 078, Aircraft and Parts, and MRIO 080, Aircraft, Missile, and Spacecraft Propulsion Units,[1] by the Air Transportation sector. This maintenance and repair control was disaggregated to the two producing MRIO's on the basis of the proportional split between their BEA updated 1977 coefficients. Additional details on the development of the control are provided below.

All input data used in developing the maintenance and repair control were obtained from Civil Aeronautics Board publications. From Part IV of the 1979 Supplement to the Handbook of Airline Statistics (Source 17211), the total maintenance expenses of 1) the certificated route air carriers, and 2) the charter air carriers[2] were obtained. Next, the proportions of total maintenance expense attributable to 1) material for flight equipment and maintenance, and 2) outside (purchased) flight equipment maintenance, were computed using detailed expense data for domestic operations of domestic trunk airlines,[3] from Tables 1A, 1C, and 1F of Trends in Airline Cost Elements (Source 17221), 1957-1978 Edition. The detailed expense data covered these items:

- maintenance material;
- outside (purchased) flight equipment maintenance;
- maintenance - flight equipment only; and
- maintenance - ground property and equipment only.

[1] *Only aircraft engines are included in this case.*

[2] *Formerly called the supplemental air carriers.*

[3] *Domestic operations of domestic trunk airlines represent a significant segment of the operations of certificated route air carriers.*

By dividing maintenance — flight equipment only, by the sum of this item and maintenance — ground property and equipment only (sum equals total maintenance), a ratio was formed which was subsequently multiplied by the maintenance material figure to obtain an estimate of material for flight equipment maintenance. This in turn was divided by the total maintenance sum, yielding the estimated proportion of total maintenance expense attributable to material for flight equipment maintenance. The expense item for outside (purchased) flight equipment maintenance was divided by the total maintenance sum, yielding the estimated proportion of total maintenance expenses attributable to outside (purchased) flight equipment maintenance. These two proportions were multiplied by the total maintenance expenses of 1) the certificated route air carriers, and 2) the charter air carriers, in order to obtain the value of material for flight equipment maintenance and of outside (purchased) flight equipment maintenance for each carrier group. Finally, each expense item was summed to the total industry level (certificated plus charter) and then the sum of the two expense items at the total industry level became the maintenance and repair control for MRIO 089.

Maintenance and Repair Inputs to Pipelines, Except Natural Gas (MRIO 090)

The value of maintenance construction performed on petroleum pipelines in 1977 was estimated at both the national and state levels. The sources and methods employed in developing these data are documented in Chapter 6.

Insurance and Communications Inputs to Air Transportation

The remaining inputs that could be estimated from primary 1977 data (and were accepted as being of adequate quality) are the communications and insurance inputs to the Air Transportation sector, MRIO 089, from MRIO 092, Communications, Except Radio and TV, and MRIO 104, Insurance. These data were developed simultaneously, as documented below.

The communications and insurance inputs to Air Transportation were developed using data from the same Civil Aeronautics Board publications used in developing maintenance and repair inputs to the sector (see previous section). From Trends in Airline Cost Elements 1957-1978 edition, Table 1F, the communications and insurance expenses

of the domestic trunk airlines[1] in domestic operations were compiled. These figures were then inflated to account for the value of these inputs to the other carrier groups in MRIO 089. Data on total operating expenses of 1) the certificated route air carriers, 2) the charter air carriers,[2] and 3) domestic operations of the domestic trunk airlines, were compiled from Part IV of the 1979 Supplement to the Handbook of Airline Statistics. The operating expenses of the certificated route and charter air carriers were summed and the result was divided by operating expenses of the domestic trunk airlines in domestic operations to obtain an expansion factor. The expansion factor was multiplied by the communications and insurance inputs to domestic operations of the domestic trunks, yielding estimates of these inputs to all of MRIO 089.

Data Quality

The inputs to transportation that were developed from primary data, as documented in the preceding sections of this chapter and in Chapter 2 account for the following percentages of total intermediate inputs (cost of supplies) by MRIO transportation sector.

MRIO Transportation Sector		% of Total Intermediate Inputs
085:	Railroads	66.8
086:	Local passenger transportation and intercity bus	19.0
087:	Motor freight	24.7
088:	Water transportation	29.4
089:	Air transportation	45.1
090:	Pipelines, except natural gas	49.1
091:	Transportation Services	7.7

As stated in the introduction and overview section, the remainder of the transportation inputs were developed using the 1972 BEA input coefficients, updated for changes in relative prices to 1977. These are not considered to be as reliable as the inputs estimated from 1977 primary data, since they are of 1972 vintage.

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[1] *A significant segment of the certificated route air carriers.*

[2] *Formerly called the supplemental air carriers.*

The major shift in the technical coefficients for transportation between 1972 and 1977 is in the energy area, due to OPEC price increases for crude oil, and the subsequent price increases for petroleum products and also competing energy products such as coal, natural gas, and electricity. Every effort has been made to insure that the inputs estimated for transportation reflect the changed technical coefficients implied by the price increases for energy products.

CHAPTER 9

GOVERNMENT ENTERPRISES

This chapter discusses the development of input data for two MRIO sectors, Federal Government Enterprises, and State and Local Government Enterprises. The concordance between MRIO and BEA I-O sectors is as follows:

MRIO Sector		BEA I-O Sector	
118:	Federal Government Enterprises	7801	U.S. Postal Service
		7803	Commodity Credit Corp.
		7804	Other Federal Government Enterprises
119:	Other State and Local Government Enterprises	7903 pt.	Part of Other State and Local Government Enterprises

Overview of Inputs and Methodology

1977 data on one component of MRIO 118, the Commodity Credit Corporation, was available and used in the MRIO data base. Inputs of energy fuels, real estate and rental payments, noncomparable imports and scrap were developed based on 1977 data (Chapter 2). The remaining inputs to MRIO Sectors 118 and 119 were developed from the 1972 BEA data updated (for price changes) to 1977. Coverage of inputs with 1977 data is shown below:

MRIO	1977 Inputs of Energy, Real Estate, Noncomparable Imports, & Scrap (Percent of Total Inputs)	Other 1977 Input Data Developed (Percent of Total Inputs)
118	26%	19.3%
119	15%	0%

Methodology: MRIO Sector 118, Federal Government Enterprises

The Commodity Credit Corporation (CCC), part of MRIO 118, purchases agricultural and food products, transportation, and storage services. In 1977, the inputs to the Commodity Credit Corporation were:

BEA I-O Code and Description

20100 Cotton
20201 Food Grains
20202 Feed Grains
20501 Vegetables
20600 Oil Bearing Crops
140400 Condensed & Evaporated Milk
141401 Flour & Other Grain Mill Products
141402 Cereal Preparation
141403 Blended & Prepared Flour
141502 Prepared Feeds n.e.c.
141600 Rice Milling
142600 Vegetable Oil Mills
143200 Food Preparations, n.e.c.
270401 Gun & Wood Chemicals
650100 Railroads & Related Service
650300 Motor Freight Trans. & Warehousing
650400 Water Transportation

Data sufficient to develop national totals for these purchases for 1977 was found in the CCC's annual publication: Report of Financial Condition and Operations FY 1977 (Source 02411). Unpublished quarterly data was used to adjust the data given in this report to a calendar year basis (Source 02411).

The CCC does not have a state-level breakdown of these commodity purchases. However, officials contacted thought it a reasonable to assume that their commodity purchases display the same state pattern as the production data for these commodities. State output data were developed previously for the commodities listed above and are described in the JFA report State Estimates of Outputs, Employment and Payrolls, 1977. These data were used to distribute the national CCC purchases among states.

The CCC report also contained data on purchases of transport and storage services. These data were given by commodity, making it possible to distribute the transport and storage purchases across states using the state distributions of the commodity outputs.

The 1972 BEA I-O matrix updated to 1977 was used to estimate the remaining inputs to MRIO 118. Since 1) MRIO 118's two remaining components, U.S. Postal Service, and Other Federal Government Enterprises, had separate BEA I-O codes and 2) 1977 output data had been developed by JFA at the state level by BEA I-O code, data were available for weighting the two input vectors at the state level. This produced separate input data by state for the Postal Service and Other Federal Government Enterprises. The final MRIO 118 input vector was then constructed by simply summing these and the inputs to the Commodity Credit Corporation, by state.

Methodology: MRIO Sector 119, Other State and Local Government Enterprises

Inputs of energy fuels, real estate and rental payments, noncomparable imports and scrap were developed based on 1977 data (Chapter 2). All other inputs to MRIO 118 were developed using the 1972 BEA I-O data for BEA Sector 7903, updated for price changes to 1977. The correspondence between BEA Sector 7903 and MRIO 118 is not exact, however. Of the activities included by BEA and listed below, only those marked with an asterisk are included in MRIO 119:

- Water
- Sewerage
- Gas
- Toll Highways*
- Water Transportation*
- Housing and Urban Renewal*
- Airports*
- Lotteries
- Other Commercial Activities
  - parking lots*
  - liquor stores*

BEA working papers (Source 03514) contained data disaggregating inputs to BEA Sector 7903 into nine component vectors representing the nine categories listed above. One further disaggregation was needed to split the "other commercial activities" vector between liquor stores and parking lots. This split was performed by simple inspection of

between liquor stores and parking lots. This split was performed by simple inspection of the data. The two functions are sufficiently disparate that separation of their inputs was relatively straightforward. The next step was the distribution of each of the six input vectors to states. Each vector was weighted by the 1977 state and local expenditures on each activity. The vectors were summed for each state, and converted to coefficients. The coefficients vary from state to state, reflecting the differences in the importance of each component of MRIO 119 to the state.

Data Quality

Data developed for the Commodity Credit Corporation was taken directly from a primary source and is of high quality. All other government enterprise sectors were developed on the basis of 1972 input patterns, updated for price changes to 1977.

State distributions are believed to be of high quality for the Commodity Credit Corporation. State distibutions for Federal government enterprises are believed to be good for the Post Office but only fair for the "other" Federal enterprises category. State distributions for the state and local government enterprises are based on Census data and are believed to be very good.

CHAPTER 10

OTHER SECTORS

Inputs of energy, real estate and rentals, noncomparable imports, and scrap to MRIO Sectors 092-117 were developed from primary 1977 data by the methods described in Chapter 2. Other inputs to MRIO Sectors 092-117 were developed using the 1972 BEA I-O matrix updated for prices to 1977.[1] Chapter 1 and Appendix A detail the procedures used in updating the BEA data and integrating it into the MRIO data base. The adjustments required in some sectors to accommodate differences in the MRIO and BEA definitions of sectors are discussed below. MRIO sectors that are not mentioned required no adjustments.

Electric Utilities

MRIO Sector 094, Electric Utilities, includes three BEA I-O Sectors: Electric Services (I-O 6801), Federal Electric Utilities (I-O 7802), and State and Local Electric Utilities (I-O 7902). The price updated BEA coefficients were summed across these three BEA I-O sectors to determine the coefficients for the MRIO sector. This was accomplished in two steps:

1. BEA inputs coefficients were weighted, at the state level, based on the percentage of output in 1977 for each BEA I-O sector, by state.[2]

2. The coefficients were summed across BEA I-O sectors to produce MRIO level coefficients which, when multiplied by output, result in dollar values for inputs.

Input coefficients vary by state based on the relative importance of the three utility types.

The major material inputs for this sector are comprised by fuels for which 1977 data were developed as described in Chapter 2.

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[1] *Inputs of energy, real estate, noncomparable imports, and scrap are not discussed in this chapter. Refer to Chapter 2 for a description of the development of data on these inputs.*

[2] *See JFA's State Estimates of Outputs, Employment and Payrolls, 1977.*

Gas Production and Distribution

MRIO Sector 095, Gas Production and Distribution, includes all of BEA I-O Code 6802 (Gas Production and Distribution Utilities) and part of BEA I-O Code 7903 (Other State and Local Government Enterprises). The input vector for the state and local government utilities was assumed to be the same as the input vector for the private utilities. This eliminated the ambiguities involved in dividing the inputs to BEA I-O 7903 (Other State and Local Government Enterprises), a sector containing nine separate types of enterprises, among each of its nine components.

The major material inputs for this sector are comprised by fuels for which 1977 data were developed as described in Chapter 2.

Water and Sanitary Services

MRIO 096, Water and Sanitary Services, includes all of BEA I-O Sector 6803 (Water Supply and Services), and part of BEA I-O Sector 7903 (Other State and Local Government Enterprises). Input data for this sector (except the inputs covered in Chapter 2) were estimated using price updated BEA coefficients for BEA I-O Sector 6803 and applying them to the total cost of supplies and services for the MRIO sector. This procedure, which is essentially the same as that used for MRIO 095, Gas Production and Distribution, assumes that the inputs to the portion of MRIO 096 contained in BEA's Other State and Local Government Enterprises sector are the same as the inputs to BEA's Sector 6803 (Water Supply and Services).

Retail Trade

The MRIO industry classification separates retail trade into four sectors:

MRIO 099	General Merchandise and Apparel Stores
MRIO 100	Food, Drug, and Liquor Stores
MRIO 101	Automotive Dealers and Gasoline Service Stations
MRIO 102	Other Retail Stores

The BEA classification scheme contains only one retail trade sector, BEA 6902. To split BEA's retail trade sector column (that is, to distribute the inputs to each of the four consuming MRIO retail trade sectors), the proportion of each MRIO retail trade

sector's output to total retail trade output was used. This method makes the assumption that inputs to each of the four retail trade MRIO sectors are the same, the input amount varying based on each retail sector's output.[1]

Real Estate and Rental

MRIO 105, Real Estate and Rental, is composed of two BEA I-O Sectors: 7101, Owner-Occupied Dwellings; and 7102, Real Estate. The price updated BEA coefficients were summed across the two BEA sectors to determine the coefficients for the MRIO sector. This was accomplished in two steps:

1. BEA input coefficients were weighted, at the state level, based on the percentage of output in 1977 each I-O sector, by state.[2]

2. The coefficients were summed across BEA I-O sectors to produce MRIO level coefficients which, when multiplied by output, result in dollar values for inputs.

Input coefficients vary by state, according to the relative importance of the two BEA real estate and rental sectors.

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[1] *In order to use the 1972 data on margins to revise the BEA coefficients to a "purchasers' value" basis (see Appendix A), it was also necessary to split BEA's retail trade sector row, that is, to distribute the retail trade margin of each consuming sector between the four MRIO retail trade sectors. BEA's "1972 I-O Output File in Producing Industry Sort Sequence" (Source 03509, on microfilm) was the source of the data used for this distribution. For each BEA consuming sector, the product(s) of each producing sector, to which the retail trade margins were attached, were matched to the MRIO retail trade sector most likely to have sold that product. The retail trade margins associated with the products assigned to each of the MRIO retail sectors were summed. These sums were used to split the total retail trade margin, as reported by BEA, into four MRIO sectors.*

[2] *Output in 1977 for each BEA I-O sector was developed, by state, as part of earlier research for this project.*

Health Services

The MRIO industry classification contains three health services sectors:

112: Doctors and Dentists, including Outpatient Care Facilities

113: Hospitals and Nursing Homes

114: Other Medical and Health Services

The BEA and SIC sectors corresponding to each of the MRIO sectors are shown below:

MRIO	BEA	SIC	Description
112	Pt. 7701	801	Physicians
	Pt. 7703	802	Dentists
		803	Osteopaths
		8041	Chiropractors
		808	Outpatient care facilities
113	7702	805	Nursing and personal care facilities
	Pt. 7703	806	Hospitals
114	Pt. 7701	0074	Veterinary Services
	Pt. 7703	8049	Health practitioners, n.e.c.
		807	Medical and dental laboratories
		809	Health and allied services, n.e.c.

Inputs to BEA Sectors 7701, 7702, and 7703 were adjusted to reflect the MRIO sectoring plan using the detailed data in BEA's "1972 I-O Output File in Producing Industry Sort Sequence" (Source 03509). The data in this BEA workfile provide the SIC level breakdowns required for the redistribution of input data. Following redistribution, the inputs are summed to the MRIO level, and converted to input coefficients.

Secondary Products and Redefinitions

There were three redefinitions affecting one of the sectors discussed in this chapter: wholesale trade. The activities, affected sectors, and amounts redefined are listed below:

Activity	Secondary Producers	Primary Producers	Amount ($ millions)
Receipts for and Selling Purchased Carcasses	097 Wholesale Trade	021 Meat Products	$ 4,259.3
Receipts for Prepared in Manufacturer's Sales Branches	097 Wholesale Trade	021 Meat Products	$ 4,088.0
Receipts for Poultry Dressing Wholesale Trade Establishment	097 Wholesale Trade	021 Meat Products	$ 187.7

The theory and data development underlying these redefinitions is discussed in Chapter 11 of this volume.

In addition to the three redefinitions, there were 18 by-product treatments and five other adjustments to MRIO sectors 092-117. Many of these by-product treatments and adjustments represent activities that were redefined in the 1972 BEA I-O data base. Accounting for the inputs associated with these redefinitions is a very important part of the development of input data to the sectors that are discussed in this chapter. Procedures used to implement the by-product treatment are detailed in Chapter 11.

Data Quality

The 1977 inputs developed for MRIO Sectors 092-117 were inputs of energy, real estate, noncomparable imports and scrap. The methodology used to develop these data and the resulting data quality are described in Chapter 2 of this report. Lacking reliable data on the remaining inputs, these inputs were estimated use price-updated 1972 BEA coefficients. To the extent that input data were developed using BEA's 1972 matrix updated for prices to 1977, the quality of these data is unknown. The quality depends on the degree to which the inputs to each industry, in constant dollars, have remained unchanged between 1972 and 1977.

CHAPTER 11

SECONDARY PRODUCTS AND REDEFINITIONS

Theory Underlying the Treatment of Secondary Products and Redefinitions

In the construction of input-output tables a serious problem arises due to the commonplace occurrence of production of more than one type of good or service by an industry. Since raw data on inputs are almost always collected on an establishment basis (with establishments commonly classified by SIC industry codes), such data reflect the total required inputs for the production of a mix of distinguishable products. In a highly aggregated I-O table, product mixes are mostly contained within the defined sectors, and the problem is less serious. However, as the level of disaggregation of the table increases, the distinction between the primary product and secondary products of an industry becomes more necessary, since product mixes will generally involve more than one sector. If careful attention is given to the pattern of product mixes during the definition of the sectoring plan, as was done for the MRIO, a large portion of the secondary product problem becomes moot. There are, however, a host of data availability constraints which preclude complete elimination of the product mix problem. Once the sectoring plan is fixed, raw input data collected on an establishment basis must be appropriately adjusted to account for the product mix produced by each industry.

Two methods of adjustment have been used in the MRIO model, redefinitions for a minority of special cases and a by-product approach for the remainder. A complete discussion of the MRIO philosophy for redefinitions and secondary products is contained in MRIO Procedures Paper No. 2, attached as Appendix B.2 to this report. The mathematical expression of the secondary product method is described in MRIO Procedures No. 3 (Appendix B.3). The remainder of this section contains an overview of the content of these documents and contrasts the MRIO methods with another common approach to secondary products currently in use by BEA. The following section contains a detailed discussion of methods used for specific secondary products and redefinitions.

Redefinitions

Redefinition involves the transfer of the secondary output, associated inputs, and value-added from the raw establishment data for the original sector in which the products are produced to the sector to which such products are primary. Such a treatment requires a large amount of analysis, both now and in updates. Redefinitions were made in the MRIO only when the general by-product method did not seem appropriate, such as when the inputs required for the secondary product are clearly similar to those of the sector to which the product is primary. After all redefinitions were made, the remaining secondary product information contained in the product mix data was addressed using a more mechanical by-product approach, based on assumptions pertaining to the future patterns of production of each industry. The assumptions used in the MRIO model are discussed in the next section on secondary products.

In the MRIO redefinitions have been used only where considered necessary to preserve the essential features of the sectoring plan. For example, force account construction activities in the rail and utility sectors have been retained as redefinitions in the MRIO. A complete discussion of force account construction redefinitions is given in Chapter 6. Other less significant redefinitions used by BEA in 1972, such as receipts for crop and livestock services performed in wholesale trade establishments, have not been redefined in the MRIO model. Although the activity in question was treated by BEA in 1972 by redefining it from wholesale trade to agricultural services, in the MRIO it is treated as a by-product production of crop and livestock services which take place as a secondary activity in the wholesale trade sector.

It is important to note the difference in the input column for the wholesale trade industry which results from adopting the MRIO approach rather than the 1972 BEA approach. In the MRIO approach, the inputs required for the crop and livestock services which take place in wholesale trade are retained in the wholesale trade column, while in the BEA redefinition approach these inputs (and the corresponding output) are moved to the agricultural services column. The MRIO approach results in the activity being a secondary product of the wholesale trade sector. Where the updated 1972 BEA coefficients are used to provide input coefficients for the wholesale trade activity in the MRIO, this difference in treatment of the secondary product must be addressed by adding the appropriate crop and livestock services inputs back into the 1972 BEA wholesale trade input column. The appropriate inputs were approximated by applying the input coefficients from the agricultural services column of the 1972 BEA table to the amount of the by-product involved. After performing this adjustment, the resulting

coefficients in the wholesale trade column are different than the original 1972 BEA table values, while the resulting coefficients in the agricultural services sector remain unchanged.

In the following section on data development, specific treatment of redefinitions in the MRIO are presented. The adjustments to the BEA table required when 1972 coefficients were needed for MRIO sectors which produced by-products are discussed in the data development section as part of the data development for secondary products. Before proceding to the discussion of data development, the theoretical framework of the MRIO's methods for handling secondary products is reviewed.

Secondary Products

After appropriate adjustments for redefined activities, the results of Task 6 are contained in a matrix which gives the joint commodity inputs required to produce the primary and secondary products of each industry. In the literature this matrix is often called the use matrix, denoted here by $U^* = (U_{i,j})$ where $U_{i,j}$ denotes the use, in purchaser's value, of commodity i by industry j. The sum of the entries in the jth column of U^* is the total inputs to industry j. The sum of the total inputs and the value-added by industry j equals the output of industry j. When the entries in the jth column of U^* are divided by the total output of industry j, the resulting column-standardized use matrix will be denoted by U.

Information on primary and secondary product production is commonly stored in a matrix called the make matrix, $M^* = (M_{i,j})$, where $M_{i,j}$ denotes the production of commodity j by industry i. The column sums of M^* are the total output of each commodity. Standardizing each entry in the make matrix by its column sum yields the column-standardized make matrix, denoted here by M. Note that M is a market shares matrix which shows as its jth column the percent of the production of commodity j which is produced by each industry. Alternatively the transpose of the make matrix may be standardized by its column sums, which are the total industry outputs. The resulting matrix shows in the jth column the percentage of the output of the jth industry accounted for by each commodity. The column-standardized transposed make matrix is denoted in this section and in Procedures Paper No. 3 as the by-product matrix, B.

When an input-output model is used as a forecasting tool, it is necessary to make an assumption about how secondary production will change over time. One possible choice is to assume that M remains constant over time. Such an assumption may be called the fixed market share assumption, since the percentage of the total consumption of a given commodity which is supplied by each industry remains fixed. Alternatively it may be assumed that B stays constant over time, implying that the mix of products produced by each industry remains fixed. The latter assumption may be referred to as the fixed product mix assumption. It should be noted that holding the market shares fixed for each commodity will result in a change in the product mix produced by some or all industries in the future, while holding the product mix constant for each industry will result in a change in market share for some or all commodities. These two assumptions are the most commonly used assumptions when "pure" input-output tables have been assembled, a "pure" table being one in which the matrix has industry columns and commodity rows, as does the MRIO.

In Procedures Paper No. 1, the by-product approach used by the MRIO model is introduced using a national level table. In Procedures Paper No. 3 this approach is formalized for the MRIO model which uses producing and distributing sectors. Following the notation of the latter paper, a very simple expression of the by-product approach may be obtained from Exhibit 4 by sorting the sectors so that the producing sectors are listed first, followed by all the distributing sectors. Ignoring imports and exports, the resulting equations may be written in block partitioned matrix form as

$$\left(\begin{array}{c|c} B & -T \\ \hline -U & I \end{array}\right)\begin{pmatrix} X \\ C \end{pmatrix} = \begin{pmatrix} O \\ Y \end{pmatrix} \qquad (1)$$

where B is a block diagonal matrix with the state-level by-product matrices, $\underline{B}_j$, along the diagonal, U is a block diagonal matrix with the state-level use matrices, $\underline{U}_j$, along the diagonal, and X, C, and Y are the industry output, commodity consumption and final demand vectors respectively. The trade flow and margin matrix, $T = (T_{i,j})$, reduces to the identity matrix, I, if there are only one region and no margins. The system of equations in (1) may be solved for X and C as a function of Y by solving simultaneously the equations

$$\begin{aligned} BX - TC &= O \\ -UX + C &= Y \end{aligned} \qquad (2)$$

The solution is

$$\begin{aligned} C &= (I - UB^{-1}T)^{-1}Y \\ X &= B^{-1}TC \\ &= B^{-1}T(I - UB^{-1}T)^{-1}Y \\ &= (T^{-1}B - U)^{-1}Y \end{aligned} \qquad (3)$$

Solution of the reduced-form equations in (3) requires inversion of a 6,000 by 6,000 matrix, while the direct solution of (1), which is discussed in Procedures Paper No. 3, requires the inversion of a 12,000 by 12,000 matrix.

A comparison of the by-product approach with the market share approach may be easily made by considering a national level or single region model with no margins. Then equation (1) reduces to

$$\begin{pmatrix} B & -I \\ -U & I \end{pmatrix} \begin{pmatrix} X \\ C \end{pmatrix} = \begin{pmatrix} O \\ Y \end{pmatrix} \qquad (4)$$

giving the solution

$$\begin{aligned} C &= (I - UB^{-1})^{-1}Y \\ X &= (B - U)^{-1}Y \end{aligned} \qquad (5)$$

Adopting the assumption of fixed market shares, the resulting equations would be

$$\begin{pmatrix} I & -M \\ -U & I \end{pmatrix} \begin{pmatrix} X \\ C \end{pmatrix} = \begin{pmatrix} O \\ Y \end{pmatrix} \qquad (6)$$

giving the solution

$$\begin{aligned} C &= (I - UM)^{-1}Y \\ X &= MC \\ &= M(I - UM)^{-1}Y \\ &= (M^{-1} - U)^{-1}Y \end{aligned} \qquad (7)$$

By comparing the right hand sides of equations (5) and (7), we see that the two methods lead to different algebraic results. However, a recent unpublished paper by Karen

Polenske and Lorris Mizrahi of MIT demonstrates that the two approaches lead to remarkably similar numerical results, when applied at the national level to an 80-order table. In their study significant differences occur only for sectors with substantial amounts of secondary product production. The forthcoming MIT paper also contains an illuminating account of the alternative secondary product approaches used by various I-O modelers.

One disadvantage of the by-product method of equations (1) through (3) is that the industry outputs need not be positive for all specifications of final demand. A simple explanation can be given for this. The use of the by-product approach assumes that the secondary production of an industry occurs in fixed proportion to primary product production. By sufficiently increasing the final demand for the primary product, more secondary product can be produced than is demanded. In such cases solution (3) will produce negative output for the industry which produces the over-supplied secondary product as its primary product, in order to preserve the balance of production and consumption of the secondary product. Commodity consumption, however, remains positive.

This disadvantage is minimal when a full bill-of-goods is specified, since it is unlikely that a realistic specification of final demand will be sufficiently different from the base year final demand to cause negatives to appear in the output vector. When changes in a partial bill-of-goods is specified, some sectors may show decreases in production even if all specified changes in final demand are positive. Whether this result is unrealistic depends on the validity of the fixed product mix assumption. Preservation of fixed market shares will lead to positive solutions for both output and consumption. However, this in itself is not sufficient grounds to validate the market share approach.

BEA is currently using the market share approach, while the UN has recommended the fixed product mix assumption, derived from somewhat different postulates. The UN methodology begins with the assumption that each commodity requires the same commodity inputs, regardless of where it is produced. Beginning with this postulate the UN method leads to equation (3) as the solution, with the matrix UB^{-1} being interpreted as containing pure commodity inputs required to make each commodity. Unfortunately, when the method is applied to actual industry data, it is often the case that UB^{-1} contains negative entries, indicating that the stringent assumption of identical input

vectors regardless of where the commodity is produced cannot be substantiated. It is interesting that the MRIO assumptions lead to the same solution as the UN method, without postulating that UB^{-1} is the pure commodity input matrix. The block matrix representation of equations (1), (4) and (6), which are based on the concept of separate production and distribution activities, should prove useful in the future exploration of the relative merits of the product mix versus the market share assumptions. Derivation of "hybrid" approaches which combine the best features of both approaches are currently being studied here and at MIT. The MRIO accounts are currently constructed using the by-product approach, but the data base will be assembled in a manner which permits the use of alternative assumptions when applying the model to forecasting applications.

In the following section specific activities which were treated as redefinitions or by-products are itemized and the methods of data development are explained for each.

Data Development

Information on production of primary and secondary products by each state-level MRIO producing sector is stored in the MRIO by-product matrix. Data required for assembly of the 1977 MRIO by-product matrix come from a variety of sources, as did the data required for the 1977 use matrix. In addition to the many cases of secondary products listed by BEA in Table 2, The Make of Commodities by Industries, 1972, the MRIO model contains four redefinitions, 19 new by-product activities, and nine other adjustments to industry input and output patterns. Only the new by-product activities and adjustments created for the MRIO are specifically enumerated here.

There were two aspects to the data development. First, since price-updated 1972 BEA input coefficients are used in the 1977 MRIO data base for some industries and since the MRIO model does not address the same redefinitions, by-products, and other adjustments as does the BEA model, the redefinitions and other adjustments in the 1972 BEA table were removed in the appropriate sectors. This reverted the BEA table to a baseline from which the MRIO data development could proceed. This process is referred to as "inverse redefinition."

The second part of the data development was the development of state-level 1977 estimates of the redefinitions, by-products, and adjustments used in the MRIO. In some

cases the estimates were made using primary 1977 product-based output data. Where the product-based data were not available, the estimates were prepared by applying the price updated percentage of an industry's output that was redefined or otherwise adjusted in BEA's 1972 make table to the industry's 1977 total output. Further detail on specific by-products and adjustments is provided below.

Inverse Redefinitions

Inverse redefinitions involved transferring outputs redefined, treated as secondary products, or otherwise adjusted in BEA's 1972 I-O methodology, along with their associated inputs, back to the industry from which they had been redefined. Values used in the inverse redefinitions were taken directly from Table A of a BEA Staff Paper, Definitions and Conventions of the 1972 Input-Output Study, July 1980.

The inverse redefinition procedure was used only where:

1) the adjustment to output made by BEA in 1972 was greater than $200 million, and

2) the adjustment made using the BEA industry classification scheme would not be an intrasector flow in the MRIO sectors plan.

Thirty-six inverse redefinitions were required.

Redefinitions

Unlike the 1972 BEA model, in which many redefinitions were made, there were only four redefinitions performed on the 1977 MRIO establishment data. The activities, primary and secondary producers, and amounts of output redefined are listed in Exhibit 11-1.

The source of the data for the redefinition from MRIO 097, Wholesale Trade, to MRIO 021, Meat Products, was the 1977 Census of Wholesale Trade (Source 03102), Commodity Line Sales. The redefined amount, $187.7 million, was obtained by adding across Wholesale "Kinds of Business" in Tables 3, 5, and 7 the sales of commodity line 4212, Dressed Poultry Killed at Establishment. Primary state data were not available.

EXHIBIT 11-1:

MRIO REDEFINITIONS APPLIED TO ESTABLISHMENT DATA*

Activity	Secondary Producer (MRIO Sector)		Primary Producer (MRIO Sector)		Amount (in millions)
Receipts for Cutting and Selling Purchased Carcasses	097	Wholesale Trade	021	Meat Products	$4,259.3[a]
Receipts for Meats Prepared in Manufacturer's Sales Branches	097	Wholesale Trade	021	Meat Products	$ 408.8[a]
Receipts for Poultry Dressing Performed in Wholesale Trade Establishments	097	Wholesale Trade	021	Meat Products	$ 187.7[b]
Receipts from Establishments Primarily Producing Alumina	043	Industrial Inorganic and Organic Chemicals	057	Primary Nonferrous Metals	$1,001.0[c]

[a] *Calculated by price-updating BEA's 1972 value to 1977, and multiplying by 1977 output.*

[b] *Source: 1977 Census of Wholesale Trade (03102), Commodity Line Sales, Tables 3, 5, 7.*

[c] *Source: 1977 Census of Manufactures (03105), Industry Series, Table 5A.*

* *Additional force-account construction redefinitions are listed in Chapter 6.*

The source of the data for the redefinition from the Industrial Inorganic and Organic Chemicals industry (MRIO 043) to Primary Nonferrous Metals and Products (MRIO 057) was the 1977 Census of Manufactures (03105), Industry Series, Industrial Inorganic Chemicals, Table 5A. The 1977 output for alumina or aluminum oxide in MRIO 043 was obtained by adding the value added ($270.0 million) to the cost of materials ($731.1 million) for SIC 28195. Approximations for states were developed using 1972 Census of Manufactures data (Source 03105, Industry Series, 1972, Table 6B). Output of SIC 28195 was in the 1972 data was disaggregated into "South Region" and "New Jersey". State distributions for the South Region were developed using data on alumina plants production capacity by state in the 1977 Minerals Yearbook (10101).

The receipts for cutting and selling purchased carcasses and for meats prepared in manufacturer's sales branches, both redefined from MRIO 097, Wholesale Trade, to MRIO 021, Meat Products, were both estimated on the basis of the 1972 redefinition amounts provided by BEA in Definitions and Conventions. The estimation procedure assumed the amounts of these activities produced in Wholesale Trade were constant proportions of the output of the Meat Products sector. The relationships thus developed were applied to the 1977 output of MRIO 021, Meat Products in each state.

By-Products

In addition to the secondary products contained in BEA's Table 2, Make of Commodities by Industries, 1972, there are 19 cases of by-product activity in the MRIO data base which were not treated as secondary products but as redefinitions by BEA in 1972 (Exhibits 11-2 and 11-3). In addition 10 cases of by-products, which were listed in the 1972 BEA make table and for which actual 1977 data were available, are listed here. (The sources of the primary data are noted in the exhibits.) Estimation of the remaining by-product activities for those in BEA's 1972 make table began with the price-updating of BEA's 1972 value for the by-product production and for total BEA sector level output of the secondary producer using Bureau of Labor Statistics price indices. After aggregation to the MRIO level, the percentage of the secondary producer's output represented by the by-product activity in 1977 prices was then calculated and applied to the 1977 MRIO output. The resulting value was the estimated 1977 MRIO by-product amount.

EXHIBIT 11-2:

SELECTED MRIO BY-PRODUCTS PRODUCED IN SECTORS OTHER THAN TRADE

Activity	Secondary Producer (MRIO Sector)		Primary Producer (MRIO Sector)		Amount (in millions)
Receipts of Restaurants and Lunch Counters Operated by Hotels	106	Hotels and Lodging Places	098	Eating and Drinking Places	$6,134.3[a]
Revenue from Housing Provided by Private Colleges	115	Educational Services	106	Hotels and Lodging Places	$ 627.2[a]
Receipts from the Sale of Meals and Beverages at Bowling Alleys, Race Tracks, Golf Courses, Amusement Parks, Sports Events, and Clubs, etc.	111	Amusements	098	Eating and Drinking Places	$1,825.1[a]
Board Receipts by Private Schools	115	Educational Services	098	Eating and Drinking Places	$ 745.3[a]
Sales of Meals and Beverages by Social and Fraternal Clubs, Museum, etc.	116	Nonprofit Organizations	098	Eating and Drinking Places	$ 726.5[a]
Receipts for Food and Beverage Sales by Army-Air Force Civilian Post Restaurants, Officers' Enlisted Men's Club, and VA Canteens	118	Federal Government Enterprises, Except Utilities and Local Transit	098	Eating and Drinking Places	$ 614.9[a]
Milk Processed and Bottled on the Farm*	001	Dairy Farm Products	022	Dairy Products	$1,358.3[b]
Liquefied Petroleum Gases*	011	Natural Gas and Liquids	050	Petroleum Refining	$2,294.8[c]
Natural Sodium, Borate, and Potassium Salts Processed (Mined, Milled, etc.) at the Mine Site*	013	Chemical and Fertilizer Minerals	043	Industrial Chemicals	$ 808.8[c]

EXHIBIT 11-2:

SELECTED MRIO BY-PRODUCTS PRODUCED IN SECTORS OTHER THAN TRADE (Continued)

Activity	Secondary Producer (MRIO Sector)		Primary Producer (MRIO Sector)		Amount (in millions)
Newspaper Receipts from Advertising*	042	Newspapers and Periodicals	108	Miscellaneous Services and Advertising	$9,270.8[d]
Periodical Receipts from Advertising*	042	Newspapers and Periodicals	108	Miscellaneous Services and Advertising	$2,857.3[d]
Catalogs, Directories, and Shopping News*	042	Newspapers and Periodicals	108	Miscellaneous Services and Advertising	$ 815.5[b]
Catalogs, Directories, and Advertising Printing, Regardless of Process*	042	Newspapers and Periodicals	108	Miscellaneous Services and Advertising	$6,821.0[d]
Receipts for Telephone Directory Advertising*	092	Communications, except Radio and TV	108	Miscellaneous Services and Advertising	$1,774.1[a]
Commercial Time Sales*	093	Radio and TV Broadcasting	108	Miscellaneous Services and Advertising	$7,870.8[e]
Room Receipts from Permanent Guests*	106	Hotels and Lodging Places	105	Real Estate and Rental	$ 327.4[a]

[a] *Calculated by price updating BEA's 1972 value and multiplying by 1977 output.*

[b] *Source: U.S. Department of Agriculture Milk and Dairy Product Reports: Milk (02134).*

[c] *Source: 1977 Census of Mineral Industries, Industry Series, Table 6.*

[d] *Source: Census of Manufactures (03105), Industry Series, Table 6A.*

[e] *Sources: Federal Communications Commission, TV Broadcast Financial Data (16201) and Federal Communications Commission, AM and FM Broadcast Data (16202).*

* *Included in BEA's secondary product matrix, Make of Commodities by Industries, 1972.*

EXHIBIT 11-3:

SELECTED MRIO BY-PRODUCTS PRODUCED IN TRADE SECTORS

Activity	Secondary Producer (MRIO Sector)		Primary Producer (MRIO Sector)		Amount (in millions)
Crop and Livestock Service Performed in Wholesale Trade Establishments	097	Wholesale Trade	004	Fruits, Nuts, Vegetables, and Miscellaneous Crops and Services	$ 363.7[a]
Receipts by Grain Elevators and Farm Supply Stores for Custom Prepared Feed	097	Wholesale Trade	024	Grain Mill Products	$2,963.9[b]
Receipts for the Sale of Bakery Products Produced on the Same Premises by Retail Bakeries	100	Food, Drug, and Liquor Stores	025	Bakery Products	$1,756.8[c]
Receipts for Stemming and Drying Tobacco at Wholesale Establishments	097	Wholesale Trade	029	Tobacco Products	$1,331.6[a]
Receipts for Rebuilt Motor Vehicle Parts (excluding carburetors) produced in Wholesale Trade	097	Wholesale Trade	077	Motor Vehicles and Parts	$2,358.7[b]
Receipts for Auto Repair and Allied Services	097	Wholesale Trade	110	Auto Rental, Repair, and Maintenance	$1,808.3[b]
Lunch Counter, Refreshment Stand, and Dining Room Receipts for Prepared Foods and Drinks for Immediate Consumption	099	General Merchandise and Apparel Stores	074	Eating and Drinking Places	$1,245.1[c]
Lunch Counter, Refreshment Stand, and Dining Room Receipts for Prepared Foods and Drinks for Immediate Consumption	100	Food, Drugs, and Liquor Stores	074	Eating and Drinking Places	$1,000.1[c]

EXHIBIT 11-3:

SELECTED MRIO BY PRODUCTS PRODUCED IN TRADE SECTORS (Continued)

Activity	Secondary Producer (MRIO Sector)		Primary Producer (MRIO Sector)		Amount (in millions)
Lunch Counter, Refreshment Stand, and Dining Room Receipts for Prepared Foods and Drinks for Immediate Consumption	101	Automotive Dealers and Gasoline Service Stations	074	Eating and Drinking Places	$ 302.8[c]
Lunch Counter, Refreshment Stand, and Dining Room Receipts for Prepared Foods and Drinks for Immediate Consumption	102	Other Retail Stores	074	Eating and Drinking Places	$2,268.4[c]
Receipts for Automotive Repair Performed by Shops Primary Engaged in the Sale of Automobiles (auto dealers) or Parts	101	Automotive Dealers and Gasoline Service Station	110	Auto Rental, Repair, and Maintenance	$13,102.5[c]
Receipts for Automotive Rental, Washing, and Allied Services	101	Automotive Sales and Gasoline Service Stations	110	Auto Rental, Repair, and Maintenance	$1,580.5[c]
Receipts for Custom Tailoring, Dressmaking, and Fur Goods Production by Retailers	099	General Merchandise and Apparel Stores	033	Apparel	$ 577.9[c]

[a] *Source: 1977 Census of Wholesale Trade (03102), Commodity Line Sales, Tables 3, 5, 7.*

[b] *Calculated by price updating BEA's 1972 value and multiplying by 1977 output.*

[c] *Source: 1977 Census of Retail Trade (03101), Merchandise Line Sales, Table 1.*

Other Adjustments

There are many additional cases of by-product activity in the MRIO data which concern resales. Data development for these involved adjusting the inputs and output of certain manufacturing and service industries to account for by-product wholesale and retail trade activities (resales) which take place there. In 1972 BEA treated these resale activities by redefinition. The MRIO approach is to treat these by-product activities with an intra-sector treatment, as discussed in MRIO Procedures Paper No. 2. Since the value of resales is already included in the 1977 MRIO industry output and cost of materials controls, only a single adjustment to the input data for each industry was required. The adjustment consists of increasing the diagonal cell of the input vector by the cost of goods resold. The affected industries also have a corresponding entry in the trade rows of the by-product matrix which is equal to the receipts for resales less cost of goods sold, i.e., the trade margin on resales. In the manufacturing sectors, actual 1977 data on resales and cost of goods sold were used from the 1977 Census of Manufactures.

Exhibit 11-4 lists the sources of data for resale amounts in the service sectors. All data were available only at the national level. Adjustments were distributed to states in proportion to the state's output of each affected industry.

EXHIBIT 11-4:

ADJUSTMENTS FOR RESALES IN SERVICE SECTORS

Activity	Producer (MRIO Sector)		Estimated Margin (in millions)
Merchandise Sales Including the Sale of Used Equipment, i.e., Computers, etc.	108	Miscellaneous Services and Advertising	$ 411.5[a]
Merchandise Sales (gasoline, liquor, newspapers, candy, etc.) at Hotels, Motels, and Camps	106	Hotels and Lodging Places	$ 84.4[a]
Sale of Merchandise by Laundries, Repair Shops, and Other Personal Service Establishments	107	Personal and Repair Services Except Auto	$ 256.4[a]
Sale of Merchandise by Business Service Establishments	108	Miscellaneous Services and Advertising	$ 289.6[a]
Sale of Merchandise by Eating and Drinking Establishments	098	Eating and Drinking Places	$ 448.2[b]
Sale of Merchandise by Automobile Repair and Allied Service Establishments	110	Auto Rental, Repair and Maintenance	$ 289.1[a]
Sale of Merchandise by Bowling Alleys, Amusement Parks, etc.	111	Amusements	$ 398.1[a]
Sales at Refreshment Stands and Vending Machines Operated by Theater Owners	111	Amusements	$ 379.3[a]
Sale of Merchandise (books, supplies, etc.) by Private Schools	115	Educational Services	$ 166.5[a]
Sale of Merchandise by Museums, Clubs, Social Organizations and Other Membership Organizations	116	Nonprofit Organizations	$ 924.4[a]

[a] *Calculated by price-updating BEA's 1972 value to 1977, multiplying by 1977 output, then calculating the margin on the activity.*

[b] *Source: 1977 Census of Retail Trade (03101), Merchandise Line Sales, Table 1.*

APPENDIX A

DEVELOPMENT AND USE OF PRICE-UPDATED 1972 BEA INPUT COEFFICIENTS

The source of 1972 BEA input data was the 496-order use table from the "Detailed Input-Output Structure of the U.S. Economy: 1972," Vol. 1 (Source 03504). This table was deflated to 1977 dollars, as described in this Appendix. 1972 BEA input coefficients updated for price changes to 1977 were used in the MRIO use matrix where primary input data for 1977 were not available and could not be estimated more accurately otherwise. The following paragraphs describe the price updating procedure and the steps made to combine the input coefficients resulting from the price updating of BEA's matrix with the coefficients developed as part of the primary data collection.

Development of Price Indices

Data Source Selection

The main source of producer prices indices is the U.S. Department of Labor, Bureau of Labor Statistics, Producer Prices and Price Indexes (Source 12107), Supplement 1978, Data for 1977, (Tables 3, 4B, 9, 10, and 11), and Wholesale Prices and Price Indexes Data for 1972 (Source 12106), (Tables 4, 5, 6, and 7). An additional source is the Bureau of Labor Statistics, Time Series, I-O Output, Price and Employment Deflators (Source 12111).

The 1977 indices were collected at the BEA 496-order level and were first selected from Tables 9, 10, and 11 of Producer Prices and Price Indexes which were based on the 1972 SIC codes or product codes. However, where the information was not available by SIC code or product code, Tables 3 and 4B, of this source were used to obtain the price index at the BLS commodity code level, and this index was then assigned to its proper SIC and BEA code. When several indices for the same SIC or commodity code were given for different bases, the index based on 1967 (1967 = 100) was selected. When no index was available for a specific BEA sector, BLS' Time Series Deflator (Source 12111) was used. The deflators were arranged by I-O sector. For the construction sectors, where detail was lacking in both the BLS and Producer Prices sources, the deflators

were calculated based on the 1977 current and constant dollar construction values-in-place obtained from the Department of Commerce, Bureau of Economic Analysis, National Income and Product Accounts 1976-79, Special Supplement to Survey of Current Business, July 1981, Table 5.5 (Source 03501).

The 1972 producer price index was obtained from the Bureau of Labor Statistics, Wholesale Prices and Price Indexes (Source 12106), Supplement 1972, Tables 4 and 5 for commodity codes and Tables 6 and 7 for SIC and product codes. The majority of indexes were based on 1967 (1967 = 100).

Methodology

Since almost all price indices published by BLS were given on a 1967 base, a two-step procedure was used for calculating the 1977/1972 price deflators. First, the 1977 price indices for all BEA commodity sectors were tabulated from the 1977 report (Source 12107) and then the 1972 price indices for the same commodities were tabulated from the 1972 report (Source 12106). The 1977/1972 price deflators were calculated by dividing the 1977 indices by the corresponding 1972 indices.

Where several SIC's or commodity codes for 1977 with separate indices representing a single BEA code were given, a weighted average was obtained by using the proper relative weights shown in Tables 3 and 11 (12106, 12107). This method was also used for the 1972 weighted averages.

When the producer price index was based on a year other than 1967 or 1972, an adjustment was made to result in a 1977 index on a 1972 base. For example, a 1977 index on a 1975 base was multiplied by a 1975 index on a 1972 base which yielded a 1977 index on a 1972 base. This adjustment was utilized where a different base was used for part of the 1972 to 1977 period.

When no price index (1972 or 1977) for a certain sector was available from the BLS price index reports, the BLS output deflator (Source 12111) for that sector was used. If, however, the appropriate BLS output deflator was also not available, the BLS output deflator for a broader group of sector was used. Since BLS price indices are only for commodities, all service sector deflators were obtained from the BLS output deflators, and the new construction sector deflators were based on NIPA current and constant dollar construction values.

Estimation of Missing Data

Price indices were available for most SIC or BEA codes. When the data were not available, the index for a related product or industry was used. Where information for two or more related product codes was available, a weighted average was used to obtain a single price index.

Computation of Inflated 1972 Input Coefficients

Because of the different treatments of wholesale and transportation margins in the MRIO and BEA I-O models, the wholesale and transportation margins had to be added to the appropriate producing rows of the BEA I-O matrix before the input coefficients could be calculated. Thus, the BEA wholesale margin matrix and the transportation margin matrices (i.e., railroad, trucking, water, air and pipeline) were first inflated to 1977 dollars based on the price indices developed for those sectors. Next, each of the 496 price indices was applied to all elements in its corresponding row in the use table, yielding a table of 1972 inputs at 1977 prices and producer's values. Then as each element in the inflated wholesale trade margin matrix was added to the corresponding element in the inflated use table, the value was subtracted from the wholesale trade row in the use matrix for the same column (i.e., consuming industry). The transportation margins were similarly added and the corresponding rows adjusted. Finally, each column was summed and the coefficients were obtained by dividing the sum into each element in that column.

Before the 1972 BEA technical coefficients were calculated, several sectors had to be adjusted because the corresponding MRIO sectors followed a slightly different classification scheme. These sectors include the following:

- BEA I-O 3.0000 -- separated into MRIO 005: Forestry Products and MRIO 006: Commercial Fishing and Trapping.
- BEA I-O 8.0000 -- separated into MRIO 010: Crude Petroleum and MRIO 011: Natural Gas.
- BEA 60.0400 -- separated into SIC 3728 (Aircraft Parts) and SIC 3769 (Missile Parts).

- BEA 69.0200 -- separated into MRIO 099: General Merchandise and Apparel Stores; MRIO 100: Food, Drug, and Liquor Stores; MRIO 101: Automotive Dealers and Gasoline Service Stations; and MRIO 102: Other Retail Stores.

- BEA 77.0300 -- separated into SIC 808, which is part of MRIO 112: Doctors and Dentists, including Outpatient Care Facilities; SIC 805, which is part of MRIO 113: Hospitals and Nursing; and the rest of BEA 77.0300, which is MRIO Sector 114: Other Medical and Health Services.

For all the above split sectors (except I-O 8.0000), the BEA worksheet data file on microfilm (Source 03509) was used as a guide to provide detailed four-digit SIC information. Where BEA microfilm did not provide any further breakdown and the input was relatively small, the input value was split based on the output values of the split sectors. In the case of BEA I-O 8.0000, the same input pattern was used for both MRIO Sectors 010 and 011. One sector, SIC 3716, Motor Homes in 1977 MRIO sectoring plan, was combined with SIC 3792 (BEA I-O 61.0601) travel trailers and campers in order to create this sector, the same input pattern for BEA I-O 61.0601 was used.

In addition to separating input columns of the above sectors, the appropriate row for each sector was also split, based on the data obtained from BEA worksheet microfilm (Source 03509). For BEA I-O 8.0000 and BEA I-O 69.0200, however, no further detailed data were available from the microfilm and a special tabulation had to be made for each of these two sectors. In the case of BEA I-O 8.0000, input into the petroleum refining industry was assumed to be all crude petroleum, and inputs into all other industries, such as chemicals, were assumed to be natural gas. For BEA I-O 69.0200, the BEA 496-order retail trade margin matrix was used to provide information on the products associated with these margins. Depending on the product classification in the four MRIO retail trade sectors, the margins were assigned to the appropriate sectors accordingly.

After these adjustments had been made to the deflated BEA inputs, the input coefficients were calculated. First, the input entries in MRIO Sectors 1-84, 120 (import), and 121 (scrap) were summed and coefficients derived based on those sums. Then a different set of coefficients were calculated for service inputs based on the sums of MRIO Sectors 085-093, 96-119, 122-125. The first set of input coefficients

was then weighted by the material input control totals (except energy) and the second set was weighted by the output control less value added less total material control (with energy). This resulted in a national I-O table with data based on 1977 technology. These entries were compared one by one, with the 1977 Census data. If the Census data for a certain MRIO sector input was missing or was less than 50 percent of the 1972 data, the 1972 value was used. In all other cases, the 1977 data were inserted into the table. This new national table was then balanced and the input coefficients re-calculated and weighted by the proper control totals at the state level to obtain the 51 state input tables.

Data Quality

In deriving the commodity price deflators and applying them to the BEA use table, two basic assumptions were made: 1) the relative price change for any group of commodities is the same in all consuming sectors; i.e., regardless of how the products were purchased, they were assumed to have the same price changes; and 2) each consuming sector is assumed to have purchased the same mixture of product from any given producing sector. These two shortcomings in the deflators could have caused some undesirable price shifts, thus distorting the relative importance of some of the inputs.

Combining 1977 Input Data With the Updated BEA Matrix

The procedure that was used to incorporate the 1977 input data into the input-output table varied from sector to sector, depending on the extent of the 1977 data that were available. For some sectors, such as service sectors except transportation and commodity credit corporation, the inputs were obtained by distributing the differences between output and value added to the detailed updated BEA input coefficients. For some other sectors, such as manufacturing and mining industries, there were total costs of material control totals by industry by state and also detailed specific material consumed data. In these cases, the BEA input coefficients for each sector were separated into two portions — material inputs and service inputs, and separate control totals well applied to these coefficients. Furthermore, before the 1977 material inputs could be inserted into the table, the suppressed data items were first estimated based on the updated BEA coefficients and then the not-specified-by-kind portion was distributed over the specified items. In all sectors, however, the energy inputs, rental

payments and noncomparable imports were compiled at the state level and incorporated into the table directly at the MRIO level.

Since most of the input data were available only at the national level, the data for all sectors were either entered directly into or aggregated to a national table. The inputs at the national level were then reconciled with output and a balanced national I-O table was obtained. The input coefficients were then re-calculated and imputed to the state level from the proper control totals.

APPENDIX B.1

MRIO Procedures: No. 1
November 4, 1981

TRADE AND TRANSPORTATION MARGINS IN THE MRIO MODEL

The treatment of trade and transportation margins in input-output tables has always posed special problems. In the national input-output tables these margins are allocated to consuming industries in association with the flow of inputs to which they apply. Thus the flow of steel to automobiles carries with it the cost of transporting the steel from the steel production plant to the automobile plant. In practice it is calculated as the revenue collected by each transportation mode for hauling steel prorated over the consumers of steel. In lieu of data on the specific modal mix and distance-of-haul for each consumer, each consumer is allocated a portion of the revenues from each mode proportionate to its value of steel consumed, reflecting the national average modal-mix and distance-of-haul.

When these allocations are completed for the flows of all commodities, each consuming industry has been assigned transportation costs for each of its inputs. This set of allocations, one for each transportation mode, is referred to as a transportation margin matrix; each column records the transportation costs (for a specific mode) on each of the inputs to a specific industry. The sum of each column represents the total transportation costs to the industry for a transportation mode. These totals are then entered as a row in the main I-O table, representing the allocation of transportation freight costs (revenues) for each mode to each industry. The commodity flows are expressed in producers' values and the transportation margin inputs (together with wholesale trade and other margins) account for the difference between producers and delivered values.

In the national table this procedure can be simplified by allocating the transportation margins to the producing industries. As long as transportation costs are allocated to consuming industries proportionate to transactions values, the exact same results will be obtained in model solutions by allocating the margins as a total to producing industries. The commodity flows then represent producers' values plus the cost of transportation.

Wholesale trade margins are handled in an identical fashion to transportation margins in the national I-O table. These margins also can be allocated to producing industries, eliminating the need for the wholesale trade margin matrix. In this case, the transactions flows in the main I-O table would be expressed in producers' values plus transportation and wholesale trade margins. Thus the intermediate transactions data could be expressed in values very close to delivered or purchasers' values, the exceptions being retail trade margins, of which 90% are allocated to final demand, and minor margins for insurance. (Excise and sales taxes are now allocated in the national I-O table either to producing industries or to wholesale or retail trade as a total for each type of tax -- the effect is the same as that suggested for transportation and wholesale trade above.)

Note: It is not contended that transportation and trade margins are always allocated to consuming industries proportionate to transactions in the national I-O table; rather this is the case in an overwhelming majority of the flows and an assumption of proportionality is a close approximation of what is now the case. This follows from the simple fact that information on how these margins apply to specific consuming industries is simply not available.

The assignment of transportation and wholesale trade margins to producing sectors eliminates two arduous procedures which are cumbersome and frustrating in both the development and updating of I-O tables, and lead to considerable complexity in exposition and interpretation of the tables:

1. The margin matrix procedure explained above. This procedure is cumbersome to perform, subject to tedious revision in every case of revision to transactions in the course of balancing the table, and equally tedious in updating the table.

2. The "unpeeling" of margins from purchasers' value to obtain the producers' values in which the transactions data are finally stated. Much of the data on materials and services purchased by each industry is available only in purchasers' or delivered values; adjusting these values to producers' values is a tedious task, subject to much error, adjustments that must be revised continually to be consistent with changes as they are made to the

transactions data. These adjustments are voluminous and are difficult to track, making it extremely difficult to maintain an audit trail from the original data. In the end, much time and effort is spent on maintaining specious detail which provides no additional information over a less elaborate procedure.

Transportation and Wholesale Margins at the Regional Level

The difficulties in allocating margins to consuming industries are compounded at the state level because of the manyfold increase in the volume of the data. Instead, it is proposed to allocate the transportation freight margins and wholesale trade margins to special distribution sectors established for this purpose. A further special treatment of retail trade margins will be employed.

There are a number of complications due to the existence of inter-state trade. Thus the transportation freight margins should be associated with the movement of interstate freight, as well as intra-state shipments. It is also difficult to identify the specific state impacts or incidence of inter-state transportation: How much for the originating state? How much for the terminating state? How much for the states that are traversed?

There is a further complication with the assignment of wholesale margins by state to producing industries. The best presumption is that wholesale trade activity is associated with consumption in each state which does not generally agree with amounts produced by each industry. If wholesale trade margins were allocated to producing industries in each state, shipments out of the state would implicitly be assigned wholesale trade activity that should properly be assigned by the receiving state. This kind of distortion on the wholesale trade imputs generated by the model must be avoided.

Fortunately, the solution to these complications is rather straightforward. The procedure requires the establishment of a separate distribution sector for each industry in each state, for each sector producing commodities (or services) subject to either transportation margins or wholesale trade margins. This presents no problem and requires no additional information; the work required is simply to segregate certain flows in the accounting conventions in the model. With current computer capacities for computation and data storage, no computational constraints need be a concern.

The flows are illustrated in matrix form in Figure 1. Production in each state is represented in the diagonal matrices; the off-diagonal matrices represent the trade flows (in the diagonal cells). Production sectors are labelled P and "sell" only to a state distribution sector, P', to distribution sectors in other states and to foreign exports (see for example, line A). The distribution sector, P', sells only to consuming industries and final demand within the state. All production inputs appear in the P column. State wholesale trade margins, for each commodity (MRIO group) are allocated wholly to the state distribution sectors, P's (lines B & E). In this way wholesale trade margins are allocated only to consumption within the state.

Transportation margin assignments are slightly more complex. Freight revenues will first be calculated for each commodity for each state-to-state link for each freight mode. There will be a large number of data items but they will be calculated by computer and stored for use, based on national revenue per ton-mile (converted to flows in dollar values), using a formula for each mode which reflects fixed terminal costs at origins and destinations and line-haul costs as a function of distance between state centroids (nodes). Intra-state freight revenues per dollar of flow for each commodity will also be calculated as an integral part of the inter-state flow procedure.

These revenues by origin-destination (O-D) link will be assigned, by a formula to be worked out, partly to the originating state and partly to the terminating state (revenues for intra-state shipments are allocated to the one state).[1] It is assumed that freight costs are paid for by consumers in the receiving state. Thus freight revenues will be allocated along with the trade flows to the distribution sector in the receiving state. For example, in Figure 1, railroad freight in state 1 is allocated to the shipment of glass products to state 2 (line C), in the column for P' in state 2. (Some railroad freight in state 1 is also allocated to P' in state 1 -- for intra-state shipments of glass products.) Some railroad freight from state 2 is allocated to this shipment also (line F), also in the column for P' in state 2. Thus freight costs become part of the value in state 2's distribution sector which is allocated to consuming industries and final demand in state 2. Thus the appropriate rail freight costs are always allocated to the customers in the receiving state, costs that reflect the distance of haul and the specific mode by which transported. (Other modal freight costs are allocated in similar rows, one for each mode -- to the same P' vectors as appropriate).

[1] *The assignment of freight transportation activity by state is necessarily a somewhat arbitrary procedure. These assignments must be calibrated with the mechanism that generates the demand for freight transportation in the model. Thus, the base-year output measures for freight transportation by state, will be developed as a fallout from the revenue assignment procedure.*

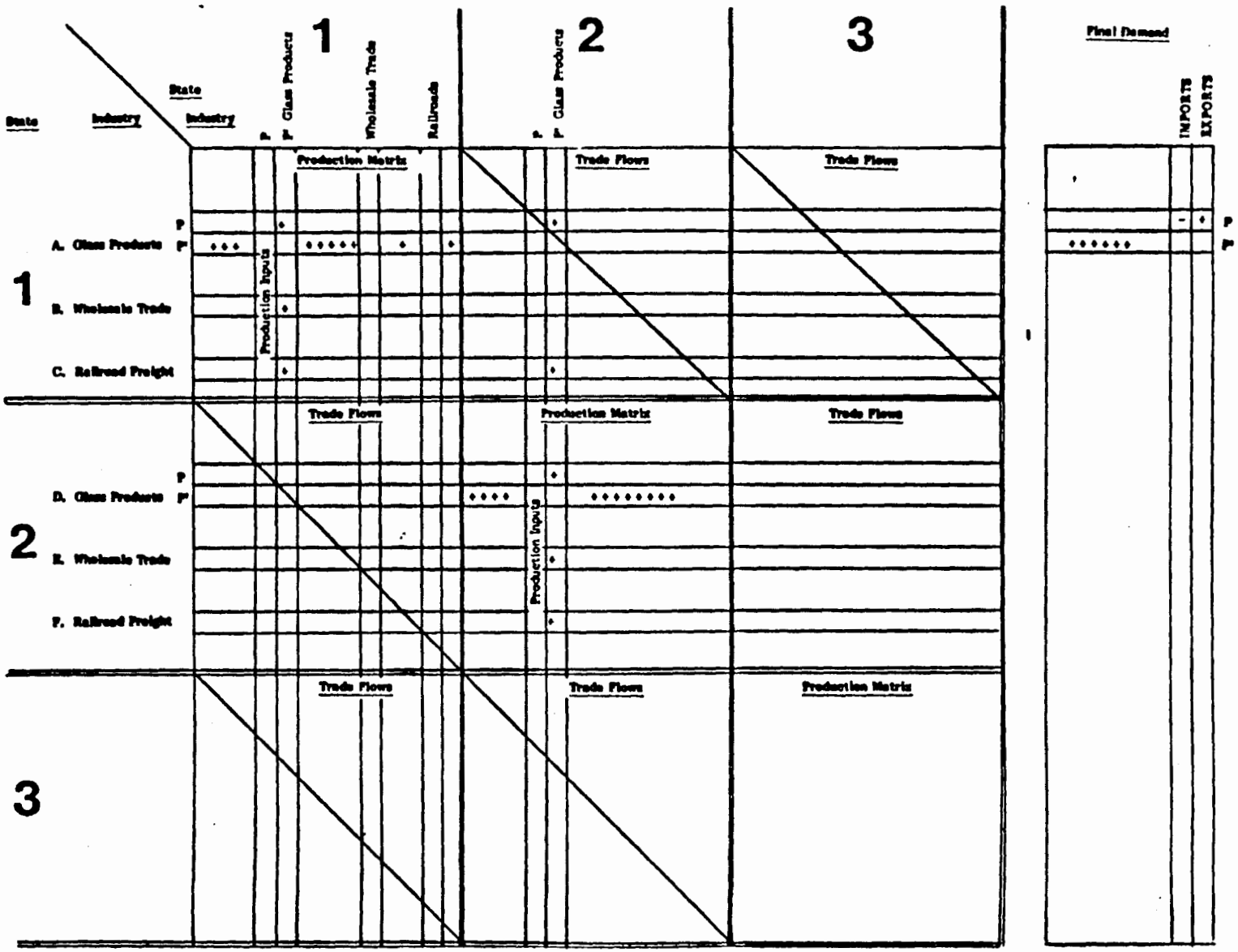


FIGURE 1: ALLOCATION OF TRANSPORTATION AND WHOLESALE TRADE MARGINS

Fortunately this procedure for handling transportation and wholesale margins is not as complex as it sounds -- it is simple straightforward accounting. It insures that margins in the correct amounts are assigned to the appropriate consumers within each state -- thus insuring that requirements for transportation and wholesale trade activity are "driven" by the appropriate demand wherever located by state. Updating is relatively simple since the margins are identified with specific flows and are shown as explicit data cells in the matrix.

Retail Trade Margins and Excise and Sales Taxes

Retail trade margins and excise and sales taxes also account for part of the difference between producers' values and purchasers' values of transactions. Since retail trade margins apply only selectively to consumers of each commodity, it is not appropriate to assign these to producing sectors (P), or to state distribution sectors (P'). Since they are allocated about 90% to personal consumption expenditures (PCE), they can be handled with few exceptions as extra detail carried in PCE, stipulated in final demand. For this purpose, several columns would be set up in final demand to record the margins on each commodity as illustrated in Figure 2. This will facilitate keeping track of the margins and taxes in stipulating final demand in model applications. Purchasers' values will be stipulated in each state and retail trade margins and excise taxes "pulled off" to derive producers' value including wholesale and transportation margins. This procedure will also facilitate the introduction of changes in excise taxes (in model applications), a topic of timely interest.

Retail margins to intermediate industries and other final demand account for only about 10% of total retail margins. These will be treated in the traditional way, i.e., allocated to sectors that consume the commodities to which the margins apply. However, the appropriate coefficients for this purpose will be estimated based on national coefficients without any precise tracking of such margins via a margin matrix.

Manufacturers' excise taxes will be allocated to the state distribution sectors discussed earlier, the P's, to avoid allocating these taxes to foreign exports. Wholesales excise taxes, either state or federal, will be allocated to these distribution sectors; this procedure allows state wholesale excise taxes to be allocated in a state-specific manner. Retail excise taxes will be handled exactly as retail margins are handled.

I-O Codes	Personal Consumption Expenditures				
	Producers' Value including Wholesale and Trade Margins	Retail Trade Margin	Retail Excise Taxes	Retail Sales Taxes	Purchasers' Value
Totals		+	+	+	

FIGURE 2: RETAIL TRADE MARGINS AND RETAIL TAXES IN PCE

APPENDIX B.2

MRIO Procedures: No. 2
November 18, 1981

REDEFINITIONS AND SECONDARY PRODUCTS IN THE MRIO MODEL

Redefinitions in input-output tables are generally made to adjust for secondary products made in establishments, products that are principally made in other industries. It is necessary to assimilate the total output of each product into a single row for distribution to consuming industries since the industry of origin is not distinguished in the consumption data.

In a few cases it is desirable to separate data for products that have been grouped together in a single Standard Industrial Classification industry that are not in fact made in the same establishment, e.g., aluminum combined with other chemicals, -- this is not strictly a redefinition of establishment data but a separation of the statistics. This distinction is important since the first involves separating data for the basic reporting unit, the establishment, whereas the latter is simply a function of the establishment classification system. In many such cases, separate data are available for the activities involved. For example, in government enterprises certain activities are redefined to their private sector counterparts: electric and gas utilities and transit systems, among others; in these cases the data are simply compiled under the appropriate sector classification code and no separation of reported data is generally necessary. Thus, redefinitions of establishments within SIC codes are covered by the sector classification system and are not dealt with in this paper. The concern here is with redefinitions of products or services within the basic reporting unit, i.e., the establishment -- to adjust the establishment data to move these products to other establishment industry classifications.

In addition to redefinitions, other adjustments to industry data as collected are necessary due to undercoverage of the activities for whatever reason.

For purposes of discussion it is convenient to group redefinitions and adjustments in the MRIO model as follows:

1. Adjustments to establishment data to redefine the production process to a product or activity basis, eliminating the production of secondary products in each industry.

2. Adjustments to output measures (and transactions) to augment the observed measures for undercoverage due to:

   a. Work done on a contract basis for which contract fees are reported, understating the full value of the product flow. Examples: ores mined or refined on a contract basis, stumpage cut and logged on a contract basis, fabrics finished on a contract basis.

   b. Services rendered for which explicit payments are not made: banking services in lieu of interest payments, implicit rental services to owner-occupied homes. Most of these cases represent implicit economic flows recognized in the National Income and Product (NIPA) accounts as imputations.

3. Adjustments to establishment data for products that are primary to more than one SIC industry -- to redefine this production to the SIC in which it is primarily produced. These cases to some extent involve products that are produced as joint products or by-products in industries other than the principal industry of production. Examples: natural gas liquids produced as joint products in natural gas processing plants, produced as primary products in petroleum refining; processed and bottled milk produced on the farm, a primary product of the processed milk industry in manufacturing; wire rope and strand produced in wire drawing mills, a primary product of the wire product industry that makes its products from purchased wire. This category is a special case of category 1 above. Products in this latter category reflect integrated operations in which the raw materials for the products are made in the same industry and, to an extent the products are either by-products or joint products of producing the basic materials.

Categories 1 and 3 above involve the conflict between the classification of production activities on an establishment basis and on a product base. The conflict arises because input data on materials, fuels and labor are generally available for establish-

ments -- and not for products, whereas consumption data are available on a product basis and the specific industries of production are not distinguished. Thus, it is convenient to have the I-O table defined on an establishment basis for input definition (the columns) and on a product basis for the distribution of output (the rows).

ESTABLISHMENT/PRODUCT CLASSIFICATION BRIDGES

There are at least three ways to bridge the establishment/product classification problem.

Method 1

In the first input-output tables produced by BLS and BEA, the secondary products of an industry were transferred to the industry to which they are primary via a synthetic flow. In this case, demand for the product is always satisfied by production from the primary industry and from other industries in fixed proportions. This is mathematically convenient, but it is hard to find any plausible combination of circumstances that would require such stability of market shares.

In conjunction with this method, certain industries were also defined on a product basis, principally agriculture and construction. In the case of agriculture, the redefinition was limited to the agricultural industries -- sectors were simply defined by product groupings, and agricultural activity in other industries, which was of a limited nature in any event, was ignored. In the case of construction, a large amount of construction carried on in other industries, referred to as force-account construction, was redefined to the construction industries, defined on a product basis.

In addition to these two major redefinitions, a few other activities were redefined. These included manufacturing performed in trade and service establishments, retail trade carried on in service industries, services carried on in the trade industries, and selected services were redefined among the services industries. These redefinitions required appropriate adjustments to the establishment output measures and input data for these industries.

Method 2

The second method is to redefine all activities to a product basis by adjusting their establishment-based output to include all production of products primary to the industry and to exclude all secondary production; inputs are adjusted similarly to reflect primary product production only. This method avoids the "clumsy" transfer procedure of Method 1 but results in the distortion of the establishment based data beyond recognition. The inability to "track" the model results with establishment-based data is a serious drawback in interpreting model results and in updating the data in the model. This method is extremely tedious to implement even at the national level since information on the separation of inputs between primary and secondary production is lacking. Inevitably most of the input adjustments are made by "scaling" the inputs of the industry of primary production by the ratio between outputs as secondary and primary production. This is a dubious procedure in many cases. The problems of adjustment are compounded at the regional level; thousands of "scalings" would be necessary without substantial justification.

Method 3

This method is designed to maintain the input data on an establishment basis as far as possible while distributing each product, regardless of where made, in a single row. This assumes that outputs of the same product in different industries are substitutable to a large extent and requires no stability of market shares. It avoids the general adjustment of the establishment input data of Method 2. It also avoids the introduction of synthetic transfers and the augmentation (duplication) of establishment output of Method 1.

The basic approach is to treat secondary products as joint products of the industries producing them, with the output flows of these secondary products shown as negative inputs from the industry row to which they are primary. In this way primary products are always distributed in a single row, with negative offsets in the row for the amounts produced as secondary products in other industries. It assumes that, if two products are produced in the same establishment, it is usually because producing more of one of the products tends to reduce the input increments needed to produce more of the other. This tends to control output proportions.

The mechanics of this treatment in the matrix are illustrated in Figure 1. The flows for several products produced in some amounts as a secondary product in another industry are illustrated. The first example is milk, processed and bottled on the farm, and sold to final consumers (via wholesale and/or retail trade). This product is primary to milk processing, a manufacturing industry. A negative flow is shown in the Milk processing row, Agriculture column, to account for this production. The other entries in the Milk processing row account for the consumption of all processed milk produced, including that produced and sold from the farm. The sum of the product output is obtained by adding all the postive numbers and ignoring the negative number. The industry output for Milk processing (the control total for its column) is the alegbraic sum of its row (including the negative number). If it produced any secondary products, the value of these secondary products would be included in deriving its column sum. Thus, in the case of Agriculture, its output is obtained as the algebraic sum of its row plus the value of processed milk shown in its column.

The next example is that of natural gas liquids produced in gas processing plants which consist of gasoline and other products that are the same as products produced in Petroleum refining, the principal producing industry. (This is a case where the Standard Industrial Classification recognizes products as primary to more than one industry -- they are a joint product, in a truer sense a by-product, of gas extraction and processing). The flow is shown as a negative amount in the Petroleum refining row, in the column for Natural gas wells and processing plants.

The two other examples involve the Wholesale trade and the Meat processing industries. These examples are typical of a large number of cases in which wholesale trade has some manufacturing operations and, conversely, manufacturing plants perform their own distribution and sales functions. In the first example, cattle slaughtering, a primary function of the Meat processing industry, is performed in wholesale trade establishments. In the second example, Meat processing plants sell and distribute their products to retailers, a function of the Wholesale trade industry.

These examples illustrate the general case in which secondary products are treated as negative allocations in the row that distributes these products, in the column of the industry that produces them. The algebraic sums of each row and corresponding column

are equal; the sums of the product distributions and the inputs to the industry (the sums of the positive numbers in the row and in the corresponding column) differ by the amount of product output and industry output. Thus, the control total for the column is establishment output and all the inputs are establishment-based; the control total for the row is product output whereever produced. Thus the accounting system provides an easy transition from the establishment-based input data to the product output data.

This treatment of secondary products assumes that the secondary products are always produced in fixed proportions to the primary product. Although this assumption is certainly not completely true, it is believed to be acceptable in view of the limitations of the alternative methods of handling secondary products in the model. These limitations were discussed above under Methods 1 and 2.

PLANS FOR THE MRIO MODEL

It is planned to adopt Method 3 as described above wherever feasible in handling secondary products (and products primary to more than one industry) in the MRIO model. Several redefinitions will made, principally in force account construction (in a redefinition both output and inputs are adjusted in moving the activity from one sector to another). Finally, a number of adjustments will be made to coverage where the Census data understate the full value of output of specified activities.

There are a number of adjustments that affect a large number of industries. These will be discussed first below and then, the specific industry adjustments will be discussed.

Force-Account Construction

New and maintenance construction performed by employees of the establishment (rather than contracted for from the construction industry) is important in a number of industries. Adjustments will be made to specific industries that account for about 80 percent of this activity (in the 1972 BEA table) as listed in Appendix A. The initial data file records the data on an establishment basis but does not include the capitalized value of new construction in the output measures (maintenance construction is a cost that would not be included in the output measure in any event). The cost of materials control, value added, employment and payroll data will be adjusted in a special

Redefinition File that will permit these adjustments to be tracked back to the Initial Data File. The adjustments will be based on input patterns developed in the construction analysis. The Redefinition File will serve also to add these data to the appropriate construction sector file. Data for specific material inputs from central sources, e.g., fuels consumed, will also be adjusted for in the Redefinition File; other inputs will simply be developed to exclude any inputs for construction activity.

Manufacturers Resales

Goods bought and sold in the same form constitute a wholesale trade function. Some sales of this nature occur in most all manufacturing industries but is generally of minor significance. It is not appropriate to treat these receipts as secondary products and accord them the Method 3 treatment since the purchase value of the goods is not relevant to the wholesale trade industry (only the markup or margin on such sales is relevant). Thus to make the adjustment it is necessary to eliminate the value of the sales from output and the cost of the goods from cost of materials, and then compute the component costs of the margin (materials and labor) and move it to the wholesale trade sector. When this is completed, minor adjustments have been made to many data items without having added much to essential information provided by the model (wholesale trade is augmented in a relatively small way by an activity that is somewhat extraneous to it and the establishment data are distorted).

In view of all this, it is deemed more appropriate to keep the establishment data intact and to simply make a "wash" transaction to account for these sales that are included in the output measure for each industry. This is accomplished by allocating these sales to the industry itself on the main diagonal, i.e., an intra-sector transaction. This procedure maintains the integrity of the establishment data while "immunizing" the flow in terms of balancing output and input in the matrix.

Rental Receipts

All rental receipts, real or imputed will be redefined into the Real estate and rental sector, following the BEA convention. Since this is only a financial flow to property type income, no signficant inputs are associated with it and therefore no adjustment will be made to establishment-based input data. Rental receipts have been excluded

from the output data (they are not included in the Census output measures and have been excluded in developing the data for other sectors). The development of the data on real and imputed rents is described in the chapter for the Real estate and rental sector in the report on output, employment and payrolls.

Electric Energy Sales

Sales of electric energy by non-utility plants will be handled by Method 3 for secondary products, as described in this paper, to the extent they can be identified by industry and state.

Specific Adjustments, Redefinitions and Secondary Products

The specific treatment of coverage adjustments and redefinitions made by BEA in 1972 national input-output table are noted in the reproduced pages from Definitions and Conventions of the 1972 Input-Output Study, BEA Staff Paper, July 1980, attached as Appendix B. Only items of $200 million or greater value in 1972 have been considered. The planned treatement of each is noted by the following symbols:

- R - redefine; move output and inputs to appropriate industry. This is for cases where the input requirements for primary and secondary outputs are independent.
- A - adjust; generally made to increase Census flows for undercoverage.
- B - treatment of secondary products by Method 3 procedures. This is for cases where cost complementarities between primary and secondary products tend to fix the output proportions.
- I - no adjustment to output; allocate flow as intra-sector.
- X - no adjustment; either not deemed significant, it affects an intermediate flow not of interest, or a reclassification does not seem appropriate
- ? - not yet resolved.

Other Secondary Products

It is planned to make only a few adjustments for other secondary products. Generally, establishment output will be considered to be product output. In cases where the difference between industry output (establishment-based) and product output in the

national totals is minor (at the MRIO level of industry aggregation), no adjustments will be made. In cases where the difference is significant, secondary product flows will be introduced in appropriate rows to approximately balance out these differences. These flows will be introduced in accordance with the Method 3 treatment of secondary products.

APPENDIX B.3

MRIO Procedures: No. 3
January 11, 1982

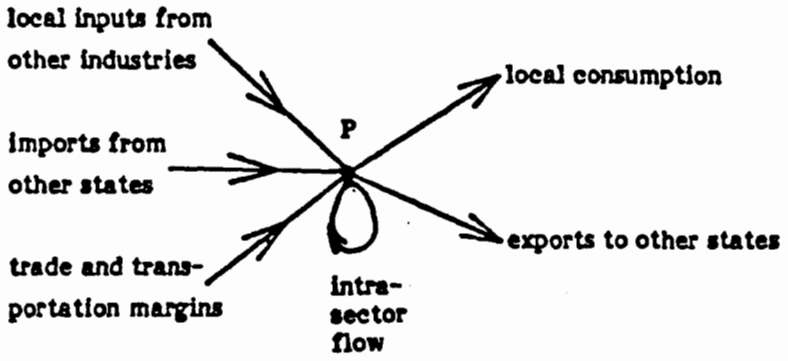
MRIO's MATHEMATICAL FORMULATION

In this paper the matrix formulation of the base year (1977) MRIO accounts is developed. Several new procedures have been introduced in the formulation of the accounts, including the use of separate activities in each state to serve as the distribution sectors for commodities consumed in the state (see MRIO Procedures No. 1), treatment of secondary products using a by-product approach (see MRIO Procedures No. 2), and the use of national and regional "clearinghouse" sectors to account for interstate service flows. Unlike previous regional models, trade flows and trade and transportation margins are incorporated explicitly into the table, an approach which will considerably simplify future updates and user applications of the model.

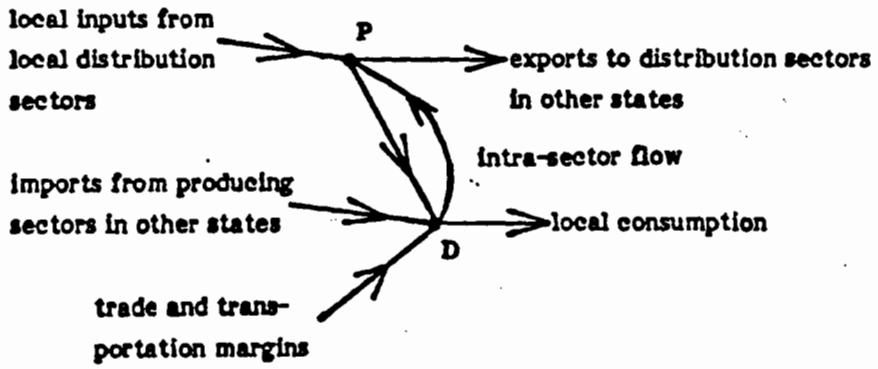
A comparison of the input/output link structure of the new margin and trade flow approach is compared to the traditional approach in Exhibit 1, with producing industries represented by a "P" and distribution activities by a "D". In the new formulation output of the producing industries (expressed in 1977 producer prices) is sold only to distributors while consumption (valued at 1977 purchaser prices) is supplied by the distributors to all users, including exports. In this paper distribution activities will be introduced for both commodity and service sectors, except for service sectors which have national clearinghouses. The distribution activities for the service industries are the only "dummy" sectors, since purchaser price is defined to equal producer price in these sectors. Hence no margins are charged and these "dummy" sectors serve only as a place holder in the matrix structure of the problem. The fundamental variables of the model are the primary product output of each industry in each state and the total consumption of each product in each state by both intermediate and final users. All other quantities of interest may be derived from the fundamental variables by a relatively simple post-solution calculation. An example of such a quantity would be the total output of a particular industry. Under the assumption of Procedures Paper No. 2, by-product production is assumed proportional to primary product production. Hence total output of the industry is a constant times primary output. If the percent change of total output is desired, this percent will be equal simply to the percent change in primary product output.

EXHIBIT 1

OLD



NEW



(output of P in producer price;
output of D in purchaser price)

The following notation will be used for the case of N industries and S states. It will be assumed that the industries are ordered such that the last n industries are service industries with associated national clearinghouses. All margin industries are assumed to have associated national or regional clearinghouse activities. For notational convenience we let n' = N-n+1 denote the index of the first industry in the ordering which has a clearinghouse. Unless otherwise noted indices extend over the full range of states and industries.

P_i^k : identifier for producing industry k in state i.

D_i^k : identifier for the distribution sector for product k (k = 1, . . ., N-n) in state i.

H^k : identifier for the national clearinghouse for service from industry k (k = n', . . ., N).

X_i^k = production (output) of primary product k by industry k in state i, in 1977 producer prices (i = H may also indicate the national clearinghouse for k = n', . . ., N).

C_i^k = consumption (both intermediate and final) of the product k (k = 1, . . ., N-n) in state i, in 1977 purchaser prices.

E_i^k = international exports of product k from state i, in freight-alongside-ship prices.

I_i^k = international imports of product k to state i, in domestic port prices.

Y_i^k = final demand for product k in state i, in purchaser prices.

$U_i^{k,l}$ = intermediate use (input) of product k (k = 1, . . ., N-n) by industry l in state i, in purchaser prices.

$B_i^{k,l}$ = by-products of type k (k = 1, . . ., N-n) produced by industry l in state i ($B_i^{k,k} = 0$), in producer prices.

$T_{i,j}^k$ = interstate (or intrastate) trade flow of product k (k = 1, . . ., N-n) moving from state i to state j, in producer prices.

$M_{i,j}^{k,l}$ = margin or interstate service flow purchased from sector k (k = n', . . ., N) in state i by the distribution sector l (l = 1, . . ., N-n) in state j, in producer prices (i may also identify the national clearinghouse).

G_i^k = allocation of national clearinghouse revenues to the producer for mode k (k = n', . . ., N) in state i, in producer prices.

It should be noted that clearinghouse and margin sectors, which have no associated local distribution sector, are treated uniquely in the above definitions. In particular, careful attention to the subscripting will show that no secondary production of a clearinghouse and margin service is defined, nor are margins paid by clearinghouse sectors. In addition, all distribution sectors purchase margins directly from the appropriate producing sector or national clearinghouse.

To aid in understanding the interrelationships of the quantities defined above, consider the particularly simple example of two industrial sectors (S = steel and F = foundries) and one transportation sector (R = railroads) in a two-state model. Exhibit 2 displays the appropriate MRIO table for this example, which utilizes a national-level rail clearinghouse to distribute the portion of interstate transportation margins which cannot meaningfully be assigned to the originating or destinating state. In this example, the steel and foundry industry in each state are represented by a producing and a distributing sector. The rail industry has no local distribution sector but has a national clearinghouse. Hence, in the notation introduced above, S = 2, n =1 and n' =N=3. Note that since the rail industry has no local distribution sector, final demand for rail transportation is satisfied directly by the producing sector for the rail industry. (Although in the two (or three) state example the clearinghouse approach may appear somewhat superfluous, its usefulness in the many state problem is immediately obvious.) In Exhibit 2, the sectors are arranged by state with adjacent producing and distributing sectors for each commodity. In Exhibit 3 the ordering of sectors has been sorted within states to group all producing sectors together, revealing the block matrix structure of the table. Reading across the first row of Exhibit 3, we obtain the following equation:

$$-X_1^S - B_1^{S,F} - B_1^{S,R} + T_{1,1}^S + T_{1,2}^S = 0$$

or,

$$X_1^S = T_{1,1}^S + T_{1,2}^S - B_1^{S,F} - B_1^{S,R} \qquad (1)$$

			REGION I					REGION II					NATIONAL RAILROAD CLEARING HOUSE	FOREIGN EXPORTS & FINAL DEMAND
			STEEL		FOUNDRY		RAIL	STEEL		FOUNDRY		RAIL		
			P_1^S	D_1^S	P_1^F	D_1^F	P_1^R	P_2^S	D_2^S	P_2^F	D_2^F	P_2^R		
REGION I	STEEL	P_1^S	$-X_1^S$	$T_{1,1}^S$	$-B_1^{S,F}$		$-B_1^{S,R}$		$T_{1,2}^S$					0
		D_1^S	$U_1^{S,S}$	$-C_1^S$	$U_1^{S,F}$,		$U_1^{S,R}$							$Y_1^S + E_1^S$
	FDY	P_1^F	$-B_1^{F,S}$		$-X_1^F$	$T_{1,1}^F$	$-B_1^{F,R}$				$T_{1,2}^F$			0
		D_1^F	$U_1^{F,S}$		$U_1^{F,F}$	$-C_1^F$	$U_1^{F,R}$							$Y_1^F + E_1^F$
	RL	P_1^R		$M_{1,1}^{R,S}$		$M_{1,1}^{R,F}$	$-X_1^R$		$M_{1,2}^{R,S}$		$M_{1,2}^{R,F}$		G_1^R	$Y_1^R + E_1^R$
REGION II	STEEL	P_2^S		$T_{2,1}^S$				$-X_2^S$	$T_{2,2}^S$	$-B_2^{S,F}$		$-B_2^{S,R}$		0
		D_2^S						$U_2^{S,S}$	$-C_2^S$	$U_2^{S,F}$		$U_2^{S,R}$		$Y_2^S + E_2^S$
	FDY	P_2^F				$T_{2,1}^F$		$-B_2^{F,S}$		$-X_2^F$	$T_{2,2}^F$	$-B_2^{F,R}$		0
		D_2^F						$U_2^{F,S}$		$U_2^{F,F}$	$-C_2^F$	$U_2^{F,R}$		$Y_2^F + E_2^F$
	RL	P_2^R		$M_{2,1}^{R,S}$		$M_{2,1}^{R,F}$			$M_{2,2}^{R,S}$		$M_{2,2}^{R,F}$	$-X_2^R$	G_2^R	$Y_2^R + E_2^R$
NAT. RAIL CLEARING-HOUSE				$M_{H,1}^{R,S}$		$M_{H,1}^{R,F}$			$M_{H,2}^{R,S}$		$M_{H,2}^{R,F}$		$-X_H^R$	0

S = STEEL
F = FOUNDRY
R = RAIL

EXHIBIT 2

			REGION I					REGION II					NATIONAL RAILROAD CLEARING-HOUSE	FOREIGN EXPORTS & FINAL DEMAND
			PRODUCERS			DISTRIBUTORS		PRODUCERS			DISTRIBUTORS			
			P_1^S	P_1^F	P_1^R	D_1^S	D_1^F	P_2^S	P_2^F	P_2^R	D_2^S	D_2^F		
REGION I	PRODUCERS	P_1^S	$-X_1^S$	$-B_1^{S,F}$	$-B_1^{S,R}$	$T_{1,1}^S$					$T_{1,2}^S$			0
		P_1^F	$-B_1^{F,S}$	$-X_1^F$	$-B_1^{F,R}$		$T_{1,1}^F$					$T_{1,2}^F$		0
		P_1^R			$-X_1^R$	$M_{1,1}^{R,S}$	$M_{1,1}^{R,F}$				$M_{1,2}^{R,S}$	$M_{1,2}^{R,F}$	G_1^R	$Y_1^R + E_1^R$
	DIST	D_1^S	$U_1^{S,S}$	$U_1^{S,F}$	$U_1^{S,R}$	$-C_1^S$								$Y_1^S + E_1^S$
		D_1^F	$U_1^{F,S}$	$U_1^{F,F}$	$U_1^{F,R}$		$-C_1^F$							$Y_1^F + E_1^F$
REGION II	PRODUCERS	P_2^S				$T_{2,1}^S$		$-X_2^S$	$-B_2^{S,F}$	$-B_2^{S,R}$	$T_{2,2}^S$			0
		P_2^F					$T_{2,1}^F$	$-B_2^{F,S}$	$-X_2^F$	$-B_2^{F,R}$		$T_{2,2}^F$		0
		P_2^R				$M_{2,1}^{R,S}$	$M_{2,1}^{R,F}$			$-X_2^R$	$M_{2,2}^{R,S}$	$M_{2,2}^{R,F}$	G_2^R	$Y_2^R + E_2^R$
	DIST	D_2^S						$U_2^{S,S}$	$U_2^{S,F}$	$U_2^{S,R}$	$-C_2^S$			$Y_2^S + E_2^S$
		D_2^F						$U_2^{F,S}$	$U_2^{F,F}$	$U_2^{F,R}$		$-C_2^F$		$Y_2^F + E_2^F$
NAT. RAIL CLEARING-HOUSE						$M_{H,1}^{R,S}$	$M_{H,1}^{R,F}$				$M_{H,2}^{R,S}$	$M_{H,2}^{R,F}$	$-X_H^R$	0
			PRODUCTION			CONSUMPTION		PRODUCTION			CONSUMPTION			

S = STEEL
F = FOUNDRY
R = RAIL

EXHIBIT 3

Equation (1) may be interpreted as stating that (in 1977 producer price) the steel industry in state 1 (P_1^S) must produce an amount of steel equal to the trade flows demanded by the steel distributors in states 1 and 2 (D_1^S and D_2^S) less the amount of steel produced as by-product by the foundry and rail producing sectors in state 1 (P_1^F and P_1^R). Similarly, the fourth row in Exhibit 3 (second row in Exhibit 2) yields

$$C_1^S = U_1^{S,S} + U_1^{S,F} + U_1^{S,R} + Y_1^S + E_1^S \qquad (2)$$

indicating that D_1^S must supply an amount of steel equal to the sum of the intermediate uses of steel by the steel, foundry and rail industries in state 1 plus the exports and final demand for steel in that state. To satisfy this demand, the fourth column of Exhibit 3 shows that D_1^S must purchase amounts $T_{1,1}^S$ and $T_{2,1}^S$ of steel plus the transportation margins $M_{1,1}^{R,S}$, $M_{2,1}^{R,S}$ and $M_{H,1}^{R,S}$ which are paid to the rail producing sectors in states 1 and 2 and to the national clearinghouse, respectively. Since the distribution sectors are assigned no value-added, a column equation

$$C_1^S = T_{1,1}^S + T_{2,1}^S + M_{1,1}^{R,S} + M_{2,1}^{R,S} + M_{H,1}^{R,S} \qquad (3)$$

may be written to show that the total output of D_1^S equals the producer value of steel consumed in state 1 plus margins. A similar column interpretation may be given to a producing sector column, except that for these sectors value-added, which is not shown in the sample table, is no longer zero. Using V_1^S to denote the value-added by the steel industry in state 1, column 1 of Exhibit 3 yields the equation

$$V_1^S + U_1^{S,S} + U_1^{F,S} = X_1^S + B_1^{F,S} \qquad (4)$$

indicating that the inputs on the left hand side of equation (4) are the amounts necessary to produce <u>both</u> the primary and secondary products of the steel industry.

The block matrix structure evident in Exhibit 3 may be exploited to express concisely the many-state table using a block matrix representation. We will use the following notation:

$$\underline{Y}_i = \begin{Bmatrix} 0 \\ \vdots \\ 0 \\ Y_i^{n'} + E_i^{n'} \\ \vdots \\ Y_i^{N} + E_i^{N} \\ Y_i^{1} + E_i^{1} \\ \vdots \\ Y_i^{N-n} + E_i^{N-n} \end{Bmatrix} \qquad (i = 1, \ldots, S)$$

$$\underline{U}_i = \begin{Bmatrix} U_i^{1,1} & \cdots & U_i^{1,N} \\ \vdots & & \vdots \\ U_i^{N-n,1} & \cdots & U_i^{N-n,N} \end{Bmatrix} \qquad (i = 1, \ldots, S)$$

$$\underline{B}_i = \begin{Bmatrix} X_i^{1} & B_i^{1,2} & \cdots & B_i^{1,N} \\ B_i^{2,1} & X_i^{2} & \cdots & B_i^{2,N} \\ \vdots & \vdots & & \vdots \\ B_i^{N-n,1} & B_i^{N-n,2} & \cdots & B_i^{N-n,N} \\ 0 & 0 & \cdots & 0 \\ \vdots & \vdots & & \vdots \\ 0 & 0 & \cdots & X_i^{N} \end{Bmatrix} \qquad (i = 1, \ldots, S)$$

$$\underline{T}_{i,j} = \begin{bmatrix} T_{i,j}^{1} & 0 & \cdots & 0 \\ 0 & T_{i,j}^{2} & \cdots & 0 \\ \vdots & \vdots & & \vdots \\ 0 & 0 & & T_{i,j}^{N-n} \\ M_{i,j}^{n',1} & M_{i,j}^{n',2} & \cdots & M_{i,j}^{n',N-n} \\ \vdots & \vdots & & \vdots \\ M_{i,j}^{N,1} & M_{i,j}^{N,2} & \cdots & M_{i,j}^{N,N-n} \end{bmatrix} \qquad (i, j = 1, \ldots, S)$$

$$\underline{T}_{H,i} = \begin{bmatrix} M_{H,i}^{n',1} & \cdots & M_{H,i}^{n',N-n} \\ \vdots & & \vdots \\ M_{H,i}^{N,1} & \cdots & M_{H,i}^{N,N-n} \end{bmatrix} \qquad (i = 1, \ldots, S)$$

$$\underline{C}_{i} = \begin{bmatrix} C_{i}^{1} & 0 & \cdots & 0 \\ 0 & C_{i}^{2} & \cdots & 0 \\ \vdots & \vdots & & \vdots \\ 0 & 0 & \cdots & C_{i}^{N-n} \end{bmatrix} \qquad (i = 1, \ldots, S)$$

$$\underline{G}_{i} = \begin{bmatrix} 0 & 0 & \cdots & 0 \\ \vdots & \vdots & & \vdots \\ 0 & 0 & \cdots & 0 \\ G_{i}^{n'} & 0 & \cdots & 0 \\ 0 & G_{i}^{n'+1} & \cdots & 0 \\ \vdots & \vdots & & \vdots \\ 0 & 0 & \cdots & G_{i}^{N} \end{bmatrix} \qquad (i = 1, \ldots, S)$$

$$\underline{X}_H = \begin{bmatrix} X_H^{n'} & 0 & \cdots & 0 \\ 0 & X_H^{n'+1} & \cdots & 0 \\ \cdot & \cdot & & \cdot \\ \cdot & \cdot & & \cdot \\ \cdot & \cdot & & \cdot \\ 0 & 0 & \cdots & X_H^{N} \end{bmatrix}$$

where $$X_H^k = \sum_{i=1}^{S} G_{i,H}^k \qquad (k = n', \ldots, N)$$

Here $\underline{Y}_i$ refers to the final demand (plus exports) vector for state i, $\underline{U}_i$ and $\underline{B}_i$ refer to the use matrix and make matrix for state i, and $\underline{T}_{i,j}$ consists of an upper part which is a diagonal matrix containing trade flows of all commodities moving from state i to state j along its diagonal, with the clearinghouse and margin payments in the lower rows. $\underline{T}_{H,i}$ contains the payments to the national clearinghouse. The diagonal matrix, $\underline{C}_i$, has the state consumption of products along the diagonal. The matrices $\underline{G}_i$ contain the allocations from each clearinghouse to the local producers, while $\underline{X}_H$ contains on its diagonal the total output of each national clearinghouse. These diagonal entries, along with the diagonals of the $\underline{B}_i$ and $\underline{C}_i$ matrices contain the fundamental variables of the model.

The above definitions allows the use of a single block-partitioned account matrix, A, to represent the many-state model as follows. We define:

$$
A = \begin{array}{c|cccccccc|l}
 & \overbrace{\text{STATE 1}} & & \overbrace{\text{STATE 2}} & & & \overbrace{\text{STATE S}} & & \overbrace{\text{NATIONAL CLEARING-HOUSES}} & \\
 & -\underline{B}_1 & \underline{T}_{1,1} & \underline{0} & \underline{T}_{1,2} & \cdots & \underline{0} & \underline{T}_{1,S} & \underline{G}_1 & \text{STATE 1} \\
 & \underline{U}_1 & -\underline{C}_1 & \underline{0} & \underline{0} & \cdots & \underline{0} & \underline{0} & \underline{0} & \\
\hline
 & \underline{0} & \underline{T}_{2,1} & -\underline{B}_2 & \underline{T}_{2,2} & \cdots & \underline{0} & \underline{T}_{2,S} & \underline{G}_2 & \text{STATE 2} \\
 & \underline{0} & \underline{0} & \underline{U}_2 & -\underline{C}_2 & \cdots & \underline{0} & \underline{0} & \underline{0} & \\
\hline
 & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \\
 & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \\
 & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \\
\hline
 & \underline{0} & \underline{T}_{S,1} & \underline{0} & \underline{T}_{S,2} & \cdots & -\underline{B}_S & \underline{T}_{S,S} & \underline{G}_S & \text{STATE S} \\
 & \underline{0} & \underline{0} & \underline{0} & \underline{0} & \cdots & \underline{U}_S & -\underline{C}_S & \underline{0} & \\
\hline
 & \underline{0} & \underline{T}_{H,1} & \underline{0} & \underline{T}_{H,2} & \cdots & \underline{0} & \underline{T}_{H,S} & -\underline{X}_H & \text{NATIONAL CLEARING-HOUSES}
\end{array}
$$

$$W = \begin{bmatrix} \underline{Y}_1 \\ \underline{Y}_2 \\ \cdot \\ \cdot \\ \cdot \\ \underline{Y}_S \\ \underline{O} \end{bmatrix} \qquad Z = \begin{bmatrix} \underline{X}_1 \\ \underline{C}_1 \\ \underline{X}_2 \\ \underline{C}_2 \\ \cdot \\ \cdot \\ \cdot \\ \underline{X}_S \\ \underline{C}_S \\ \underline{X}_H \end{bmatrix}$$

Here A is a square accounts matrix of dimension $q = S(2N-n)+n$ and W is the final demand (plus exports) vector of dimension q by 1. The column vector Z is of the same dimension as W and contains as its elements the entire set of fundamental variables, including the primary product output and the total consumption of the product for each industry in each state, plus the output of each national clearinghouse activity. In forecasting applications it will be necessary to solve for Z, hence this vector will be defined as the solution vector.

To convert the base year accounts matrix to a coefficient matrix suitable for forecasting applications, each column of A must be divided by the negative of the corresponding element of the solution vector. In other words, each column of A is to be divided by the element in that column which lies along the diagonal. The resulting coefficient matrix will then contain the number 1 along its diagonal. Using "a" to represent the coefficient matrix, we have

$$a_{i,j} = \frac{A_{i,j}}{A_{i,i}} \qquad (i,j = 1, \ldots, q)$$

The MRIO model may then be represented as a set of linear equations. The solution vector for a future year may then be obtained as a linear function of the exogeneously stipulated final demand vector for that year. The base year equation is

$$a Z^{77} = W^{77} \tag{5}$$

Assuming for now the invertability of the coefficient matrix, a, we may write the solution for the forecast year, represented by an asterisk, as

$$Z^{*} = a^{-1} W^{*} \tag{6}$$

Since the coefficient matrix is quite large (q approximately 12,000), actual inversion of the matrix may not be the most efficient method of obtaining solutions. An alternative method is to expand the inverse in a series expansion. We note that since the matrix a contains ones along its diagonal the required inverse may be written formally as

$$a^{-1} = (I - L)^{-1} = I + L + L^{2} + \ldots \tag{7}$$

where the matrix L = I-a contains zeroes on the diagonal. Existence and convergence properties of the series expansion in equation (7) remain to be investigated. Determination of such properties is complicated by the fact that L contains both negative and positive values, hence convergence will not be monotonic.

APPENDIX C

Concordance of MRIO, BEA I-O and SIC Codes

Revisions to: 032, 033, 034, 055, 058 and 124

MRPIS Code	Sector Name	1977 BEA I-O Code	Sector Name	1977 SIC
	Agriculture, forestry and fisheries			
001	Dairy farm products	10100	Dairy farm products	0241, pt. 0191, pt. 0259, pt. 0291
002	Livestock and poultry	10200	Poultry and eggs	025 (excl. pt. 0259); pt. 0191, pt. 0219, pt. 0291
		10301	Meat animals	021 (excl. pt. 0219), pt. 0191, pt. 0259, pt. 0291
		10302	Miscellaneous livestock	027 pt. 0191, pt. 0219, pt. 0259, pt. 0291
003	Cotton, grain and tobacco	20100	Cotton	0131, pt. 0191, pt. 0219, pt. 0259, pt. 0291
		20201	Food grains	pt. 011, pt. 0191, pt. 0219, pt. 0259, pt. 0291
		20202	Feed grains	pt. 011, pt. 0139, pt. 0191, pt. 0219, pt. 0259, pt. 0291
		20203	Grass seeds	pt. 0139, pt. 0191, pt. 0219, pt. 0259, pt. 0291
		20300	Tobacco	0132, pt. 0191, pt. 0219, pt. 0259, pt. 0291
004	Fruits, nuts, vegetables, and misc. crops and services	20401	Fruits	pt. 017, pt. 0191, pt. 0219, pt. 0259, pt. 0291
		20402	Tree nuts	0173, pt. 0179, pt. 0191, pt. 0219, pt. 0259, pt. 0291

(cont'd)

Concordance of MRIO, BEA I-O and SIC Codes

MRPIS Code	Sector Name	1977 BEA I-O Code	Sector Name	1977 SIC
	Agriculture, cont'd			
004	Fruits, nuts, vegetables, and misc. crops and services	20501	Vegetables	0134, 0161, pt. 0119, pt. 0139, pt. 0191, pt. 0219, pt. 0259, pt. 0291
		20502	Sugar crops	0133, pt. 0191, pt. 0219, pt. 0259, pt. 0291
		20503	Miscellaneous crops	pt. 0119, pt. 0139, pt. 0191, pt. 0219, pt. 0259, pt. 0291
		20600	Oil bearing crops	0116, pt. 0119, pt. 013, pt. 0173, pt. 0219, pt. 0259, pt. 0291
		20701	Forest products	pt. 018, pt. 0191, pt. 0219, pt. 0259, pt. 0291
				pt. 018, pt. 0191, pt. 0219, pt. 0259, pt. 0291,07* (excl. 074)
005	Forestry products			08
006	Commercial fishing and trapping			09
	Mining			
007	Iron and ferroalloy ores	50000	Iron and ferroalloy ores mining	101, 106
008	Nonferrous ores	60100	Copper ore mining	102
		60200	Nonferrous metal ores mining, except copper	103-5, pt. 108, 109
009	Coal	70000	Coal mining	1111, pt. 1112, 1211, pt. 1213

Concordance of MRIO, BEA I-O and SIC Codes

MRPIS Code	Sector Name	1977 BEA I-O Code	Sector Name	1977 SIC
	Mining cont'd			
010	Crude petroleum			pt. 131, pt. 132, pt. 138
011	Natural gas and liquids			pt. 131, pt. 132, pt. 138
012	Stone, clay, sand and gravel	90001	Dimension, crushed and broken stone mining and quarrying	141-2
		90002	Sand and gravel mining	144
		90003	Clay, ceramic, and refractory minerals mining	145
		90004	Nonmetallic mineral services and miscellaneous minerals mining and quarrying	pt. 148, 149
013	Chemical and fertilizer minerals	100000	Chemical and fertilizer mineral mining	147
	Construction			
014	Residential building construction	110101	New residential 1-unit structures, nonfarm	pt. 15, pt. 17
		110102	New residential 2-4 unit structures, nonfarm	pt. 15-17
		110103	New residential garden apartments	pt. 15-17
		110104	New residential high-rise apartments	pt. 15-17
		110105	New residential additions and alterations, nonfarm	pt. 15-17

Concordance of MRIO, BEA I-O and SIC Codes

MRPIS Code	Sector Name	1977 BEA I-O Code	Sector Name	1977 SIC
	Construction cont'd			
015	Nonresidential building construction	110106	New hotels and motels	pt. 15-17
		110107	New dormitories and other group housing	pt. 15-17
		110201	New industrial buildings	pt. 15-17
		110202	New office buildings	pt. 15-17
		110203	New warehouses	pt. 15-17
		110204	New garages and service stations	pt. 15-17
		110205	New stores and restaurants	pt. 15-17
		110206	New religious buildings	pt. 15-17
		110207	New educational buildings	pt. 15-17
		110231	New hospitals	pt. 15-17
		110232	New residential institutions and other health facilities	pt. 15-17
		110241	New amusement and recreation buildings	pt. 15-17
		110250	Other nonfarm buildings	pt. 15-17
016	Public utility construction	110301	New telephone and telegraph facilities	pt. 16-17
		110302	New railroads	pt. 16-17
		110303	New electric utility facilities	pt. 16-17
		110304	New gas utility facilities	pt. 16-17
		110305	New petroleum pipelines	pt. 16-17
		110306	New water supply facilities	pt. 16-17
		110307	New sewer system facilities	pt. 16-17
		110308	New local transit facilities	pt. 16-17

Concordance of MRIO, BEA I-O and SIC Codes

MRPIS Code	Sector Name	1977 BEA I-O Code	Sector Name	1977 SIC
	Construction cont'd			
017	Highways and Streets	110400	New highways and streets	pt. 16-17
018	Other Construction	110501	New farm housing units and additions and alterations	pt. 15, pt. 17
		110502	New farm service facilities	pt. 15, pt. 17
		110601	New petroleum and natural gas well drilling	pt. 138
		110602	New petroleum, natural gas, and solid mineral exploration	pt. 108, pt. 1112, pt. 1213, pt. 138, pt. 148
		110603	New access structures for solid mineral development	pt. 108, pt. 1112, pt. 1213, pt. 148
		110701	New military facilities	pt. 15-17
		110702	New dams and reservoirs	pt. 15-17
		110703	Other new conservation and development facilities	pt. 15-17
		110704	Other new nonbuilding facilities	pt. 15-17
019	Maintenance construction	120100	Maintenance and repair, residential	pt. 15, pt. 17
		120201	Maintenance and repair of other nonfarm buildings	pt. 15-17
		120202	Maintenance and repair of farm residential buildings	pt. 15, pt. 17

(cont'd)

MRPIS Code	Sector Name	1977 BEA I-O Code	Sector Name	1977 SIC
	Construction cont'd			
019	Maintenance construction	120203	Maintenance and repair of farm service facilities	pt. 15, pt. 17
		120204	Maintenance and repair of telephone and telegraph facilities	pt. 16-17
		120205	Maintenance and repair of railroads	pt. 16-17
		120206	Maintenance and repair of electric utility facilities	pt. 16-17
		120207	Maintenance and repair of gas utility facilities	pt. 16-17
		120208	Maintenance and repair of petroleum pipelines	pt. 16-17
		120209	Maintenance and repair of water supply facilities	pt. 16-17
		120210	Maintenance and repair of sewer facilities	pt. 16-17
		120211	Maintenance and repair of local transit facilities	pt. 16-17
		120212	Maintenance and repair of military facilities	pt. 15-17
		120213	Maintenance and repair of conservation and development facilities	pt. 15-17
		120214	Maintenance and repair of highways and streets	pt. 16-17

(cont'd)

Concordance of MRIO, BEA I-O and SIC Codes

MRPIS Code	Sector Name	1977 BEA I-O Code	Sector Name	1977 SIC
	Construction cont'd			
819	Maintenance construction	120215	Maintenance and repair of petroleum and natural gas wells	pt. 138
		120216	Maintenance and repair of other nonbuilding facilities	pt. 15-17
	Manufacturing			
820	Ordnance	130200	Ammunition, except for small arms, n.e.c.	3483
		130300	Tanks and tank components	3795
		130500	Small arms	3484
		130600	Small arms ammunition	3482
		130700	Other ordnance and accessories	3489
821	Meat products	140101	Meat packing plants	2011
		140102	Sausages and other prepared meats	2013
		140103	Poultry dressing plants	2016
		140104	Poultry and egg processing	2017
822	Dairy products	140200	Creamery butter	2021
		140300	Cheese, natural and processed	2022
		140400	Condensed and evaporated milk	2023
		140500	Ice cream and frozen desserts	2024
		140600	Fluid milk	2026

Concordance of MRIO, BEA I-O and SIC Codes

MRPIS Code	Sector Name	1977 BEA I-O Code	Sector Name	1977 SIC
	Manufacturing cont'd			
023	Canned and frozen foods	140700	Canned and cured sea foods	2091
		140800	Canned specialties	2032
		140900	Canned fruits and vegetables	2033
		141000	Dehydrated food products	2034
		141100	Pickles, sauces, and salad dressings	2035
		141200	Fresh or frozen packaged fish	2092
		141301	Frozen fruits, fruit juices and vegetables	2037
		141302	Frozen specialties	2038
024	Grain mill products	141401	Flour and other grain mill products	2041
		141402	Cereal breakfast foods	2043
		141403	Blended and prepared flour	2045
		141501	Dog, cat, and other pet food	2047
		141502	Prepared feeds, n.e.c.	2048*
		141600	Rice milling	2044
		141700	Wet corn milling	2046
025	Bakery products	141801	Bread, cake, and related products	2051
		141802	Cookies and crackers	2052
026	Sugar and confectionery products	141900	Sugar	2061-3
		142001	Confectionery products	2065
		142002	Chocolate and cocoa products	2066
		142003	Chewing gum	2067

Concordance of MRIO, BEA I-O and SIC Codes

MRPIS Code	Sector Name	1977 BEA I-O Code	Sector Name	1972 SIC
	Manufacturing cont'd			
027	Beverages, extracts, and sirups	142101	Malt beverages	2082
		142102	Malt	2083
		142103	Wines, brandy, and brandy spirits	2084
		142104	Distilled liquor, except brandy	2085
		142200	Bottled and canned soft drinks	2086
		142300	Flavoring extracts and sirups, n.e.c.	2087
028	Other food products	142400	Cottonseed oil mills	2074
		142500	Soybean oil mills	2075
		142600	Vegetable oil mills, n.e.c.	2076
		142700	Animal and marine fats and oils	2077
		142800	Roasted coffee	2095
		142900	Shortening and cooking oils	2079
		143000	Manufactured ice	2097
		143100	Macaroni and spaghetti	2098
		143200	Food preparations, n.e.c.	2099
029	Tobacco products	150101	Cigarettes	211
		150102	Cigars	212
		150103	Chewing and smoking tobacco	213
		150200	Tobacco stemming and redrying	214
030	Fabric, yarn and thread mills	160100	Broadwoven fabric mills and fabric finishing plants	221-3, 2261-2
		160200	Narrow fabric mills	224

(cont'd)

Concordance of MRIO, BEA I-O and SIC Codes

MRPIS Code	Sector Name	1977 BEA I-O Code	Sector Name	1977 SIC	
	Manufacturing cont'd				
030	Fabric, yarn and thread mills	160300	Yarn mills and finishing of textiles, n.e.c.	2269, 2281-3*	
		160400	Thread mills	2284	
031	Floor coverings and misc. textile products	170100	Floor coverings	227	
		170200	Felt goods, n.e.c.	2291	
		170300	Lace goods	2292	
		170400	Padding and upholstery filling	2293	
		170500	Processed textile waste	2294	
		170600	Coated fabrics, not rubberized	2295	
		170700	Tire cord and fabric	2296	
		170900	Cordage and twine	2298	
		171001	Nonwoven fabrics	2297	
		171002	Textile goods, n.e.c.	2299	
032	Hosiery and knit goods	180101	Women's hosiery, except socks	2251	Revised
		180102	Hosiery, n.e.c.	2252	
		180300	Knit fabric mills	2257-8	
033	Apparel	180400	Apparel made from purchased materials	231-8*, 39996	Revised
		180201	Knit outerwear mills	2253	
		180202	Knit underwear mills	2254	
034	Other fabricated textile products	180203	Knitting mills, n.e.c.	2259	Revised
		190100	Curtains and draperies	2391	
		190200	Housefurnishings, n.e.c.	2392*	
		190301	Textile bags	2393	
		190302	Canvas and related products	2394	

Concordance of MRIO, BEA I-O and SIC Codes

MRPIS Code	Sector Name	1977 BEA I-O Code	Sector Name	1977 SIC
	Manufacturing cont'd			
834	Other fabricated textile products	190303	Pleating and stitching	2395
		190304	Automotive and apparel trimmings	2396
		190305	Schiffli machine embroideries	2397
		190306	Fabricated textile products, n.e.c.	2399
835	Logging and lumber	200100	Logging camps and logging contractors	2411
		200200	Sawmills and planing mills, general	2421
		200300	Hardwood dimension and flooring mills	2426
		200400	Special product sawmills, n.e.c.	2429
836	Wood products	200501	Millwork	2431
		200502	Wood kitchen cabinets	2434
		200600	Veneer and plywood	2435-6
		200701	Structural wood members, n.e.c.	2439
		200800	Wood preserving	2491
		200901	Wood pallets and skids	2448
		200902	Particleboard	2492*
		200903	Wood products, n.e.c.	2499
		210000	Wood containers	2441, 2449
837	Pre-fabricated buildings and mobile homes	200702	Prefabricated wood buildings	2452
		610602	Mobile homes	2451
838	Household furniture	220101	Wood household furniture	2511
		220102	Household furniture, n.e.c.	2519
		220103	Wood TV and radio cabinets	2517

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Concordance of MRIO, BEA I-O and SIC Codes

MRPIS Code	Sector Name	1977 BEA I-O Code	Sector Name	1977 SIC
	Manufacturing cont'd			
038	Household furniture	220200	Upholstered household furniture	2512
		220300	Metal household furniture	2514
		220400	Mattresses and bedsprings	2515
039	Other furniture and fixtures	230100	Wood office furniture	2521
		230200	Metal office furniture	2522
		230300	Public building furniture	2531*
		230400	Wood partitions and fixtures	2541*
		230500	Metal partitions and fixtures	2542
		230600	Drapery hardware and blinds and shades	2591
		230700	Furniture and fixtures, n.e.c.	2599
040	Paper and allied products	240100	Pulp mills	261*
		240200	Paper mills, except building paper	262
		240300	Paperboard mills	263
		240400	Envelopes	2642
		240500	Sanitary paper products	2647
		240602	Building paper and board mills	266*
		240701	Paper coating and glazing	2641
		240702	Bags, except textile	2643
		240703	Die-cut paper and board	2645
		240704	Pressed and molded pulp goods	2646
		240705	Stationery products	2648
		240706	Converted paper products, n.e.c.	2649*
041	Paperboard containers and boxes	250000	Paperboard containers and boxes	265

Concordance of MRIO, BEA I-O and SIC Codes

MRPIS Code	Sector Name	1977 BEA I-O Code	Sector Name	1977 SIC
	Manufacturing cont'd			
041	Newspapers, periodicals and other printing and publishing	260100	Newspapers	271
		260200	Periodicals	272
		260301	Book publishing	2731
		260302	Book printing	2732
		260400	Miscellaneous publishing	274*
		260501	Commercial printing	2751-2, 2754
		260502	Lithographic plate-making and services	2795
		260601	Manifold business forms	276
		260602	Blankbooks and loose-leaf binders	2782
		260700	Greeting card publishing	277
		260801	Engraving and plate printing	2753
		260802	Bookbinding and related work	2789
		260803	Typesetting	2791
		260804	Photoengraving	2793
		260805	Electrotyping and stereotyping	2794
043	Industrial chemicals	270100	Industrial inorganic and organic chemicals	281* (excl. 28195), 2865, 2869*
044	Agricultural chemicals	270201	Nitrogenous and phosphate fertilizers	2873-4
		270202	Fertilizers, mixing only	2875
		270300	Agricultural chemicals, n.e.c.	2879
045	Other chemical products	270401	Gum and wood chemicals	2861
		270402	Adhesives and sealants	2891
		270403	Explosives	2892

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Concordance of MRIO, BEA I-O and SIC Codes

MRPIS Code	Sector Name	1977 BEA I-O Code	Sector Name	1977 SIC
	Manufacturing cont'd			
045	Other chemical products	270404	Printing ink	2893
		270405	Carbon black	2895
		270406	Chemical preparations, n.e.c.	2899
046	Plastics and synthetics	280100	Plastics materials and resins	2821
		280200	Synthetic rubber	2822*
		280300	Cellulosic man-made fibers	2823*
		280400	Organic fibers, non-cellulosic	2824*
047	Drugs	290100	Drugs	283*
048	Cosmetics and cleaning products	290201	Soap and other detergents-	2841
		290202	Polishes and sanitation goods	2842
		290203	Surface active agents	2843
		290300	Toilet preparations	2844
049	Paint and allied products	300000	Paints and allied products	285
050	Petroleum refining and allied products	310101	Petroleum refining	291
		310102	Lubricating oils and greases	2992
		310103	Products of petroleum and coal, n.e.c.	2999
		310200	Paving mixtures and blocks	2951
		310300	Asphalt felts and coatings	2952
051	Rubber and misc. plastics	320100	Tires and inner tubes	301
		320200	Rubber and plastics footwear	302

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Concordance of MRIO, BEA I-O and SIC Codes

MRPIS Code	Sector Name	1977 BEA I-O Code	Sector Name	1977 SIC
	Manufacturing, cont'd			
051	Rubber and miscellaneous plastics	320301	Reclaimed rubber	303
		320302	Fabricated rubber products, n.e.c.	306*
		320400	Miscellaneous plastics products	307
		320500	Rubber and plastics hose and belting	304
052	Leather and leather products	330001	Leather tanning and finishing	311
		340100	Boot and shoe cut stock and findings	313
		340201	Shoes, except rubber	3143-9
		340202	House slippers	3142
		340301	Leather gloves and mittens	315
		340302	Luggage	316
		340303	Women's handbags and purses	3171
		340304	Personal leather goods	3172
		340305	Leather goods, n.e.c.	319
053	Glass and glass products	350100	Glass and glass products, except containers	321, 3229, 323
		350200	Glass containers	3221
054	Stone and clay products	360100	Cement, hydraulic	324
		360200	Brick and structural clay tile	3251
		360300	Ceramic wall and floor tile	3253
		360400	Clay refractories	3255
		360500	Structural clay products, n.e.c.	3259

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Concordance of MRIO, BEA I-O and SIC Codes

MRPIS Code	MRPIS Sector Name	1977 BEA I-O Code	1977 BEA I-O Sector Name	1977 SIC	
	Manufacturing, cont'd				
054	Stone and clay products	360600	Vitreous plumbing fixtures	3261	
		360701	Vitreous china food utensils	3262	
		360702	Fine earthenware food utensils	3263	
		360800	Porcelain electrical supplies	3264	
		360900	Pottery products, n.e.c.	3269	
		360100	Concrete block and brick	3271	
		361100	Concrete products, n.e.c.	3272	
		361200	Ready-mixed concrete	3273	
		361300	Lime	3274	
		361400	Gypsum products	3275	
		361500	Cutstone and stone products	328	
		361600	Abrasive products	3291	
		361700	Asbestos products	3292	
		361800	Gaskets, packing and sealing devices	3293	
		361900	Minerals, ground or treated	3295*	
		362000	Mineral wool	3296	
		362100	Nonclay refractories	3297	
		362200	Nonmetallic mineral products, n.e.c.	3299	
055	Iron and steel mills and forging	370101	Blast furnaces and steel mills	3312	
		370102	Electrometallurgical products	3313*	Revised
		370104	Cold finishing of steel shapes	3316	
		370105	Steel pipe and tubes	3317	

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Concordance of MRIO, BEA I-O and SIC Codes

MRPIS Code	Sector Name	1977 BEA I-O Code	Sector Name	1977 SIC	
	Manufacturing, cont'd				
055	Iron and steel mills and forging	370300	Iron and steel forgings	3462*	
		370401	Metal heat treating	3398	
		370402	Primary metal products, n.e.c.	3399	
056	Iron and steel foundries	370200	Iron and steel foundries	332	
057	Primary nonferrous metals and products	380100	Primary copper	3331	
		380200	Primary lead	3332	
		380300	Primary zinc	3333	
		380400	Primary aluminum	3334, 28195	
		380500	Primary nonferrous metals, n.e.c.	3339	
		380600	Secondary nonferrous metals	334	
		380700	Copper rolling and drawing	3351	
		380800	Aluminum rolling and drawing	3353-5	
		380900	Nonferrous rolling and drawing, n.e.c.	3356	
		381000	Nonferrous wire drawing and insulating	3357	
		381100	Aluminum castings	3361	
		381200	Brass, bronze, and copper castings	3362	
		381300	Nonferrous castings, n.e.c.	3369	
		381400	Nonferrous forgings	3463*	
058	Metal containers and misc. metal products	370103	Steel wire and related products	3315	Revised
		390100	Metal cans	3411	
		390200	Metal barrels, drums, and pails	3412	

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MRPIS Code	MRPIS Sector Name	1977 BEA I-O Code	1977 BEA I-O Sector Name	1977 SIC
	Manufacturing, cont'd			
058	Metal containers and misc. metal products	420100	Cutlery	3421
		420201	Hand and edge tools, n.e.c.	3423
		420202	Hand saws and saw blades	3425
		420300	Hardware, n.e.c.	3429
		420401	Plating and polishing	3471
		420402	Metal coating and allied services	3479
		420500	Miscellaneous fabricated wire products	3495-6
		420700	Steel springs, except wire	3493
		420800	Pipe, valves, and pipe fittings	3494, 3498
		421000	Metal foil and leaf	3497
		421100	Fabricated metal products, n.e.c.	3499
059	Structural metal products	400100	Metal sanitary ware	3431
		400200	Plumbing fixture fittings and trim	3432
		400300	Heating equipment, except electric	3433
		400400	Fabricated structural metal	3441
		400500	Metal doors, sash, and trim	3442
		400600	Fabricated plate work (boiler shops)	3443
		400700	Sheet metal work	3444
		400800	Architectural metal work	3446
		400901	Prefabricated metal buildings	3448
		400902	Miscellaneous metal work	3449

Concordance of MRIO, BEA I-O and SIC Codes

MRPIS Code	Sector Name	1977 BEA I-O Code	Sector Name	1977 SIC
	Manufacturing, cont'd			
060	Screw machine products and metal stampings	410100	Screw machine products and bolts, nuts, rivets and washers	345
		410201	Automotive stampings	3465
		410202	Crowns and closures	3466
		410203	Metal stampings, n.e.c.	3469*
061	Engines and turbines	430100	Turbines and turbine generator sets	3511
		430200	Internal combustion engines, n.e.c.	3519
062	Farm and lawn equipment	440001	Farm machinery and equipment	3523*
		440002	Lawn and garden equipment	3524
063	Construction and mining equipment	450100	Construction machinery and equipment	3531*
		450200	Mining machinery, except oil field	3532
		450300	Oil field machinery	3533
064	Materials handling equipment	460100	Elevators and moving stairways	3534
		460200	Conveyors and conveying equipment	3535
		460300	Hoists, cranes, and monorails	3536*
		460400	Industrial trucks and tractors	3537*
065	Metalworking equipment	470100	Machine tools, metal cutting types	3541
		470200	Machine tools, metal forming types	3542

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Concordance of MRIO, BEA I-O and SIC Codes

MRPIS Code	Sector Name	1977 BEA I-O Code	Sector Name	1977 SIC
	Manufacturing, cont'd			
065	Metalworking equipment	470300	Special dies and tools and machine tool accessories	3544-5*
		470401	Power driven hand tools	3546
		470402	Rolling mill machinery	3547
		470403	Metalworking machinery, n.e.c.	3549
066	Special industry machinery and equipment	480100	Food products machinery	3551
		480200	Textile machinery	3552
		480300	Woodworking machinery	3553
		480400	Paper industries machinery	3554
		480500	Printing trades machinery	3555
		480600	Special industry machinery, n.e.c.	3559*
067	General industrial and other non-electrical machinery and equipment	490100	Pumps and compressors	3561, 3563
		490200	Ball and roller bearings	3562
		490300	Blowers and fans	3564*
		490400	Industrial patterns	3565
		490500	Power transmission equipment	3568*, 3569*
		490600	Industrial furnaces and ovens	3567
		490700	General industrial machinery, n.e.c.	3569
		500001	Carburetors, pistons, rings, valves	3592
		500002	Machinery, except electrical, n.e.c.	3599
068	Office and computing equipment	510101	Electronic computing equipment	3573
		510102	Calculating and accounting machines	3574

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Concordance of MRIO, BEA I-O and SIC Codes

MRPIS Code	Sector Name	1977 BEA I-O Code	Sector Name	1977 SIC
	Manufacturing, cont'd			
068	Office and computing equipment	510200	Typewriters	3572
		510300	Scales and balances	3576
		510400	Office machines, n.e.c.	3579
069	Service industry machinery and equipment	520100	Automatic merchandising machines	3581
		520200	Commercial laundry equipment	3582
		520300	Refrigeration and heating equipment	3585
		520400	Measuring and dispensing pumps	3586
		520500	Service industry machines, n.e.c.	3589*
070	Electric transmission and electrical industrial equipment	530100	Instruments to measure electricity	3825
		530200	Transformers	3612
		530300	Switchgear and switchboard apparatus	3613
		530400	Motors and generators	3621
		530500	Industrial controls	3622
		530600	Welding apparatus, electric	3623
		530700	Carbon and graphite products	3624
		530800	Electrical industrial apparatus, n.e.c.	3629
071	Household appliances	540100	Household cooking equipment	3631*
		540200	Household refrigerators and freezers	3632
		540300	Household laundry equipment	3633

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Concordance of MRIO, BEA I-O and SIC Codes

MRPIS Code	Sector Name	1977 BEA I-O Code	Sector Name	1977 SIC
	Manufacturing, Cont'd			
971	Household appliances	540400	Electric housewares and fans	3634*
		540500	Household vacuum cleaners	3635
		540600	Sewing machines	3636
		540700	Household appliances, n.e.c.	3639
972	Electric lighting and wiring equipment	550100	Electric lamps	3641
		550200	Lighting fixtures and equipment	3645-8
		550300	Wiring devices	3643-4
973	Receiving sets, records and tapes	560100	Radio and TV receiving sets	3651
		560200	Phonograph records and tapes	3652
974	Communications equipment	560300	Telephone and telegraph apparatus	3661
		560400	Radio and TV communication equipment	3662
975	Electronic components	570100	Electron tubes	3671-3
		570200	Semiconductors and related devices	3674
		570300	Electronic components, n.e.c.	3675-9
976	Other electrical equipment	580100	Storage batteries	3691
		580200	Primary batteries, dry and wet	3692
		580300	X-ray apparatus and tubes	3693
		580400	Engine electrical equipment	3694
		580500	Electrical equipment and supplies, n.e.c.	3699*

Concordance of MRIO, BEA I-O and SIC Codes

MRPIS Code	Sector Name	1977 BEA I-O Code	Sector Name	1977 SIC
	Manufacturing, Cont'd			
077	Motor vehicles and parts	590100	Truck and bus bodies	3713*
		590200	Truck trailers	3715
		590301	Motor vehicles and car bodies	3711
		590302	Motor vehicle parts and accessories	3714
078	Aircraft and parts			3721, 3728
079	Missiles, spacecraft and parts			3761, 3769
080	Aircraft, missile and spacecraft propulsion units			3724, 3764
081	Other transportation equipment	610100	Ship building and repairing	3731
		610200	Boat building and repairing	3732
		610300	Railroad equipment	374
		610500	Motorcycles, bicycles, and parts	375
		610601	Travel trailers and campers	3792*
		610603	Motor homes (made from purchased materials)	3716
		610700	Transportation equipment, n.e.c.	3799
082	Scientific and photographic equipment, watches and clocks	620100	Engineering and scientific instruments	3811
		620200	Mechanical measuring devices	3823-4, 3829

Concordance of MRIO, BEA I-O and SIC Codes

MRPIS Code	Sector Name	1977 BEA I-O Code	Sector Name	1977 SIC
	Manufacturing, Cont'd			
082	Scientific and photographic equipment, watches and clocks	620300	Environmental controls	3822
		620700	Watches, clocks, and parts	387
		630300	Photographic equipment and supplies	386
083	Medical, Dental and Optical equipment	620400	Surgical and medical instruments	3841
		620500	Surgical appliances and supplies	3842
		620600	Dental equipment and supplies	3843
		630100	Optical instruments and lenses	383
		630200	Ophthalmic goods	385
084	Other manufactured products	640101	Jewelry, precious metal	3911
		640102	Jewelers' materials and lapidary work	3915
		640104	Silverware and plated ware	3914
		640105	Costume jewelry	3961
		640200	Musical instruments	393
		640301	Games, toys, and children's vehicles	3944
		640302	Dolls	3942
		640400	Sporting and athletic goods, n.e.c.	3949
		640501	Pens and mechanical pencils	3951
		640502	Lead pencils and art goods	3952
		640503	Marking devices	3953
		640504	Carbon paper and inked ribbons	3955

Concordance of MRIO, BEA I-O and SIC Codes

MRPIS Code	Sector Name	1977 BEA I-O Code	Sector Name	1977 SIC
	Manufacturing, Cont'd			
984	Other manufactured products	640600	Artificial trees and flowers	3962
		640701	Buttons	3963
		640702	Needles, pins, and fasteners	3964
		640800	Brooms and brushes	3991
		640900	Hard surface floor coverings	3996
		641000	Burial caskets and vaults	3995
		641100	Signs and advertising displays	3993
		641200	Manufacturing industries, n.e.c.	3999 (excl. 39996)
	Transportation			
985	Railroads	650100	Railroads and related services	40*, 474, pt. 4789
986	Local passenger transportation and inter-city bus	650200	Local and suburban transit and interurban highways passenger transportation	41
		790100	Local government passenger transit	pt. 41
987	Motor freight	650300	Motor freight transportation and warehousing	42*, pt. 4789
988	Water transportation	650400	Water transportation	44
989	Air transportation	650500	Air transportation	45
990	Pipelines, except natural gas	650600	Pipe lines, except natural gas	46
991	Transportation services	650701	Freight forwarders and other transportation services	471, 4723, pt. 478
		650702	Arrangement of passenger transportation	4722

Concordance of MRIO, BEA I-O and SIC Codes

MRPIS Code	Sector Name	1977 BEA I-O Code	Sector Name	1977 SIC
	Communications			
092	Communications, except radio and TV	660000	Communications, except radio and TV	48 (excl. 483)
093	Radio and TV broadcasting	670000	Radio and TV broadcasting	483
	Electric, gas, and sanitary services			
094	Electric utilities	680100	Electric services (utilities)	pt. 491, pt. 493
		780200	Federal electric utilities	pt. 491
		790200	State and local electric utilities	pt. 491
095	Gas production and distribution	680200	Gas production and distribution (utilities)	492*, pt. 493
096	Water and sanitary services	680301	Water supply and sewerage systems	494, 4952
		680302	Sanitary services, steam supply, and irrigation systems	495 (excl. 4952), 496-7, pt. 493
	Trade and services			
097	Wholesale trade	690100	Wholesale trade	50*, 51* (excl. manufactures' sales offices)

Concordance of MRIO, BEA I-O and SIC Codes

MRPIS Code	Sector Name	I-O Code	Sector Name	1977 SIC
	Trade and services, cont'd			
098	Eating and drinking places	740000	Eating and drinking places	58
099	General merchandise and apparel stores			53, 56
100	Food, drug and liquor stores			54, 591, 592
101	Automotive dealers and gasoline service stations			55
102	Other retail stores			52, 57, 593-599, 7396
103	Banking, credit agencies and investment brokers	700100	Banking	60
		700200	Credit agencies	61* (excl. pt. 613), 67*
		700300	Security and commodity brokers	62

Concordance of MRIO, BEA I-O and SIC Codes

MRPIS Code	Sector Name	1977 BEA I-O Code	Sector Name	1977 SIC
	Trade and services, cont'd			
104	Insurance	700400	Insurance carriers	63*
		700500	Insurance agents, brokers, and services	64*
105	Real estate and rental	710100	Owner-occupied dwellings	not applicable
		710200	Real estate	65-6*, pt. 1531
106	Hotels and lodging place	720100	Hotels and lodging places	70*
107	Personal and repair services, except auto	720201	Laundry, cleaning, garment services and shoe repair	721, 725
		720202	Funeral service and crematories	726
		720203	Portrait, photographic studios, and miscellaneous personal services	722, 729*
		720204	Electrical repair shops	762
		720205	Watch, clock, jewelry and furniture repair	763-4
		720300	Beauty and barber shops	723-4*
108	Misc. services and advertising	730101	Miscellaneous repair shops	769
		730102	Services to dwellings and other buildings	734

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Concordance of MRIO, BEA I-O and SIC Codes

MRPES Code	Sector Name	1977 BEA I-O Code	Sector Name	1977 SIC
	Trade and services, cont'd			
108	Misc. services and advertising	730103	Personnel supply services	736
		730104	Computer and data processing services	737
		730105	Management and consulting services, testing and research labs	7391-2,,7397
		730106	Protective services	7393
		730107	Equipment rental and leasing	7394
		730108	Photofinishing labs, photocopy, and commercial photography	7332-3, 7395
		730109	Other business services	732, 7331, 7339, 735, 7399*
		730200	Advertising	731
109	Misc. professional services	730301	Legal services	811
		730302	Engineering, architectural, and surveying services	8911
		730303	Accounting, auditing and bookkeeping, and miscellaneous services, n.e.c.	893*, 899
110	Auto rental, repair and maintenance	750001	Automotive rental and leasing, without drivers	751
		750002	Automotive repair shops and services	753, 7549
		750003	Automobile parking and car washes	752, 7542

Concordance of MRIO, BEA I-O and SIC Codes

MRPIS Code	Sector Name	1977 BEA I-O Code	Sector Name	1977 SIC
	Trade and Services cont'd			
111	Amusements	760100	Motion pictures	78
		760201	Theatrical producers (except motion pictures), bands, and entertainers	792
		760202	Bowling alleys, billiard and pool establishments	793
		760203	Commercial sports except racing	7941
		760204	Racing (including track operation)	7948*
		760205	Membership sports and recreation clubs	7997
		760206	Other amusement and recreation services	791, 799* (excl. 7997)
112	Doctors and dentists, inc. outpatient care facilities			801-3,809
113	Hospitals and nursing	770200	Hospitals	806
		770301	Nursing and personal care facilities	805
114	Other medical and health services			074,804, 807, 809
115	Educational services	770401	Elementary and secondary schools	821
		770402	Colleges, universities, and professional schools	822
		770403	Libraries, correspondence and vocational schools, and educational services, n.e.c.	823-9

Concordance of MRIO, BEA I-O and SIC Codes

MRPIS Code	Sector Name	1977 BEA I-O Code	Sector Name	1977 SIC
	Trade and Services cont'd			
116	Nonprofit organizations	770501	Business associations and professional membership organizations	861-2
		770502	Labor organizations and civic, social, and fraternal associations	863-4
		770503	Religious organizations	866
		770504	Other membership organizations	84, 865, 869, 8922
117	Other social services	770600	Job training and related services	8331
		770700	Child day care services	8351
		770000	Residential care	8361
		770900	Social services, n.e.c.	8321*, 8399
	Government enterprises			
118	Federal government enterprises, except utilities and local transit	780100	U.S. Postal Service	4311
		780300	Commodity Credit Corporation	pt. 613
		780400	Other Federal Government enterprises	several
119	State and local government enterprises, except utilities and local transit	790300	Other State and local government enterprises	several
	Special industries			
120	Directly allocated imports	800000	Noncomparable imports	
121	Scrap	810001	Scrap	

Concordance of MRIO, BEA I-O and SIC Codes

MRPIS Code	Sector Name	1977 BEA I-O Code	Sector Name
	Special Industries cont'd		
122	Government industry	820000	Government industry ----
123	Household industry	840000	Household industry ----
Added 124	Rest of World		
	Final Demand		
150	Personal consumption expenditures		
151	Gross private fixed capital formation		
152	Net inventory change		
153	Gross exports		
154	Federal gov't capital expenditures, (except defense)		
155	State and local gov't capital expenditures		
156	Federal defense expenditures (current and capital)		
157	Federal gov't current expenditures (except defense)		
158	State and local gov't current expenditures		
159	Foreign imports		

*Indicates those industries in which there was a change in composition between the 1972 and 1977 SIC's.

APPENDIX D

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