The Structure of The Twin Cities' Economy:

An Input-output Perspective

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Metropolitan Council
OF THE TWIN CITIES AREA

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I. INTRODUCTION

The Metropolitan Council has recently completed an input-output study of the Twin Cities Metropolitan Area economy. The study was initiated in the Fall of 1972 with most of the work being completed in 1973 and 1974. The purpose of the study was to provide basic economic data in the Twin Cities Metropolitan Area and to systematically relate this data to the overall development of the Region. The products resulting from the study are a computerized model which includes various kinds of economic data and allows for analyzing economic changes, a set of projections to 1980, and two summary reports prepared by consultants on how the model was developed.

Purpose and Outline of this Report

This report is designed to accomplish several purposes. First, it will provide an explanation of what input-output analysis* is and the information produced from such analysis. Second, a set of tables, aggregated from the detailed information in the study, has been developed to explain the input-output model for the Metropolitan Area. Third, the report will include information on selected industries from detailed input-output tables. Fourth, there will be a general description of possible applications of the input-output information by public and private users. It is hoped that the report will stimulate further applications by other organizations, public and private, in the Metropolitan Area.

The remainder of the report is divided into four parts. Section II discusses some possible applications of input-output analysis as a means of providing some perspective to the detailed description of the model. The detailed description, contained in Section III, includes explanations of the tables that are the main products of input-output analysis. This section also explains how input-output tables were developed for the Twin Cities Metropolitan Area. Section IV presents the information on the Twin Cities using simplified input-output tables which were aggregated from the detailed information developed during the study. This detailed information is the subject of Section V, which shows the relative importance of specific industries with respect to various data items such as sales, imports, exports, etc. The author of this report was Gene Knaff.

Background

An understanding of the regional economy is essential to planning for the future growth and development of the seven-county Metropolitan Area. This understanding requires information on the present structure of the economy, how it has changed over time, why it has evolved in a particular way, and what its future

*Terms indicated by underlining (section and column headings excluded) are defined in the glossary on page 39.

might be. Unfortunately, there is relatively little economic information on metropolitan areas collected on a regular basis. In addition, our knowledge of the causal factors involved in the operation of metropolitan economies is limited. This study was undertaken in order to fill in some gaps in this knowledge--to provide basic economic information at a detailed level and to organize this information in a way which would provide an idea of how the regional economy "works." The input-output technique, an analytical technique which has been applied at all levels of government, seemed the best approach available to provide basic information at a detailed level and some analytical capability.

Input-Output Analysis: General Description

In designing the study of the regional economy, input-output analysis was one of several techniques considered. Other techniques which are commonly used to study regional economies include economic base analysis, econometric methods, and various systems of regional accounts. (See page 9 for a fuller explanation of regional accounts.) It was decided that some detailed information by industry was needed and that the information should be organized in a way which illustrates the structure of the Region's economy. This was to allow for estimating the impact of economic changes on the Region for use in projecting future economic activity.

Of all the techniques, the input-output technique seemed best suited to meet these needs. It requires information on intermediate sales and final sales, purchases, imports, exports, value added, and employment by occupation and by industry. In addition, the information is organized in a systematic way which shows the structure of the Region's economy, the actual interrelationships among detailed kinds of economic activity. It gives the dollar flows among industrial sectors within the economy, between these sectors and consumers within the Region, and links the detailed kinds of economic activity within the Region to buyers and sellers outside the Metropolitan Area.

The input-output structure implies a theory of economic growth. Sales to final demand provide the stimulus to growth; the local processing sector responds to produce what is necessary to satisfy the quantity of goods "demanded" by final consumers. The final demand sectors are independent forces which determine the level of economic activity within the Region.

General Findings

In 1971, the base year selected for the study, the gross output of the Metropolitan Area was over $19 billion. The Gross Area Product, a concept equivalent to Gross National Product at the national level, was almost $11 billion. This represented 1.04 per cent of the Gross National Product, about 13 per cent larger than the Region's share of U. S. population in 1970.

Table 1 compares the distribution of Gross Area Product and Gross National Product by major industrial grouping in 1971. Although the actual input-output study separated the regional economy into 95 industries, for purposes of this descriptive report these have been aggregated into ten industries: agriculture, mining, construction, durables manufacturing, non-durables manufacturing, transportation-communications-utilities (T.C.U.), trade (wholesale and retail), finance-insurance-real estate (F.I.R.E.), services, and government. The Appendix contains a full listing of the standard industrial classifications defined for the study and how these were aggregated into ten industries used in this report.

Table 1
Distribution of Gross Area Product (GAP) for the Metropolitan Area and the Gross National Product (GNP), 1971

	GAP (in millions)	Per Cent of Total	GNP (in billions)	Per Cent of Total
Agriculture	$ 51.2	0.5	$ 33.7	3.2
Mining	8.1	*	16.3	1.5
Construction	698.3	6.4	50.6	4.8
Durables	1,968.1	17.9	151.7	14.4
Non-Durables	1,278.2	11.7	111.6	10.6
T.C.U.	951.6	8.7	91.7	8.7
Trade	1,863.1	17.0	182.0	17.3
F.I.R.E.	2,020.3	18.4	151.0	14.3
Services	865.6	7.9	122.0	11.6
Government	1,263.4	11.5	140.6	13.3
Other	--	--	3.7	0.3
	$10,967.9	100.0	$1,054.9	100.0

*Less than .1 of one per cent.

The manufacturing sectors account for the largest share of Gross Area Product (GAP), almost 30 per cent. Most of this product (17.9 per cent) is produced by the durables manufacturing industry (e.g., ordnance, farm machinery, computers, and metal products). The other large contributors to Gross Area Product are finance-insurance-real estate, generating 18.4 per cent of GAP; wholesale and retail trade, 17.0 per cent; and government, 11.5 per cent. Compared with the United States as a whole, the Metropolitan Area has a relatively small agriculture industry (0.5 per cent versus 3.2 per cent in the U.S.), larger manufacturing production, more construction, and a larger finance-insurance-real estate industry. The services and government industries were relatively smaller than for the entire United States.

The distribution of gross output among industries, summarized in Table 2, is similar to the distribution of Gross Area Product. Construction and non-durables manufacturing account for a somewhat larger proportion of gross output than Gross Area Product, reflecting the double-counting of intermediate goods. Non-manufacturing activity still represents the major proportion (66 per cent) of the regional total. Most of this non-manufacturing is concentrated in wholesale and retail trade and the finance-insurance-real estate industries. These two major groups, trade and finance, account for 30 per cent of gross output and 35 per cent of Gross Area Product. This reflects the Twin Cities' role as the major service center for the Upper Midwest. Manufacturing output is itself well diversified, with no individual industry accounting for more than ten per cent of total manufacturing output.

Table 2
Distribution of Imports, Exports, and Gross Output
Among Major Industries, Metropolitan Area, 1971

	Imports (in 000's)	Per Cent of Imports	Exports (in 000's)	Per Cent of Exports	Gross Output (in 000's)	Per Cent of Gross Output
Agriculture	$ 55,865	0.9	$ 2,996	0.5	$ 132,727	0.7
Mining	3,413	*	-	-	14,558	*
Construction	461,595	7.6	536,292	8.1	2,062,815	10.7
Durables	895,032	14.7	2,418,063	36.5	3,477,100	18.0
Non-Durables	1,305,238	21.4	1,540,238	23.3	3,071,340	15.9
T.C.U.	433,711	7.1	676,827	10.2	1,659,073	8.6
Trade	454,213	7.5	869,709	13.1	2,946,957	15.3
F.I.R.E.	331,296	5.4	307,480	4.6	2,828,539	14.6
Services	208,628	3.4	247,609	3.7	1,629,263	8.4
Government	29,067	0.5	-	-	1,323,924	6.9
Miscellaneous	-	-	-	-	166,695	0.9
Final Demand	1,917,087	31.5	-	-	-	-
Total	$6,095,145	100.0	$6,626,214	100.0	$19,312,991	100.0

*Less than .1 of one per cent.

Most of the Region's gross output (66 per cent) was sold within the Metropolitan Area, 22 per cent as intermediate goods and 44 per cent as finished products. The remaining 34 per cent, amounting to $6.6 billion, was shipped to markets outside the Area. Table 2 includes information on export sales by major industrial groups. Approximately 60 per cent of these exports were manufactured goods, although certain non-manufacturing industries such as construction, trade, and transportation also exported large amounts.

The Metropolitan Area makes $6.1 billion of purchases from businesses located outside the Region. Thirty-one per cent of these imports were finished goods (final demand) bought by consumers, businesses, and governments. The remaining imports ($4.2 billion) represented intermediate goods used as inputs by Metropolitan Area industries. The Area is heavily dependent on imports of certain primary goods, such as petroleum and natural gas, steel, and agricultural products. In addition, the Region imports substantial amounts of textiles, electronic components, business services, and processed food products.

Implications

First, the information on the regional economy indicates the importance of non-manufacturing industries. One positive aspect of this is that an economy which is not heavily dependent on one or two industries is somewhat insulated from cyclical fluctuations. From a public land-use planning perspective, the mix of industries or the shift from manufacturing to non-manufacturing could significantly affect the physical structure of the Region. Different kinds of economic activity have different space needs and different public service needs. These requirements are reflected in the locational patterns of these activities. For example, if the Metropolitan Area were to become primarily a financial center, most of the new non-residential construction would be office buildings, probably clustered in a few areas such as the downtowns. If the Area were to be primarily a manufacturing center, new construction might involve factories built along the highway networks in outlying suburbs where large tracts of land are available. Each of these situations implies a different physical layout for the Area.

Second, many of the industries which are important export industries for the Region are expected to grow faster than the national economy as a whole. The Bureau of Labor Statistics estimates that nationally transportation-communications-utilities, finance-insurance-real estate, and the services industries will increase their shares of 1980 gross output in the United States. Although over-all manufacturing is expected to retain a relatively constant share of 1980 output, several manufacturing industries expected to grow at above-average rates are well-established in the Metropolitan Area (e.g., computers).

Third, the Metropolitan Area imports half of the intermediate inputs used by its processing sector, plus additional amounts of final goods. These imports represent local money which leaves the regional economy. If this money could be retained in the Region, it would stimulate additional regional production. The products imported would suggest logical candidates for new industry, provided production regionally is feasible in terms of market and the kind of product. The kinds of products which account for most of the imports into the Region will be discussed in Section V of this report.

Since the basic information in the study is limited to one point in time (1971), it is not possible to make any statements on trends. It may, however, suggest ways to influence or attract certain kinds of growth in the future. This includes

suggestions on the kinds of industries to attract or how changes in particular industries, locally or nationally, might influence the Region as a whole. There is definitely a need to plan for future growth, not merely react to growth as it occurs, and to provide an environment for growth which is in the best interest of the citizens of the Region.

II. POSSIBLE APPLICATIONS OF THE INPUT-OUTPUT MODEL

Input-output analysis is not a new technique, having been developed by Wassily Leontief in the 1930's. Originally, it was designed as a descriptive technique to quantify the interrelationships among economic sectors and to provide a working model of the economy. The first applications of the technique were at the national level, where it is still regularly used, primarily for forecasting. For example, manpower projections by the Department of Labor are based on an input-output model of the United States economy.

Economists have also adopted the technique for urban and regional economic analysis. Urban analysts have used it to estimate economic impacts, for example, the effect on an economy from a change in a particular industry. Impact studies and forecasts have been the most common applications of input-output analysis.

This section will discuss some possible uses of the input-output tables by public agencies and private groups. The section is not intended to cover all possible applications. It is hoped that the discussion of the model, the information it contains and the way in which the information is organized, will suggest further applications to potential users of the model.

Manpower Planning

Developing manpower projections was one of the uses that was considered in the original design of the study. With this application in mind, detailed information on employment by occupation was collected for each industry. The occupational information was related to the data in the basic transactions table (see pages 9-11 for fuller explanation of the transactions table). This relationship makes it possible to derive the employment opportunities implicit in the projections of the future economy of the Metropolitan Area. This is similar to the approach of the U. S. Bureau of Labor Statistics in projecting future manpower needs by occupation.

Information Base

The transactions table provides an illustration of the local economy as it is at a particular point in time. It describes the economy as it is, not as it should be or might be (e.g., at full employment). It shows the final demand for goods and services produced locally and the intermediate transactions necessary to satisfy that demand. From the intermediate transactions among production industries, one can identify strong linkages among industries.

Impact Analysis

The structure of the tables developed makes it possible to estimate the impact of changes in specific sectors of the economy on the entire economy. Essentially, this involves changing certain entries of the table (e.g., changing sales of a particular industry) and recomputing the effect on total output. The inverse table (see pages 17-19) enables one to compute this quite easily. Some examples of possible applications in this regard would be to estimate the effect of a reduction in federal government spending in the Region or the location of a new firm in the Area. In this regard, the model might also be helpful in assessing indirect impacts on the Area. For example, a change in the consumption of a wood furniture product at a national level could be related to the local economy by assuming a proportionate change in the local industry.

Regional Forecasts

The input-output model provides a means of forecasting the future growth of the Metropolitan Area and how different industries will participate in this growth. The approach taken in these projections is to make forecasts of the independent variables in the model, the final demand sector. The projected final demand values are distributed among industries, and these values are multiplied by the inverse matrix to derive future outputs by industry. The assumption involved is that the input-output interrelationships remain constant, a valid assumption in the short run. For this reason, projections must be limited to five or ten years. The longer range the projection, the less valid is the assumption.

By combining the projections of future final demand with the inverse table, the model will give the estimated output from each industry implied by the increased final demand. From the increased output, one can estimate the requirements of raw materials, labor, and capital. For example, this is the source of the occupational projections mentioned in regard to manpower planning. The employment needs projected are converted to their occupational components.

Economic Development

One of the more frequent uses of input-output tables is to identify potential new industries for an area. The model designates the Region's dependence on external industries through the information it includes on imports and exports. A separate import table has been developed which shows the importing local industry and the external industries from which goods and services are imported. In addition, the inverse table gives the "multipliers" for each local industry, the multiple by which indirect production is stimulated in the local economy. Thus, it is possible to determine how individual firms might increase regional production, the kinds of local inputs that are available to new industry, and the potential market for a new firm that exists in the local area. All of these would be useful in identifying potential industries which might locate in the Region or existing firms which might wish to expand.

Energy Demand Analysis

The input-output model could be modified and applied to energy problems. Since various energy sources are important inputs to the production processes of all industries, separate sectors could be developed for these energy sources. For example, separate industries might be included for electric utilities and gas utilities. An alternative approach would be to build a separate table of energy coefficients which would be compatible with the existing input-output tables.

The Minnesota Energy Agency has developed an input-output model of the state economy. It is using the model to estimate the impact of different energy supply and demand situations on the state's economy and to project future energy requirements. The Energy Agency model provides detailed classification of energy-producing industries and separate tables on fuel use by industry group for different kinds of fuels.

Market Analysis

Individual firms may find the information useful in analyzing potential markets in the Twin Cities Metropolitan Area. The tables contain information on sales by industry and can be used to estimate future growth in sales. The industry classifications correspond to the classifications used in the national input-output tables and the projections done at the national level. Import information is detailed by industry, showing the external industries from which products are purchased. This might suggest a potential market for existing local firms which can produce a product presently imported.

Other Uses

Additional data on a particular problem might be adaptable to the industrial groups used in the tables. The economic projections from the input-output model could then be applied to the particular problem. For example, by using space required per unit of output one could project future industrial land-use requirements. Similarly, by using pollution coefficients by type of pollution for a particular industry, future environmental problems might be estimated.

The examples mentioned provide some idea of specific applications of the model. It is also hoped that these examples and the description of the information in the tables and the way in which the information is organized will suggest further applications by potential users.

III. THE INPUT-OUTPUT FRAMEWORK

This section of the report includes a general description of input-output analysis and will explain in greater detail what is involved in developing an input-output model -- what the model looks like, how it is put together, and what products result.

An input-output model can be thought of as a system of accounts on the economic activity in a particular area. Just as an individual firm keeps accounts of how it is progressing, so can accounts be developed to monitor what's happening in a local or regional economy. The firm's books keep track of its sales and purchases; a set of regional accounts provides similar information for the regional economy. Input-output tables are one method of organizing economic information about the Region into a set of accounts.

These tables are the main product of the input-output technique. The basic table, the transactions table, gives the sales (and purchases) of a particular industry to other industries and final users. The logic behind the table is quite simple -- each industry requires certain inputs (labor, raw materials, semi-finished goods, capital goods) to achieve a specific level of production. Since a purchase by one industry represents a sale by another industry, a matrix is a convenient way of arraying the information.

Figure 1
Transactions Table

		Intermediate Goods and Services: Agriculture, Mining, Construction, Manufacturing, Transportation, Trade, Finance, Services	Final Demand: Metropolitan Area Exports	Total Gross Output
Processing Sectors	Agriculture, Mining, Construction, Manufacturing, Transportation, Trade, Finance, Services	I	III	
Payments	Value Added, Imports	II	IV	
	Total Gross Input			

The transactions table can be best described by using a diagram (Figure 1). The table can be partitioned in four sections. Quadrant I in the upper left shows inter-industry transactions, the sales and purchases of intermediate goods among local industries. Reading across each row gives the sales from the industry on the left to the industry at the top of the column. Similarly, reading down each column gives the purchases by the industry at the top from each industry on the left. Thus, any individual entry in a row and column intersection -- or "cell" -- shows sales by the industry on the left to the industry at the top, or conversely, purchases by the industry at the top from the industry on the left.

Quadrant II in the lower left gives the imports, value added, and total inputs for the industry at the top of each column. Quadrant III in the upper right summarizes sales by local industries to final demand sectors. Final demand here includes final purchases in the Metropolitan Area and purchases by industries outside the Area (exports). The final demand sectors are important in input-output analysis, which assumes that final demand determines the level of production in an economy. Quadrants II and III are related insofar as they cover all non-intermediate transactions involving regional firms. Quadrant II summarizes payments made for non-intermediate goods and services; Quadrant III summarizes sales of non-intermediate goods and services. For example, Quadrant II includes payments to primary factors of production (wages, profits, rents, and interest),and imports. Quadrant III includes purchases by households and governments, of capital goods by industries, and exports. Quadrant IV in the lower right covers all other transactions, providing the residual amounts necessary to balance the transactions table and arrive at Gross Area Product. Logically, this section contains the inputs which are used directly by final demand. These inputs are not involved in inter-industry transactions within the Area. The main inputs involved here would be government employment and imports from the rest of the world which are purchased by final users in the local area.

The bottom row and last column for the processing sectors in the table represent the total output of each local industry. The row total, total sales, must equal the column total, total purchases, according to the accounting assumption of the model. This equality is only true for individual industries; it is not true for the items in Quadrant II (payments) and Quadrant III (final demand). For example, imports do not equal exports. However, the sum of all sales to final demand will equal the sum of all purchases from Quadrant II.

Given the interdependency among industries, one can go a step further. If it is known that sales of an industry will increase by a certain amount, it is possible to trace how this increase will affect industries which are closely linked to that industry. A ripple effect is created in the regional economy, a series of purchases working through the economy because of the inter-relationships among sectors. This may involve a number of "rounds" as the initiating sector stimulates another local industry which may, in turn, purchase some goods from the first industry. For example, an increase in manufacturing

sales stimulates purchases of agricultural goods by manufacturing. The increase in agricultural goods may stimulate increased purchases of manufactured goods by agriculture. Each successive round, of course, involves a smaller increase in output until eventually the increased input requirements become negligible amounts. Thus, increased demand for an industry's product requires increased output in that industry and additional output of intermediate goods and services from local industries supporting that industry. Conversely, a decrease in demand of an industry's product will mean lower output in that industry and any supporting industries.

In order to estimate the impact of such changes in the economy, some additional manipulations are necessary to convert the transactions table from a set of descriptive accounts into an analytical system. Two additional tables, a coefficients table and an inverse table, can be derived from the transactions table. The transactions table can be "standardized" by converting the dollar entries to coefficients by dividing the cost of each input by the total amount of inputs purchased. This represents the amount of each input purchased by an industry to produce a dollar's worth of output. From the magnitude of these coefficients it is also possible to determine which industries are most closely linked to the producing industry.

The coefficients table gives the direct requirements to produce a dollar's worth of output in each industry. The coefficients table could be used to trace out the "rounds" of transactions resulting from an initial change in demand for an industry's output. By adding up the change in output of all industries, one could approximate the total change in the local economy's output. The first round gives the direct change; the changes from successive rounds give the indirect changes.

This process can be quite complex as the coefficients table becomes large. There is a convenient mathematical operation that can be used to compute the total effects, direct and indirect. This operation, known as inverting a matrix,* produces a special kind of matrix or table, the inverse table, which shows the cumulative effects of the round-by-round transactions on each industry. Using the inverse table one can easily estimate the change in total regional output resulting from a change in the demand for an industry's output.

These three tables -- the transactions table, the coefficients table, and the inverse table -- are the main products of an input-output model. The following section will explain briefly how the input-output tables for the Twin Cities Metropolitan Area were developed and include a set of summary tables from the study.

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*The inverse matrix is used to compute general solutions to sets of simultaneous linear equations. The input-output model can be described mathematically as such a set of linear production relationships, each industry having a separate equation.

IV. THE TWIN CITIES AREA ECONOMY: AN INPUT-OUTPUT PERSPECTIVE

The first part of this section gives a general description of the approach used to develop the detailed input-output tables for the Metropolitan Area. This includes information on the survey of individual firms. The second part presents the summary transactions table for the Twin Cities Metropolitan Area and the third part, the coefficients table and the inverse table.

The detailed input-output tables for the Twin Cities Metropolitan Area have been aggregated into summary tables for purposes of this report. The tables identify 96 processing sectors and are too large to display conveniently. Consequently, these sectors have been combined into ten summary sectors or industries. The ten industries are identical to those used previously in the report and are described in the Appendix (page 30).

Implementing the Input-Output Technique

The actual work involved in constructing an input-output model is quite difficult. Most of the necessary information has to be collected as part of the study. There are no convenient sources of published information available for individual industries. In addition, even the information in the summary accounts of individual firms is not exactly in the form needed. In designing the study, it is necessary to know what limited information is available and to weigh the extra costs involved in surveying individual firms against the improvement in the information.

There are several basic considerations which have to be made preliminary to the data collection phase of the study. First, what is the geographical area which will be included in the study? Second, how are firms to be classified or grouped? Third, how will the necessary data be collected?

In the Twin Cities Area study, the Region was defined to include the counties of Anoka, Carver, Dakota, Hennepin, Ramsey, Scott and Washington. The classification of industries was influenced by several factors, including the similarity of individual firms, the perceived importance of an industry to the Region, the number of firms in the industry, and the possibility of disclosing information on a specific firm. There are several existing classification systems, the most common being the Standard Industrial Classification (SIC) codes published by the U. S. Office of Budget and Management.

The industry classification system used in the study was similar to that used in the national input-output studies. In those industries in which the Area had relatively large concentrations of employment, a more detailed breakdown was used. For example, the food processing industry was divided into four subsectors. As a result, the intermediate sector in the Metropolitan Area study contains 96 industries compared with 86 industries in the national tables. The resulting classification does not correspond exactly to any level of

Standard Industrial Classifications. (See Appendix for input-output categories and their correspondence to SIC codes.)

In addition to the intermediate or production sector of the regional economy, the model specifies several final demand sectors. The final demand sectors include six kinds of final consumers within the Metropolitan Area and a single category for final consumers inside the Region. These exports to final consumers are distinguished from exports to intermediate users (e.g., manufacturing firms) outside the Metropolitan Area.

In this report, the size of the input-output tables has been reduced from 107 rows and columns to 16 rows and columns. The sixteen categories include eleven intermediate or production sectors, two final demand sectors, total intermediate output, total final demand, and gross output.

The primary information used to develop the transactions table was collected directly from individual firms in the Metropolitan Area. Most of this information was obtained through mailed questionnaires, although some personal interviews were also conducted. Information was received from all the industries in the Region surveyed , although in some instances the information was incomplete or from only one or two firms. In those industries in which the sample information was considered inadequate, information from the national input-output tables was used to estimate the input structure of the local industry.

The survey was designed at a greater level of detail than the final transaction table. The sample design for the study distinguished approximately 120 processing industries, whereas the final transactions table included 96 industries. This 120-sector classification was the sampling frame from which the surveyed firms were drawn. The resulting survey included approximately 40 per cent of the manufacturing firms and 15 per cent of the non-manufacturing firms in the Metropolitan Area. In designing the survey, there was an attempt to balance costs in time and manpower with the improvement in data. There was less concern with uniform statistical procedures than with obtaining good coverage of those industries which were most important to the Region or which could not be easily estimated from secondary sources. Thus, efforts were concentrated in the larger firms within the industries with the largest employment. For example, the fifty largest employers in the Area were interviewed directly by a private consulting firm.

The results of the survey varied from industry to industry, ranging from responses of less than ten per cent to 90 per cent. Over-all, about 15 per cent of the firms surveyed returned completed questionnaires. These responses represented over half of the Area's employment, as the survey effort was concentrated on the Region's larger firms.

Once the responses had been received and checked, these results were tabulated in industry totals. This information provided the basic data for developing the transactions table. The data was checked against secondary information on total sales and total employment. Where the survey results

represented 20 per cent or more of these totals, the survey results were used to estimate the input structure of an industry. In other instances, information from the national input-output tables was utilized. Various secondary sources of information were used in this process. The final step in the process of building the transaction table was to balance the row and column totals within the table. This balancing work is a lengthy process, requiring repetitive adjustments in the rows and columns in order to make certain that the table is internally consistent.

Summary Transactions Table

For purposes of this report, the tables of the input-output study have been aggregated into "mini-tables" which divide the regional economy into ten intermediate industries. The actual tables produced in the study included 96 industries and eight final demand sectors.

The transactions table, which was discussed in Section III, illustrates the dollar transactions among individual sectors in the economy. This includes sales and purchases among industries, showing the interdependencies among industries in the Area. In addition, trading patterns with outside industries are given. This information indicates which local industries rely on outside industries for certain inputs, from what outside industries they import, and to what extent local industries depend on outside markets (export sales).

Table 3 presents the aggregated transactions table for the Metropolitan Area. The table shows the sales and purchases within the Twin Cities economy during 1971. The entries in the table are dollar transactions in thousands of dollars. For example, the first entry in the agriculture industry is $7,643,000, and the total output of this industry $132.7 million.

The first ten rows and columns in the table indicate inter-industry transactions among local industries. Each column indicates the goods and services purchased by the industry at the top of the column for use as inputs in its production process. Every purchase represents a sale by another industry. Thus, reading across a row gives the sales by the industry on the left to the industry at the top of each column. For example, the entry in the cell formed by the intersection of the services row and the construction column is approximately $127.3 million. This amount can be viewed as the sale of services to the construction industry or, conversely, the purchase of services by the construction industry.

Notice also that industries purchase from themselves. For example, the services industry purchases about $112 million from itself (intersection of the services row and the services column). This covers transactions among firms within the industry. For example, a local law firm provides legal services to a local accounting firm, both firms being classified in the services industry.

Table 3
Inter-Industry Transactions, 1971*

Producing Industry / Payments	Intermediate Goods and Services											Final Demand			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
	Agr.	Mining	Construc.	Durables	Non-Durables	T.C.U.	Trade	F.I.R.E.	Services	Gov't.	Misc.	$ Total Inter-mediate Outputs	Metro Final Demand	Exports	Total Output	
Agriculture	$7,643	$ 0	$ 526	$ 0	$ 70,479	$ 247	$ 196	$ 5,286	$ 0	$ 616	$ 0	$ 84,993	$ 17,738	$ 29,996	$ 132,727	1
Mining	71	0	10,302	197	4,053	0	130	146	0	0	0	14,899	-341	0	14,558	2
Construction	1,057	0	757	9,796	8,290	5,508	4,225	73,957	19,235	11,588	0	134,413	1,392,110	536,292	2,062,815	3
Durables Mfg.	308	315	350,462	332,701	57,814	56,461	58,024	10,881	40,523	328	839	916,207	142,030	2,418,063	3,477,100	4
Nondurables Mfg.	4,907	0	143,625	63,173	216,148	54,526	95,033	17,849	186,053	2,364	144,690	929,168	601,934	1,540,238	3,071,340	5
T.C.U.	799	665	29,257	38,052	29,213	15,361	59,547	27,657	82,136	6,783	4,100	293,570	688,676	676,827	1,659,073	6
Trade	4,299	59	195,225	36,028	29,026	17,395	111,132	10,320	26,448	1,604	5,000	446,536	1,630,712	869,709	2,946,957	7
F.I.R.E.	4,063	1,431	31,737	64,632	29,799	53,671	64,757	99,542	50,925	2,989	0	403,546	2,117,513	307,480	2,828,539	8
Services	2,421	395	127,275	49,288	35,554	51,313	167,528	162,209	111,814	3,704	4,515	716,016	665,638	247,609	1,629,263	9
Government	22	0	1,021	951	514	13,275	19,155	16,866	9,049	178	0	61,031	1,323,924	0	1,323,924	10
Miscellaneous	74	207	12,694	19,153	7,032	6,053	49,115	42,209	28,888	1,270	0	166,695	0	0	166,695	11
Intermediate Inputs	25,664	3,072	902,881	613,971	487,922	273,810	629,642	476,922	555,071	31,424	166,695	4,167,074	8,519,703	6,626,214	19,312,991	12
Value Added	51,198	8,073	698,339	1,968,097	1,278,180	951,552	1,863,102	2,020,321	865,564	1,263,433	0	10,967,859				13
Imports	55,865	3,413	461,595	895,032	1,305,238	433,711	454,213	331,296	208,628	29,067	0	4,178,058				14
Output	132,727	14,558	2,062,815	3,477,100	3,071,340	1,659,073	2,946,957	2,828,539	1,629,263	1,323,924	166,695	19,312,991				15

*All amounts in 1,000's of dollars.

The figures in column 12 gives the total intermediate output of each industry, the sales by local industries to other local industries of intermediate goods. Similarly, the elements of row 12 represent the total purchases of intermediate goods by local industries from local industries. The figure in the intersection of row 12 and column 12 is the total intermediate transactions (sales = purchases) among Metropolitan Area industries, almost $4.2 billion. Although total intermediate sales equals total intermediate purchases, this is not true for each industry. For example, construction had sales of $134 million to local industries (element 3 of column 12) and purchased $903 million (element 3 of row 12). Non-durables manufacturing sold $929 million locally (element 5 of column 12) and purchased $488 million from local industries (element 5 of row 12).

Row 14 and column 14 summarize the imports of intermediate products and the exports of intermediate and final products by local industries. As might be expected, the largest amounts of imports are purchased by manufacturing industries. Non-durables manufacturing imports $1.3 billion and durables manufacturing, $895 million. The manufacturing industries account for most of the exports of intermediate and finished goods, almost $4.0 billion.

"Value added" locally is given in row 13. "Value added" is simply the difference between industry sales and the cost of materials purchased. Included in this difference are the returns to the various factors of production -- wages, salaries, rents, profits, and depreciation. Thus, the value added by a firm to the raw materials it purchases (production of other firms) is the value of its labor and capital applied to these materials to transform them into the firm's product. Value added provides a good measure of the actual output produced by a particular industry and avoids the double counting included in gross sales. For this reason, value added is used as the primary measure of local production. Total value added was $10,967,859,000 in 1971. The industry accounting for the largest share of value added was finance-insurance-real estate, $2.0 billion.

Column 13 shows purchases from local industries by final users in the Metropolitan Area. Metropolitan Area final demand amounted to $8.5 billion in 1971, approximately 78 per cent of Gross Area Product. The local industry selling the largest amount to Metropolitan Area final demand was finance-insurance-real estate, $2.1 billion.

Additional Summary Tables

The coefficients table and the inverse table for the Metropolitan Area economy have also been aggregated to a ten-industry level. The summary coefficients table is given in Table 4 and the summary inverse table in Table 5. These two tables are derived from the transactions table in order to provide a more useful analytical system. First, the coefficients table is formed by dividing each element in a column by the column total (total output for an industry). The resulting coefficient represents the percentage purchased from each industry for each dollar of output. The basic assumption involved is that the purchases of any industry will remain a constant percentage of total output.

For example, consider an increase in the output of the construction industry. The coefficients table tells us that, for each dollar increase in output, the construction industry purchases the following amounts of goods and services from other local industries: 17 cents from durables manufacturing, 9 cents from trade sectors, 7 cents from non-durables manufacturing and 6 cents worth of services. Twenty-two cents worth of goods and services are imported, purchased from businesses outside the Area.

Secondary impacts can also be calculated from the direct coefficients table. For example, for each dollar of sales the construction industry purchases 17 cents ($1.00 x .1698) from durables manufacturing. Durables manufacturing, in turn, uses this increase in its sales to purchase additional inputs: 0.3 cents (.0185 x .1698) of finance, insurance and real estate services and 1.6 cents (.0956 x .1698) of durable goods from other firms in its own industry.

The total of all these secondary impacts could be estimated by examining each of the local industries which supply durable manufacturers. In addition, one could determine third and fourth round effects in a similar way. Each of these impacts would get progressively smaller until the additional increments to local production are almost nil. The accumulation of all the indirect effects represents additional local production induced by the original increase in the output of the durables manufacturing industry. This process whereby indirect production is stimulated is referred to as the "multiplier effect."

Using the direct coefficients table to estimate these secondary effects is an extremely time-consuming process, especially if the matrix is large. With the aid of a computer it is possible to produce a table which summarizes the multiplier effects for each industry. The resulting table, which we call the inverse matrix, shows the production in each industry in a column on the left needed to support an increased dollar's worth of output by the industry in a row at the top (see Table 5). The sum of each column in the inverse table gives the total increase in local production, the direct increase from the industry at the top of the column and all the indirect increases in production from supporting local industries. This sum is the "multiplier" for the sector at the top of the column; it represents the total change in local production from a dollar's change in output to the industry at the top of the column.

Each element in any column of the inverse matrix gives the total local production in the industry listed on the left resulting from a dollar's change in the sales of the industry at the top of the column. For example, the column for the construction industry shows that, for each dollar of output produced, the construction industry purchases 0.3 cents ($1.00 x 0.0029) from the local agricultural sector. The diagonal element, where the row and column intersect for the same industry, is always larger than one. For example, the diagonal element for the services industry is 1.0841. This includes the dollar increase in sales by the services industry and the additional increase in the indirect production generated by this increase in sales. The sum of any column gives the industry "multiplier," the total income generated locally for every dollar increase in sales by the industry at the top of the column.

Table 4
Coefficients Table: Distribution of a Dollar's Worth of Output

	Agr.	Mining	Construc.	Durables	Non-Durables	T.C.U.	Trade	F.I.R.E.	Services	Gov't.	Misc.
Agriculture	.0575	-0-	.0002	-0-	.0229	.0001	*	.0018	-0-	.0034	-0-
Mining	.0005	-0-	.0049	*	.0013	-0-	*	*	-0-	-0-	-0-
Construction	.0079	-0-	.0003	.0028	.0026	.0033	.0014	.0261	.0118	.0652	-0-
Durables	.0023	.0216	.1698	.0956	.0188	.0340	.0196	.0038	.0248	.0018	.0504
Non-durables	.0369	-0-	.0696	.0181	.0703	.0328	.0325	.0063	.1141	.0133	.8680
TCU	.0060	.0456	.0141	.0109	.0095	.0092	.0202	.0097	.0504	.0382	.0246
Trade	.0323	.0040	.0946	.0103	.0094	.0104	.0377	.0071	.0162	.0090	.0300
F.I.R.E.	.0306	.0982	.0153	.0185	.0097	.0323	.0219	.0351	.0312	.0168	-0-
Services	.0182	.0271	.0616	.0141	.0115	.0309	.0568	.0573	.0686	.0208	.0270
Government	.0001	-0-	.0004	.0002	.0001	.0080	.0064	.0059	.0055	.0010	-0-
Miscellaneous	.0011	.0146	.0070	.0061	.0029	.0041	.0172	.0156	.0182	.0076	-0-
Subtotal	.1934	.2111	.4378	.1766	.1590	.1651	.2137	.1687	.3408	.1781	1.0000
Imports	.4209	.2344	.2237	.2574	.4249	.2614	.1541	.1171	.1280	.1637	-0-
Value Added	.3857	.5545	.3385	.5660	.4161	.5735	.6322	.7142	.5312	.6592	-0-
Total Output	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 5
Inverse Matrix:
Direct and Indirect Effects of a Dollar's Worth of Output

	Agr.	Mining	Construc.	Durables	Non-Durables	T.C.U.	Trade	F.I.R.E.	Services	Gov't.	Misc.
Agriculture	1.0624	0.0008	0.0029	0.0009	0.0265	0.0015	0.0018	0.0030	0.0040	0.0046	0.0232
Mining	0.0007	1.0001	0.0052	0.0001	0.0015	0.0001	0.0002	0.0002	0.0003	0.0004	0.0013
Construction	0.0101	0.0037	1.0033	0.0042	0.0039	0.0057	0.0039	0.0287	0.0151	0.0667	0.0043
Durables	0.0086	0.0301	0.1974	1.1096	0.0255	0.0425	0.0292	0.0145	0.0404	0.0191	0.0810
Non-Durables	0.0513	0.0247	0.1045	0.0327	1.0842	0.0483	0.0655	0.0356	0.1585	0.0348	0.9502
TCU	0.0101	0.0506	0.0248	0.0146	0.0126	1.0136	0.0269	0.0158	0.0592	0.0427	0.0390
Trade	0.0384	0.0078	0.1042	0.0137	0.0130	0.0139	1.0430	0.0132	0.0236	0.0182	0.0442
F.I.R.E.	0.0368	0.1060	0.0274	0.0233	0.0138	0.0372	0.0284	1.0409	0.0406	0.0224	0.0160
Services	0.0274	0.0394	0.0803	0.0206	0.0169	0.0389	0.0686	0.0687	1.0841	0.0319	0.0481
Government	0.0009	0.0013	0.0021	0.0008	0.0006	0.0087	0.0076	0.0068	0.0069	1.0018	0.0012
Miscellaneous	0.0025	0.0171	0.0113	0.0072	0.0035	0.0056	0.0195	0.0174	0.0212	0.0091	1.0047
Total	1.2492	1.2816	1.5634	1.2277	1.2020	1.2160	1.946	1.2448	1.4539	1.2517	2.2132

The bottom row in Table 5 shows the total multipliers for each industry. It is obvious that the multiplier effect varies significantly from industry to industry. These multipliers vary from 2.21 in the government sector to 1.20 in non-durables manufacturing. Eight of the eleven sectors are in the range of 1.2 to 1.3.

The significance of Table 5 is that it transforms the transactions table (Table 3) into a useful tool for measuring the effect of changes in the sales of individual industries. The initial table provides a simple accounting system of the sales and purchases of local industries; the third table allows one to estimate the impact of changes in this system.

Two points should be kept in mind in using these tables. First, individual firms in the Region are grouped into a small number of sectors. This is done in order to make analysis of the local economy somewhat manageable. The fewer the number of sectors, of course, the less representative the sector results are of the individual firm. Furthermore, the more diverse the firms within a particular grouping, the less representative the sector numbers. While the examples presented in this report are highly aggregated, the actual tables divided the Region into approximately ninety sectors. The classification method was developed based on an attempt to minimize the diversity within groups. Almost two-thirds of the sectors are manufacturing industries. Within each industry the numbers appearing in the input-output tables represent averages of the individual firms in an industry.

The second point is that the coefficients and inverse tables are both based on the transactions table. The basic assumption involved is that the relationships among industries, developed from the transactions table, do not change over time. Obviously, this is not true. Constant production coefficients and constant relative prices will not prevail in the long-run for a variety of reasons, the most basic reason being technological change. This difficulty limits the usefulness of an input-output table for long-range forecasting. Thus, at the national level, input-output projections are limited to a 10-15 year period and the basic table is updated every five years.

V. THE TWIN CITIES INPUT-OUTPUT MODEL: DETAILED FINDINGS

This section takes a closer look at the data in the detailed tables for the Metropolitan Area (96 industries). Most of the discussion focuses on the economic measures presented in Section I -- Gross Area Product (GAP), value added, sales, purchases, imports, and exports.

The detailed transactions table is organized exactly like the transactions tables presented in Section IV. The only difference is that it is much larger, 96 industries rather than ten. As was mentioned earlier, the concepts involved are defined as the same as those used in the national input-output tables. For example, GAP provides a comprehensive measure of the dollar value of goods and services produced in the Metropolitan Area which is comparable to the Gross National Product, the most common measure of national economic performance.

Production, whether at the local level or the national level, can be approached from the product side or the income side, the output side or the input side. The product side looks at the costs of producing these goods and services which are produced, the income side at the costs of producing these goods and services -- labor, raw materials, intermediate goods, and capital. Input-output tables include both viewpoints. The columns of the table give the income or input side, the rows the product or output side. The tables include inter-industry or intermediate transactions in addition to final transactions and transactions with industries outside the Region (imports and exports). Thus, we will look at intermediate transactions, sales to final demand, exports, and imports in addition to value added (Gross Area Product).

Intermediate sales represent sales of intermediate goods, goods which are used as inputs in the production of other goods. These sales represent the major part of the transactions table, at least in terms of the number of cells (intersection of a row and column). In total dollars, the intermediate sales within the Metropolitan Area in 1971 amounted to almost $4.2 billion. This amount represents less than 22 per cent of the total gross output of the Region. Area industries sold another $2.8 billion of intermediate goods to producers outside the Region and purchased $4.2 billion of intermediate products from outside firms.

The industries accounting for the largest amounts of intermediate sales and purchases are listed in Table 6. The top half of the table gives the industries selling the largest amounts of intermediate goods and services to other industries within the Metropolitan Area. The bottom part of the table gives the industries purchasing the largest amount of intermediate goods and services from Area industries. Notice that total intermediate sales equals intermediate purchases, almost $4.2 billion.

The industries selling the largest amounts of intermediate products within the Metropolitan Area are service-related -- business services, trade services, real estate services, printing, banking, and insurance. The top five industries accounted for 36.5 per cent of the sales of intermediate products within the Area. Three of the industries listed sold more than half of their total output to intermediate users within the Area -- business services (68 per cent), fabricated metal products (90 per cent), and petroleum refiners (53 per cent). Another industry, non-broadcasting communications, sold 49 per cent to intermediate users within the Region. Commercial printing, on the other hand, sells less than five per cent of its industry output to intermediate users in the Area.

The second part of Table 6 shows the largest purchasers of intermediate transactions within the Area. Twenty per cent of the intermediate products are purchased by a single industry -- construction. Wholesale trade and business services account for another 19 per cent. Thus, these top three purchasers represent almost 40 per cent of the purchase of intermediate products within the Area. Intermediate purchases within the Region amount to less than half

Table 6
Intermediate Transactions Within Metropolitan Area -
(Ten Largest), 1971

a. Sales of Intermediate Goods to Local Industries

Input-Output Number	Producing Industry	Intermediate Sales (000's)	Per Cent of Region's Total Intermediate Sales	Per Cent of Industry's Output
73	Business Services	$536,244	12.9	68.2
69.1	Wholesale Trade	373,619	9.0	25.9
71	Rental, Real Estate	207,605	5.0	11.4
26.2	Commercial Printing	202,427	4.9	4.9
70	Finance, Insurance	195,941	4.7	19.6
40	Fabricated Metal Products	170,205	4.1	90.5
12	Maintenance & Repair	134,413	3.2	39.9
31	Petroleum	131,783	3.2	52.9
68	Utilities	119,455	2.9	19.5
66	Communications (Exc. Broadcasting)	105,735	2.5	49.2

Total Intermediate Sales Within Metropolitan Area - $4,167,074,000

b. Purchases of Intermediate Goods by Local Industries

Input-Output Number	Purchasing Industry	Intermediate Purchases (000's)	Per Cent of Region's Total Intermediate Purchases	Per Cent of Industry's Purchases
11	Construction	$819,173	20.0	47.5
69.1	Wholesale Trade	436,933	10.5	30.3
73	Business Services	357,749	8.6	45.5
71	Rental, Real Estate	242,004	5.8	13.2
70	Finance, Insurance	234,918	5.6	23.5
69.2	Retail Trade	192,709	4.6	12.8
59	Motor Vehicles	139,220	3.3	34.2
72	Hotels, Personal Serv.	101,587	2.4	36.8
14.2	Meat Products	93,825	2.3	18.3
51.2	Office Machines	89,619	2.2	14.8

Total Intermediate Purchases Within Metropolitan Area - $4,167,074,000

of the industry output of each industry on the list. This is to be expected, since intermediate transactions include neither wages and salaries nor imports of intermediate products.

Although the intermediate transactions do not account for a large proportion of the Region's gross production, they establish the linkages among industries within the Region. This allows one to estimate how a dollar of sales can be traced through the step-by-step interactions to arrive at the multipliers discussed briefly in Section IV.

The transactions table can be used to determine whether the output of an industry, intermediate or total, is sold mainly to a few industries or to many. For example, the sales of the business services industry are concentrated in about ten industries with construction and finance-insurance accounting for over 40 per cent of these sales. Similarly, in regard to the purchase of intermediate products, the transactions table gives the amount purchased from specific industries. For example, more than one-third of the local products bought by the business services industry are purchased from the local commercial printing industry.

In addition to the sales to intermediate users within the Metropolitan Area, the transactions table illustrates sales to final demand. Final demand represents sales of finished goods to consumers outside the processing sector. This includes households, investors, government agencies, and foreign buyers. The final demand sector is of special importance in the input-output model because it is viewed as being exogenous or independent, the sector in which changes occur as a result of outside forces, changes which reverberate through the rest of the economy. Final demand is considered the driving force or impetus causing changes in the local economy.

Sales to final demand in 1971 amounted to almost $12.3 billion, almost three times larger than sales of intermediate goods within the Metropolitan Area. This represented 64 per cent of the gross output of the local economy. Approximately 69 per cent of final demand sales were to consumers in the Metropolitan Area, the remainder being export sales.

Local final demand is broken down into six categories: personal consumption; local government; state government; federal non-defense; federal defense; and gross private fixed capital formation. The largest component of local final demand is personal consumption (64.4 per cent). The four government sectors account for 24.1 per cent ($2.0 billion) of local final demand, with local government representing more than half of the amount.

The industries selling the largest dollar value of goods and services to local final demand in 1971 were construction and service industries. The industries selling the largest amounts are listed in Table 7 along with the percentage these amounts are of all sales to metropolitan final demand and of the output of each

Table 7
Sales to Metro Final Demand
(Ten Largest Industries), 1971

Input-Output Number	Producing Industry	Dollar Amount (000's)	Per Cent of Region's Total Final Demand	Per Cent of Industry's Output
71	Rental, Real Estate	$1,619,785	19.0	88.6
11	New Construction	1,240,665	14.6	71.9
84	Government	1,146,415	13.5	100.0
69.2	Retail Trade	1,038,653	12.2	69.1
69.1	Wholesale Trade	592,059	6.9	41.0
70	Finance, Insurance	497,728	5.8	49.7
68	Utilities	404,602	4.7	66.1
75	Auto Repair Services	278,317	3.3	73.8
14.1	Food Products*	259,003	3.0	50.5
72	Hotels, Misc. Services	160,702	1.9	58.3

Table 8
Sales to Rest-of-U. S. Final Demand
(Ten Largest Industries), 1971

Input-Output Number	Producing Industry	Dollar Amount (000's)	Per Cent of Region's Total Exports**
11	New Construction	$485,185	7.3
69.2	Retail Trade	380,506	5.7
13	Ordnance	306,875	4.6
69.1	Wholesale Trade	240,000	3.6
51	Office and Accounting Machines	234,305	3.5
59	Motor Vehicles	217,649	3.3
14.4	Beverages	210,016	3.2
14.1	Food Products*	185,224	2.8
70	Finance, Insurance	152,480	2.3
14.2	Meat Products	152,022	2.3

*All food products except meat products, grain mill products and beverages, each of which is a separate industry.

**Total exports include sales to final demand (57.7 per cent) and sales of intermediate goods (43.3 per cent).

industry. The real estate-rental sector ($1.6 billion) and new construction ($1.2 billion) accounted for 59 per cent of the sales by local firms to final consumers in the Metropolitan Area. All of these sectors also sold most of their goods output to local consumers.

The remaining sales to final demand (31 per cent) are exported outside of the Metropolitan Area. The major exporters to final demand are shown in Table 8. Exports to final demand consumers represent about 58 per cent of the Area's exports. Major products sold to consumers outside the Area are construction ($485 million), retail trade ($381 million), and wholesale trade ($240 million). Largest products sold to outside final demand included defense-related products ($307 million), office and accounting machines ($234 million), motor vehicles ($218 million), and beverages ($210 million).

The remaining exports from the Area, 42 per cent of all exports, are intermediate or unfinished goods which are sold to industries outside the Area. The largest amounts are sold by the following sectors: office and accounting machines ($323 million), wholesale trade ($238 million), paper products ($225 million), and the trucking industry ($222 million). Table 10 brings together the two types of export sales (final demand and intermediate goods) to show total exports from the Region. The leading export sectors in the Metropolitan Area were office and accounting machines ($717 million), new construction ($485 million), retail trade ($392 million), ordnance ($322 million), and finance-insurance ($307 million). These six sectors account for 38 per cent of the Area's exports.

Another perspective of the local economy is provided in the value added row of the transaction table. The term "value added" is self-explanatory -- it looks at only the value added to a product during each processing stage. It avoids the duplication present in gross output and is equivalent to the Gross Area Product measure described in Section 1.

Value added is defined as gross output minus the costs of purchased materials and inputs of services. This includes the various income payments earned locally (wages, rents, profits, etc.). Table 11 lists the local industries which have the largest dollar amounts of value added and shows the percentage each is of the Gross Area Product. These percentages are also compared with those national industries having the highest ratio of value added to the Gross National Product.

In each economy, the Metropolitan Area and the entire United States, the top three sectors are ranked the same: trade, rental-real estate, and government. Although the rankings are the same, the percentage shares are quite different. In the Metropolitan Area, these three sectors accounted for 41 per cent of the Gross Area Product; in the United States as a whole, these accounted for 35 per cent of Gross National Product. Six of the remaining industries appear on both lists and have similar percentage shares except for the finance-insurance industry. This industry has a larger share in the Metropolitan Area (five per cent) than in the nation as a whole (three per cent).

Table 9
Exports of Intermediate Goods
(Ten Largest Industries), 1971

Input-Output Number	Producing Industry	Dollar Amount (000's)	Per Cent of Region's Total Exports*
51	Office & Accounting Machines	$323,233	4.9
69.1	Wholesale Trade	238,000	3.6
24	Paper Products	225,483	3.4
65.4	Motor Freight Transport	222,472	3.4
65.2	Railroads	164,933	2.5
70	Finance, Insurance	155,000	2.3
29	Drugs, Cosmetics	138,068	2.1
73	Business Services	96,154	1.5
44	Farm Machinery	95,840	1.4
26.1	Printing & Publishing	83,260	1.3

*Total exports include sales to final demand (57.7 per cent) and sales of intermediate goods (42.3 per cent).

Table 10
Export Sales as a Per Cent of Total Regional Exports
(Ten Largest Industries), 1971

Input-Output Number	Producing Industry	Export Sales (000's)	Per Cent of Region's Total Exports
51	Office & Accounting Machines	$557,538	8.4
11	New Construction	485,185	7.3
69.1	Wholesale Trade	478,000	7.2
69.2	Retail Trade	391,709	5.9
13	Ordnance	322,372	4.9
70	Finance, Insurance	307,480	4.6
59	Motor Vehicles	290,199	4.4
65.4	Motor Freight Transport	262,472	4.0
24	Paper Products	248,483	3.7
14.4	Beverages	215,063	3.2

One other important part of the input-output table is the purchase of goods and services from outside by Metropolitan Area purchasers. These imports may be either intermediate goods which are used by local firms to produce final goods and services or are purchased by final users in the Area. The majority (68.8 per cent) of the imports into the Area in 1971 were intermediate goods purchased by local industries. The major intermediate goods imported by Metropolitan Area industries are shown in Table 12. The four largest are business services ($341 million), non-livestock agricultural products ($328 million), crude petroleum and natural gas ($310 million), and primary iron and steel ($182 million). Imports account for about half of the intermediate goods used as inputs in the production of goods and services by Area industries. In addition to these intermediate goods and services, other goods and services are imported into the Area and purchased by final purchasers (households, government, and investment). Table 13 lists the dollar value of the products accounting for the largest purchases by final users. Imports account for 22.5 per cent of total sales to local final demand. The main products imported are motor vehicles ($281 million), clothing ($235 million), food products ($135 million), and furniture ($103 million).

Total imports into the Metropolitan Area include both purchases by industries of intermediate goods and purchases by local final demand of finished goods. The products accounting for the largest amounts of total imports are given in Table 14 along with the ratio of these amounts to the total input of that industry in the Metropolitan Area. This latter ratio, imports to local production, gives an indication of the products for which the Area is heavily dependent on outside producers. These products include crude petroleum and natural gas, non-livestock food products, clothing, primary iron and steel, and electronic components. In each instance, the dollar value of products imported from these industries is much greater than the output of the same local industry.

Table 15 lists the industries which purchase the largest dollar amounts of imports. Included in the table is the percentage of each industry's intermediate inputs which are purchased outside the Area. The largest importers are the construction industry, the retail trade industry, the utilities industry, the food processing industry, and the finance-insurance industry. These largest importers accounted for 42 per cent of total intermediate imports.

Table 11
Value Added by Industry of Origin (Eleven Largest), Metro Area, 1971,
Compared with the United States, 1966

Metropolitan Area, 1971			United States, 1966		
Input-Output Number	Purchasing Industry	Per Cent of Region's GAP	Input-Output Number	Purchasing Industry	Per Cent of U. S. GNP
69	Trade	17.0	69	Trade	15.0
71	Rental, Real Estate	13.4	71	Rental, Real Estate	10.4
84	Government	10.5	84	Government	9.3
70	Finance, Insurance	5.0	11	New Construction	4.4
11	New Construction	4.6	65	Transportation	4.0
65	Transportation	4.2	77	Medical Education Services	3.9
51	Office & Accounting Machines	3.9	14	Food Products	3.4
14	Food Products	3.5	70	Finance, Insurance	3.1
73	Business Services	3.5	73	Business Services	3.0
68	Utilities	2.6	2	Non-Livestock Agriculture	2.5
75	Auto Repair Services	1.8	68	Utilities	2.3

Table 12
Major Imports by Metro Area Industries
(Ten Largest), 1971

Input-Output Number	Product Imported	Dollar Value (000's)	Per Cent of Region's Total Inputs
73	Business Services	340,504	4.1
2	Non-Livestock Agricultural Products	328,399	3.9
8	Crude Petroleum, Natural Gas	309,730	3.7
37	Primary Iron and Steel	182,476	2.2
71	Real Estate, Rental	168,896	2.0
70	Finance, Insurance	162,996	1.9
57	Electronic Components	135,990	1.6
14.1	Food Products*	134,769	1.6
36	Stone, Clay Products	131,107	1.6
1	Livestock Products	120,281	1.4

Table 13
Major Imports Purchased by Local Final Demand
(Eight Largest Industries), 1971

Input-Output Number	Product Imported	Dollar Value (000's)	Per Cent of Region's Total Final Demand	Per Cent of Total Imports
59	Motor Vehicles	$281,455	3.3	4.6
18	Apparel	234,825	2.8	3.9
14.1	Food Products*	134,854	1.6	2.2
22	Furniture	103,008	1.2	1.7
64	Miscellaneous Manufacturing	90,884	1.1	1.5
54	Household Appliances	83,304	1.0	1.4
56	Radio-TV Equipment	83,296	1.0	1.4
14.4	Beverages	79,834	0.9	1.3

*All food products except meat products, grain mill products, and beverages, each of which is a separate category.

Table 14
Major Imports into Metro Area
(Ten Largest Industries), 1971

Input-Output Number	Product Imported	Dollar Amount (000's)	Per Cent of Region's Total Imports	Per Cent of Total Metro Final Demand
59	Motor Vehicles	$385,910	6.3	4.5
73	Business Services	370,521	6.1	4.3
2	Other Agricultural Products	362,409	5.1	4.3
8	Crude Petroleum, Natural Gas	309,730	5.1	3.6
14.1	Food Products*	269,623	4.4	3.2
18	Apparel	243,894	4.0	2.9
70	Finance, Insurance	189,996	3.1	2.2
37	Primary Iron & Steel	182,476	3.0	2.1
71	Real Estate, Rental	169,896	2.8	2.0
57	Electronic Components	138,092	2.3	1.6

Table 15
Industries Purchasing Largest Amount of Imports
(Ten Largest), 1971

Input-Output Number	Purchasing Industry	Dollar Value (000's)	Per Cent of Industry's Imports
11	New Construction	$406,151	33.1
69.1	Wholesale Trade	319,785	42.3
68	Utilities	275,282	84.4
14.1	Food Products*	272,496	78.4
14.2	Meat Products	253,068	73.0
70	Finance, Insurance	217,718	48.1
31	Petroleum Refining	165,064	78.0
59	Motor Vehicles	149,594	51.8
75	Auto Repair Services	139,650	80.0
69.2	Retail Trade	134,428	41.1

*All food products except meat products, grain mill products, and beverages, each of which is a separate industry.

APPENDIX

APPENDIX

INDUSTRY CLASSIFICATION

This appendix includes two classification systems, the first of which is a simplification of the second. The second classification is that which was used in developing the Metropolitan Council Input-Output Model. It contains 96 industries and is described in Table B. The simplified classification aggregates these 96 industries into the ten major industry groups listed in Table A. The Input-Output numbers in Table A are keyed to the industries in Table B which, in turn, are related to SIC codes.

Table A
Major Industry Groups

Industry Title	Related Input-Output Numbers
Agriculture	1, 2, 3, 4
Mining	5, 6, 7, 8, 9, 10
Construction	11, 12
Durables Manufacturing	13, 20, 21, 22, 23, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51.1, 51.2, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62.1, 62.2, 63, 64
Non-durables Manufacturing	14.1, 14.2, 14.3, 14.4, 15, 16, 17, 18, 19, 24, 25, 26.1, 26.2, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36
T.C.U. (transportation, communications, utilities)	65.1, 65.2, 65.3, 65.4, 65.5, 66, 67, 68
Trade	69.1, 69.2
F.I.R.E. (finance, insurance, real estate)	70, 71
Services	72, 73, 74, 75, 76, 77
Government Enterprises	78, 79
Other	80, 81, 82, 83, 84, 85, 86

Table B
Detailed Industry Classification

Input-Output Number	Industry Title	Related SIC Codes (1957 Edition)
	Agriculture	
1	Livestock and livestock products	013, pt. 014, 0193, pt. 02, pt. 0729
2	Other agricultural products	011, 012, pt. 014, 0192, 0199, pt. 02
3	Forestry and fishery products	074, 081, 082, 084, 086, 091
4	Agricultural, forestry and fishery services	071, 0723, pt. 0729, 085, 098, 073
	Mining	
5	Iron and ferroalloy ores mining	1011, 106
6	Nonferrous metal ores mining	102, 103, 104, 105, 108, 109
7	Coal mining	11, 12
8	Crude petroleum and natural gas	1311, 1321
9	Stone and clay mining and quarrying	141, 142, 144, 145, 148, 149
10	Chemicals and fertilizer mineral mining	147
	Construction	
11	New construction	138, pt. 15, pt. 16, pt. 17 pt. 6561
12	Maintenance and repair construction	pt. 15, pt. 16, pt. 17

Table B (cont.)

Input-Output Number	Industry Title	Related SIC Codes (1957)
	Manufacturing	
13	Ordnance and accessories	19
14.1	Food and kindred products except meat products, grain mill products and beverages	20 (excluding 201, 204, and 208)
14.2	Meat products	201
14.3	Grain mill products	204
14.4	Beverages	208
15	Tobacco manufactures	21
16	Broad and narrow fabrics, yarn and tread mills	221, 222, 223, 224, 226, 228
17	Miscellaneous textile goods and floor coverings	227, 229
18	Apparel	225, 23 (excluding 239), 3992
19	Miscellaneous fabricated textile products	239
20	Lumber and wood products, except wooden containers	24 (excluding 244)
21	Wooden containers	244
22	Household furniture	251
23	Other furniture and fixtures	25 (excluding 251)
24	Paper and allied products, except paperboard containers and boxes	26 (excluding 265)
26.1	Printing and publishing, except commercial printing	27 (excluding 2751 and 2752)
26.2	Commercial printing	2751 and 2752

Table B (cont.)

Input-Output Number	Industry Title	Related SIC Codes (1957)
	Manufacturing	
27	Chemicals and selected chemical products	281 (excluding 2819), 286, 287, 289
28	Plastics and synthetic materials	282
29	Drugs, cleaning, and toilet preparations	283, 284
30	Paints and allied products	285
31	Petroleum refining and related industries	29
32	Rubber and miscellaneous plastics	30
33	Leather tanning and industrial leather products	311, 312
34	Footwear and other leather products	31 (excluding 311, 312)
35	Glass and glass products	321, 322, 323
36	Stone and clay products	324, 325, 326, 327, 328, 329
37	Primary iron and steel manufacturing	331, 332, 3391, 3399
38	Primary nonferrous metals manufacturing	28195, 33, 334, 335, 336, 3392
39	Metal containers	3411, 3491
40	Heating, plumbing and fabricated structural metal products	343, 344
41	Screw machine products, blots, nuts, etc., and metal stampings	345, 346
42	Other fabricated metal products	342, 347, 348, 349 (excluding 3491)

Table B (cont.)

Input-Output Number	Industry Title	Related SIC Codes (1957)
	Manufacturing	
43	Engines and turbines	351
44	Farm machinery and equipment	352
45	Construction, mining, oil field machinery and equipment	3531, 3532, 3533
46	Materials handling machinery and equipment	3534, 3535, 3536, 3537
47	Metalworking machinery and equipment	354
48	Special industry machinery and equipment	355
49	General industrial machinery and equipment	356
50	Machine shop products	359
51.1	Office and accounting machines, except computing and related machinery	357 (excluding 3571)
51.2	Computing and related machines	3571
52	Service industry machines	358
53	Electric transmission and distribution equipment, and electrical industrial apparatus	361, 362
54	Household appliances	363
55	Electric lighting and wiring equipment	364
56	Radio, television, and communication equipment	365, 366

Table B (cont.)

Input-Output Number	Industry Title	Related SIC Codes (1957)
	Manufacturing	
57	Electronic components and accessories	367
58	Miscellaneous electrical machinery, equipment and supplies	369
59	Motor vehicles and equipment	371
60	Aircraft and parts	372
61	Other transportation equipment	373, 374, 375, 379
62.1	Professional, scientific and controlling instruments and supplies, except engineering and scientific instruments	3821, 3822, 3841, 3842, 3843, 387
62.2	Engineering and scientific instruments	3811
63	Optical, ophthalmic, and photographic equipment and supplies	383, 385, 386
64	Miscellaneous manufacturing	39 (excluding 3992)
	Transportation, Communication, Electric, Gas, and Sanitary Services	
65.1	Transportation, excluding rail, air highway passenger, and motor freight	44, 46, 47 (excluding 473, 474)
65.2	Railroads and related services	40, 474
65.3	Local, suburban and interurban highway passenger transportation	41
65.4	Motor freight transportation and warehousing	42, 473

Table B (cont.)

Input-Output Number	Industry Title	Releated SIC Codes (1957)
	Transportation, Communication, Electric, Gas, and Sanitary Services	
65.5	Air transportation	45
66	Communication, except radio and television broadcasting	481, 482, 489
67	Radio and television broadcasting	483
68	Electric, gas, water, and sanitary services	49
	Wholesale and Retail Trade	
69.1	Wholesale trade	50 (excluding manufacturers sales offices)
69.2	Retail trade	52, 53, 54, 55, 56 57, 58, 59, 7396
	Finance, Insurance and Real Estate	
70	Finance and insurance	60, 61, 62, 63, 64, 67
71	Real estate and rental	65 (excluding pt. 6561), 66
	Services	
72	Hotels and lodging places; personal and repair services, except automobile repair	70, 72, 76 (excluding 7694 and pt. 7699)
73	Business services	73 (excluding 7396), 7694, pt. 7699, 81, 89 (excluding 8921)
74	Research and development	eliminated
75	automobile repair and services	75

Table B (cont.)

Input-Output Number	Industry Title	Related SIC Codes (1957)
76	Amusements	78, 79
77	Medical, educational services, and nonprofit organizations	0722, 80, 82, 84, 86, 8921
	Government Enterprises	
78	Federal government enterprises	
79	State and local government enterprises	
	Other	
80	Gross imports of goods and services	
81	Business travel, entertainment and gifts	
82	Office supplies	
83	Scrap, used and secondhand goods	
84	Government industry	
85	Rest of the World industry	
86	Household industry	

GLOSSARY

Cell	A location in a table (matrix) formed by the intersection of a row and column.
Coefficient	See "input coefficient."
Coefficients Table	The table (matrix) formed by computing input coefficients for the transactions table; that is, by dividing each entry in the transactions table by the total of the column in which it is located.
Durables Manufacturing	Those industries which produce durable goods, goods which are not consumed when used but can be used over a number of years (e.g., automobiles, appliances, machinery).
Econometric Methods	Methods developed by that branch of economics which uses statistical and mathematical techniques to solve economic problems and to test and measure theoretical economic relationships.
Economic Base Analysis	An anlysis technique which assumes that an urban economy involves two kinds of activities: basic activities which produce and distribute goods and services for export outside the economy; and service (or non-basic) activities whose goods and services are consumed within the economy. The export function is viewed as the primary ("basic") determinant of economic growth as expansion of export activities induces growth in the service industries.
Exports	Regionally manufactured goods and services which are sold directly to consumers and producers outside the Metropolitan Area.
Final Demand	Sales of finished goods and services to final users which include households, government and business (capital investment and inventory accumulation).

Final Sales	Sales to final demand. (Sales are divided into two categories in input-output analysis: intermediate sales and final sales.)
Finished Products	Products which are ready for final consumption and are not used as inputs in the production of other goods and services.
Gross Area Product (GAP)	The total value of all final goods and services produced in the Metropolitan Area in a given year. Gross Area Product includes personal consumption expenditures on goods and services, gross private domestic investments, net export investment and government purchases of goods and services. (Gross Area Product equals gross output less the value of imports and other materials used as inputs.)
Gross National Product (GNP)	The total value of all final goods and services produced in the country in a given year.
Gross Output	The total value of all goods and services produced, both intermediate products and final products. (Gross output involves "double-counting" as it includes the total value of a product after each stage of processing rather than just the value added during each stage.)
Imports	Goods and services purchased by producers and consumers in the Metropolitan Area from producers outside the Area.
Industry	A group of firms producing similar products.
Input Coefficient	The value of inputs required from an industry to produce a dollar's worth of output by the purchasing industry. Input coefficients are computed by dividing each element in a column from the transactions table by the total of that column.

Input-Output Analysis	An economic analysis technique which describes the interaction of three elements of an economy: final demands, the input requirements of each industry -- raw materials, semi-finished goods, primary factors -- and the gross outputs of each industry as distributed among sectors of the economy.
Input-Output Model	The mathematical representation of an economy (a set of simultaneous linear equations) which is based on the theoretical concepts of input-output analysis.
Intermediate Goods	Goods and services which will be used as inputs by other industries. (Intermediate goods are distinguished from finished products.)
Intermediate Sales	Sales of unfinished goods and services (See also final sales and intermediate goods.)
Intermediate Transactions	(See intermediate goods and intermediate sales.)
Inverse Table (Matrix)	A table of coefficients representing the total change, direct and indirect, in output resulting from a dollar's change in final demand. The table is derived from the input coefficients table by applying a mathematical operation, matrix inversion.
Matrix	A rectangular array of numbers; a table of numbers in rows and columns.
Multiplier	The economic process whereby an injection of new income into an economy induces additional income as this injected income passes through several transactions within the economy. The result is an increase in income greater than the amount of the initial injection; the more each dollar is spent again within the economy, the greater the total increase.

Nondurables Manufacturing	Those industries which produce nondurable goods, goods which are consumed relatively quickly (e.g., food products, paper products, clothing).
Primary Factors	Basic inputs which are determined outside the economic system (e.g., land, labor, existing capital).
Regional Accounts	In this report, this term refers to a general approach to regional economic analysis which involves an integrated set of accounts summarizing socio-economic information about a region and designed to provide a framework within which to analyze regional issues.
Sector	A term which refers to groupings of similar economic activities, both processing industries and groups of final users (e.g., households, government).
Standard Industrial Classification (SIC Codes)	A classification of all kinds of economic activities developed by several government agencies and published by the Office of Management and Budget.
Transactions Table	A table summarizing the dollar volume of sales and purchases among individual industries.
Value Added	The sales of a firm or industry less the cost of materials purchased from other firms or industries. Value added includes payments for wages and salaries, profits, rents, interest, taxes and depreciation, and represents the value added to a product by labor and capital within the firm or industry.