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The Structure of the U.S. Economy

The input-output tables on the next seven pages divide the economy into 81 sectors and list the transactions among them. The numbers are the constants of the technological relations among the sectors

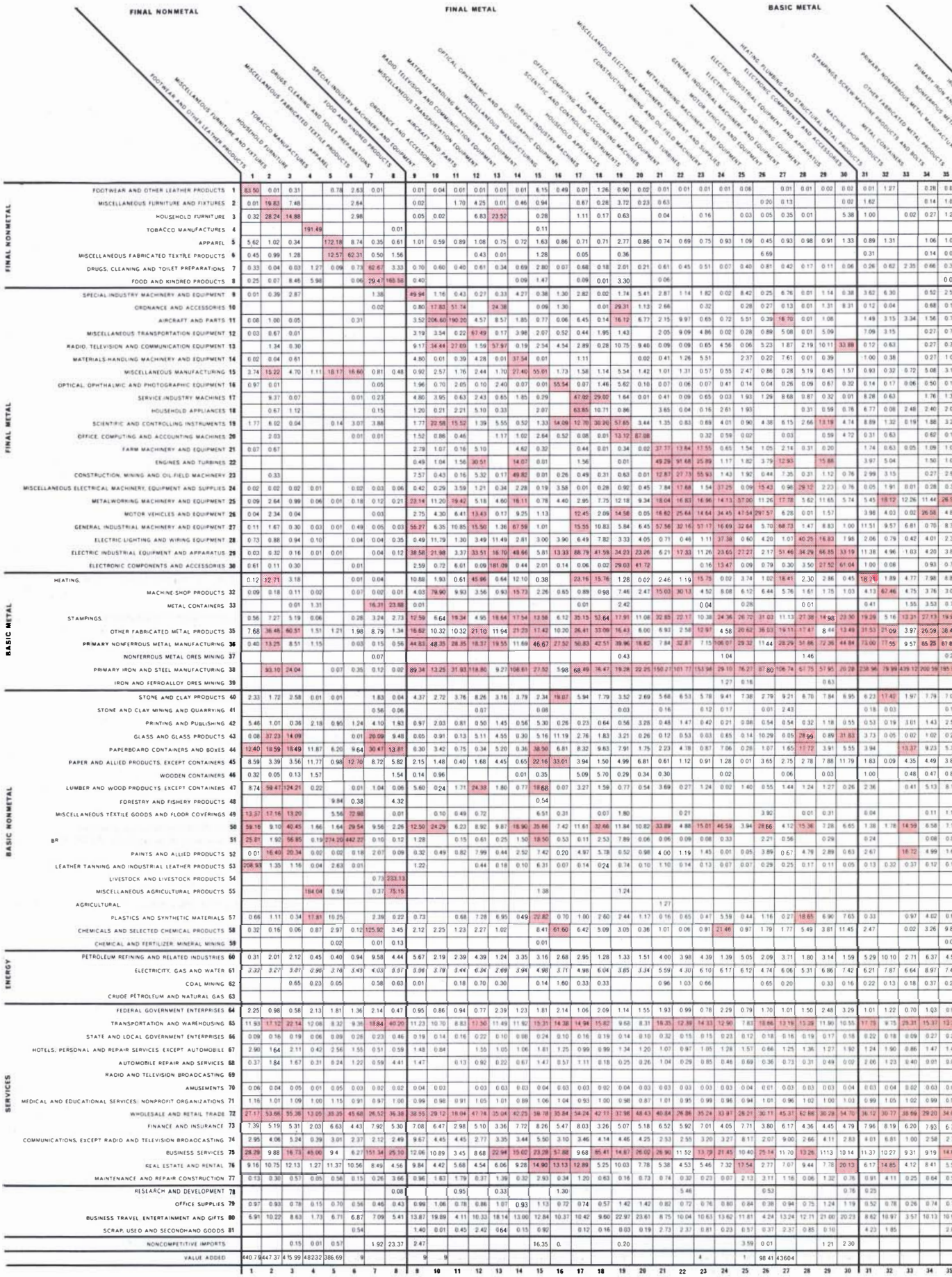
by Wassily W. Leontief

"Gross national product," "Total output," "Value added by manufacture," "Personal consumption expenditures," "Federal Government expenditures," "Exports"—these headings in the book of national accounts describe the familiar external features of the economic system. In recent years the students and the managers of the system have been confronted with many questions that cannot even be clearly posed in such aggregative terms. To answer them one must now look "under the hood" at the inside workings of the system. In the fiscal agencies of many governments, in universities and in large industrial organizations in this country and abroad the needed insight is being supplied by the technique of "input-output" analysis. This technique reckons with the intermediate sales and purchases—that is, the outputs and inputs—that carry goods and services from industry to industry, from manufacturer to distributor and on to their final purchaser in the market. The technique thus ties predictions about the external configuration of the system to the indirect flows of supply and demand within. Input-output analysis of the U.S. economy has recently taken a major step forward with the publication by the Office of Business Economics in the U.S. Department of Commerce of the preliminary results of a study of the interindustry relations of the system as of the year 1958. The report features an input-output "table" that breaks down the system into 81 industries or functional economic sectors.

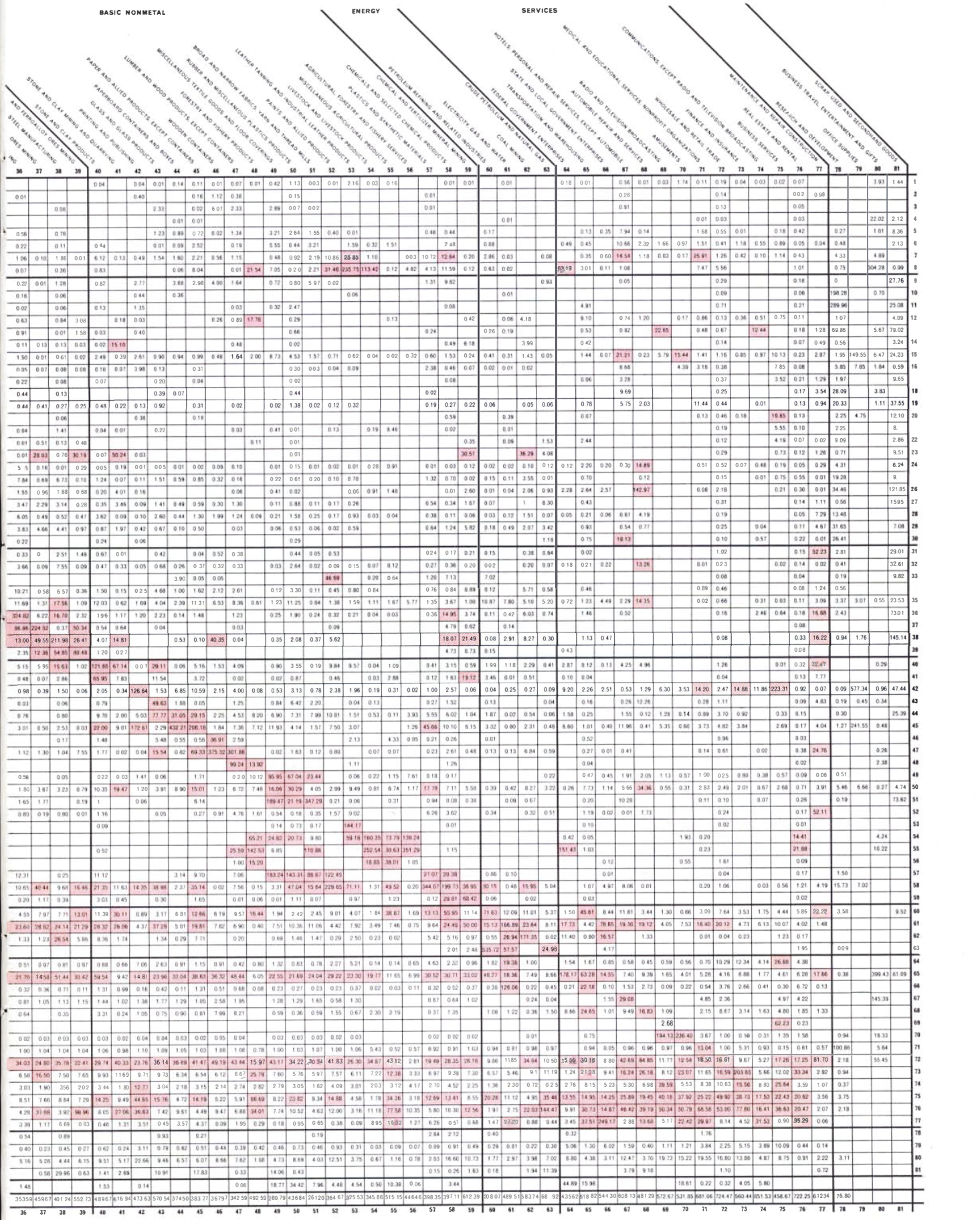
The Federal Government is charged by the Constitution itself with the task of taking a decennial census. Ever since the first census of 1790 Federal statistical agencies have maintained the tradition of keeping a comprehensive quantitative record of the country's social and economic progress. As the economy has grown in complexity and size, so have the variety and volume of data collected. It was not until the end of World War I, however, that the collecting agencies undertook to organize the data in accordance with some distinct picture of the economic system. The conceptual framework for the specification of the national accounts was supplied by the aggregative models of prevailing economic theory. That framework has evolved over the years as theory has evolved and today shows the pervasive influence of the ideas of the great British economist John Maynard Keynes.

The need for finer-grained information was felt acutely by the administrators of the U.S. industrial production effort during World War II. Given President Roosevelt's order for "50,000 airplanes," it was easy enough to predict that the country would have to produce more aluminum. It was not immediately apparent, however, that the building of aluminum potlines would collide with a shortage of copper—a shortage ultimately met by borrowing silver from Fort Knox to make the massive bus bars that delivered electricity to the potlines. As the locus of concern in the war-production effort shifted from the Office of Production Management to the administration of the Controlled Materials Plan in 1943 and 1944, officials were grateful to have at hand an input-output table of the U.S. economy for the year 1939. This was the first input-output table prepared under official Government sponsorship. It broke the system down into 95 sectors. (The author had constructed and published in 1936 tables of 42 sectors for the years 1919 and 1929.) The technique appeared promising enough, however, to encourage the Air Force and the Bureau of Labor Statistics in the Department of Labor to join forces after the war in Project Scoop. At a cost of $1.5 million a 200-sector input-output table of the economy was constructed for the year 1947, based on detailed statistical studies of transactions among 450 industrial sectors [see "Input-Output Economics," by Wassily W. Leontief; SCIENTIFIC AMERICAN, October, 1951].

After such an auspicious beginning the publication in late 1964 of a table of only 81 sectors for the year 1958, on a reported budget of less than $1 million, would seem a step backward. But the 1958 table does constitute progress in the input-output analysis of

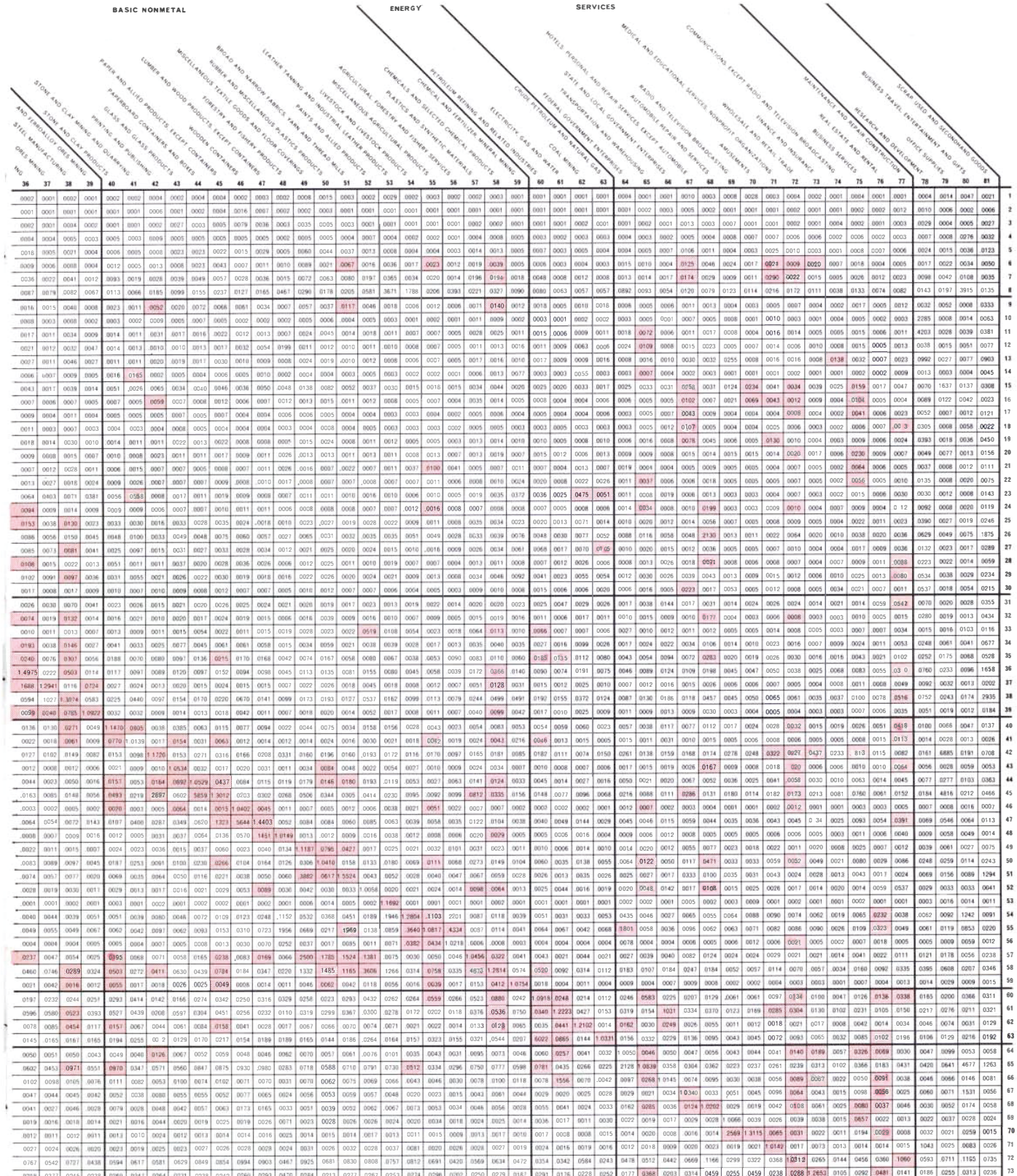


COEFFICIENT TABLE is one way to present transactions among 81 sectors of economy. Sectors are listed vertically at left and are repeated horizontally at top. Reading horizontally across one sector, the coefficients in each cell govern outputs, or sales, to

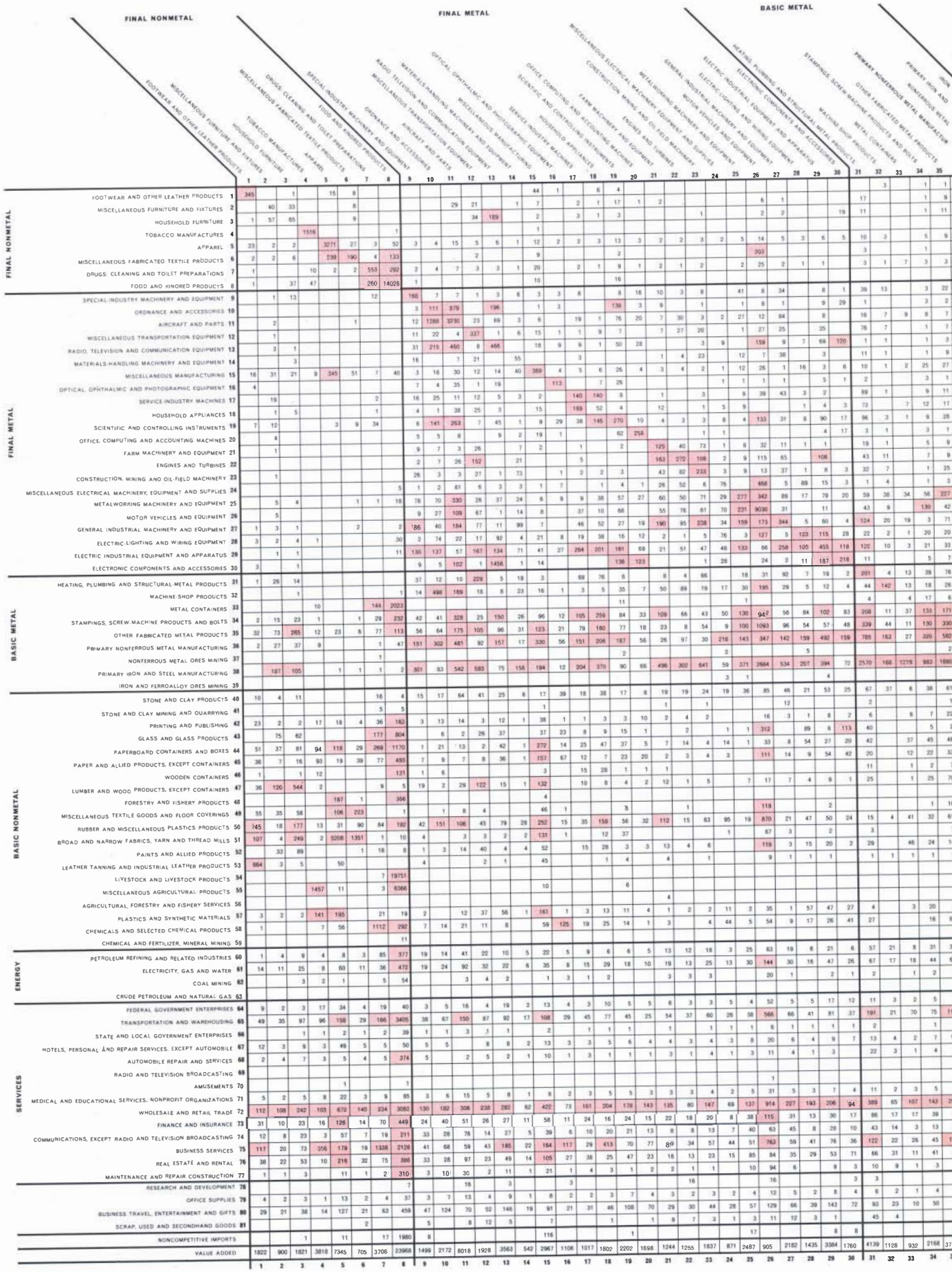


other sectors. Reading vertically down one sector, they govern inputs, or purchases. The coefficients are ratios of the input in a given cell to the total output of sector in whose vertical column the cell appears. Cells are colored where the ratio exceeds 1/81.

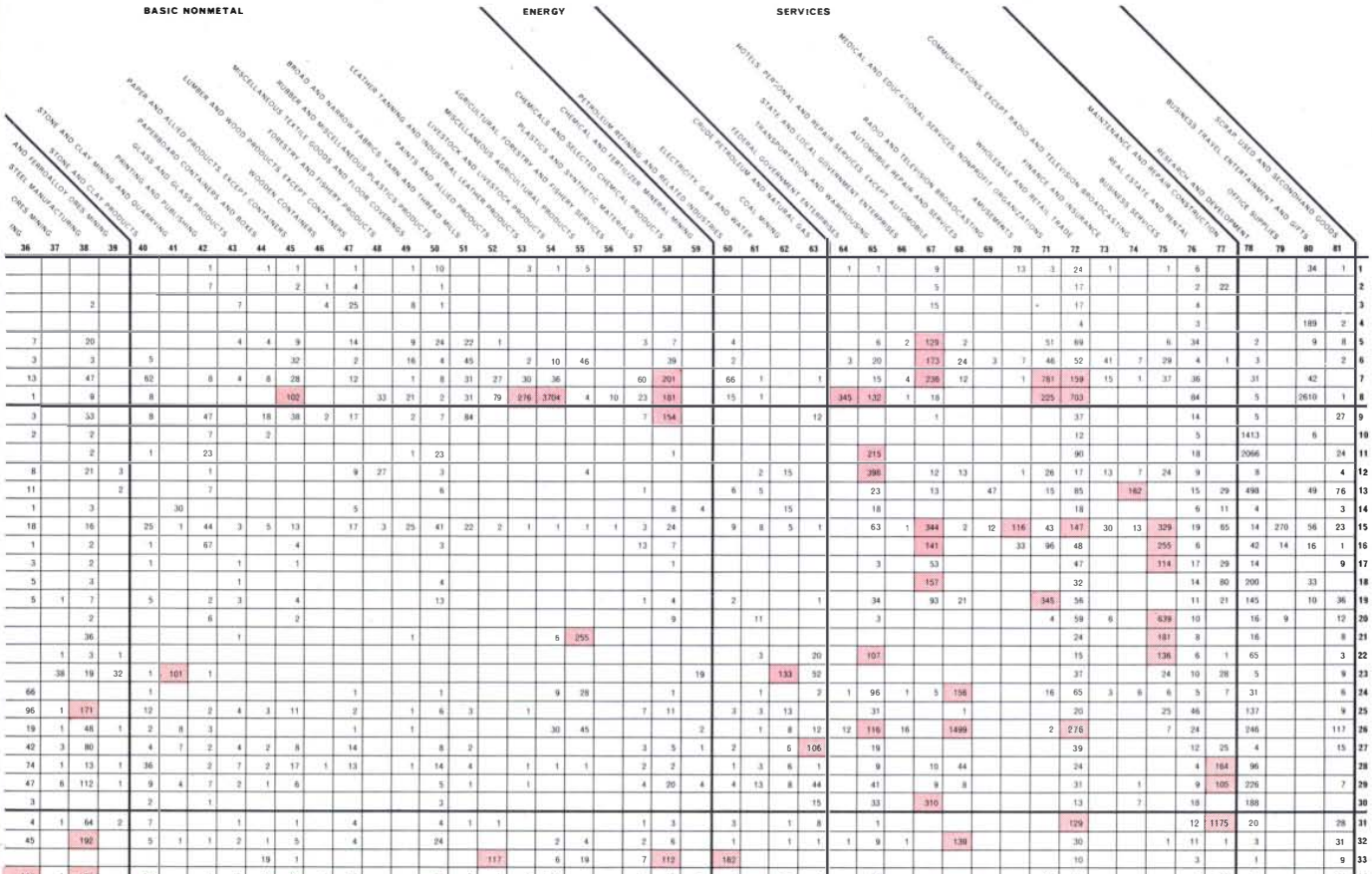
INVERSE-COEFFICIENT TABLE shows indirect relations between the 81 sectors of the economy. Each sector delivers a certain amount of its output to what is called "final demand." (The final-demand totals appear in table on page 32.) The coefficient



in any cell of this table gives, per dollar of delivery to final demand made by sector listed at top, the total input directly and indirectly required from industry listed at left. Cells are colored where delivery of sector at left exceeds 1/81 of its total output.



DOLLAR-FLOW TABLE contains figures that show, in millions of dollars, the transactions among the 81 sectors of the economy that are required to sustain a gross national product of $600 billion, as set forth in table on page 32. Cells are left blank where the trans-



actions were less than $.5 million. Colored cells indicate the largest transactions. Each cell in bottom row ("Value added") indicates what the sector in whose column it appears contributes to gross national product above the sum of its inputs from other industries.

		PERSONAL CONSUMPTION EXPENDITURES	INVESTMENT, PRODUCERS' DURABLE EQUIPMENT	NEW CONSTRUCTION	NET INVENTORY CHANGE	FEDERAL GOVERNMENT PURCHASES	STATE AND LOCAL GOVERNMENT PURCHASES	EXPORTS	COMPETITIVE IMPORTS	TOTAL FINAL DEMAND	GROSS DOMESTIC OUTPUT
		1	2	3	4	5	6	7	8	9	10
FINAL NONMETAL	FOOTWEAR AND OTHER LEATHER PRODUCTS 1	3469	8		42	29	4	50	21	3583	4133
	MISCELLANEOUS FURNITURE AND FIXTURES 2	173	1080	275		34	172	24		1757	2012
	HOUSEHOLD FURNITURE 3	3196	167	398	9	35	75	22		3884	4378
	TOBACCO MANUFACTURES 4	5684			32			585	36	6201	7916
	APPAREL 5	14880			173	58	115	192	45	15027	18994
	MISCELLANEOUS FABRICATED TEXTILE PRODUCTS 6	1482		1		140		25	11	1635	3054
	DRUGS, CLEANING AND TOILET PREPARATIONS 7	4982			72	179	243	440	60	5856	8829
	FOOD AND KINDRED PRODUCTS 8	60994		23	351	262	350	1489	1772	61697	84719
FINAL METAL	SPECIAL-INDUSTRY MACHINERY AND EQUIPMENT 9	27	1981		144	41	41	501	44	2404	3364
	ORDNANCE AND ACCESSORIES 10	212		7	113	3042	6	25	17	3388	6235
	AIRCRAFT AND PARTS 11	34	480		360	8722		754	80	9550	16979
	MISCELLANEOUS TRANSPORTATION EQUIPMENT 12	971	1591	3	102	880	51	403	80	3718	4992
	RADIO, TELEVISION AND COMMUNICATION EQUIPMENT 13	1821	1362	49	98	1881	82	269	56	5310	8042
	MATERIALS-HANDLING MACHINERY AND EQUIPMENT 14		479	335	36	185	67	104	20	1117	1458
	MISCELLANEOUS MANUFACTURING 15	3390	374	113	45	45	239	157	337	4025	7064
	OPTICAL, OPHTHALMIC AND PHOTOGRAPHIC EQUIPMENT 16	610	215		6	178	19	119	104	1043	2027
	SERVICE-INDUSTRY MACHINES 17	325	1261	263	48	86	27	179	7	2086	2974
	HOUSEHOLD APPLIANCES 18	3260	127	276	88	29		229	2	3823	4835
	SCIENTIFIC AND CONTROLLING INSTRUMENTS 19	473	722	257	10	746	118	251	155	2402	4690
	OFFICE, COMPUTING AND ACCOUNTING MACHINES 20	78	1365		18	100	118	182	59	1766	2959
	FARM MACHINERY AND EQUIPMENT 21	10	2283	3	32	7	25	256	172	2381	3303
	ENGINES AND TURBINES 22	170	783	3	81	324	3	288	9	1480	2962
	CONSTRUCTION, MINING AND OIL-FIELD MACHINERY 23		1791	229	100	109	29	962	1	3018	4162
	MISCELLANEOUS ELECTRICAL MACHINERY, EQUIPMENT AND SUPPLIES 24	347	113	20	34	121	44	96	29	679	2039
	METALWORKING MACHINERY AND EQUIPMENT 25	39	1562	1	179	233	5	446	51	2057	4863
	MOTOR VEHICLES AND EQUIPMENT 26	12262	4793	2	726	409	599	1230	863	17706	30346
	GENERAL INDUSTRIAL MACHINERY AND EQUIPMENT 27		1411	366	111	967	5	368	13	2992	5003
	ELECTRIC LIGHTING AND WIRING EQUIPMENT 28	420	34	1067	41	25	13	87	15	1590	3062
	ELECTRIC INDUSTRIAL EQUIPMENT AND APPARATUS 29	21	2156	569	179	241	7	372	77	3108	6802
	ELECTRONIC COMPONENTS AND ACCESSORIES 30	198	36	3	64	313		121	2	605	3539
BASIC METAL	HEATING, PLUMBING AND STRUCTURAL-METAL PRODUCTS 31	97	957	6966	98			305	27	8200	10756
	MACHINE-SHOP PRODUCTS 32			3	15	57	48	20	23	89	2102
	METAL CONTAINERS 33		14		17	23		34	1	88	2776
	STAMPINGS, SCREW-MACHINE PRODUCTS AND BOLTS 34	335		118	91	126	5	40	37	496	4898
	OTHER FABRICATED METAL PRODUCTS 35	509	221	1166	62	150	62	336	145	2237	8574
	PRIMARY NONFERROUS METAL MANUFACTURING 36	14		1166	14	448		408	1236	786	12189
	NONFERROUS METAL ORES MINING 37				44	263		6	393	167	1365
	PRIMARY IRON AND STEEL MANUFACTURING 38	26		2986	209	156		730	387	3302	25448
	IRON AND FERROALLOY ORES MINING 39				30			56	612	587	1046
BASIC NONMETAL	STONE AND CLAY PRODUCTS 40	285		5480	41	10		133	138	5812	10044
	STONE AND CLAY MINING AND QUARRYING 41	24		839	4	13	15	31	159	737	2012
	PRINTING AND PUBLISHING 42	3267		10	17	119	239	119	54	3717	16771
	GLASS AND GLASS PRODUCTS 43	172		114	6	3		91	84	291	2853
	PAPERBOARD CONTAINERS AND BOXES 44	48				5		24	5	72	4825
	PAPER AND ALLIED PRODUCTS, EXCEPT CONTAINERS 45	1139		434		99	14	340	1338	688	12643
	WOODEN CONTAINERS 46				13	2	1	4	8	14	588
	LUMBER AND WOOD PRODUCTS, EXCEPT CONTAINERS 47	203	11	4401	80	11		148	697	4135	10577
	FORESTRY AND FISHERY PRODUCTS 48	377			26	184		41	412	152	1522
	MISCELLANEOUS TEXTILE GOODS AND FLOOR COVERINGS 49	1008	62	5	38	7		62	440	665	2907
	RUBBER AND MISCELLANEOUS PLASTICS PRODUCTS 50	1735	74	417	46	156	101	285	45	2678	9100
	BROAD AND NARROW FABRICS, YARN AND THREAD MILLS 51	944			147	73	15	278	345	818	14093
	PAINTS AND ALLIED PRODUCTS 52	22		264	5	3		38	2	319	2497
	LEATHER TANNING AND INDUSTRIAL LEATHER PRODUCTS 53				4			39	50	16	1173
	LIVESTOCK AND LIVESTOCK PRODUCTS 54	2806			813			35	315	3340	32653
	MISCELLANEOUS AGRICULTURAL PRODUCTS 55	3273		318	566	1474	31	2357	479	7541	30133
	AGRICULTURAL, FORESTRY AND FISHERY SERVICES 56				28	62	94	4			2016
	PLASTICS AND SYNTHETIC MATERIALS 57	11			58	6		456	54	361	5630
	CHEMICALS AND SELECTED CHEMICAL PRODUCTS 58	291		492	33	991	326	912	459	2520	15652
	CHEMICAL AND FERTILIZER MINERAL MINING 59	1			1	13	15	69	108	11	632
ENERGY	PETROLEUM REFINING AND RELATED INDUSTRIES 60	9695		1323	243	968	309	873	892	12236	23054
	ELECTRICITY, GAS AND WATER 61	10751		201		463	655	55	49	12076	26968
	COAL MINING 62	348			30		81	447	4	842	3665
	CRUDE PETROLEUM AND NATURAL GAS 63				58			44	1612	1627	12817
SERVICES	FEDERAL GOVERNMENT ENTERPRISES 64	836				77	88	82		1082	5454
	TRANSPORTATION AND WAREHOUSING 65	11233	669	2425	178	1869	535	2987	24	19920	43749
	STATE AND LOCAL GOVERNMENT ENTERPRISES 66	414		18		154	6	6		599	6357
	HOTELS; PERSONAL AND REPAIR SERVICES, EXCEPT AUTOMOBILE 67	12598				326	114			13039	16208
	AUTOMOBILE REPAIR AND SERVICES 68	5818		354		169	106			6447	10481
	RADIO AND TELEVISION BROADCASTING 69							13		13	2060
	AMUSEMENTS 70	4377			30	23	61	350		4719	7529
	MEDICAL AND EDUCATIONAL SERVICES; NONPROFIT ORGANIZATIONS 71	27157		78		152	425			27812	30150
	WHOLESALE AND RETAIL TRADE 72	81465	4958	6657	127	888	254	1907	860	97116	126318
	FINANCE AND INSURANCE 73	15645		584			248	35	62	16573	35078
	COMMUNICATIONS, EXCEPT RADIO AND TELEVISION BROADCASTING 74	5737	536	146		247	275	96		7036	13000
	BUSINESS SERVICES 75	2499		3427		751	752	229		7658	32506
	REAL ESTATE AND RENTAL 76	53230	1664	281		166	333	333		56007	82399
	MAINTENANCE AND REPAIR CONSTRUCTION 77			9		1430	4525			5964	22493
	RESEARCH AND DEVELOPMENT 78					6910				6910	7126
	OFFICE SUPPLIES 79			19		98	173			290	1806
	BUSINESS TRAVEL, ENTERTAINMENT AND GIFTS 80			302					218	84	8577
	SCRAP, USED AND SECONDHAND GOODS 81	18	1080	98	269	154	450	275	404	758	961
	NONCOMPETITIVE IMPORTS	5207	28		14	3695		263	13639	4433	
	VALUE ADDED	6218		24959	422	26036	25572	5798	896	87 5	600000
		389358	34285	70321	2022	67359	38245	31410	28955	600000	
		1	2	3	4	5	6	7	8	9	10

FINAL DEMAND on industry is listed in this table. Ninth column gives totals for deliveries to final-demand sectors; 10th lists each industry's output. The total of the "Total final demand" column is gross national product of $600 billion. Colored figures are negative.

the U.S. economy. In particular its reception by the business community, now equipped with computers of sufficient capacity to make use of the technique, indicates that future ventures in this field by Government agencies will have more generous backing and encouragement.

To visualize the economy as it is revealed by input-output analysis it is easiest to begin with a table of dollar flows, the third of the three interindustry tables that illustrate this article [*see preceding two pages*]. This table shows the dollar flows corresponding to a gross national product of $600 billion, a bench mark first surpassed by the economy in 1964. The makeup of this hypothetical gross national product is detailed by industry and by category of ultimate market or final demand in the table at the left. From this bill of goods the table of interindustry dollar flows was computed, purely for purposes of demonstration, in accordance with the specifications for the economy set out in the Department of Commerce input-output table for the year 1958 (when the gross national product was $445 billion). The cells in each horizontal row of the table show the distribution of the outputs—the sales—of that industry or sector to each of the 81 industrial sectors. The sum of these outputs plus the industry's deliveries to final demand equals its total output—the conventional index of the activity of an industry—which is shown in the column at the far right in the table at the left.

As every sale is a purchase, so each figure in a horizontal row is also a figure in a vertical column: each output from one industry is shown to be an input to another. The figures in each vertical column accordingly list the inputs to that industry or sector from all the others. In the "Value added" row at the bottom of the table the entry for the industry in question totals up its wage bill, depreciation, profit and other "prime factor" charges. These constitute the industry's own contribution to the gross national product above the value of the inputs it draws from other industries or sectors. The value added plus the total of the intermediate inputs (including the entry in the "Imports" row) equal the total output of the industry, as entered in the total-output ("Gross domestic output") column in the table at the left. The rows and columns —that is, the outputs and inputs, or sales and purchases, making up the total activity of the economy—thus come into

balance in the double-entry bookkeeping of input-output economics.

The dollar-flow table also shows the national accounts in balance. The sum of all the entries in the value-added row is equal to the sum of all the entries in the "Total final demand" column in the table on the opposite page. This figure is the gross national product. As the final-demand columns show, "gross national product" expresses the total activity of the economy in terms of the expenditures by which goods and services are acquired for final use by consumers and the Government and for investment and exports.

Here it should be noted that no total is given at the foot of the total-output column in the same table. That is because this figure—$1,032 billion—is misleading as an index of economic activity. It compounds all the intermediate transactions through which goods or services reach their final destination in the marketplace; it redundantly adds, for example, to the consumer's outlay for fabricated steel in an automobile ("Personal consumption expenditures," row 26 in the table) the price paid by the motor vehicles and equipment industry for the same metal in the raw sheet (column 26, row 38 in the dollar-flow table on pages 30 and 31) and again the price paid by the primary iron and steel manufacturing industry for the same metal in the ore (column 38, row 39). The consumer, of course, pays only once for the metal in the ore and for each unit of value added between the mine and the showroom. In accounting for these interindustry transactions, each of which is reckoned in the total output of the industry in question, and relating these transactions to final demand, input-output analysis yields its deep insights into the structure and operation of the economy.

The figures in the dollar-flow table were computed from the quite different set of figures shown in the table on pages 26 and 27. These are the input-output coefficients on which the technique of input-output analysis turns. The figure in each cell expresses the ratio of the input from the industry in whose row the cell appears to the total output of the industry in whose column the cell appears. Although the dollar-flow figures in the table on pages 30 and 31 are hypothetical, the input-output coefficients reflect the real activity of the U.S. economy in the year 1958, as analyzed by the Office of Business Economics. In the present table the coefficients from the Office of Business Economics table have been recomputed by the Harvard Economic Research Project in order to show gross domestic output. Competitive imports are therefore entered as negative figures in final demand, whereas noncompetitive imports are entered in an external row at the bottom of the table and represent tropical agricultural products such as coffee and certain minerals. It should be noted also that sectors 78 through 81 are "dummy" industries, set up to simplify the estimating procedures.

As can be imagined, the construction of this table has involved a considerable enterprise in fact-gathering. Actual records of interindustry transactions had to be searched out and compiled, and these studies were supplemented and refined by reference to the technological considerations underlying the transactions. Although the coefficients in the table can be read as dollar figures (the sum of all the coefficients in a column plus the coefficient in the value-added row comes to $1,000.00), they are better visualized as standing for the input of the actual physical quantity of this or that commodity purchasable at the price (in 1958 dollars) shown and required to produce $1,000 worth of the output of the industry in whose column it appears. For each sector of the economy the column of input-output coefficients specifies the mix and proportion of inputs required to produce each unit of output. For the economy as a whole an input-output table reveals the structure of interlocking interdependencies that ties the highly differentiated and specialized parts of the system together as a whole. It presents, in effect, a working model of the system. As such it can be employed for the experimental study of a great many theoretical and practical questions about the economy.

The computation of the table of transactions for a $600 billion gross national product illustrates one such use. Input-output analysis derives its conceptual framework from recognition of the fact that all the possible interconnections of the different sectors of a national economy can be regarded as special instances of the general solution of a single large system of equations in matrix algebra. In the case of the 1958 table the system contains 81 equations, each corresponding to an industry or a sector and each involving 81 distinct but interdependent variables. The parameters of these variables, the constants of the equations, are the input-output coefficients. The coefficients answer the question "In what proportions?" To solve the equations for $600 billion—that is, to answer the question "How much?"—the first step was to set up the appropriate bill of final demand. With these numbers given, solution of the equations produced the dollar-flow table and the total outputs required of each industry. The task of computation is of course immense. Each unit of output from industry *A* requires inputs from industries *B*, *C*, *D* and so on; these inputs ultimately call for an increase in output from industry *A*, which itself turns out to be a supplier to *B*, *C*, *D* or a supplier to their suppliers, and so the flow of direct and indirect demand cascades again. Nonetheless, the solution of the 81 equations with their 81 variables, carried out to five significant figures, required only three minutes on the IBM 7090 computer at Harvard University.

The dollar flows and total outputs thus satisfy not only the final demand laid directly on each sector but also the demand laid indirectly on each sector by the final demand for the output of the sectors to which it delivers inputs and still other sectors to which its customers deliver inputs. In the case of the rubber industry (row 50), for example, the total output depends not alone on the direct demand for the industry's products arising from consumer and Government expenditures and from exports but on the indirect demand for rubber set up by the final demand for motor vehicles and equipment (column 26), for footwear and other leather products (column 1) and for transportation and warehousing (column 65). At a $600 billion gross national product, the total final demand for rubber is $2,678 million, but the total output of the industry is shown to be $9,100 million. Most of the rubber industry's output reaches final demand via inputs from rubber to other industries. A table of input-output coefficients can thus be used to forecast the total output required of an industry by changes in the size or composition of the gross national product.

An input-output matrix of another kind appears on pages 28 and 29. The figures in this matrix represent the general solution (by "inversion") of the input-output coefficient matrix. Each of these "inverse" coefficients expresses for the industry in whose row the cell appears that portion of the industry's total output required directly and in-

directly to meet one unit of final demand for the product of the industry in whose column the cell appears. An inverse matrix facilitates many calculations that can be carried through without the mediation of a computer. Multiplication of the final consumer demand for automobiles ($12,262 million), for instance, by the inverse coefficient (.0129) appearing in the cell at the intersection of the automotive-industry column (column 26) and the iron-ore-industry row (row 39) yields $158 million. The figure expresses the direct and indirect demand for iron ore generated by the sale of $12,262 million worth of automobiles to consumers. Because the automotive industry buys no ore directly, however, the cell shows no entry at all in the table of input-output coefficients or in the table of dollar flows.

With the help of a table that embodied a more detailed analysis of the system, indirect relations of a still more remote order might be resolved. How would the demand for sulfuric acid be affected, for example, by a given increase in public expenditure for primary education? The demonstrated interdependence of the elements in the economic system suggests that such an effect may be of significance to some producers in the chemical industry. A rise in school budgets will increase the sale of elementary textbooks, which in turn means an increased demand for printing stock. The paper manufacturers' response to this demand will require an increase in the output of the wood-pulp industry, and the chemical industry will accordingly experience a step-up in the demand for sulfuric acid. The relatively coarse aggregation of the system in the present table, however, buries education in the "State and local government purchases" column in final demand and lumps sulfuric acid along with other chemicals in an undifferentiated chemical industry in sector 58.

In the tables illustrating this article the 81 industrial sectors have been "triangulated"; that is, they have been arranged in accordance with the hierarchy of interindustry dependence. The coloring of the cells in the table of input-output coefficients on pages 26 and 27 brings the structure into graphic relief. Here the color distinguishes those cells in which the input-output coefficient exceeds 1/81, that is, the cells to which the input exceeds $12.35 per $1,000 of output from the sector in whose column the cell appears. In

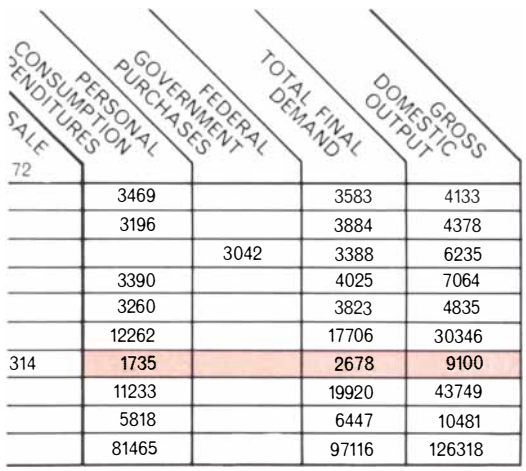
	FOOTWEAR AND OTHER LEATHER PRODUCTS 1	HOUSEHOLD FURNITURE 3	ORDNANCE AND ACCESSORIES 10	MISCELLANEOUS MANUFACTURING 15	HOUSEHOLD APPLIANCES AND EQUIPMENT 18	VEHICLES MOTOR 26	RUBBER AND MISCELLANEOUS PLASTICS PRODUCTS 50	WAREHOUSING AND TRANSPORTATION 65	AUTOMOBILE REPAIR AND SERVICES 68	WHOLESALE AND RETAIL TRADE EX
FOOTWEAR AND OTHER LEATHER PRODUCTS 1										
3										
10										
15										
18										
26										
RUBBER AND MISCELLANEOUS PLASTICS PRODUCTS 50	245	177	151	252	158	870	276	338	360	
65										
68										
72										

INTERINDUSTRY TRANSACTIONS between the rubber industry (subsumed under "Rubber and miscellaneous plastics products") and nine other sectors of the economy are excerpted from the dollar-flow input-output table. Such transactions account for most of the activity of the rubber industry. The gross domestic output of the rubber industry is given (*column at right*) as $9,100 million. The value of rubber delivered to total final demand is only $2,678 million. The difference between the figures is the amount of rubber sold to other industries. Each of these other industries somehow uses rubber and then in turn makes deliveries to still other

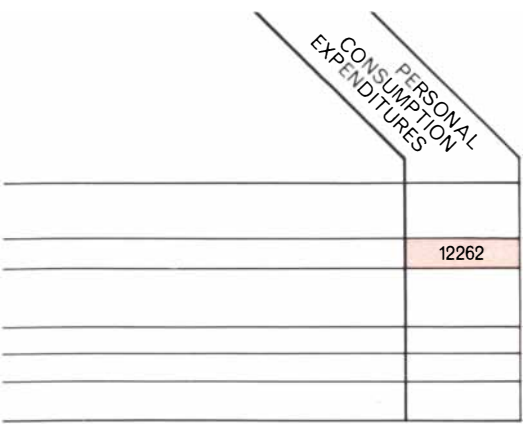
	VEHICLES AND MOTOR EQUIPMENT 26	PRIMARY IRON AND STEEL MANUFACTURING 38	IRON AND FERROALLOY ORES MINING 39
MOTOR VEHICLES AND EQUIPMENT 26			
PRIMARY IRON AND STEEL MANUFACTURING 38	2664 2088		
IRON AND FERROALLOY ORES MINING 39	.0129	1396	

INDIRECT ECONOMIC RELATION between iron ore and automobiles is illustrated in excerpts from the dollar-flow table and the inverse table. The steel industry ("Primary iron and steel manufacturing") buys iron ore from sector called "Iron and ferroalloy ores mining" and sells it to the automobile industry ("Motor vehicles and equipment"). This process is summarized in cells at

any one column, therefore, the colored cells identify the principal suppliers to that industry. As can be seen, most of the colored cells fall on or below the diagonal line running from the upper left to the lower right corner. (The cells on the diagonal show the intramural transactions of each of the 81 industrial sectors.) The distribution of colored cells indicates that the sectors in the upper rows of the table deliver little of their output to other industrial sectors and so deliver most of it directly to one or another final-demand column. In contrast, the output of the sectors toward the bottom of the table is distributed primarily as inputs to other industrial sectors. The colored cells tend to cluster, moreover, in the blocks of intersecting rows and columns set off from one another by the heavier horizontal and vertical lines that mark



industries or to final demand. Whether an industry delivers to final demand or to other industries depends on the nature of its product. Footwear, for example, unlike rubber, delivers primarily to final demand.



intersections of the three sectors. Only an inverse coefficient appears in the cell at the intersection of ore and automobiles.

the major categories of industry. In general, the sectors above and below any given row in the table bear quite different relations to that industrial sector: those above are its customers; those below are its suppliers.

Such triangulation of an input-output table not only serves to develop graphically the structure of the system but also facilitates the use of the table in forecasting and planning. Computation of the indirect effects of an increase in final demand for the output of a given industry, for example, requires principally the use of the coefficients for the inputs from the industries below it in the table. Correspondingly the computation of effects on this sector exerted by demand originating elsewhere in the system involves mainly the coefficients of its deliveries to its customers in the rows above.

The sectors in the inverse and dollar-flow tables are triangulated in the same order, but the cells in these two tables are colored to highlight the structure of the system from two different points of vantage. In the inverse table the coloring of the cells in each row distinguishes the principal industrial customers of the industry in whose row the cells appear, that is, the customers to which the industry delivers 1/81 or more of its total output. This might be described as the sales managers' view of the system. In the dollar-flow table the color identifies the 645 cells (roughly the same number of cells as in the two other tables) that show interindustry transactions of $100 million or more. Correspondingly this could be described as an economic analysts' view of the system.

During the 25 years since the publication of the first officially sponsored input-output table for the U.S. economy, many other countries—developed and underdeveloped, free-enterprise and centrally planned—have constructed tables for their systems. At three international congresses on input-output analysis, the last held under the auspices of the United Nations Secretariat in Geneva in 1962, planners from socialist countries and business economists from the West have found that they have a common language for discussion not only of theory but also of concrete experience in the solution of practical problems of many kinds. Last fall, simultaneously with the release of the 1958 table for the U.S., the statistical office of the Common Market countries published a set of statistically compatible tables for France, Belgium, West Germany, Italy and Holland; the construction of an integrated table for the entire western European economic complex will soon follow. At the other end of the scale an increasing number of smaller economic units —many states in the U.S. and even cities and metropolitan areas—have been compiling their own input-output tables. Managements of a number of large industrial enterprises, in the U.S. and abroad, have constructed input-output tables of their companies in order to gain better control of the effects that follow from the mutual interdependence of their many departments and of the phases in their production processes. In West Germany and France these internal corporate tables are coupled to the tables for the national economy in the storage memory of the computers in which they are put to work.

Further development of input-output analysis and the realization of its potentialities for informed and rational decision-making at all levels of economic life call for detailed and more up-to-date tables. Comparison of the 1947 and 1958 input-output tables for the U.S. economy indicates significant changes in the input-output coefficients arising from technological innovation. Change in a single input-output coefficient means change in the structure of the equation in which it appears; this forces a new solution of all the equations in a table and brings about change in all the elements of the inverse matrix. Even if the bill of final demand remains the same, therefore, this revises the dollar flows throughout the table and the total outputs of all the industries, although to a lesser degree in those more remote in the order of triangulation. These effects of change in coefficients suggest an important use of input-output analysis, which is to assess the consequences of critical advances in technology. With sufficiently detailed and current data at hand it would be possible to reckon with these results in advance.

Work has now begun on the preparation of an input-output table for the U.S. economy based on the data from the census of manufactures for 1963. It is to be hoped that this table will be designed to describe the steadily increasing complexity of the system in terms of at least 500 to 600 sectors. Such an input-output table would give the discipline of economics the 200-inch telescope it requires for its work today.