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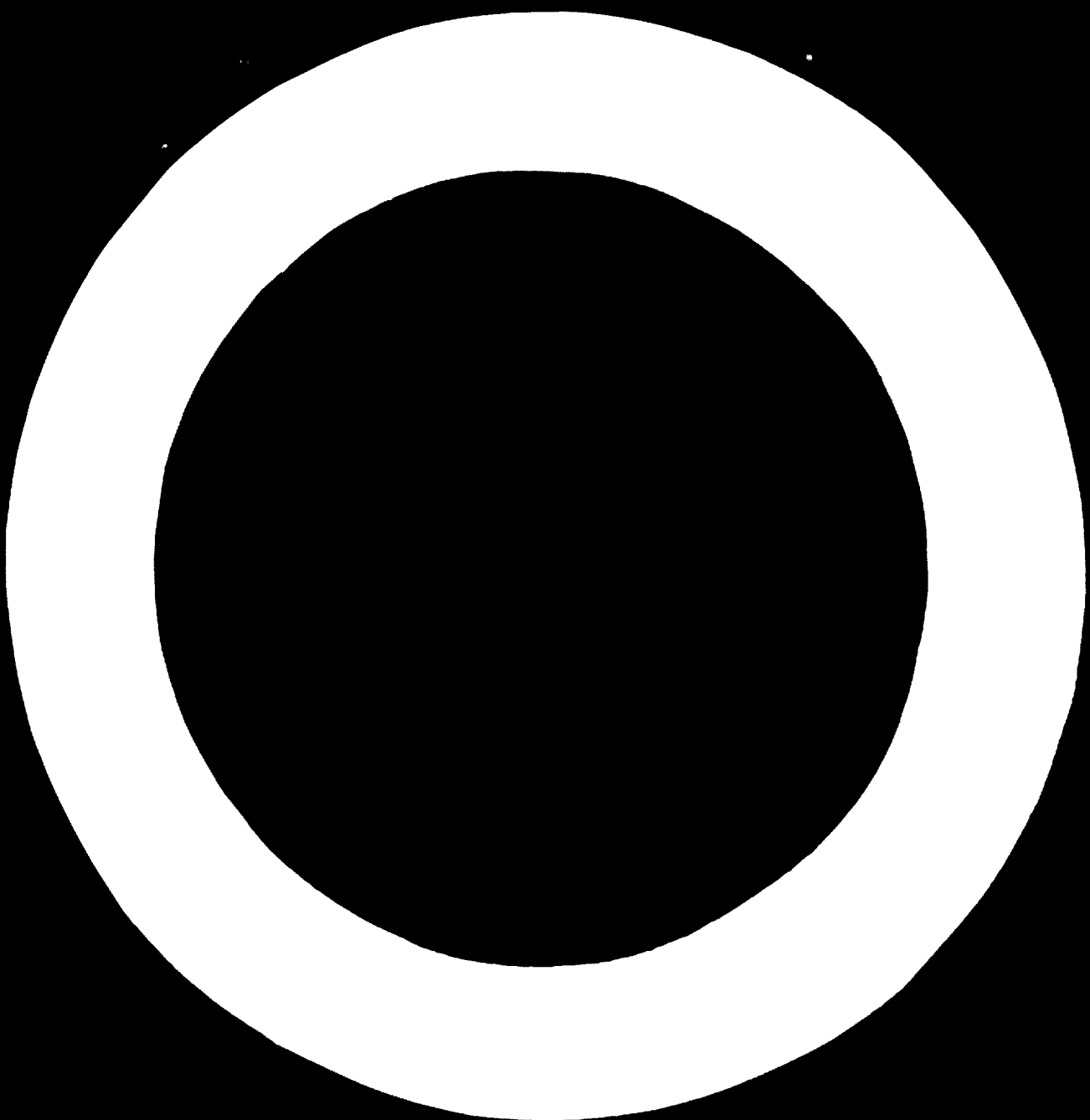

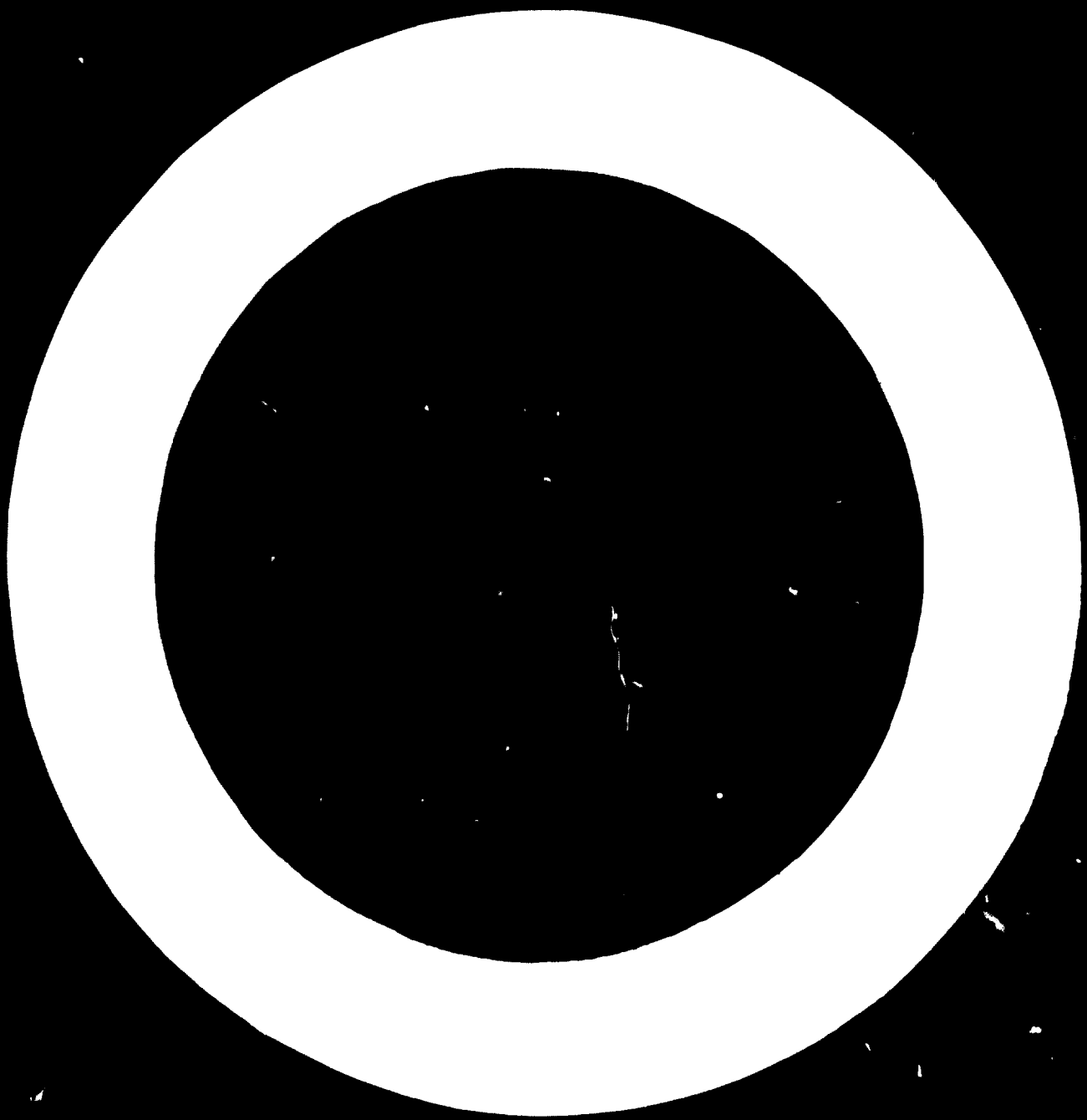

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THE POSITION OF METALWORKING INDUSTRIES IN THE STRUCTURE OF AN INDUSTRIALIZING ECONOMY

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In this report are described the relationships, to each other and to all other sectors of an industrial economy, of industries in the metalworking complex. Systematic quantitative information should facilitate translation of the preliminary aggregative outlines of a national development plan into specific industrial programmes which, in turn, should provide a firm basis for detailed design and assessment of individual investment projects.

The emphasis in this intermediate stage of developmental planning is on interindustrial balance: on the provision, for each newly established branch of production, of an appropriate supply of raw and semi-finished materials, of power, and of other kinds of inputs on the one hand, and of a properly assured outlet for its output on the other. The analytical procedures and the factual information are intended to facilitate planning the expansion of metalworking industries within a framework assuring balanced growth of all sectors in a developing economy.

In an industrial economy, metalworking industries function as the chief suppliers of durable capital goods to all sectors. Indeed, metalworking and construction sectors are the only major suppliers of durable capital goods. In 1958, United States metalworkers contributed 31 per cent of all gross private capital formation, the bulk of the remainder coming from the construction industry. In contrast, their contribution of current account inputs, that is, materials, parts and components, and services to other industries in the economy, was relatively small. Because of the special interest here in capital-producing sectors, particular attention must be given to problems of capital accumulation, of growth and replacement, if the economic functions of the metalworking industries are to be understood.

CURRENT ACCOUNT INPUT-OUTPUT TABLES

The presentation will be organized around a series of tables, each designed to illustrate a particular aspect of industrial interdependence. Table 1 is an input-output table for the United States in 1958. It shows the dollar value of sales by establishments in each of the eighty-one industries of the economy in relation to each other and to final consumers, households, Government, exports and imports, net change in inventories and gross capital formation. Imports are shown as negative entries, i.e., as an offset to other final demand items. Each row describes the industrial destinations of an industry's products; each column details an industry's purchases from the other sectors. If we divide the purchases by each industry (in a given column) by that industry's output, we obtain a set of input-output coefficients. These are shown in table 2. The coefficients in each column are essentially a recipe for a unit of its output. They show, for example, how much coal, ore and scrap are purchased by the steel industry per unit of steel output.

Throughout the world, input-output tables have been made for more than fifty countries varying in stages of industrial development and types of economic organization. Economies differ quite a bit, and so, naturally, do the input-output tables which describe them. Look, for example, at the input-output tables for India and Japan, tables 3 and 4. While it is not easy to compare them (the transactions are in different currencies, and prices and the sectoring plans are not the same), important resemblances and differences are apparent. Sales and purchases by manufacturing and particularly by metalworking sectors have much greater relative importance in Japan than in India. In both countries, however, primary metals producers and other metalworking sectors supply the bulk of metalworkers' inputs.

A country which is formulating its development plan will want, naturally, to base its analysis on its own input output table in so far as possible. In the discussion which follows, we shall refer most often to the most recent material for the United States economy, since this is the material most readily available to us. Because the United States already has a highly developed metalworking complex, we can use it to provide examples of the interrelationships among metalworking and other sectors. Later, imports are introduced as an alternative source of metalworking products. The analytical procedures which are presented can, and indeed should, be applied to data for other economies as well.

In tables 1 and 2, sectors have been arranged roughly in "triangular order", i.e., the industries producing primarily final goods (machinery, clothing, processed foods) are placed at the top of the chart, followed by the producers of intermediate products (engines and turbines, electronic components, machine shop products), and still below that by producers of raw materials, energy, etc. If production were always a "one-way street", the arrangement would be perfectly triangular: there would be no transactions in the upper triangle of the input-output table. But this is not the case. Chemicals are used to make paper, but paper is used to package chemicals.

Steel is used to make blast furnaces, but blast furnaces are used to make steel. Nuts, bolts, and screws go into machines, but are also made by machines, etc. These circular or backfeeding aspects are very important in a complex industrialized economy. It is important to insure balance among these interdependent processes, in planning or forecasting economic development.

A standard input-output computation permits us to trace the impact of any given change in deliveries to final demand on all inter-industry flows on current account, and hence on all industries' outputs. If more automobiles are to be produced for consumers or for export, then the economy will have to deliver more steel, metal products, textiles, and power to the automobile industry. To supply these additional inputs to automobiles, the steel industry will have to consume more coal, ore, and scrap, the metal products industry still more steel, the textile industry more chemicals and natural fibres. To supply this second round of additional inputs, still more ore, coal and scrap, more chemicals, more coal, and so on, are needed. To compute all the direct and indirect requirements of a given change in final demand, we compute the so-called "inverse coefficient matrix."[1] Table 5 is such an inverse matrix. Each element tells how much of the products of the industry on the left are required per unit increase in final demand for the product listed at the top. The inverse coefficient for steel into automobiles tells how much the total production of steel in the economy must increase per dollar increase in deliveries of automobiles to final demand. Inverse coefficients will always be equal to or larger than direct input-output coefficients (table 2) because they include indirect, in addition to direct, production requirements.

Foreign trade and import substitution

In tracing the direct and indirect effects of changes in the bill of final demand on domestic outputs, exports must be added to the other items included in the final demand, while imports have to be entered in it as a column of negative figures. If, for example, a country were to increase its export of electric motors, the output of the electric motors industry and of its various direct and indirect suppliers would have to increase by the same amount by which they would have to be raised if the additional motors were produced for domestic use. Increased imports of electric motors would have just the opposite effect.

Import substitution is nothing but a combination of a cut in imports and an equal rise in domestic output (with the level of domestic final demand remaining the same as it was before). The combined direct and indirect impact of the two shifts on every sector of the economy can be estimated through simple summation of the separate effects of each of them. In general, given a complete export programme and a corresponding import programme of a country, their total effect on the level of output in each branch of domestic industry can be estimated through subtraction of the direct and indirect effects of all types of imports from the combined (positive) effects of all the different kinds of exports.

Using the table of technical input coefficients, it is even simpler to compute the import requirements for raw material, semi-finished and finished goods or the export surpluses corresponding to any combination of projected output levels of domestic industries with given quantities of their respective products allocated to exports and absorbed in final domestic use. The inputs required by each industry to attain the projected level of output can be determined on the basis of the appropriate input coefficients. These inputs combined with projected deliveries to final use will yield estimates of total domestic demand for each type of goods. Comparing these with the projected total domestic outputs, we arrive at the figures of required imports or exportable surpluses.

Labour and capital coefficients; aggregation to a 38-sector classification

Large coefficients in the United States coefficient table and in the inverse coefficients table are shaded. They represent relatively important direct or indirect linkages between a given selling industry (identified on the left) and purchasing industry (identified at the top). Sectors 9–35 (sector 15 can be excluded) in tables 1, 2, and 5 are metalworking sectors.

With large capacity high-speed computing equipment, it is not difficult to deal with eighty-odd sector input-output tables, or even much larger ones. On the other hand, it is still very clumsy to print and reproduce large matrices on a single page of paper. To facilitate presentation here, we have chosen to consolidate or aggregate the United States input-output materials to a thirty-eight-order classification. The consolidated flow and coefficient tables are given as tables 6 and 7. Since we are concentrating on the metalworking sectors, we have kept full detail in the twenty-five metalworking industries, but aggregated the non-metalworking sectors into only thirteen sectors. Metalworking sectors are renumbered 1–25. The last five rows in the coefficient table, 7, show total fixed capital requirements (dollars per dollar of output), labour requirements in man-years per thousand dollars of output, for three different types of labour skills, and total labour requirements. Multiplying the output levels for each of the thirty-eight industries by these labour coefficients, we can obtain estimates of each of the three types of labour required in each producing sector. Comparison of these estimates of labour requirements with projections of skilled labour supply or manpower training plans will tell whether a given set of output levels is feasible.

Supplies of other factors of production which may introduce bottlenecks can be treated analogously. If an economy has only a limited supply of, for instance, an

[1] $(I-A)^{-1}$, where A is the matrix of flow coefficients

coefficients: $\begin{pmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & & & \\ \vdots & & & \\ a_{n1} & & & a_{nn} \end{pmatrix}$ as exemplified in table 5

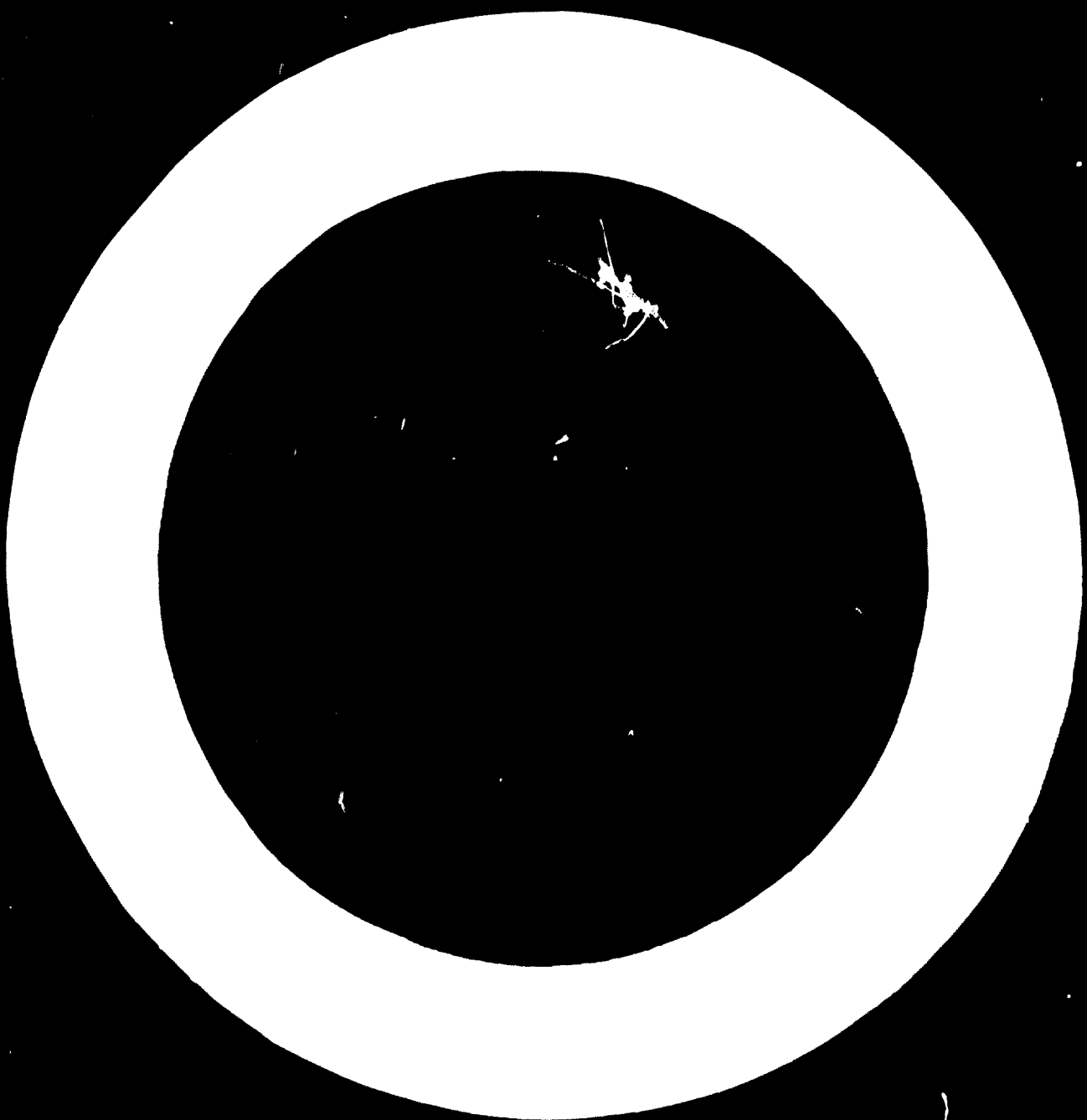


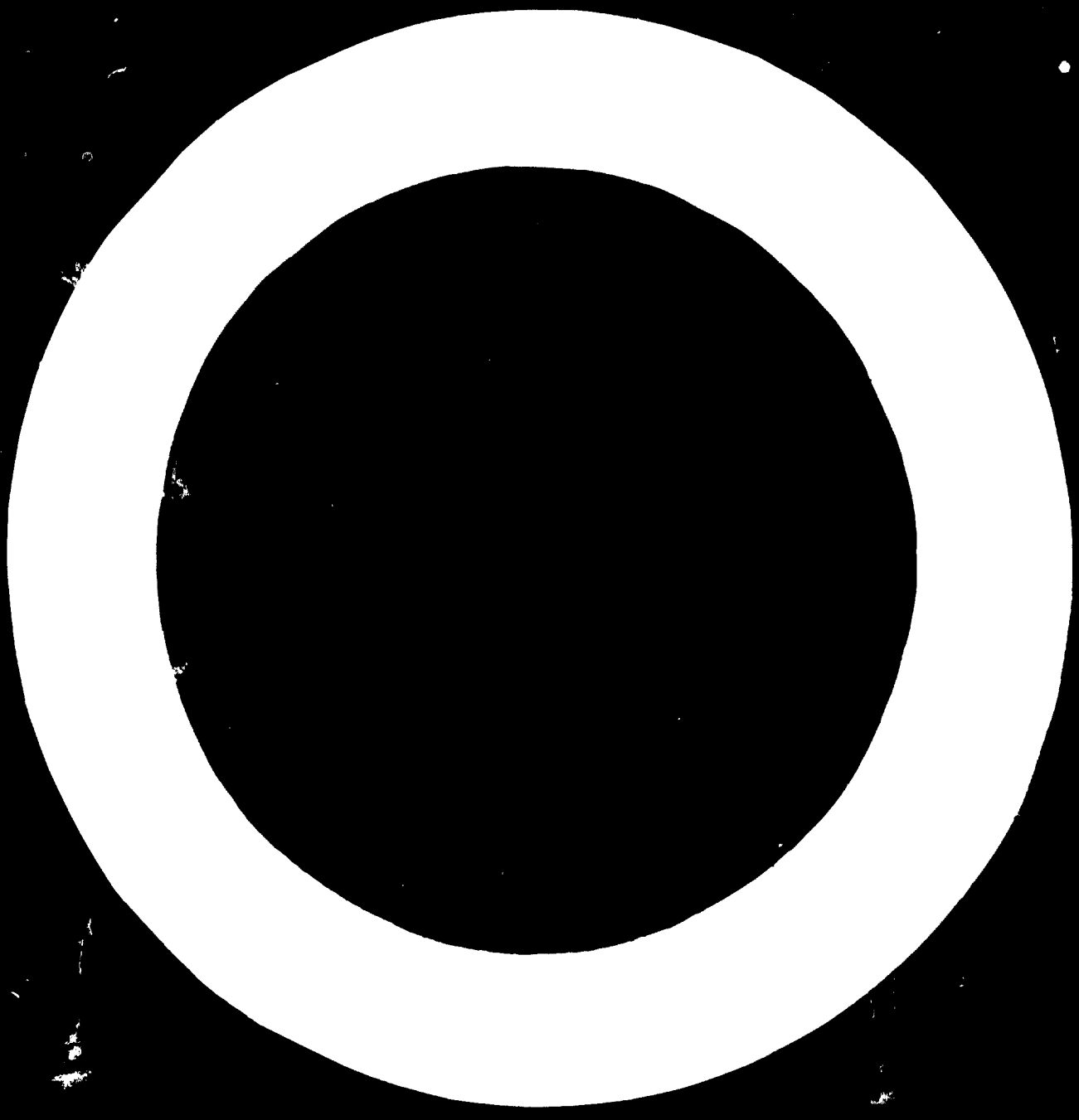
Table … INPUT-OUTPUT

Table … FINAL DEMAND ON INDUSTRY

Table 2. Coe[illegible]ients[a]

FINAL NONMETAL	FINAL METAL	BASIC METAL	BASIC NONMETAL	ENERGY	SERVICES
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[a] [illegible] 1958 United States economy. Sectors are listed vertically and are re[illegible] … 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 shaded where the ratio exceeds 1.81.



ore, or petroleum, which cannot be increased in the short run, then their requirements can be computed as in the case of skilled labour, and the feasibility of a given programme evaluated. Imports can sometimes fill the gap.

Capital requirements should be treated in exactly the same way in the short run. Given sufficient time, of course, skilled labour can be "produced" through education and industrial training programmes and capital goods can be manufactured. The role of metalworking industries in the investment process is considered in detail later on.

A line is drawn around the industries in the metalworking bloc in tables 6 and 7. Note that there are very few sizeable entries beyond 26 (construction) in the I–25 band of metalworking suppliers. Within the bloc, however, there are strong elements of interdependence. Before going further into the relation of metalworking to other sectors, let us survey the internal structure of metalworking more carefully.

Internal Structure of the Metalworking Complex

Summing the transactions within the box (table 6), we observe that the total value of transactions among the metalworkers themselves is 28 per cent of their combined total output. Thus, a fair proportion of metalworking activity is "taking in each other's wash". Makers of, for instance, engines and turbines, purchase bolts and nuts and stampings from other metalworkers and, in turn, furnish marine engines to boat builders. Intra-industry transactions along the "diagonal" may often consist of sales of specialized parts made in one establishment to assembling plants included in the same industry. Thus, for example, the very large volume of sales among automobile establishments reflects the United States practice of decentralizing automobile assembly plants throughout the country.

Table 8 presents direct input-output coefficients for the metalworking sectors alone for the United States in 1958.[2] Metalworking industries are specially arranged in that table to highlight their internal organization: industries which specialize in components for other metalworking industries are placed near the bottom of the table, and producers who specialize primarily in final metal products are located near the top.

Final metal products are divided into three major groups: transportation equipment (automobiles, aircraft, railroad equipment, cycles, etc.), electrical equipment (electrical transmission equipment, radio and television sets, household appliances, office and computing machines) and non-electrical equipment (industrial processing equipment, farm machinery, materials-handling equipment, metalworking machinery, etc.). Industries listed near the top of each final product group or "bloc", such as office, computing and accounting machinery, and materials-handling machinery, sell little or nothing to other metalworking sectors on current account. Below them are listed sectors such as electronic components and

[2] Coefficients in tables 8 and 9 exclude some fictitious "secondary product" transfers included in tables 2 and 7.

electric lighting and wiring equipment, which provide current inputs to electrical machinery producers at later stages, or engines and turbines, which produce components for industrial and transportation equipment manufacturers. The bottom rows of the table consist of industries which perform more general metalworking functions not specialized to a particular final metal product: stampers, makers of ball and roller bearings, etc. These provide components for all the later stages of metalworking production.

Note the bloc character of the electrical and nonelectrical machinery sectors. These blocs buy relatively little from each other, although both groups purchase from the "general intermediate" metalworkers detailed at the bottom of the table. Transportation equipment manufacturers do not form a self-contained bloc. They purchase from both the electrical and the nonelectrical blocs as well as from each other.[1]

One should not, of course, expect metalworking complexes to be fully developed in all economies. Relatively few metalworking activities will be represented in the input-output table for a developing economy, and within each input-output category the mix of such activities will be very different. The expansion, proliferation, and balancing of these activities is an essential part of economic development. Even among highly industrialized countries, specialization patterns vary to some extent.

Some variations in the division of labour within the metalworking bloc appear from a comparison of tables 8, 9, and 10. Table 8 shows the interdependence of metalworking sectors for the United States in 1958. Table 9 shows the same kind of picture for the United States in 1947. Although we know that there were many dramatic changes in metalworking techniques used during the period 1947–1958, the over-all pictures are similar: the relative dependence of each of the sub-blocs on the others does not change substantially, and the importance of general intermediate metalworkers in the over-all picture remains about the same. This paradox of input-output coefficient stability in the face of known instances of changing techniques should not be surprising. New cutting techniques, for example, are introduced gradually, affecting only a very small portion of actual operation at first. Some qualitative changes in the design of components may not be discernible in terms of the present industry classification.

Table 9 describes the Japanese metalworking complex for 1960. While the basic industrial classification is different from that of the United States, it was possible

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[1] The specialization pattern observed in the United States input-output table for metalworking must be interpreted in the light of the conventions of the input-output accounting. The statistics are compiled for establishment units and classified in terms of the principal activity of each establishment. Common metalworking processes such as stamping, sheet-metal work, die making, wire work, etc., are actually performed within many product-specialized metalworking establishments, but are "transferred" hypothetically to the special-processing sectors in the input-output account. Furthermore, where several processing stages are integrated within an establishment, they may never appear as transactions at all. Thus, table 6 and the derived coefficients in table 7 do not tell us exactly how much stamping activity was actually performed in the United States economy, but only what stamping products were purchased or sold

Table

INPUT-OUTPUT FOR

Current account inter-industry

(Ten million

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Construction, urban and industrial	1																
Construction, rural	2																
Electrical equipment	3			2	1	2	2										
Transport equipment	4				7												
Non-electrical equipment	5	23	3	6	1	6	3	0			1				7		
Iron and steel	6	214	26	4	22	71	43										
Iron ore	7						5										
Cement	8	44	5														
Other metals	9			10	3	44	12			8							
Other minerals	10			0			7		6	5							
Plantations	11																
Leather and leather products	12			0							0		46				4
Animal husbandry	13												42		16		10
Food industries	14												2	55	48		6
Food grains	15													97	23	421	
Cotton and other textiles	16			0													18
Jute textiles	17			1	0		1		0			1	0		6	3	4
Other agriculture	18														772	3	300
Chemical fertilizers	19											6				15	
Glass, wooden, and non-metallic mineral products	20	280	35	2	1	1		0			0	3			1		6
Forestry products	21	61	8	1	11					0			9				
Motor transport	22																
Petroleum products/	23	14		1	2	1	2		0	0		0	1		5	12	7
Crude oil	24																
Rubber products	25			0	8	0											
Rubber	26																
Chemicals	27			3	4	5	6			0		2	12	19	7	4	34
Railways	28																
Electricity	29			2	3	4	6	0	3	1	1	0	1		6	6	22
Coal	30			0	0	3	11		6	0		1	0		3	0	6
Others	31			40	27	28	14	0	4	0	2	11	6		90	9	72
Intermediate sum	32	636	77	72	90	165	112	1	27	14	4	24	119	171	984	473	489
Value added	33	314	309	45	91	130	111	7	20	13	41	168	47	932	271	3489	277
Margin	34	251	31	9	20	50	47	0	7	4	1	3	23	27	67	13	34
Value of output	35	1201	416	126	201	344	269	8	53	32	45	196	189	1130	1323	3974	800

Note: Flows under 5 million rupees are represented by zero.

[a] Represents adjustment for exaggerated industrial consumption shown in table

[b] Inclusive of margin.

[c] Inclusive of "others."

[d] No interindustry transactions shown for rows 22 and 28. Subtotal for row 32 is therefore less than subtotal for column 31 by 443.0.

[e] Gross value added.

[f] Includes RS. 98.1 crores of taxes on petroleum products.

[g] Includes RS. 33.6 crores of taxes on petroleum products.

[h] 1090.5 C.I.F. value of imports, excluding RS. 33.6 crores of taxes on petroleum products.

[i] Petroleum products measured at market prices.

3

INDIAN ECONOMY, 1960–1961

transactions (1959–60 prices)

rupees)

17	18	19	20	21	22	23	24	25	26	27	28	29	30	Intermediate sum (cols. 1–30)	31	Others	32	Household consumption	33	Government consumption	34	Exports	35	Imports	36	Gross fixed capital formation	37	Stocks	38	Output	39
																133				104						378				1201	
																										416				416	
														6				33		17		1		57		124		2		126	
														7				39		46		1		69		173		5		201	
1			1			8		0		2			4	65				113		31		3		229		345		16		344	
														380		4						10		121				4		269	
														5								2						0		8	
			3											53								0		0				0		53	
										3				80		1						0		49				2		32	
			6							8				32		1						24		10						45	
								16						16				74				110		9				6		196	
														51		18		96				24		0				1		189	
										3				71				1057				21		19						1130	
										11				122				979		94		36		10				102		1321	
														541				3520						195				58		3974	
0			0					7		0				26				703		11		55		4				9		808	
3		1								2				30		5						94		0				2		130	
61	84									0				1220		172		761				49		125				19		2097	
	9													30		0								11				1		21	
			8							7				345				63				2		11				2		398	
			59							13				161		12						12		5						180	
														165		63		97												325	
0	6	0	10		104	0		0		3	23	3	0	195		12		81		27		4		83#						237	
						44								44										40						3	
					17			1						26		4		40				1		3				0		68	
								1						1										2				1		0	
3	2	4	26			1		4		63				200				179				10		111				6		234	
														278		87		89												454	
4	2	0	7			2		1		6	3		3	83		6		11		5								27		103	
1		1	6					0		3	32	14	7	95		4		6				2		1				2		109	
6		3	39	9	29	26	0	5		14	18	13	5	468						185*		7		11						15716	
78	104	10	167	9	150	81	0	35		137	75	29	19	4353#		530		7942		520		468		1091#		2082		231		15598	
49	1992	9	198	171	173	56	3	25		122	378	66	89	9594		3224				860												13678	
3	1	2	33		2	3		8		25	0	8	1	671				4663#				165				276					
130	2097	21	398	180	375	237	3	68		284	454	103	109	14715		530		12605		1380		633		1091		2278		231			

Table

INPUT-OUTPUT FOR

Current account inter-

(*Billion*

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Agriculture, Forestry and Fisheries	1	490	10	2	1541	339	332	46	0	1	50	58	5	2	2	1
Coal, Petroleum and Natural Gas	2	0	3	2	5	6	1	11		0	2	25	255	22	5	1
Metal and Other Mining	3	1		1	8		0	3	0		0	33	0	46	176	
Food Products and Tobacco	4	125			527	6	0	1	0	18		20		0		0
Textiles and Apparel	5	35	2	0	2	892	5	4	2	4	38	7	1	2	5	16
Wood Products and Furniture	6	7	2	0	15	5	90	16	1	0	0	21	2	2	6	23
Pulp, Paper, etc.	7	4	1	1	28	8	3	280	120	0	0	70	2	16	5	12
Printing and Publishing	8	1	2	1	4	7	1	20	6	0	0	5	1	2	10	13
Leather Products	9	0			1	18	0	0	0	8		0			0	2
Rubber Products	10	2		0	0	7	1	0	0	0	5	1		0	4	26
Chemicals	11	149	4	3	85	248	21	19	15	2	26	468	7	11	26	36
Petroleum and Coal Products	12	41	1	3	19	10	3	7	0	0	5	55	19	24	125	20
Ceramic, Stone, and Clay Products	13	4	0	0	38	0	1	1	0	0	2	8	0	44	27	29
Primary Metals	14	8	5	2	25	11	32	2	2	2	1	22	5	15	2186	680
Machinery, except Transportation Equip.	15	21	6	3	3	13	3	3	4	0	2	13	5	3	40	818
Transportation Equipment	16	14	1	0	1	0	1					0	0	1	2	12
Precision Instruments	17	0	0	0	0	1	0	0	1	0	0	0	0	0	1	23
Miscellaneous Manufacturing	18	7	0	0	8	4	3	0	1	2	3	1	1	0	1	39
Construction	19	16	2	5	12	5	3	1	1	1	1	8	2	5	10	8
Electricity and Gas	20	6	17	6	17	24	6	33	2	0	3	53	3	23	66	25
Trade	21	34	4	3	145	88	30	20	11	3	11	57	8	27	71	68
Real Estate	22	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Transportation and Communication	23	26	5	5	64	31	19	21	20	1	4	48	15	34	67	66
Services	24	28	6	3	48	31	11	9	12	1	3	52	5	12	31	59
Undistributed	25	21	6	12	114	41	11	10	19	1	6	54	34	13	90	118
Intermediate Total	26	1036	80	52	2710	1795	577	507	216	45	162	1080	368	309	2953	2096
Business Consumption	27	7	7	6	33	20	13	5	15	0	3	22	6	7	29	52
Wages and Salaries	28	224	107	56	182	251	100	67	88	6	35	149	16	91	318	399
Profit	29	1615	10	32	176	184	56	59	59	4	36	139	100	91	385	401
Depreciation	30	210	21	13	47	47	11	24	8	1	5	91	21	22	100	69
Indirect Taxes	31	48	6	4	510	12	7	4	2	0	1	20	123	7	13	50
Subsidies	32	1	0	0	29							0				
Value Added	33	2103	150	111	919	515	188	159	173	12	80	451	266	219	845	972
Total Production	34	3138	230	163	3629	2310	764	666	389	56	242	1531	634	523	3798	3067

Note: Flows under 500 million yen are represented by zero.

to subdivide the complex into roughly the same general bloc categories used in tables 8 and 9. Note the resemblances between the specialization patterns of the two countries: the relative paucity of above diagonal entries, the relative self-sufficiency of blocs and the prominence of general intermediate metalworking sectors. These latter seem to be less important in Japan than in the United States, while transactions among establishments within each sector seem to be relatively large. It is not clear whether this difference represents real differences in specialization patterns of Japanese and United States establishments or differences in accounting conventions. (Perhaps the Japanese count plants making wire products for household machines in the household machinery rather than the wire products industry.)

General intermediate metalworkers sell the bulk of their output as current inputs. They furnish parts and components to other metalworking sectors. Products of the later stages of metalworking, the so-called "final metalworking" products, are delivered to both metalworking and non-metalworking sectors on capital account: they become part of the stocks of durable goods essential for modern industrial technology. Referring back to the national input-output table, table 1 or table 6, we note that transactions between metalworkers and other industrial sectors are really very small. Metal-

4

JAPANESE ECONOMY, 1960

industry transactions

of yen)

16	17	18	19	20	21	22	23	24	25	Intermediate total	Non-household consump. expend.	Private consump. expend	Gov't expend. on current account	Domestic fixed capital formation	Net inventory increase	Exports	Subtotal (cols. 27-32)	Imports	Tariffs	Total outputs
26											27	28	29	30	31	32	33	34	35	36
1	5	13	26	0	1	0	0	7	24	2949	29	556	1	14	100	61	761	567	5	3138
1	0	0	0	88			15	7	2	450		10	2		6	0	6	218	7	230
		2	51	1					3	324		3			5	1	8	169	0	163
	0	2			2			2	24	725	372	2556		86	61	3075	61	118	53	3629
6	5	3	33	1	21	0	12	17	101	1212	24	647	5	3	67	364	1109	10	1	2310
15	1	15	380	1	22	0	2	18	3	645	6	50	2	20	8	37	123	4	0	764
3	4	15	12	0	31	0	3	15	18	650	2	8	3		14	17	28	12	0	666
1	0	1	6	1	31	0	11	128	0	235	2	113	15		5	3	138	4	0	389
1	3	3	0					0	1	37		15	0		2	4	21	1	0	56
95	1	0	4	0	0		1	6	11	163	1	35	1		13	31	80	1	0	242
16	5	92	25	0	1		2	93	41	1394	41	122	7		37	61	269	119	13	1531
5	2	4	53	13	50	0	122	21	26	629	0	33	18		22	13	85	77	3	634
10	2	1	293	1	1	0	0	5	11	477	2	10	0		14	46	52	5	0	523
168	23	20	524	4	13		2	8	57	3816	4	15	2	78	51	189	183	195	6	3798
256	9	1	244	32	1	0	7	12	46	1541	10	178	11	1143	149	155	1645	109	10	3067
203			45	0	33	0	123	3	25	466		71	43	597	36	178	924	26	2	1362
4	32	0	8	1	3	0	1	35	4	113	0	47	1	28	12	31	119	14	2	217
8	2	5	30	0	3	0	1	20	25	165	3	87	1	5	12	81	188	3	1	349
5	1	1	3	25	31	79	16	56	0	293			6	2877		6	2889	0		3182
13	1	3	6	5	23	1	24	57	6	422		157	7		0	4	169	1		590
36	6	16	155	9	39	0	29	78	23	971	102	1099	13	158	23	136	1532	14		2489
0	0	0	1	0	7	0	2	8		23		596					596			619
24	5	8	132	23	104	0	76	114	99	1010	10	486	51	13	7	145	713	81		1804
26	9	12	49	4	166	8	32	283	107	1007	277	1600	1471			5	3353	5	1	4354
47	10	15	99	12		5	100	83	0	918		1	11		22	90	102	55	6	959
940	126	230	2177	220	577	93	580	1073	659	20654	885	8456	1649	4780	678	1719	18166	1696	110	37064
15	5	6	40	12	200	1	45	191	146	885										
207	40	43	455	92	689	3	627	1766		6010										
125	30	55	477	62	793	294	242	960	71	6457										
42	5	5	56	125	149	161	283	277		1793										
32	11	9	7	80	82	68	26	88	87	1299										
							0		3	34										
422	91	118	1005	370	1912	526	1224	3281	300	16910										
1362	217	349	3182	590	2489	619	1804	4354	959	37069										

workers supply important inputs only to other metalworkers, and changes in final demand for sectors other than metalworking have very little direct or indirect impact on metalworking sectors. The characteristic dependence of all sectors on the metalworking complex becomes apparent only when the capital account is considered.

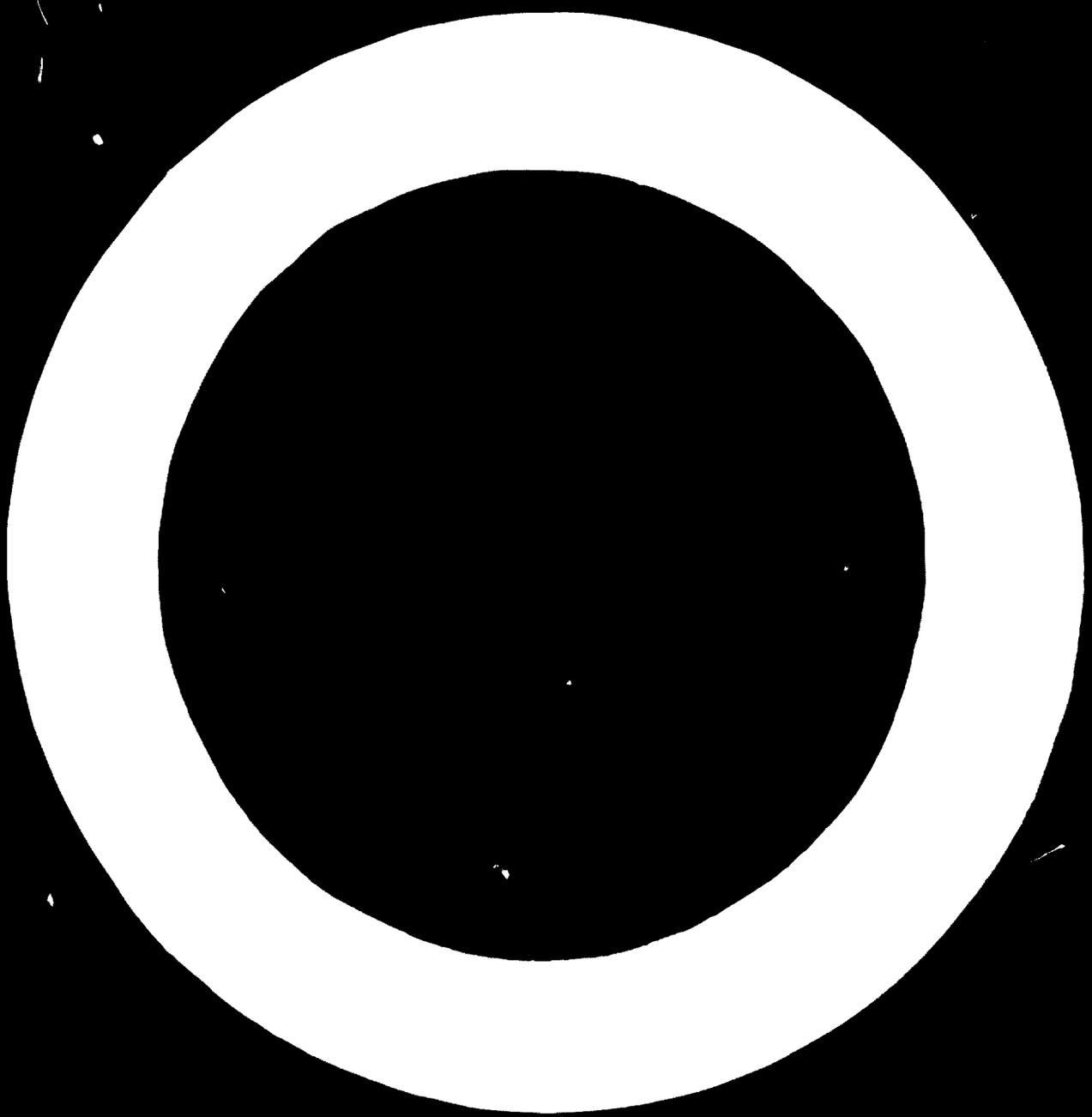
REDUCED INPUT-OUTPUT TABLES

Being interested primarily in metal products, we should like to ignore all the other sectors of the economy except in so far as they contribute to, and in turn depend upon the growth of the metalworking complex in the framework of an over-all developmental plan. We shall now introduce an analytical device that will permit us to centre all attention on a selected group of industries, in this case, the metalworking complex, with the assurance that the requirements of all the other sectors of the economy are automatically taken into account. In order to explain the practical meaning of the analytical transformation that leads to the construction of what we call the reduced input-output matrix of a national economy, we will ask you to visualize a situation in which, for trading purposes, all industries of a country have been divided in two groups. The industries belonging to

Table 5. INVERSE COEFFICIENTS

FINAL NONMETAL · FINAL METAL · BASIC METAL · BASIC NONMETAL · ENERGY · SERVICES

Inverse coefficient table shows direct and indirect relations between the eighty-one sectors of the 1958 United States economy. Each sector delivers a certain amount of its output to what is called "final demand." (The final demand totals appear in table IV.) 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 [illegible] its total output.



group I are "contracting" industries, those in group II are identified as "subcontracting" industries.

Each contracting industry covers its direct input needs for the products of other group I industries by direct purchases and each group II industry makes direct purchases from other group II industries. However, the products of group II industries delivered to group I industries are manufactured on the basis of special work contracts. Under such a contract, the group I industry placing an order with a group II industry provides the latter with its own products and also the products of all other group I industries, in amounts required to fill the particular order. To be able to do so, it must, of course, first purchase all these goods, from group I industries that manufacture them, on its own account. The relationship between a contracting, group I, and a subcontracting, group II, industry is thus analogous to the relationship between a tailor and his customer who buys the cloth himself and then brings it to the tailor to be made into a suit.

In planning its purchases from other sectors, each group I industry has, under these conditions, to take into account not only its own immediate input requirements but also the input requirements of the group II industries to which it will have to deliver correct amounts of the products of various group I industries (including, frequently, its own) to be processed under contract. For planning purposes, a group I industry might as well account for the amounts of the product of group I industries that it will have to supply to the group II industries working for it, as if they were elements of its own input structure. That is exactly what is being done in constructing a reduced input-output table.

The relationship of the reduced table to the original table from which it is derived is similar to the relationship of an abbreviated train timetable to the complete, detailed timetable which also lists the intermediate stations. The subdivision of all the sectors of an economy into groups I and II must, of course, depend on the specific purpose of the proposed analysis.

Using a reduced table for planning purposes, we can be sure that if the input-output flows among the group I industries shown in it are properly balanced, the balance between the outputs and inputs of all the other industries omitted from it will also be secured, at least with respect to the supply and demand for commodities and services classified in group I.

In the process of consolidation, the technical details of which we will not describe here, the labour and the capital coefficients of each of the selected principal industries can also be transformed, that is, recomputed, in such a way that these coefficients will reflect not only its own labour and capital requirements, but also the capital and labour requirements of all the group II industries which deliver their products to it. It is as if, under the imaginary contracts described above, each group I industry provided the group II industries working for it, not only with the inputs coming from all the different group I sectors, but also with all the capital and labour employed by the group II industries in filling their contractual orders. Thus, the output levels of all the primary industries as projected on the basis of reduced input-output table will, if multiplied with the appropriate consolidated capital and labour coefficients, account not only for the capital and labour requirements of these group I industries, but also for those of all the group II industries without whose support these output levels could not be attained.

Table 11 is a reduced coefficient table derived from table 7. All the metalworking industries, construction, and ferrous metals are included in group I, and all other industries are considered to be in group II. Thus, while table 7 has thirty-eight endogenous sectors, table 11 has only twenty-seven. All of the coefficients in the twenty-seven-order reduced table are equal to or greater than the corresponding coefficients in the original thirty-eight-order table. For example, the coefficient showing ferrous metal inputs into construction and mining equipment (row 27, column 13) is .15 in the original table and .16 in the reduced table. This is because the reduced table's coefficient includes both iron and steel used directly to make construction and mining equipment and iron and steel used directly and indirectly to make the products which construction machinery manufacturers purchase from group II industries: pit props for coal mines, steel sheet for metal containers used to package paint, repair parts for rubber and plastics producers' machinery used in the production of plastic parts and tyres, etc. The last five rows of both tables show labour (subdivided by skill types) and total capital requirements on the original and the reduced form basis respectively. Total capital requirements for farm equipment in table 11 include not only capital goods used directly in making farm equipment, but also capital requirements for making paints used in manufacturing farm equipment.

The reader will note that the differences between corresponding "input coefficients" in tables 11 and 7 are very small indeed. Most of the differences between corresponding entries were small enough to disappear when the coefficients were rounded to two decimal places. On the other hand, differences between corresponding labour and capital coefficients in the original and reduced tables are sizeable. This feature brings out, once again, the unique position of metalworking industries in relation to the rest of the economy. As was pointed out before, metalworkers furnish only a very small proportion of their products to non-metalworkers on current account. Thus, as members of group I, they are not required to contribute appreciable amounts of metalworking products to their subcontracting suppliers in group II. Direct purchases by metalworkers from other metalworkers account for most of all current account metalworking product requirements in the reduced table. Metalworkers do have to supply relatively large amounts to group II industries on capital account, if the latter are to be able to furnish requisite non-metalworking inputs to group I industries, but this is a quite different matter that will be taken up in the context of dynamic input-output analysis. Similarly, under this new system of accounting, metalworking sectors are called upon to supply labour not only for their own production but also for the production of all their inputs from group II

Table

THIRTY-EIGHT SECTOR INPUT-OUTPUT

Current account inter-

(*Millions of*

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Aircraft and parts	1	2414	17	9	15	15	1	52	1	.		2	9	2	5	22	5	.	56	6
Ships, trains, trailers, and cycles	2	3	251	20		1	7	1	.	.		4	8	15	5	20	5	1	5	26
Motor vehicles and equipment	3	81	50	6795		28	8	1	53	.		10	7	45	41	56	6		51	8
Office and computing machines	4	6			193			7	1		13	1	4	1			1	1	46	3
Service industry machines	5	8	9	29		106	104	4	.	2	.	2	12	2	1	.	1		6	2
Household appliances	6	28	19			143	39	2	4	1	2		3	1	9	.	.		2	3
Radio, television, and communication equipment	7	344	6	119	21	7	1	330	7	5	90	.	23	2	.	.	1	7	38	52
Batteries, x-ray, and engine electrical equipment	8	46	5	352	1	.	1	2	57	67	2	2	1	5	19	39	3	6	3	11
Electric lighting and wiring equipment	9	16	13	96	9	15	28	69	57	92	21	3	1	3	2	1	1	6	12	86
Electronic components and accessories	10	76	.	18	92	.	.	1088	21	8	162	.	7	1			.	.	102	140
Materials handling machinery and equipment	11	5	16	5	.	3		.		.		41	12	17	1	3	1		.	2
Special industry machinery and equipment	12	6	1	6	12	6	.	2	.	.	1	5	125	6	7	3	10	2	6	6
Construction, mining, and oil-field machinery	13	2	20	10	.	1	1	1	2	1	2	54	19	173	31	61	5	.	2	6
Farm machinery and equip	14	2	19	24	.	1	.		1	1		5	7	54	92	30	1		1	1
Engines and turbines	15	20	114	87		4			2			15	1	80	120	202	8		.	81
Machine shop products	16	126	13	147	5	2	4	6	12	4	3	17	10	14	37	66	107	1	26	9
Optical, ophthalmic and photographic equipment	17	26	.	1	.	.	5	14	1	.	1	.	5	.	.	.	.	86	20	3
Scientific, controlling instruments and clocks	18	197	5	100	8	29	109	33	6	6	13	1	4	2	3	2	2	22	202	67
Electrical apparatus and motors	19	43	125	50	52	200	149	100	36	78	88	53	97	35	15	38	8	21	120	341
Metalworking machinery and equipment	20	246	19	257	21	7	28	28	22	13	15	17	58	52	44	37	29	7	43	59
General industrial machinery and equipment	21	138	58	130	14	35	39	8	26	3	3	73	139	176	140	71	15		20	45
Hardware, plating, valves, and wire products	22	131	79	823	13	59	119	72	7	40	36	23	42	40	17	6	33	16	57	43
Stamping, screw machine products and bolts	23	245	18	709	25	79	193	112	37	63	62	19	32	32	80	49	8	9	63	76
Heating, plumbing, and structural metal products	24	8	171	23	.	52	57	4	.	5	1	13	27	49	6	3	3		4	15
Automotive repair services	25	2	3	8	1	2	1	1	1	1	.	1	4	3	3	1	2	1	1	3
New and maintenance construction; glass, stone and clay products	26	72	51	370	8	22	37	55	16	82	105	5	14	19	16	16	34	47	24	51
Primary iron and steel mining and manufacturing	27	405	442	2005	49	154	275	56	47	155	54	117	224	975	367	224	127	9	67	299
Primary nonferrous metal mining and manufacturing	28	360	68	261	42	114	153	117	164	122	119	13	112	22	19	72	123	42	141	369
Miscellaneous manufacturing and service sectors	29	90	60	134	59	29	41	129	23	45	67	45	49	39	32	32	22	20	106	123
Chemicals, plastics, rubber, drugs, and prints	30	119	101	829	30	55	166	112	113	102	70	24	41	57	97	16	4	108	69	107
Lumber and wood products; paper and paper products	31	68	141	138	29	51	70	219	13	50	62	3	23	11	19	17	.	62	66	73
Textiles and leather goods	32	19	12	310	2	2	17	7	2	3	4	3	9	3	5	3	5	3	51	8
Food, tobacco and metal containers	33											.	1	.	3				24	
Coal, petroleum and utilities	34	102	43	171	11	19	27	25	12	16	24	8	28	34	26	20	29	12	18	53
Radio and television broadcasting; communications	35	56	10	47	9	8	15	20	5	6	8	4	24	10	6	6	11	5	16	21
Transportation and warehousing	36	112	65	426	18	34	57	69	20	31	28	13	28	44	40	27	15	22	34	61
Wholesale and retail trade	37	229	178	688	107	122	151	211	52	144	145	46	97	109	100	59	49	55	133	155
Other business and personal services	38	177	78	774	91	73	345	209	54	67	103	37	79	87	100	65	58	124	113	131
Totals		6028	2282	15972	938	1477	2247	3167	875	1211	1300	678	1386	1719	1509	1265	733	695	1748	2544

Note: Flows less than .5 million are represented by dots; components may not add to total because of rounding.

6

FOR UNITED STATES ECONOMY, 1958

industry transactions only

dollars)

20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	Final demand	Gross domestic output
20	63	5	6	12		1	1	.	32	18	19	2	7	.		163	68	1561	1435	12693
1	19	5	1	57	10	3	18	6	15	2	9	.	23	13	5	303	13	70	2778	3723
173	24	32	98	32	1131	9	37	15	140	2	6	1	58	16		88	208	209	13318	22836
.	.	1	2	3			1		34	7	10	.		8		2	14	301	1321	2217
7	33	9	7	67		219	2	2	12	3	15	.	.			2	35	149	1401	2249
7		13	9	54		266	2	4	36	4	5		5				24	279	2630	3594
.	7	2	1	1		59	1	8	137	6	8			8	157	18	64	405	4079	6008
.	4	2	1	.	118	20	.	50	8	2	1	.	32	2	4	73	49	48	496	1534
2	4	15	15	17	33	951	10	56	16	14	30	6	26	8		7	13	83	443	2287
.	1	5	3	8		4		2	11	2	2	2		11	5	25	10	387	454	2649
9	29	7	1	8		281	2	1	4	9	6	.		11		14	13	8	575	1081
31	25	16	2	29		6	24	2	32	136	102	65		9			28	15	1784	2509
7	28	19	1	24		268	39	29	10	15	1			139			28	29	2057	3084
6	8	7	4	14		3	27	.	11	1	1	1	20	.			18	154	1745	2439
7	48	7	6	32		2	3	1	3	.			.	17		81	11	155	1094	2200
22	22	19	14	33	105	8	144	34	47	24	8	1	10	2		7	22	11	438	1587
.	1	1	2	1		1	2	1	23	18	53	3	.	.	.	.	36	930	805	1542
3	23	21	7	71	16	213	5	4	55	39	14	15	1	2	.	26	42	447	1683	3498
99	193	25	15	91	6	514	85	40	39	24	12	1	10.	52	.	31	23	182	2012	5103
207	67	171	42	44	1	14	129	73	14	19	20	4	40	15	.	23	15	156	1575	3629
118	257	54	3	92		303	60	34	23	14	23	3	16	86		14	29	12	1468	3744
75	72	248	98	253	114	1021	336	109	126	187	461	59	180	411	3	41	63	54	875	6440
97	42	129	100	155		131	126	94	121	58	72	5	225	23		15	44	28	311	3686
14	69	57	29	150		6080	49	3	34	7	33	1	10	10		1	98	24	925	2035
2	3	6	3	17	133	313	7	6	8	27	101	15	395	59	17	821	826	479	4639	7913
35	48	52	35	89	245	7126	484	63	60	371	365	62	1561	716	301	1259	1005	6978	58387	80285
277	400	1262	739	1920		2562	5181	205	308	305	240	6	921	89		38	7	30	141	19900
106	106	439	241	587		1177	368	4021	328	251	88	5	64	37	23	49	16	51	170	10220
70	63	109	59	115	107	673	683	486	458	723	802	724	2256	331	185	769	2060	2793	367	13944
21	27	128	72	57	342	2433	324	294	466	7204	1329	2168	2232	775	8	345	484	1487	8041	29159
7	26	148	78	99	14	5136	123	56	1662	925	11660	462	1846	157	130	144	1222	6812	6690	38513
4	7	21	7	13	36	29	18	29	340	690	419	13168	261	11	14	45	144	658	16295	32675
1	.	5	13	3		264	7	1	2246	728	1117	18025	2254	133		138	693	2451	89750	121535
41	37	78	58	94	189	2074	1152	310	54	1398	671	267	1849	16653	81	1692	2648	2284	17176	49587
30	34	18	9	32	55	162	70	30	29	108	295	84	298	75	148	271	1012	3084	4760	10841
28	49	86	57	193	74	2618	1007	214	2725	834	1174	502	3495	1313	19	2106	396	971	19332	33290
102	170	219	108	290	671	6702	701	338	675	916	1458	1133	4912	608	67	1004	1582	2767	69498	95250
139	102	189	103	225	679	3827	538	265	1354	2048	1881	965	6460	2998	834	2279	11799	20014	130035	189549
1768	2106	3627	2047	4932	4079	45472	11768	6888	11699	17138	22961	21532	79153	24797	1993	11896	24898	56264	970327	892828

Table

THIRTY-EIGHT SECTOR INPUT-OUTPUT

(*Dollars per*

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
Aircraft and parts	1	.19	.	.	.01	.01	.	.01	.	.		.	.	.	.
Ships, trains, trailers, and cycles	2	.	.07	.		.	.	.	.	.		.	.	.	.
Motor vehicles and equipment	3	.01	.01	.30	.	.01	.	.	.03	.		.01	.	.01	.02
Office and computing machines	4	.			.09	.	.	.	.	.	.	.	.	.	
Service industry machines	5	.	.	.	.	.05	.03	.	.	.	.	.	.	.	.
Household appliances	6	.	.01			.06	.01	.	.	.	.	.	.	.	.
Radio, television, and communication equipment	7	.03	.	.01	.01	.	.	.05	.	.	.03	.	.01	.	.
Batteries, x-ray, and engine electrical equipment	8	.	.	.02	.	.	.	.	.04	.03	.	.	.	.	.01
Electric lighting and wiring equipment	9	.	.	.	.	.01	.01	.01	.04	.04	.01	.	.	.	.
Electronic components and accessories	10	.01	.	.	.04	.	.	.18	.01	.	.06	.	.	.	
Materials handling machinery and equipment	11	.	.	.	.	.		.		.		.04	.	.01	.
Special industry machinery and equipment	12	.	.	.	.01	.	.	.	.	.	.	.	.05	.	.
Construction, mining, and oil-field machinery	13	.	.01	.	.	.	.	.	.	.	.	.05	.01	.06	.01
Farm machinery and equipment	14	.	.01	.	.	.	.		.	.		.	.	.02	.04
Engines and turbines	15	.	.03	.		.			.			.01	.	.03	.05
Machine shop products	16	.01	.	.01	.	.	.	.	.01	.	.	.02	.	.	.02
Optical, ophthalmic, and photographic equipment	17	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Scientific, controlling instruments, and clocks	18	.02	.	.	.	.01	.03	.01	.	.	.	.	.	.	.
Electrical apparatus and motors	19	.	.03	.	.02	.09	.04	.02	.02	.03	.03	.05	.04	.01	.01
Metalworking machinery and equipment	20	.02	.01	.01	.01	.	.01	.	.01	.01	.01	.02	.02	.02	.02
General industrial machinery and equipment	21	.01	.02	.01	.01	.02	.01	.	.02	.	.	.07	.06	.06	.06
Hardware, plating, valves, and wire products	22	.01	.02	.04	.01	.03	.03	.01	.	.02	.01	.02	.02	.01	.01
Stampings, screw machine products, and bolts	23	.02	.	.03	01	.04	.05	.02	.02	.03	.02	.02	.01	.01	.03
Heating, plumbing, and structural metal products	24		.05	.	.	.02	.02	.	.	.	.	.01	.01	.02	.
Automotive repair services	25	.	.	.	.	.	.	.	.	.	.	.	.	.	.
New and maintenance construction, glass, stone, and clay products	26	.01	.01	.02	.	.01	.01	.01	.01	.04	.04	.	.01	.01	.01
Primary iron and steel mining and manufacturing	27	.03	.12	.09	.02	.07	.08	.01	.03	.07	.02	.11	.09	.15	.15
Primary nonferrous metal mining and manufacturing	28	.03	.02	.01	.02	.05	.04	.02	.11	.05	.04	.01	.04	.01	.01
Miscellaneous manufacturing and service sectors	29	.01	.02	.01	.03	.01	.01	.02	.02	.02	.03	.04	.02	.01	.01
Chemicals, plastics, rubber, drugs, and paints	30	.01	.03	.04	.01	.02	.05	.02	.07	.04	.03	.02	.02	.02	.04
Lumber and wood products; paper and paper products	31	.01	.04	.01	.01	.02	.02	.04	.01	.02	.02	.	.01	.	.01
Textiles and leather goods	32	.	.	.01	.	.	.	.	.	.	.	.	.	.	.
Food, tobacco and metal containers	33														
Coal, petroleum and utilities	34	.01	.01	.01	.	.01	.01	.	.01	.01	.01	.01	.01	.01	.01
Radio and television broadcasting; communications	35	.	.	.	.	.	.	.	.	.	.	.	.01	.	.
Transportation and warehousing	36	.01	.02	.02	.01	.01	.02	.01	.01	.01	.01	.01	.01	.01	.02
Wholesale and retail trade	37	.02	.05	.03	.05	.05	.04	.04	.03	.06	.05	.04	.04	.04	.04
Other business and personal services	38	.01	.02	.03	.04	.03	.10	.03	.04	.03	.04	.03	.03	.03	.04
Total capital	A	0.3	0.4	0.2	0.7	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.6	0.4	0.4
Professional, technical and clinical workers,	B	21.1	13.7	5.6	17.9	11.9	12.1	20.4	19.3	15.5	20.7	16.8	19.3	14.0	14.0
Skilled workers	C	21.5	24.4	6.0	18.7	12.4	12.4	12.3	11.7	11.2	12.5	17.5	20.1	14.6	14.5
Semi-skilled and unskilled workers	D	19.2	20.0	14.9	23.4	15.7	16.7	33.9	32.2	27.0	63.4	22.0	25.2	18.4	18.3
Total labour	E	61.8	58.6	26.4	60.0	40.0	41.2	66.6	63.2	53.8	67.6	56.4	64.6	47.0	46.7

Note: Coefficients less than .005 are represented by dots; components may not add to total because of rounding. Labour rows B–E are man years per thousand dollars of output.

COEFFICIENTS FOR UNITED STATES ECONOMY, 1958

(dollar)

15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
.01	.	.	.02	.	.01	.02	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.01
.01	.	.	.	.01	.	.01	.	.	.01	.	.	.	.	.	.	.	.	.	.	.	.01	.	.
.03	.		.01	.	.05	.01	.	.03	.	.14	.	.	.	.01	.	.	.	.	.	.	.	.	.
	.	.	.01	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	.		.	.	.	.01	.	.	.01	.	.	.	.	.	.	.	.	.	.	.	.	.	.
.	.		.	.	.		.	.	.01	.	.	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.01	.01	.	.	.	.	.	.	.	.		.01	.	.	.	.	.	.01	.	.	.
.02	.	.	.	.	.	.	.	.	.	.01	.	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.02	.	.	.	.	.	.	.01	.	.01	.	.	.	.	.	.	.	.	.	.
	.	.	.03	.03	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.
.	.		.	.	.	.01	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.
.	.01	.	.	.	.01	.01	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.
.03	.	.	.	.	.	.01	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.
.01	.		.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.
.09	.01		.	.02	.	.01	.	.	.		.	.		.	.	.	.	.	.	.	.	.	.
.03	.07	.	.01	.	.01	.01	.	.	.	.01	.	.01	.	.	.	.	.	.	.	.	.	.	.
	.	.06	.01			.	.	.	.		.	.	.	.	.	.	.					.	.
.	.	.01	.06	.01	.	.01	.	.	.01	.	.	.	.	.	.	.	.	.	.	.	.	.	.
.02	.	.01	.03	.07	.03	.05	.	.	.01	.	.01	.	.	.	.	.	.	.	.	.	.	.	.
.02	.02		.01	.01	.04	.02	.03	.01	.01	.		.01	.01	.	.	.	.	.	.	.	.	.	.
.03	.01		.01	.01	.03	.07	.01		.01		.	.	.	.	.	.	.	.	.	.	.	.	.
	.02	.01	.02	.01	.02	.02	.04	.03	.03	.01	.01	.02	.01	.01	.01	.01	.	.	.01	.	.	.	.
.02	.01	.01	.02	.01	.03	.01	.02	.03	.02			.01	.01	.01		.	.	.	.	.	.	.	.
						.02	.01	.01	.02		.08						.	.	.	.	.02	.01	
										.02													
.01	.02	.03	.01	.01	.01	.01	.01	.01	.01	.03	.09	.02	.01		.01	.01		.01	.01	.03	.04	.01	.04
.10	.08	.01	.02	.06	.08	.11	.20	.20	.24		.03	.26	.02	.02	.01	.01		.01					
.03	.08	.03	.04	.07	.03	.03	.07	.07	.07		.01	.02	.39	.02	.01								
.01	.01	.01	.03	.02	.02	.02	.02	.02	.01	.01	.01	.03	.05	.03	.02	.02	.02	.02	.01	.02	.02	.02	.01
.01	.	.07	.02	.02	.01	.01	.02	.02	.01	.04	.03	.02	.03	.03	.24	.03	.07	.02	.02		.01	.04	.01
.01	.	.04	.02	.01	.	.01	.02	.02	.01		.06	.01	.01	.12	.03	.30	.01	.02		.01		.01	.04
	.	.	.01	.										.02	.02	.01	.40						
			.01											.16	.02	.03	.06	.43				.01	.01
.01	.02	.01	.01	.01	.01	.02	.01	.02	.01	.02	.03	.06	.03		.05	.02	.01	.02	.34	.01	.05	.03	.01
	.01				.01	.01				.01						.01				.01	.01	.01	.02
.01	.01	.01	.01	.01	.01	.01	.01	.02	.02	.01	.03	.05	.02	.20	.03	.03	.02	.03	.03		.06		.01
.03	.03	.04	.04	.03	.03	.05	.03	.03	.04	.08	.08	.04	.03	.05	.03	.04	.03	.04	.01	.01	.03	.02	.01
.03	.04	.08	.03	.03	.04	.03	.03	.03	.03	.09	.05	.03	.03	.10	.07	.05	.03	.05	.06	.08	.07	.12	.11
0.4	0.6	0.6	0.3	0.4	0.6	0.5	0.5	0.5	0.4	1.1	0.5	0.5	0.6	0.6	0.8	0.6	0.9	0.5	2.0	1.9	0.2	0.4	0.1
12.2	27.3	20.3	19.1	18.2	19.6	16.4	14.4	17.9	14.0	21.8	1.7	8.7	8.4	8.2	14.0	19.8	11.1	7.1	7.3	57.0	25.0	105.1	49.5
12.7	28.4	12.1	11.6	11.0	20.4	19.1	13.8	16.6	13.0	70.1	1.4	13.0	8.1	4.9	5.8	14.4	5.6	8.0	6.3	16.9	15.4	8.0	3.5
16.0	35.7	34.4	32.8	30.3	25.6	21.5	24.8	33.6	26.2	15.3	5.3	22.8	19.3	14.1	18.4	30.8	59.3	57.3	9.1	2.3	39.7	21.7	6.1
40.9	91.4	66.8	63.5	59.6	65.6	55.0	52.9	68.1	53.1	107.2	8.9	44.5	35.8	27.2	38.2	65.0	76.0	67.9	27.7	76.2	80.1	135.4	59.1

Table 8

INTERNAL STRUCTURE OF METALWORKING: UNITED STATES, 1958

Input-output coefficients excluding secondary transfers

(Dollars per dollar)

			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Transportation Equipment	Aircraft and parts	1	.19																								
	Ships, trains, trailers and cycles	2		.07																							
	Motor vehicles and equipment	3		.01	.30											.01											.14
Electrical Equipment	Office and computing machines	4				.09														.01							
	Service industry machines	5					.05	.02																			
	Household appliances	6		.01				.01																			
	Radio, television and communication equipment	7	.02						.05																		
	Batteries, x-ray and engine electrical equipment	8			.01					.04	.02					.01	.02										.01
	Electric lighting and wiring equipment	9					.01	.01	.01	.02	.04										.01						
	Electronic components and accessories	10	.01			.04			.17	.01		.06								.03	.02						
Non-Electrical Equipment	Materials handling machinery and equipment	11											.04														
	Special industry machinery and equipment	12												.05													
	Construction, mining, and oil-field machinery	13													.06												
	Farm machinery and equipment	14														.04											
	Engines and turbines	15		.03									.01		.01	.05	.09										
	Machine shop products	16	.01		.01								.01			.01	.03	.07		.01							.01
Instruments	Optical, ophthalmic and photographic equipment	17																	.06								
	Scientific, controlling instruments and clocks	18	.01				.01	.03												.06						.01	
General Metalworking	Electrical apparatus and motors	19		.03		.02	.09	.04	.01	.01	.02		.05	.03	.01	.01	.01		.01	.02	.07	.02	.04			.01	
	Metalworking machinery and equipment	20	.02		.01	.01		.01		.01	.01	.01	.01	.01	.01	.02	.02	.01		.01	.01	.06	.01	.02	.01		
	General industrial machinery and equipment	21	.01	.01		.01	.01	.01		.02			.05	.04	.05	.06	.02				.01	.03	.07			.01	
	Hardware, plating, valves and wire products	22	.01	.02	.04	.01	.02	.03	.01		.02	.01	.01	.01	.01			.01	.01	.01	.01		.01	.04	.02	.03	.01
	Stampings, screw machine products and bolts	23	.02		.03	.01	.03	.05	.02	.02	.03	.02	.01	.01	.01	.03	.02		.01	.02	.01	.01	.01	.01	.03	.01	
	Heating, plumbing and structural metal products	24		.04									.01	.01	.01								.01			.02	
	Automotive repair services	25																									

Note: Coefficients less than .005 are excluded.

Note: Coefficients less than .005 are excluded.

Table 9

INTERNAL STRUCTURE OF METALWORKING: UNITED STATES, 1947

Input-output coefficients excluding secondary transfers

(Dollars per dollar)

			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Transportation Equipment	Aircraft and parts	1	.11																								
	Ships, trains, trailers and cycles	2		.08																							
	Motor vehicles and equipment	3		.01	.26																						.19
Electrical Equipment	Office and computing machines	4				.03																					
	Service industry machines	5					.06	.02																			
	Household appliances	6					.03	.03																			
	Radio, television and communication equipment	7							.13			.07															
	Batteries, x-ray and engine electrical equipment	8			.01					.02	.01		.01	.01			.02										.03
	Electric lighting and wiring equipment	9							.01		.06	.20							.01								.01
	Electronic components and accessories	10							.06			.06															
Non-Electrical Equipment	Materials handling machinery and equipment	11											.03														
	Special industry machinery and equipment	12												.03													
	Construction, mining and oil-field machinery	13													.02	.01											
	Farm machinery and equipment	14													.01	.05											
	Engines and turbines	15		.04									.02		.05	.08	.05				.01		.01				
	Machine shop products	16		.03				.01							.01		.01	.01									.02
Instruments	Optical, ophthalmic and photographic equipment	17																	.07								
	Scientific, controlling instruments and clocks	18	.01				.01	.01												.09						.01	
General Metalworking	Electrical apparatus and motors	19		.03		.01	.09	.07	.01	.01	.02	.01	.05	.03	.02		.01		.01	.01	.05	.02	.03			.02	
	Metalworking machinery and equipment	20	.01		.03	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01		.01	.01	.05	.01	.02	.01	.01	
	General industrial machinery and equipment	21	.01		.01		.01	.01		.01			.03	.03	.03	.03	.04	.01		.01	.01	.02	.04			.01	.01
	Hardware, plating, valves and wire products	22	.01	.02	.02	.02	.03	.03	.01	.01	.02	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.03	.02	.03	.02
	Stampings, screw machine products and bolts	23	.02	.01	.04	.02	.06	.08	.03	.02	.05	.03	.02	.02	.02	.04	.03	.01	.04	.03	.02	.01	.01	.03	.01	.04	
	Heating, plumbing and structural metal products	24		.02																			.01			.03	
	Automotive repair services	25																									

Note: Coefficients less than .005 are excluded.

industries. Comparison of the last rows in tables 11 and 7 shows that these amounts are far from trivial.

The transformation of the original input-output table to reduced form also requires, of course, an appropriate consolidation of the column containing the final bill of goods. These deliveries to final users are recomputed in the same way as the inputs to a group I industry: purchases from sectors classified in group II are not shown as such. Instead of that, the amount of the product of each of the group I industries absorbed by all the group II industries in the production of their deliveries to final users are added to the amounts of the same goods directly purchased by the final users. Thus, the consolidated final bill of goods will not show any purchases from the chemical sectors, when chemicals is classified as a group II industry. The figure representing the final deliveries from the ferrous metals industry will, however, be augmented by the amount of ferrous metals absorbed in the manufacture of chemicals actually purchased by the final users. Thus, in the reduced, compact input table, the balance between total supply and the total demand for the products of all the group I industries will be accounted for as fully as in the original table.

Table 12 is a reduced input-output flow table corresponding to the thirty-eight-order flow table, table 6. Note that the total output levels for the twenty-seven industries included in group I are the same in both tables. Corresponding final demand entries for each group I industry are larger in table 12 than in table 6. This is because final demand for, say, materials-handling equipment, in the reduced table, includes not only materials-handling equipment directly purchased for the expansion of industrial capacity but also repair and maintenance parts furnished by the producers of this equipment to the manufacturers of food, chemicals, textiles, and other excluded group II items in final demand.

By using a compact input-output table with the corresponding complement of appropriately enlarged technical coefficients, the planner can centre his attention on a selected group of industries without worrying that any particular decision concerning the levels of output in these industries may turn out to be abortive because of unforeseen capital or labour shortages or insufficient supplies of materials, produced by these group I industries, in any other sectors.

Capital account

Let us shift our attention, now, to the economy's capital account. Table 13 is a capital stock matrix for the United States economy in 1958. Each entry shows the value of the stock of goods, produced by the industry identified on the left, held by the industry identified at the top of the table. While input-output flow tables report actual transactions, sales and purchases among industries over a given time period (generally a year), the stock table presents the inventory of buildings, machines and all other facilities held by each industry at a given point of time. Thus, a flow table is analogous to the income account and a stock table to the physical assets in the capital account. They show different aspects of the same productive process.

Strictly speaking, all items which are reported as flows should also appear as stocks, perhaps in the form of inventories: materials, goods in process, and finished goods. So-called "fixed capital goods" are distinguished by their relative longevity: the sizes of their stocks will be large relative to their annual flows. Compared with inventories, a machine or building tends to remain in the stock for a relatively long period of time – three, five, ten, even fifty years before it is replaced. Actually, the stocks in table 13 do not include the relatively short-lived inventory items, but only stocks of durable capital goods.

Table 13 has two outstanding features. First, notice the importance of metalworking products in the stocks of durable capital.

More than 42 per cent of the economy's capital originated in metalworking industries. In contrast to the current account picture shown in table 6, metalworking stocks appear to be important across the entire table, that is, in virtually all using industries. Second, note the preponderance of stocks held outside the manufacturing sectors. While we are accustomed to thinking of steel, automobiles and cement as the prototype of capital intensive industries, much larger actual volumes of capital goods are required in our networks of communication, transportation and trade. This feature is important in newly developing countries as well. In the United States economy, these co-ordinating sectors are growing in relative importance, and so are their capital requirements. Agricultural capital is also far from negligible in the general picture.

The ratio of stock appearing in each cell to the annual rate of output of the industry which uses it is called a capital coefficient. A table, or matrix, of capital coefficients tells the value of the stocks of the various types of durable or capital goods required per unit of output. (Here the notion of capacity output is important because of the possibility of idle capital goods.) Table 14 is a matrix of (fixed or durable) capital coefficients. To make the table less cumbersome, only capital coefficients greater than .005 are cited in the table.

This simplification tends once again to emphasize the concentration of capital originating in a few metalworking sectors. Total capital required per unit of capacity is given, for each sector at the bottom of the table. These total capital coefficients vary greatly from industry to industry, particularly outside of manufacturing.[4]

Accumulation of required capital stocks

How do we relate stock requirements, described in table 13, to interindustry flow requirements pictured in table 6? It takes time to produce and accumulate stocks

[4] Complete sets of capital coefficients, such as those cited in table 14, are not yet available for many countries. A set was developed for the Indian economy on a fairly aggregated classification basis and sets of total capital coefficients (corresponding to the column sums in table 14) are available for several years for Japan. Rough preliminary intercomparison suggests that the Japanese capital coefficients are of the same order of magnitude as those for the United States. Those for India appear to be roughly double the United States ones. The source of the differences, real or statistical, has still to be studied in some detail.

Table 10

INTERNAL STRUCTURE OF METALWORKING; JAPAN, 1960

Input-output coefficients including secondary transfers

(One per cent)

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Transportation Equipment	Shipbuilding 1																						
	Railroad equipment 2		.04																				
	Motorcycles and bicycles 3			.20																			.03
	Miscellaneous transportation equipment 4				.41																		
	Aircraft 5					.11																	
	Motor vehicles 6						.14																.29
Elect Equip	Household machines 7							.13															
	Household electrical appliances 8								.17												.01		
	Office machines 9									.07													
Nonelec Equip	Industrial machinery 10							.05			.17												
	Machinery and equipment for general use 11										.04	.14	.01		.01								
	Machine tools and metal forming machines 12									.01			.14										
	Prime movers, boiler 13	.12		.14			.15				.02	.01		.21						.01			.08
Instruments	Optical instruments 14														.13								
	Watches and clocks 15								.02							.14							
	Precision machines 16	.01				.02				.02	.01	.02	.01		.04		.13						
General Metalworking	Miscellaneous batteries and wiring devices 17	.02	.01	.07	.01	.07	.04	.01	.15					.01				.25	.04				.03
	Heavy electric machinery and apparatus 18	.01						.05	.01		.03	.03	.01					.01	.15				
	Metal products for construction 19				.01						.01	.01								.03			
	Miscellaneous metal products 20	.02		.01			.01	.01	.01		.01	.01		.02		.01		.01		.02	.01		.01
	Ball and roller bearings and other common parts 21	.02	.02	.04	.07	.02	.02	.04	.02	.16	.05	.04	.09	.03	.02	.05	.03	.01	.04			.04	.02
	Repair of automobiles 22					.01					.01	.01										.01	

Note: Coefficients less than .005 are excluded.

of capital goods. In the short run, therefore, the stock of capital invested in, that is, possessed by, various producing sectors of the economy sets an upper limit on the flow of outputs that they can produce. The capital coefficient table tells us what durable goods we must have to produce any given set of outputs. Realistically, if these capital goods (largely metalworking products) are not available, the projected levels of production cannot take place. As time goes on, a step-by-step accumulation of domestically produced, or imported, capital increases the productive capacities of an economy and, if these are properly balanced, permits it to increase its output and deliveries to final demand.

Purchases of capital goods by the various industries are not reported in a conventional input-output table as current account transactions, but are relegated to a special gross capital formation column in final demand (table I-5). This column tells the total amounts of office machinery, trucks and electrical transmission equipment supplied to the whole economy in a given year. In the absence of capital imports over the years, all additions to equipment stocks must pass through the gross capital formation account. The single gross capital formation column is a sum of additions to capital stock made by all using industries. It combines new tractors bought by agriculture with those bought by mining and construction. Given the detailed statistical information, one could elaborate this single capital formation column into a complete matrix of many columns which would tell gross additions of each kind of capital goods in each industry in a given year. Thus, we would distinguish separately the tractors bought by agriculture and by construction, the materials-handling equipment bought by food processing and chemicals and automobiles, etc.

Each element in the gross capital formation vector, or in a capital flow matrix, in turn combines two elements: capital goods to replace or renew existing stocks, and capital to expand productive capacity by net addition to previously accumulated stocks. In a highly industrialized country, a relatively large proportion (perhaps 60 per

Tabl

"REDUCED" INPUT-OUTPUT COEFFICIENT

(Dollars p

		1	2	3	4	5	6	7
Aircraft and parts	1	.19	.01	.	.01	.01	.	.0
Ships, trains, trailers, and cycles	2	.	.07	.	.	.	.	.
Motor vehicles and equipment	3	.01	.01	.30	.	.01	.	.
Office and computing machines	4	.	.	.	.09	.	.	.
Service industry machines	5	.	.	.	.	.05	.03	.
Household appliances	6	.	.01	.	.	.06	.01	.
Radio, television, and communication, equipment	7	.03	.	.01	.01	.	.	.0
Batteries, x-ray, and engine electrical equipment	8	.	.	.02	.	.	.	.
Electric lighting and wiring equipment	9	.	.	.	.	.01	.01	.0
Electronic components and accessories	10	.01	.	.	.04	.	.	.1
Materials handling machinery and equipment	11	.	.	.	.	.	.	.
Special industry machinery and equipment	12	.	.	.	.01	.	.	.
Construction, mining, and oil-field machinery	13	.	.01	.	.	.	.	.
Farm machinery and equipment	14	.	.01	.	.	.	.	.
Engines and turbines	15	.	.03	.	.	.	.	.
Machine shop products	16	.01	.	.01	.	.	.	.
Optical, ophthalmic, and photographic equipment	17	.	.	.	.	.	.	.
Scientific, controlling instruments, and clocks	18	.02	.	.	.	.01	.03	.0
Electrical apparatus and motors	19	.	.03	.	.02	.09	.04	.0
Metalworking machinery and equipment	20	.02	.01	.01	.01	.	.01	.0
General industrial machinery and equipment	21	.01	.02	.01	.01	.02	.01	.
Hardware, plating, valves, and wire products	22	.01	.02	.04	.01	.03	.04	.0
Stampings, screw machine, products, and bolts	23	.02	.01	.03	.01	.04	.05	.0
Heating, plumbing, and structural metal products	24	.	.05	.	.	.02	.02	.
Automotive repair services	25	.	.	.	.	.	.	.
New and maintenance construction, glass, stone, and clay products	26	.01	.02	.02	.01	.02	.02	.0
Primary iron and steel mining and manufacturing	27	.03	.12	.09	.02	.07	.08	.0
Total capital	A	.04	0.6	0.4	0.9	0.6	0.6	0
Professional, technical and clinical workers	B*	26.8	26.0	15.2	29.8	25.6	28.8	31
Skilled workers	C*	23.0	27.9	8.1	21.0	15.6	16.0	15
Semi-skilled and unskilled workers	D*	23.1	28.2	21.6	29.7	24.1	26.4	41
Total labour	E*	72.9	86.2	44.8	80.5	65.3	71.1	87

Notes: Labour rows B* to E* are man years per thousand dollars of output. Coefficients under .005 are represented by a dot.

cent in the United States) of annual capital goods purchases is devoted to renewal or modernization, and 40 per cent to expansion. In developing countries, the percentages for expansion will be much higher.

Table 15 gives rough estimates of the split of the gross capital formation vector into a replacement and an expansion portion for the United States in 1958. To simplify the present exposition, it will be assumed that replacement requirements are fixed, say, at approximately the levels given in column two of table 15.[5] Beyond the maintenance and replacement of existing stocks, additional capital goods are required for the expansion of capacity. Let us see how this second component of gross capital formation is determined.

If we begin in a situation of full utilization of capacity in consumption goods industries, additional capital requirements will be proportional to the increase in output levels in each industry. Suppose a change in consumption demand calls for higher levels of output in consumer goods and supporting industries. Higher output levels will be possible only if necessary additional capital stocks are also forthcoming. For each industry the amounts of the different kinds of capital goods per unit of additional output are given by a column in the capital coefficient matrix. To produce an output $1 million greater than 1958's, the food industry must

[5] One can argue that roughly the same proportion of capital stock must be renewed each year. Since capital stock requirements are, in turn, proportioned to output, one can then justify converting the replacement capital flows to coefficients and adding them to the coefficients of the original flow matrix. This procedure is obviously a gross oversimplification, particularly if applied in analysis of a highly industrialized economy. In many instances, it is difficult to distinguish replacement from expansion expenditures, and the development of new technological alternatives makes replacement a matter of economic advantage rather than pure technical necessity. In developing countries, where a large proportion of equipment is of recent origin, and new capital goods are relatively difficult to obtain, it will generally be rational to restrict replacement to a minimum level close to that required by absolute technological necessity.

R UNITED STATES ECONOMY, 1958

8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
	.	.	.	.	.	.	.01	.	.	.02	.	.01	.02	.	.	.	.	.	.
	.	.	.	.	.01	.	.01	.	.	.	.01	.	.01	.	.	.01	.	.	.
.04	.	.	.01	.	.02	.02	.03	.	.	.02	.	.05	.01	.01	.03	.	.14	.	.
	.	.01	.	.	.	.	.	.	.	.01	.	.	.	.	.	.	.	.	.
	.	.	.	.	.	.	.	.	.	.	.	.	.01	.	.	.01	.	.	.
	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.01	.	.	.
.06 .01	.	.03	.	.01	.	.	.	.	.01	.01	.01	.	.	.	.	.	.	.	.
.04	.03	.	.	.	.	.01	.02	.	.	.	.	.	.	.	.	.	.02	.	.
.01 .04	.04	.01	.	.	.	.	.	.	.	.	.02	.	.	.	.	.	.	.01	.
.18 .01	.	.06	.	.	.	.	.	.	.	.03	.03	.	.	.	.	.	.	.	.
.	.	.	.04	.	.01	.	.	.	.	.	.	.	.01	.	.	.	.	.	.
.	.	.	.	.05	.	.	.	.01	.	.	.	.01	.01	.	.	.	.	.	.
.	.	.	.05	.01	.06	.01	.03	.	.	.	.	.	.01	.	.	.	.	.	.
.	.	.	.	.	.02	.04	.01	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.01	.	.03	.05	.09	.01	.	.	.02	.	.01	.	.	.	.	.	.
.01	.	.	.02	.	.	.02	.03	.07	.	.01	.	.01	.01	.	.	.	.01	.	.01
.	.	.	.	.	.	.	.	.	.06	.01	.	.	.	.	.	.	.	.	.
.01	.	.01	.	.	.	.	.	.	.01	.06	.01	.	.01	.	.	.01	.	.	.
.02 .02	.03	.03	.05	.04	.01	.01	.02	.01	.01	.03	.07	.03	.05	.	.	.01	.	.01	.
.01 .02	.01	.01	.02	.02	.02	.02	.02	.02	.01	.01	.01	.06	.02	.03	.01	.01	.	.	.01
.02	.	.	.07	.06	.06	.06	.03	.01	.	.01	.01	.03	.07	.01	.	.01	.	.	.
.01 .01	.02	.02	.02	.02	.01	.01	.	.02	.01	.02	.01	.02	.02	.04	.03	.03	.02	.02	.02
.02 .03	.03	.02	.02	.01	.01	.03	.02	.01	.01	.02	.02	.03	.01	.02	.03	.02	.	.	.01
	.	.	.01	.01	.02	.	.	.	.	.	.	.	.02	.01	.01	.02	.	.08	.
	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.02	.01	.
.01 .02	.04	.05	.01	.01	.01	.01	.01	.03	.04	.01	.02	.01	.02	.01	.02	.02	.04	.10	.03
.01 .04	.07	.02	.11	.09	.16	.15	.10	.08	.01	.02	.06	.08	.11	.20	.20	.24	.	.03	.26
.04 .07	.06	.06	.06	.08	.06	.06	.05	.08	.09	.06	.07	.08	.07	.08	.08	.06	.13	.08	.09
31.5 33.7	31.0	35.1	28.1	30.6	22.7	25.2	20.4	37.7	36.6	31.4	29.2	28.5	27.1	26.1	28.9	25.1	41.0	21.7	21.1
15.0 15.9	14.8	15.8	19.8	22.8	16.3	16.8	14.7	31.2	16.0	14.7	14.2	22.3	19.3	17.1	19.8	16.0	72.9	5.9	16.5
41.2 43.8	36.8	43.3	28.8	32.4	22.8	24.6	21.1	42.6	44.9	42.9	38.9	30.5	27.2	33.7	42.4	34.0	23.1	17.0	31.8
87.8 93.4	82.6	94.2	76.7	85.8	61.8	66.6	56.2	111.5	97.4	89.1	82.3	81.4	73.6	76.9	91.1	75.1	137.1	44.6	69.3

equire additional capital stocks of 2 × (.117) of farm machinery, 2 × (.026) of motor vehicles, 2 × (.189) of construction, and similarly prescribed amounts from other metalworking sectors. These are the additions to capital stock which must be delivered, that is, included in the gross capital formation column, if the given expansion programme is to be possible. Thus, if we increase the consumption column in final demand, we must also add to the capital formation column. But this latter addition to final demand will itself generate further output increases, in turn, further additional capital requirements, and so on.

As an illustration, column three of table 16 shows the amounts of additional capital goods which must be supplied by the various sectors of the economy in order to support a 20 per cent increase in household consumption. It is obtained by multiplying the increase in household consumption, detailed in column one, by the inverse coefficient matrix. This gives total outputs required on current account to deliver the specified increase in consumption (column two); multiplying the increase in total output levels for each industry (column two) by the corresponding capital coefficients, given in table 14. The sum-totals of all capital requirements from each supplying sector are given in column three.

Note that direct increases in household demand (column one) and their indirect current account impact (column two) affect, primarily, non-metalworking sectors. (The only important exceptions to this occur in automobiles and other consumers' durable sectors. These elements are usually much less important during the early stages of industrial development.) The capital impact (column three), of course, is heaviest in metalworking and construction.

The current consumption and capital formation vectors in final demand are in fact interrelated through stringent technological requirements. In the absence of idle capacity, our increase in household consumption required

Table

"REDUCED" INPUT-OUTPUT TABLE FOR

Current account inter-industry

(Millions of

		1	2	3	4	5	6	7	8	9	10
Aircraft and parts	1	2419	20	25	17	16	6	56	1	2	2
Ships, trains, trailers, and cycles	2	5	253	28	1	2	9	1	1	1	1
Motor vehicles and equipment	3	86	52	6804	2	29	10	5	54	2	2
Office and computing machines	4	7	1	5	194	1	2	9	1	1	13
Service industry machines	5	9	9	31		106	105	5		2	
Household appliances	6	29	20	3		144	40	3	4	1	3
Radio, television, and communication equipment	7	348	8	128	22	8	4	334	8	7	92
Batteries, x-ray, and engine electrical equipment	8	49	6	357	2	1	1	4	59	68	1
Electric lighting and wiring equipment	9	21	14	101	10	16	30	71	59	94	21
Electronic components and accessories	10	78	1	22	93	1	1	1089	21	8	162
Materials handling machinery and equipment	11	5	16	6		3					
Special industry machinery and equipment	12	8	3	15	13	7	2	5	1	1	2
Construction, mining, and oil-field machinery	13	5	21	14		2	2	2	3	2	3
Farm machinery and equipment	14	3	19	26		1	1	1	1	1	
Engines and turbines	15	21	114	89		4	1	1	2		
Machine shop products	16	129	14	151	6	3	5	7	14	5	4
Optical, ophthalmic, and photographic equipment	17	28	1	6	1	1	7	16	1	1	2
Scientific, controlling instruments and clocks	18	199	7	107	8	29	111	36	7	7	14
Electrical apparatus and motors	19	47	126	56	52	201	152	103	38	80	89
Metalworking machinery and equipment	20	252	21	264	22	8	31	30	24	15	17
General industrial machinery and equipment	21	141	59	134	15	36	40	10	27	5	4
Hardware, plating, valves, and wire products	22	145	86	850	16	64	127	83	13	96	42
Stampings, screw machine products, and bolts,	23	254	21	720	26	82	197	117	41	66	65
Heating, plumbing and structural metal products	24	9	172	26		53	57	5		6	2
Automotive repair services	25	12	10	38	4	6	7	10	3	5	5
New and maintenance construction, glass, stone, and clay products	26	110	73	486	20	36	70	88	28	98	122
Primary iron and steel mining and manufacturing	27	425	451	2039	54	161	286	69	56	163	62
Totals	T	4840	1597	12531	579	1022	1306	1620	470	686	736

Note: Flows less than 500,000 are represented by a dot; components may not add to total because of rounding.

a total volume of capital formation almost as great as the initial increase in final demand. Going one step beyond table 16, we could show that the capital formation in column three itself requires additional capacity and hence still more capital in the metalworking and construction industries.

Available capacity in the capital goods industries limits the rate at which consumer goods industries can expand. Furthermore, the production and installation of new capacity does not take place instantaneously: there are appreciable lags between the production of goods that go into the creation of new productive capacities and the utilization of those leading to an increase in current output flows.

TIMING OF INVESTMENT IN METALWORKING INDUSTRIES IN A DEVELOPING ECONOMY

An increase in the rate of output in one or several different sectors in any given year has to be preceded by a sequence of investments properly distributed over a number of preceding years.

It is the task of dynamic input-output analysis to describe direct and indirect intertemporal dependence among the levels of output, investment, and employment in all the different sectors of a growing economy. A dynamic input-output table, similar in its structure to a static one, can be constructed, in which all flows of goods and services are identified not only in terms of their sectoral origin and destination, but also in terms of the time, for example, the year, in which the particular transaction that they describe took place. The total output, the final deliveries, and the labour inputs of each sector are entered on such a time-phased input-output table separately for each year. For purposes of developmental planning, steel demanded and supplied in the year 1966 has to be distinguished from the steel demanded and supplied in 1967. In a sense, these are now different goods. A dynamic input-output table describing the development of a national economy, broken down, say, into twenty sectors, over a period of ten years, would have

NITED STATES ECONOMY, 1958

nsactions only

	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	FD	GDO
3	11	4	7	23	6	2	59	9	22	65	10	8	18	10	94	21	9755	12692
5	9	16	6	21	6	1	6	28	2	20	8	3	60	12	48	34	3137	3723
11	9	46	42	57	7	1	54	12	174	26	36	101	38	1136	67	54	13919	22836
1	4	2	1	.	1	1	47	4	1	1	3	3	4	4	30	7	1866	2216
2	12	2	1	.	1	.	6	2	7	33	9	7	67	1	233	4	1589	2248
.	4	1	9	.	.	.	4	4	8	1	14	10	56	2	285	7	2940	3594
1	25	3	1	1	2	8	40	55	2	9	6	3	6	6	108	17	4755	6807
3	2	5	20	40	4	6	5	15	2	5	7	3	6	119	47	8	685	1533
3	3	4	2	2	3	7	14	90	3	5	20	17	23	35	979	17	622	2286
1	7	1	.	.	.	1	102	141	1	2	6	4	10	3	26	5	862	2648
41	12	17	1	3	1	.	.	2	9	29	7	1	8	1	288	4	625	1081
5	126	6	8	3	10	3	8	8	31	26	19	3	31	4	55	31	2073	2508
54	20	173	32	62	6	1	3	8	8	28	22	3	28	2	293	47	2239	3084
5	7	54	92	30	1	.	2	2	6	8	7	4	15	1	15	29	2105	2439
15	2	80	121	202	8	.	1	82	7	49	8	6	33	1	21	8	1323	2199
17	11	14	37	67	108	2	28	12	23	23	23	16	37	106	29	151	545	1586
	6	1	1	1	1	86	21	5	1	2	3	3	3	3	37	7	1298	1542
1	5	3	4	2	3	23	203	69	4	24	24	8	74	20	252	14	2237	3497
53	98	35	16	39	9	21	122	345	100	194	29	18	97	9	549	95	2328	5103
18	60	53	45	38	30	8	45	65	209	68	177	46	52	3	49	138	1843	3628
73	140	177	141	71	16	1	22	48	119	238	57	5	97	2	332	69	1645	3743
25	46	43	20	9	37	20	65	56	80	77	265	107	272	125	1237	380	2103	6439
20	34	33	81	51	11	11	67	85	100	45	139	105	167	4	199	144	800	3686
13	28	49	6	3	3	.	5	16	14	70	58	30	152	2	6102	54	1098	8034
2	7	6	6	3	4	4	6	10	6	8	16	9	29	148	533	58	6956	7912
11	28	32	30	26	43	61	46	82	52	66	92	57	135	313	7868	646	69565	80285
120	231	479	371	228	132	14	79	320	284	407	1286	753	1949	12	2760	5231	18421	19900
504	946	1340	1102	983	455	284	1059	1575	1277	1547	2352	1335	3968	2082	22537	7282	157334	216449

200 (20 10) rows and 200 columns. The final deliveries of each type of goods, to consumption and exports, as well as the imports (entered as negative figures), will be entered in such a table in the form of a dated bill of goods showing the deliveries from each sector separately for each year.

Investment, i.e., additions to the stock of capital goods productively employed in various sectors, can now be shifted out of the externally prescribed column of final demand into the main body of the input-output table describing interindustrial transactions. A rise in output in any given year requires creation of appropriate productive capacities, i.e., additional investment, in the preceding years. If the magnitudes of the appropriate capital coefficients are known, the direct and indirect linkages between the final deliveries of one year and the corresponding input and output changes, some of them charged to the capital account, in the preceding years, can be computed through inversion of a dynamic input-output matrix, just as the direct and indirect effects of changes in the final deliveries on current interindustrial transactions can be determined through inversion of a ordinary static input-output matrix.

Because, as we have seen before, the products of the metalworking industries are used mainly for investment purposes, a proper integration of their output into an over-all developmental plan depends to a very large extent on proper timing. To illustrate the use of dynamic input-output computations for this purpose, we have constructed and solved a dynamic input-output system.

The flow, capital and labour coefficients incorporated in that dynamic matrix, as in some of our previous examples, are those of United States industries for 1958. The product mixes in the household consumption, the export, and the import vectors used in these computations are based on Indian input-output studies. They seem to represent fairly well the structure of final demand which prevails in a developing economy. New productive capacities created from the output of one year are assumed to be put into operation in the following year.

Table

STOCKS OF CAPITAL GOODS IN

(Millions of

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Aircraft and parts	1																		
Ships, trains, trailers, and cycles	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Motor vehicles and equipment	3	11	22	91	3	9	10	13	6	4	2	8	27	30	27	4	9	9	6
Office and computing machines	4	16	9	28	5	2	6	8	2	3	4	2	6	7	4	3	4	9	9
Service industry machines	5	4	2	6	2	1	2	3	1	1	2	.	2	2	1	1	1	3	4
Household appliances	6		2	20															
Radio, television, and communication equipment	7	3	2	7	1	1	1	2	.	1	1	.	1	1	1	1	1	1	1
Batteries, x-ray, and engine electrical equipment	8	1	1	6	1	.	.	2	.	.	.	.	1	1	1	1	1	1	.
Electric lighting and wiring equipment	9	11	7	30	4	3	4	7	2	2	3	2	5	5	4	3	4	4	4
Electronic components and accessories	10																		
Materials handling machinery and equipment	11	232	88	690	95	65	90	143	51	53	58	22	56	69	48	32	53	61	42
Special industry machinery and equipment	12	14	75	30	4	3	4	176	35	32	78	2	23	7	5	18	6	126	124
Construction, mining, and oil-field mach	13	1	1	2	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
Farm machinery and equipment	14																		
Engines and turbines	15	6	6	31	4	.	1	9	2	.	.	.	4	4	6	3	3	6	2
Machine shop products	16																		
Optical, ophthalmic, and photographic equipment	17	3	1	5	1	.	1	1	.	.	1	.	1	1	1	.	.	2	5
Scientific, controlling instruments, and clocks	18	19	12	44	6	3	6	17	2	4	8	2	6	7	6	6	4	8	24
Electrical apparatus and motors	19	98	58	280	45	21	42	166	43	22	55	12	43	44	35	18	35	28	25
Metalworking machinery and equipment	20	645	415	1582	219	162	194	53	65	88	22	114	384	350	248	171	301	50	74
General industrial machinery and equip	21	119	83	389	57	30	51	73	25	26	35	17	53	55	40	23	30	48	52
Hardware, plating, valves, and wire products	22	25	15	62	9	4	9	17	4	5	8	3	10	11	8	5	6	9	11
Stampings, screw machine products, and bolts	23	12	7	33	5	3	4	7	2	2	3	2	6	6	4	3	4	4	4
Heating, plumbing, and structural metal products	24	84	53	269	29	13	32	45	11	21	22	8	26	32	30	20	14	22	26
Automotive repair services	25																		
New and maintenance construction, glass, stone, clay production	26	1088	615	2295	376	201	382	572	172	213	260	130	487	490	322	243	304	288	351
Primary iron and steel mining and manufacturing	27	27	12	46	7	3	6	13	3	4	6	2	7	8	6	4	4	7	9
Primary nonferrous metal mining and manufacturing	28	33	21	89	13	7	12	21	6	7	9	5	15	15	11	8	10	11	13
Miscellaneous manufacturing and service sectors	29	3	2	9	1	1	1	2	1	1	1	.	2	2	1	1	1	1	1
Chemicals, plastics, rubber, drugs, and paints	30	14	8	37	5	3	5	8	3	3	3	2	7	6	5	3	5	4	5
Lumber and wood products, paper and paper products	31	73	37	134	25	13	25	37	8	13	18	9	33	33	20	16	19	18	24
Textiles and leather goods	32																		
Food, tobacco, and metal containers	33	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Coal, petroleum, and utilities	34	7	4	16	2	1	2	4	1	1	2	1	3	3	2	2	2	2	2
Radio, television broadcasting and communications	35	1	1	3				1	.	.	.	.	1	1	.	.	.	.	.
Transportation and warehousing	36	48	28	116	17	10	17	26	8	10	11	6	22	22	15	11	15	13	15
Wholesale and retail trade	37																		
Other business and personal services	38	327	194	791	118	68	114	180	56	66	78	42	151	149	104	75	102	92	106
Totals	T	2915	1739	7139	1055	630	1021	1607	512	584	689	392	1385	1359	953	674	938	827	938

3

THE UNITED STATES ECONOMY, 1958

dollars)

19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	Totals
																	2875			2875
.	.	.	.	.	.	.	18	171	19	.	4	29	1	222	17		33116			33600
23	27	28	44	23	111		340	57	35	73	239	375	238	2809	330	345	5807	1112		12307
9	10	8	14	19	14		111	162	35	28	212	127	106	306	239	65	8	447	716	2760
3	2	2	3	2	3	251	9	37	7	8	90	39	65	228	161	28	4	1264	291	2541
										5	2	35	798	5			8			874
2	2	2	3	2	2		8	18	5	3	20	20	11	20	128	8797	38	38		9144
2	2	1	2	1	2		9	23	8	2	26	22	9	16	129	69			.	340
8	10	7	11	7	10		35	77	22	12	90	89	49	85	47	1027	8		.	1700
						584					.				21	9			.	614
138	138	138	254	193	150		488	662	230	280	702	842	483	2148	280				.	9122
106	31	10	82	15	13	584	1899	617	291	272	2967	4664	2230	3750	929					19181
1	.	.	.	.	.		1432	183	182	.	42	5	2	1017	2331					5202
							240	1	3		.			12641	9					12895
8	7	3	8	3	9		46	130	42	11	154	184	46	84	3721					9545
1	1	1	2	1	2		9	44	7	2	59	29	12	24	43				.	261
13	11	8	14	8	15		104	198	58	15	432	233	94	192	1183	11		95	32	2900
147	52	53	45	44	88		294	603	208	104	658	540	250	491	15623	184	11			20567
289	691	502	643	488	690		136	2605	523	387	168	323	94	337	3516		38	2604	.	19171
94	108	71	113	81	112		370	1527	622	150	1340	822	460	842	848					8766
19	17	12	20	12	21		617	233	70	26	421	296	134	256	781			38	.	3193
9	11	8	13	9	11		37	77	22	13	87	92	52	88	43			219	.	902
60	41	35	57	36	60	251	253	751	189	58	1126	678	267	838	1251	11		1055	.	7774
691	786	596	955	585	946	6690	4134	6533	2499	967	6996	7317	3981	20384	50153	3258	17402	27491	9599	180750
14	12	9	14	8	15		82	192	64	19	365	248	105	206	6904				.	8420
25	28	20	32	21	31		114	254	73	36	351	301	157	280	233	6519				8779
2	3	2	4	2	3		10	21	6	4	23	24	14	23	26	9		561	90	856
10	12	9	15	10	13		53	89	27	15	107	104	58	100	49		335			797
38	62	38	63	32	61		132	286	81	60	302	452	296	420	143	1179		2556	553	7309
							.	.	.		.							209	.	209
.	.	.	.	.	.		1	.	.	.	3	2	1	8	4					21
5	5	4	7	4	6		18	41	12	7	47	49	26	45	25					359
1	1	1	1	1	1		4	8	2	1	9	10	5	9	5					71
32	38	29	46	29	43		149	289	86	46	335	345	186	664	466	121	5799	162	24	9300
220	259	195	313	199	293		858	1961	566	317	2285	2357	1272	2159	1187				2	17257
969	2369	1792	2880	1835	2728	8360	12020	17851	5997	2923	19662	20703	11501	50695	90823	21631	65112	37819	11313	915361

Table

FIXED CAPITAL COEFFICIENTS FOR

(Dollars per dollar

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
Aircraft and parts	1														
Ships, trains, trailers and cycles	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Motor vehicles and equipment	3	.	.	.	.	.	.	.	.	.	.	.01	.01	.01	.01
Office and computing machines	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Service industry machines	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Household appliances	6		.	.											
Radio, television, and communication equipment	7	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Batteries, x-ray, and engine electrical equipment	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Electric lighting and wiring equipment	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Electronic components and accessories	10														
Materials handling machinery and equipment	11	.02	.02	.02	.05	.03	.02	.02	.03	.02	.02	.02	.02	.02	.02
Special industry machinery and equipment	12	.	.01	.	.	.	.	.02	.02	.01	.03	.	.01	.	.
Construction, mining, and oil-field machinery	13	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Farm machinery and equipment	14														
Engines and turbines	15	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Machine shop products	16														
Optical, ophthalmic, and photographic equipment	17	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Scientific, controlling instruments, and clocks	18	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Electrical apparatus and motors	19	.01	.01	.01	.02	.01	.01	.02	.02	.01	.02	.01	.02	.01	.01
Metalworking machinery and equipment	20	.04	.08	.04	.11	.07	.04	.01	.03	.03	.01	.10	.14	.09	.08
General industrial machinery and equipment	21	.01	.02	.01	.03	.01	.01	.01	.01	.01	.01	.01	.02	.01	.01
Hardware, plating, valves, and wire products	22	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Stampings, screw machine products and bolts	23	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Heating, plumbing, and structural metal products	24	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
Automotive repair services	25														
New and maintenance construction, glass, stone, and clay products	26	.07	.12	.06	.19	.08	.09	.07	.09	.08	.09	.11	.17	.13	.10
Primary iron and steel mining and manufacturing	27	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Primary nonferrous metal mining and manufacturing	28	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Miscellaneous manufacturing and service sectors	29	.	.	.	.01	.	.	.	.	.	.	.	.01	.	.
Chemicals, plastics, rubber, drugs, and paints	30	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lumber and wood products; paper and paper products	31	.01	.01	.	.01	.01	.01	.	.	.	.01	.01	.01	.01	.01
Textiles and leather goods	32														
Food, tobacco, and metal containers	33		.	.	.	.	.	.	.			.	.	.	.
Coal, petroleum and utilities	34	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Radio, TV broadcasting and communications	35	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Transportation and warehousing	36	.	.01	.	.01	.	.	.	.	.	.	.01	.01	.01	.
Wholesale and retail trade	37														
Other business and personal services	38	.02	.04	.02	.06	.03	.03	.02	.03	.02	.03	.04	.05	.04	.03
Totals	T	.20	.33	.19	.55	.26	.24	.21	.27	.22	.24	.33	.49	.36	.30

Note: Coefficients less than .0005 are represented by dots; components may not add to total because of rounding.

4

UNITED STATES ECONOMY, 1958

r year)

15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
											.10										.01		
.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.09		
.	.	.01	.	.	.01	.01	.01	.	.01		.01	.01	.	.	.01	.01	.01	.03	.01	.03	.02	.01	
.	.	.01	.	.	.	.	.	.	.		.	.	.	.	.01	.	.	.	.01	.01		.	.01
.	.	.	.	.	.	.	.	.	.	.03	.	.	.	.	.	.	.	.	.	.		.01	
											.03						.02						
.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.79	.		
.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.01			
.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.09			
										.07													
.01	.03	.04	.01	.02	.03	.03	.04	.04	.02		.02	.05	.02	.02	.02	.02	.02	.01	.02	.01			
.01	.	.08	.03	.02	.01	.	.01	.	.	.07	.06	.05	.01	.02	.09	.11	.06	.03	.02				
.	.	.	.	.	.	.	.	.	.		.05	.	.	.01	.	.	.	.01	.05				
											.01		.	.	.	.		.12	.				
.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.08				
.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.				
.	.	.	.01	.	.	.	.	.	.		.	.	.	.	.01	.01	.	.	.03	.		.	.
.01	.02	.02	.01	.02	.01	.01	.02	.01	.01		.01	.02	.01	.02	.02	.01	.01	.	.34	.02	.		
.07	.15	.03	.02	.05	.15	.12	.10	.11	.08		.	.07	.06	.04	.	.01	.	.	.08		.	.03	
.01	.02	.03	.01	.02	.02	.02	.02	.02	.01		.01	.03	.04	.05	.04	.02	.01	.01	.02				
.	.	.01	.	.	.	.	.	.	.		.02	.	.01	.01	.01	.01	.	.	.02			.	
.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.				
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.03	.01	.01	.02	.01	.03	.02	.01	.01	.03	.		.01	
.01	.15	.17	.10	.11	.17	.14	.14	.13	.11	.85	.14	.17	.15	.19	.21	.17	.11	.19	1.09	.29	.05	.29	.10
.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.		.01	.
.	.	.	.	.	.	.	.	.	.		.	.	.	.	.01	.01	.	.	.15				
.	.	.01	.	.	.01	.	.	.	.		.	.01	.01	.01	.01	.01	.	.	.01	.59			
.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.				
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01		.	.01	.01	.01	.01	.0	.01	.	.	.11		.03	.01
											.01											.	
.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.				
.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.				
.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.				
.	.01	.01	.	.01	.01	.01	.01	.01	.01		.	.01	.01	.01	.01	.01	.	.01	.01	.01	.02	.	.
.03	.05	.06	.03	.04	.06	.05	.05	.04	.03		.03	.05	.05	.04	.07	.05	.03	.02	.03				.
.28	.47	.50	.25	.32	.52	.43	.43	.40	.32	1.06	.53	.42	.46	.50	.58	.48	.30	.47	1.97	1.94	.17	.32	.12

The inverse of the dynamic matrix is essentially similar to the inverse of a static input-output matrix. It describes the changes in the output of each industry required, directly and indirectly, to deliver one additional unit (for example, $1 million worth in fixed base year prices) of the output of any given industry to final demand. In a dynamic system, that change cannot, however, be described by a single figure. It consists of a whole train of successive changes in the output of the industry in question, distributed over a number of years preceding the year in which the final delivery is actually to be made. The sequence of figures shown below represents, for example, a single element of a dynamic inverse. It shows

Year	-8	-7	-6	-5	-4	-3	-2	-1	0
Change in output	0.001	0.001	0.003	0.006	0.012	0.026	0.056	0.111	0.065

the successive changes in the output of the auto, aircraft and intermediate metalworking industries, distributed over the preceding nine-year period, that would be required, directly and indirectly, in order to enable the national economy to deliver an additional dollar's worth of products of the electrical equipment and instruments industry to final demand in the last year, i.e., the year 0.

Theoretically, the chain stretches backward over an infinite number of years. Its earlier members, however, are so small that for all practical purposes they can safely be neglected.

The large negative entry in the last year, i.e., the year in which the delivery to final demand is actually made, requires explanation. It reflects an abrupt reduction in the utilization of previously accumulated productive capacities that would become idle as soon as the final delivery has been made. Actually, an increase in the final delivery of electrical equipment and instruments in year 0 is most likely to be followed by an equal, or possibly even a greater increase, projected or planned for the following year, i.e., for year -1. The effects on the industry in question of these two elements of a given dynamic, that is, time-phased, bill of goods should be superimposed. They are described, in this instance, by a summation of the two series.

Year	-8	-7	-6	-5	-4	-3	-2	-1	0	1
Change in output	0.001	0.001	0.003	0.006	0.012	0.026	0.056	0.111	0.065	
		0.001	0.001	0.003	0.006	0.012	0.026	0.056	0.111	0.065
Total	0.001	0.002	0.004	0.009	0.018	0.038	0.082	0.167	0.046	0.065

Table 15

EXPENDITURES ON FIXED CAPITAL EQUIPMENT (EXCLUDING CONSTRUCTION) FOR REPLACEMENT AND EXPANSION OF CAPACITY, U.S. ECONOMY, 1958

(Millions of dollars)

Capital producing sectors	*Total fixed capital expenditures*	*Expenditures for replacement and modernization*	*Expenditures for expansion of capacity*
Aircraft and parts	360	291	69
Ships, trains, trailers and cycles	1,175	966	209
Motor vehicles and equipment	3,561	3,027	534
Office and computing machines	1,017	379	638
Service industry machines	950	278	672
Household appliances	93	28	65
Radio, television and communication equipment	1,006	269	737
Batteries, x-ray, and engine electrical equipment	83	34	49
Electric lighting and wiring equipment	25	9	16
Electronic components and accessories	27	12	15
Materials handling machinery and equipment	350	197	153
Special industry machinery and equipment	1,467	819	648
Construction, mining and oilfield machinery	1,316	618	698
Farm machinery and equipment	1,670	1,386	284
Engines and turbines	576	216	360
Optical, ophthalmic and photographic equipment	161	49	112
Scientific, controlling instruments, and clocks	530	176	354
Electrical apparatus and motors	1,618	552	1,066
Metalworking machinery and equipment	1,152	673	479
General industrial machinery and equipment	1,051	536	515
Hardware, plating, valves and wire products	166	78	88
Heating, plumbing, structural metal products	706	313	393
Miscellaneous manufacturing and service sectors	1,115	469	646
Chemicals, plastics, rubber, drugs and paints	53	17	36
Lumber and wood products, paper and paper products	930	315	615
Textiles and leather goods	49	17	32
Food, tobacco and metal containers	10	5	5
Radio and television broadcasting, communications	362	72	290
Transportation and warehousing	507	233	274
Trade and services	3,744	1,736	2,008
Total	25,830	13,770	12,060

Table 16

DIRECT AND INDIRECT EFFECTS OF A HYPOTHETICAL 20 PER CENT INCREASE IN PRIVATE CONSUMPTION EXPENDITURES ON INDUSTRIAL OUTPUTS AND GROSS FIXED CAPITAL REQUIREMENTS, UNITED STATES 1958

(*Millions of dollars*)

Producing sectors	*Increase in consumption expenditures* (1)	*Additional output required on current account* (2)	*Additional capital required to produce* (2) (3)
1. Aircraft and parts	5	108	298
2. Ships, trains, trailers and cycles	145	235	425
3. Motor vehicles and equipment	1,840	3,083	1,162
4. Office and computing machines	12	110	498
5. Service appliances	49	114	446
6. Household appliances	483	546	226
7. Radio, television and communication equipment	273	401	1,344
8. Batteries, x-ray, and engine electrical equipment	52	170	48
9. Electric lighting and wiring equipment	63	159	230
10. Electronic components and accessories	30	194	107
11. Materials handling machinery and equipment	0	16	1,189
12. Special industry machinery and equipment	4	74	2,766
13. Construction, mining and oilfield machinery	0	58	766
14. Farm machinery and equipment	2	72	2,697
15. Engines and turbines	25	96	722
16. Machine shop products	0	101	0
17. Optical, ophthalmic and photographic equipment	94	193	81
18. Scientific, controlling instruments, clocks	70	232	405
19. Electrical apparatus and motors	3	175	3,176
20. Metalworking machinery and equipment	6	148	1,942
21. General industrial machinery and equipment	0	118	966
22. Hardware, plating, valves and wire products	76	582	403
23. Stampings, screw machinery products and bolts	50	365	116
24. Heating, plumbing, structural metal products	14	200	1,019
25. Automotive repair services	887	1,337	0
26. New and maintenance construction, glass, stone, clay	72	2,779	26,119
27. Primary iron and steel mining and manufacturing	4	1,403	338
28. Primary non-ferrous metal mining and manufacturing	2	724	235
29. Miscellaneous manufacturing and service sectors	1,276	3,396	141
30. Chemicals, plastics, rubber, drugs and paints	1,052	4,189	93
31. Lumber and wood production, paper and paper production	1,205	5,070	1,098
32. Textiles and leather goods	3,265	6,376	57
33. Food, tobacco and metal containers	10,966	22,768	3
34. Coal, petroleum and utilities	3,116	7,808	42
35. Radio and television broadcasting, communications	782	1,643	8
36. Transportation and warehousing	1,732	4,222	535
37. Wholesale and retail trade	12,313	15,368	0
38. Other business and personal services	17,365	26,629	2,019
Total	57,332	112,697	51,668

Note: Column components may not correspond to totals due to rounding.

The productive capacities built up for the delivery of an additional dollar's worth of electrical equipment and instruments in year 0 are not set free as they were in the previous example. Instead, they are utilized to fill additional capacity requirements serving the next year's needs. The sum-total of two superimposed trains of additional outputs of autos, aircraft and intermediate metalworkers contributed (directly and indirectly) by that industry for final delivery of one dollar's worth of electronic equipment and instruments in year 0 and another dollar's worth of electronic equipment and instruments in year 1 now turns out to be positive in year 0. True, it becomes negative in the year −1. However, the requirements generated by subsequent deliveries to final demand in years 2, 3 and so on will obviously postpone the final liquidation of idle capacities indefinitely.

The combined total effects, on the output levels of a particular industry, of any given sequence of final deliveries planned or projected over a number of years, can thus be computed by summing the properly weighted elements of the dynamic inverse year by year.

The inverse, that is, the generalized numerical solution of the dynamic system described above, is reproduced in full in table 17. Each one of its elongated rectangular cells holds nine figures, representing a sequence of nine annual changes in the output level of the industry named on the left of the row. These changes represent the required direct and indirect contributions of that industry to the

delivery by the industry listed at the head of the corresponding column of one additional unit of its respective output to final demand in the last year, year 0.

As in most other input-output computations, the unit in terms of which the output of each sector is measured (unless specified otherwise) is a dollar's worth in base year prices. Base year prices are the prices in terms of which we compiled the basic sets of technical coefficients that went into the construction of the dynamic input-output system. Wherever some of the coefficients, for example, the labour coefficients or the electric energy consumption coefficients, are described in physical units such as man-years or kilowatt-hours, the corresponding output and input levels in the inverse of the dynamic matrix will be expressed in such units, too. Incidentally, there exists no objection to the simultaneous use of base year price measures in some parts of the system and direct physical measures in others.

we have to compute a properly weighted average of the corresponding elements of the dynamic inverse.

The final results of such a computation are summarized in table 18. It shows how an additional composite unit (say, an additional dollar's worth in base year prices) of household consumption, of exports, or of imports, would affect the production programmes of the three metalworking sectors, of the ferrous metals and of the construction industries over the nine-year stretch at the end of which the final deliveries are actually to be made. The product mixes ascribed to the household consumption bundle, the export bundle, and the import bundle are based on the projected composition of these three vectors for India in 1970.

All sequences of output changes can be of course translated into corresponding nine-year sequences of changes in investment and employment. These are

Table 17

DYNAMIC INVERSE

Final demand, in year 0, for products of industry

Year of output:	1									2									3									4									5								
	9	8	7	6	5	4	3	2	1	9	8	7	6	5	4	3	2	1	9	8	7	6	5	4	3	2	1	9	8	7	6	5	4	3	2	1	9	8	7	6	5	4	3	2	1
1	0.000	0.000	0.000	0.001	0.002	0.005	0.012	0.041	1.167	0.000	0.000	0.000	0.001	0.002	0.004	0.013	0.018	0.015	0.000	0.000	0.000	0.001	0.002	0.003	0.004	0.004	0.005	0.000	0.000	0.001	0.001	0.002	0.005	0.007	0.009	0.071	0.000	0.000	0.001	0.001	0.002	0.005	0.014	0.008	0.020
2	0.001	0.002	0.004	0.008	0.017	0.035	0.076	0.160	0.028	0.001	0.002	0.003	0.007	0.015	0.032	0.071	0.104	1.137	0.001	0.001	0.003	0.006	0.012	0.026	0.056	0.111	0.065	0.001	0.002	0.004	0.009	0.018	0.038	0.079	0.205	0.174	0.001	0.002	0.004	0.009	0.018	0.039	0.085	0.104	0.152
3	0.000	0.001	0.001	0.002	0.005	0.011	0.024	0.037	0.004	0.000	0.000	0.001	0.002	0.005	0.010	0.022	0.034	0.000	0.000	0.000	0.001	0.002	0.004	0.008	0.018	0.038	1.158	0.000	0.001	0.001	0.003	0.006	0.012	0.029	0.063	0.055	0.000	0.001	0.001	0.003	0.006	0.012	0.027	0.059	0.084
4	0.001	0.001	0.003	0.007	0.014	0.030	0.061	0.162	0.235	0.001	0.001	0.003	0.006	0.013	0.027	0.052	0.181	0.245	0.001	0.001	0.002	0.005	0.010	0.022	0.045	0.119	0.168	0.001	0.002	0.003	0.007	0.015	0.032	0.073	0.085	0.899	0.001	0.002	0.003	0.007	0.015	0.033	0.065	0.690	0.265
5	0.000	0.001	0.002	0.004	0.009	0.021	0.038	0.290	0.000	0.000	0.001	0.002	0.004	0.009	0.019	0.027	0.194	0.000	0.000	0.001	0.001	0.002	0.003	0.007	0.015	0.026	0.042	0.000	0.001	0.001	0.002	0.005	0.010	0.021	0.058	0.015	0.000	0.001	0.001	0.002	0.005	0.010	0.023	0.052	1.284

1 Railroad, farm, and construction equipment 2 Autos, aircraft, and intermediate metalworkers 3 Electrical equipment and instruments
4 Construction 5 Ferrous metals

Each entry tells the output in a given year of the industry designated by number at the left (see key to industry, above), required per dollar increase in final deliveries in year 0 of the industry designated by number at the top.

The total annual final bill of goods projected or planned for a particular national economy is usually described in terms of several different bundles of goods destined to satisfy different kinds of final demand. For purposes of present analysis we distinguish three such bundles. One, by far the largest, consists of the combination of goods and services absorbed in private household consumption, another is destined for export, and the third represents imports. To determine the direct and indirect effects of a change in the level of household consumption or of exports and imports, in any given year, on the time-phased production programme of a particular industry, we have only to add together the separate effects of the final deliveries from each industry that make up that particular bundle of final demand. In other words, entered in table 18, too. In interpreting these investment and employment figures, it is important to remember that the entire computation is based on a reduced input matrix in which only the five listed industries were included in group I, all others being treated as belonging to group II. Hence, the capital and the labour figures shown for each of the five selected industries satisfy not only its own requirements, but also requirements of capital and labour for group II industries supplying intermediate inputs to it.

Finally, we wish to show how the elements of the dynamic inverse are used as building blocks in the construction of a developmental plan for metalworking industries. In actual planning, we must sum all the direct and indirect requirements for metalworking outputs

generated by the whole chain of annual final bills of goods specified over the entire stretch of time covered by a particular over-all projection. Because of the retroactive effects of each annual bill of goods, the given projection of the final demand must be extended for a number of years beyond the last year of the period of time covered by the detailed programme of sectoral production, investment, and employment.

Table 19 presents such a hypothetical production programme and investment programme for the three metalworking industries covering a time span of ten years.

The sequence of annual deliveries to final demand that these production programmes are intended to serve was projected for eight years beyond the last year covered by the detailed sectoral programmes. It is described in terms of levels of household consumption, of exports, and of imports given for the first year and growing at three constant, but different prescribed rates for the years that follow. For the first year, the relative magnitudes of the total levels of household consumption, of exports, and of imports are set at 20.0: 1.0: 1.5 (which implies an aggregate final demand or gross national product of 20.0 + 1.0 − 1.5 = 19.5). The excess of imports above exports implies foreign aid or private capital inflow. Consumption is assumed to expand at an annual rate of 4 per cent and exports and imports at the rate of 3 per cent.

The time-phased direct and indirect output requirements corresponding to one unit of annual final deliveries of each kind are shown in table 18. Changes in the annual levels of each one of the three components of final demand and the corresponding growth in the output level of each one of the three metalworking industries are shown in table 19. Total investment and employment in each sector is shown for each year, too. The projected growth curves of the three components of final demand extend beyond the last year for which the sectoral production programmes were actually computed. While these later

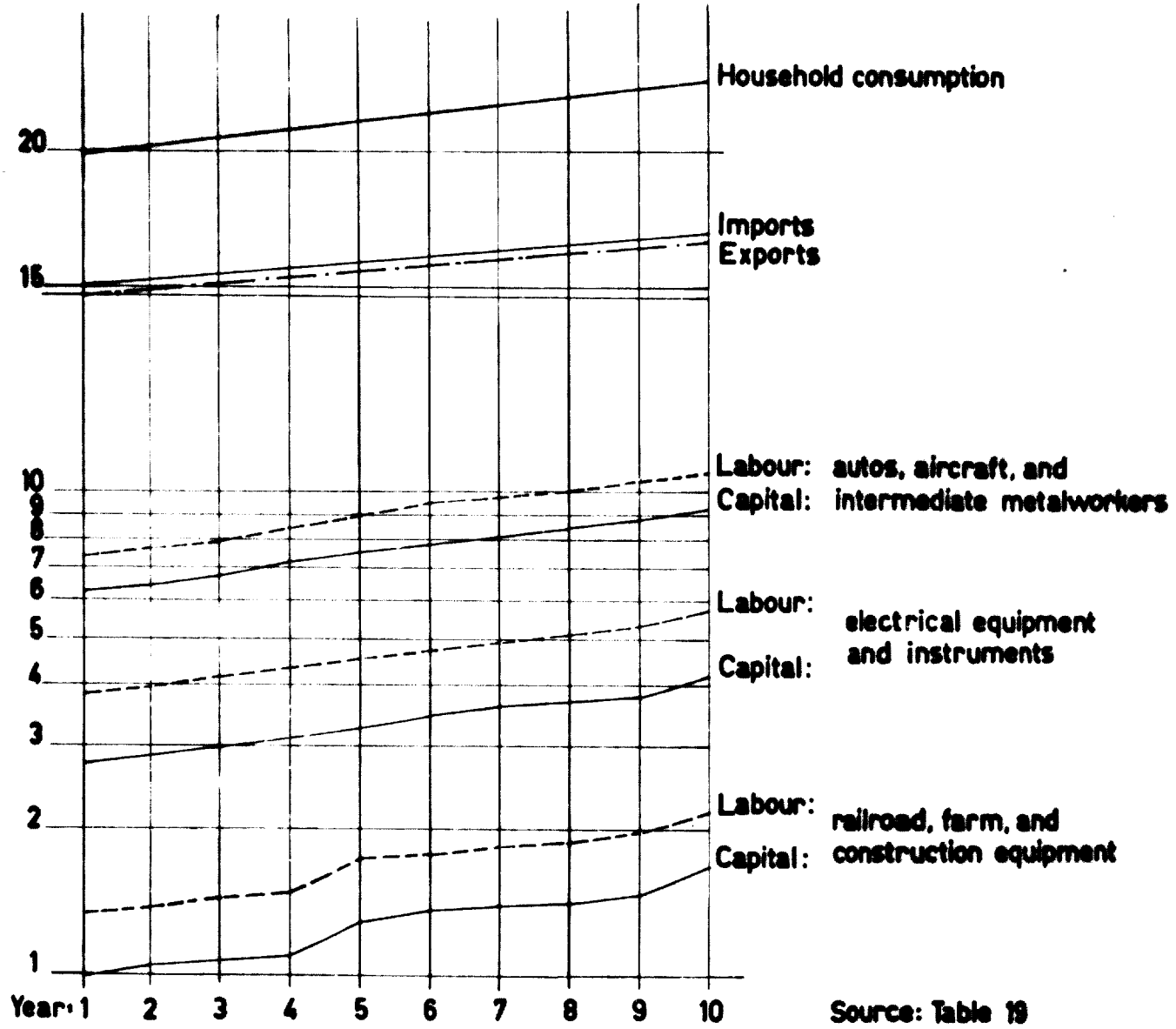


Figure 1

RELATIVE RATES OF GROWTH OF CONSUMPTION, EXPORTS, IMPORTS AND OF LABOUR AND CAPITAL IN THREE METALWORKING INDUSTRIES

Table

ANNUAL SEQUENCES OF INDUSTRIAL OUTPUT, LABOUR IN SELECTED FINAL DEMAND

		Private consumption											
Year of output:		8	7	6	5	4	3	2	1	0	8	7	6
Railroad, farm and construction equipment	Output[a]	.0001	.0002	.0005	.0010	.0023	.0041	.0144	.1010	.1102	.0001	.0003	.0006
	Labour[b]	.0096	.0201	.0429	.0910	.1977	.3569	1.2553	8.8320	9.6368	.0122	.0262	.0551
	Capital[c]	.0001	.0002	.0003	.0007	.0015	.0027	.0093	.0657	.0717	.0001	.0002	.0004
Autos, aircraft and intermed. metal-workers	Output	.0008	.0018	.0038	.0080	.0169	.0354	.0825	.0078	.0827	.0011	.0023	.0048
	Labour	.0630	.1340	.2850	.6030	1.2830	2.6830	6.2590	.5930	6.2740	.0812	.1723	.3658
	Capital	.0005	.0011	.0024	.0051	.0108	.0225	.0526	.0050	.0527	.0007	.0015	.0031
Electrical equipment and instruments	Output	.0003	.0006	.0012	.0025	.0052	.0109	.0245	.0649	.0878	.0003	.0007	.0015
	Labour	.0224	.0474	.1000	.2121	.4510	.9409	2.1137	5.5978	7.5745	.0285	.0604	.1285
	Capital	.0002	.0003	.0007	.0015	.0033	.0068	.0152	.0417	.0544	.0002	.0004	.0009
Construction	Output	.0007	.0015	.0031	.0067	.0141	.0308	.0548	.1898	.2635	.0009	.0019	.0040
	Labour	.0312	.0660	.1400	.2975	.6271	1.3737	2.4423	8.4642	11.7534	.0401	.0852	.1802
	Capital	.0006	.0012	.0025	.0054	.0113	.0247	.0439	.1522	.2113	.0007	.0015	.0032
Ferrous metals	Output	.0002	.0005	.0010	.0021	.0045	.0094	.0222	.0391	.0526	.0003	.0006	.0013
	Labour	.0153	.0326	.0700	.1477	.3148	.6546	1.5407	2.7119	3.6466	.0201	.0423	.0895
	Capital	.0002	.0004	.0009	.0019	.0040	.0084	.0198	.0348	.0468	.0003	.0005	.0012

[a] Dollars of output required per dollar increase in final demand.
[b] Man years required per thousand dollars of final demand.
[c] Dollars of investment required per dollar of final demand.

projections were used in the computations, they are not reproduced in the table.

The total levels of consumption, exports, and imports, together with the corresponding levels of investment and employment in the three metalworking industries, are also depicted in figure I. The vertical scale is logarithmic, so that the steeper slopes represent higher, the gentler slopes lower, rates of growth.

The metalworking outputs shown in table 19 grow more rapidly than the assumed rate for households, 4 per cent. (Unfortunately, the differences in rate of growth are too small to be apparent in figure 1.) The relatively high rates of growth of all metalworking industries are explained by the fact that both exports and imports are in this case assumed to expand less rapidly (3 per cent) than household consumption (4 per cent). Since imports contain more manufactured metal products than either exports or domestic consumption, their relatively lower growth rate has to be compensated by accelerated expansion of domestic metalworking industries called upon to cover a greater and greater proportion of the total demand for manufactured metal products. We have here a typical instance of import substitution.

The assumption of a constant rate of growth for each component bundle of final demand was used only to simplify the computation and the presentation of its details. The figures contained in the numerical inverse of a dynamic input-output system permit us to determine, through a simple process of addition and subtraction, a mutually consistent set of time-phased production programmes corresponding to any given also, time-phased combination of final deliveries.

The time profile of final deliveries represents a country's specific goals and projections and must be tailored to its specific needs and policies. Ideally, of course, the dynamic inverse itself should be tailored to the special features of each developing area. This requires expert judgment as to the appropriate input-output and capital coefficients to choose as a basis for planning. Practical planners already know that collection and selection of basic data is still the most difficult part of their task.

18

AND CAPITAL REQUIRED FOR AN INCREASE OF ONE DOLLAR

BUNDLES IN YEAR 0

Imports						Exports								
5	4	3	2	1	0	8	7	6	5	4	3	2	1	0
.0013	.0029	.0053	.0197	.0285	.1181	.0001	.0002	.0005	.0010	.0022	.0041	.0147	.0688	.0712
.1164	.2537	.4636	1.7225	2.5142	10.3349	.0096	.0201	.0429	.0892	.1951	.3552	1.2851	6.0143	6.2277
.0009	.0019	.0035	.0128	.0185	.0769	.0001	.0002	.0003	.0007	.0015	.0026	.0096	.0447	.0463
.0102	.0217	.0456	.1032	.0368	.1966	.0008	.0018	.0037	.0079	.0167	.0350	.0805	.0349	.0803
.7765	1.6493	3.4576	7.8329	2.7901	14.9183	.0622	.1328	.2816	.5966	1.2675	2.6550	6.1100	2.6497	6.0917
.0065	.0139	.0290	.0658	.0234	.1253	.0005	.0011	.0024	.0050	.0107	.0223	.0513	.0223	.0512
.0032	.0067	.0140	.0323	.0800	.0105	.0003	.0005	.0012	.0024	.0052	.0108	.0242	.0298	.0324
.2725	.5804	1.2108	2.7864	6.9027	.9055	.0216	.0466	.0992	.2096	.4459	.9297	2.0853	2.5682	2.7924
.0020	.0042	.0087	.0200	.0495	.0065	.0002	.0003	.0007	.0015	.0032	.0067	.0150	.0184	.0200
.0086	.0181	.0395	.0170	.2599	.3617	.0007	.0015	.0031	.0066	.0139	.0304	.0545	.1977	.2741
.3827	.8068	1.7613	3.1666	11.5929	16.1309	.0308	.0651	.1383	.2939	.6199	1.3550	2.4325	8.8183	12.2244
.0069	.0145	.0317	.0569	.2084	.2900	.0006	.0012	.0025	.0053	.0112	.0244	.0437	.1586	.2198
.0027	.0058	.0122	.0287	.0656	.0797	.0002	.0005	.0010	.0021	.0045	.0093	.0219	.0387	.0419
.1900	.4050	.8439	1.9866	4.5459	5.5236	.0153	.0326	.0687	.1463	.3113	.6476	1.5179	2.6828	.8217
.0024	.0052	.0108	.0255	.0583	.0708	.0002	.0004	.0009	.0019	.0040	.0083	.0195	.0344	.0405

Table 19

ANNUAL SEQUENCES OF INDUSTRIAL OUTPUTS, LABOUR AND CAPITAL REQUIREMENTS FOR ASSUMED ANNUAL RATES OF GROWTH OF FINAL DEMAND BUNDLES[a]

Year		1	2	3	4	5	6	7	8	9	10
Household consumption		20.0000	20.8000	21.6000	22.4000	23.2000	24.2000	25.2000	26.2000	27.2000	28.2000
Exports		1.0000	1.0300	1.0600	1.0900	1.1200	1.1500	1.1800	1.2200	1.2600	1.3000
Imports		1.5000	1.5450	1.5900	1.6350	1.6800	1.7250	1.7700	1.8300	1.8900	1.9500
Railroad, farm, and construction equipment	Output	.1511	.1553	.1603	.1681	.1963	.2024	.2093	.2145	.2228	.2513
	Labour	13.2200	13.5900	14.0200	14.7100	17.1700	17.7100	18.3100	18.7600	19.4900	21.9800
	Capital	.0983	.1011	.1043	.1094	.1278	.1317	.1362	.1396	.1450	.1635
Autos, aircraft, and intermediate metalworkers	Output	.9609	.9978	1.0421	1.1031	1.1628	1.2068	1.2542	1.3058	1.3737	1.4420
	Labour	72.9300	75.7300	79.1000	83.7300	88.2600	91.6000	95.1900	99.1100	104.2600	109.4500
	Capital	.6127	.6362	.6644	.7033	.7414	.7695	.7997	.8326	.8759	.9194
Electrical equipment and instruments	Output	.4419	.4572	.4744	.4967	.5321	.5502	.5685	.5889	.6095	.6535
	Labour	38.1100	39.4300	40.9100	42.8400	45.8900	47.4500	49.0300	50.7900	52.5600	56.3600
	Capital	.2735	.2830	.2936	.3074	.3293	.3405	.3518	.3645	.3772	.4044

[a] Based on assumption of 4 per cent annual growth rate of household consumption and 3 per cent annual growth rate of exports and imports.

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