DOMESTIC PRODUCTION AND FOREIGN TRADE; THE AMERICAN CAPITAL POSITION RE-EXAMINED [1]

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"A fin d'être absolument clair dans nos recettes, nous n'avons pas craint de répéter plusieurs fois un même mot dans une phrase. Nos lecteur nous seuront gré d'avoir évité les recherches de style dans un ouvrage qui n'en comporte pas."

French Cookbook by Tante Marie

I. THE STRUCTURAL BASIS OF INTERNATIONAL TRADE

COUNTRIES trade with each other because this enables them to participate in and to profit from the international division of labor. Not unlike businesses and individuals, each area specializes in those lines of economic activity to which it happens to be best suited and then trades some of its own outputs for commodities and services in the production of which other countries have a comparative advantage. The word comparative is in this connection of particular significance.

The United States, for example, exports automobiles and imports newsprint. It does so because the quantity of Canadian paper which we can obtain in exchange for, say, a million dollars' worth of American cars is larger than the additional amount of newsprint which we would be able to produce at home if we withdrew the capital, labor, and other resources now absorbed in the manufacture of one million dollars' worth of automobiles and used it instead to increase the output of our domestic paper industry. Canada, for analogous but in a sense opposite reasons, finds it advantageous to obtain its automobiles from the United States in exchange for newsprint rather than to divert resources from their present employment in its paper industry into an increased domestic production of cars.

This explanation of the international exchange of goods and services in terms of the comparative advantage of the alternative allocation of resources in each of the trading countries, was originally developed in the writings of David Ricardo and other so-called classical economists of the late eighteenth and the early nineteenth centuries. It still constitutes the basis of the modern theory of international trade. The theory of comparative costs—as many other economic theories—reigns, however, in the pages of college text books without actually governing the practice of empirical economic analysis.

Until recently, we had so little systematic knowledge of the productive structure of our own or of any other national economy that the application of such general theoretical principles to the analysis and explanation of actual foreign trade relationships has been practically out of the question. Most of what has been said on that subject consisted of reasonable common sense conjectures or of plausible examples which—like the automobile and newsprint reference used above—serves well enough to illustrate the logic of the theoretical argument, but had hardly any specific base in detailed facts and figures.[2]

A widely shared view on the nature of the trade between the United States and the rest of the world is derived from what appears to be a common sense assumption that this country has a comparative advantage in the production of commodi-

[1] The study described in this paper constitutes a part of the systematic analysis of *The Structure of the American Economy* conducted by the Harvard Economic Research Project. Miss Sue Smulekoff, assisted by Mrs. Nancy Bromberger, has prepared the statistical tables presented in this paper and performed the numerical computations underlying these tables.

[2] As an example of the recent empirical studies in that field, see Macdougall, G. D. A., British and American export: a study suggested by the theory of comparative costs, *Econ. Jour.* **61** (1): 697–724, 1951; also, Macdougall, G. D. A., British and American exports: a study suggested by the theory of comparative costs, *Econ. Jour.* **62** (2): 487–522, 1952. A succinct discussion of the theoretical problems involved can be found in Samuelson, P. A. International trade and the equalization of factor prices, *Econ. Jour.* **58**: 163–184, 1948; and International factor price equalization once again, *Econ. Jour.* **59**: 180–197, 1949.

ties which require for their manufacture large quantities of capital and relatively small amounts of labor. Our economic relationships with other countries are supposed to be based mainly on the export of such "capital intensive" goods in exchange for foreign products which—if we were to make them at home—would require little capital but large quantities of American labor. Since the United States possesses a relatively large amount of capital—so goes this oft repeated argument—and a comparatively small amount of labor, direct domestic production of such "labor intensive" products would be uneconomical; we can much more advantageously obtain them from abroad in exchange for our capital intensive products.

Recent progress in the collection and systematic organization of detailed quantitative information on the structure of all the various branches of the American economy, accompanied by a parallel advance in the technique of large scale numerical computation, now enables us to narrow the frustrating gap between theory and observation.[3]

This is the first preliminary progress report on a study designed to analyze the structural basis of trade relationships between the United States and the rest of the world.

II. DIRECT AND INDIRECT INPUT REQUIREMENTS

None of the basic factual information used here had to be collected especially for this particular inquiry. Both the statistical data and the analytical procedure employed constitute an integral part of the so-called input-output or inter-industry research program jointly conducted by various agencies of the government and private institutions, of which the Harvard Economic Research Project is one.

The factual information referred to above comprises many sets of figures of which the largest and in a sense the most important is organized in terms of a so-called input-output table.[4] This table describes the actual flow of commodities and services among all the different parts of the American economy. Specifically, it shows how each one of our manufacturing industries, each branch of agriculture, each kind of transportation and distribution—in short each sector of the American economy—depends upon every other sector. A single column of an input-output table, shows, for example, how many steel sheets, steel bars, and other steel products automobile manufacturers buy from the steel industry for every million dollars' worth of cars they produce; it also shows how many yards (or dollars' worth) they need of upholstery material, how much paint from the chemical industry and so on. Similarly, the "steel industry column" of the same table describes the various kinds of inputs, such as, coal, ore, etc., which the steel industry must obtain from the other sectors of the economy in order to produce an additional million dollars' worth of its own output which, of course, consists of various steel products. The table contains as many columns as there are separate industries so that it presents each link connecting any two sections of the economy.

On the basis of the statistical information contained in an input-output table one can determine the effect of any given increase or decrease in the level of output in any one sector of the economy upon the rate of production in all the other sectors.

Using the 1947 input-output structure of the American economy as the basis of such computations, one finds that to produce an additional million dollars' worth of automobiles the output of steel would have to increase by 235 thousand dollars, the output of chemicals by 58 thousand dollars, while raising the production of non-ferrous metals by 79, of textiles by 39 thousand dollars and so on. Even the communication services—telephone and telegraph—would have to contribute indirectly to the production of a million dollars' worth of additional automobiles.

Column 2 in our table 1 shows the result of this particular computation. Without entering into the discussion of technical details it may be sufficient to observe that the magnitude of every one of the entries depends upon all the input-output relationships among all the sectors of the economy, and that the computation of each one of these figures is equivalent to the solution of a system of as many simultaneous equations as there are distinct sectors in the economy.

The more minute the breakdown of industries in the basic input-output table, the more detailed the final results will be. The following analysis is based on a 200 industry breakdown consolidated in some of its stages—for purposes of computation and simplified presentation—into fifty sectors (38

[3] For description of the so-called input-output approach to structural economic analysis, see Leontief, Wassily, and members of the Harvard Economic Research Project, *Studies in the structure of the American Economy*, N. Y., Oxford Univ. Press, 1952.

[4] Evans, W. Duane, and Marvin Hoffenberg, The interindustry relations study for 1947, *Rev. of Economics and Statistics* **34**: 97–142, 1952.

TABLE 1

CAPITAL AND LABOR REQUIREMENTS FOR THE FINAL OUTPUT OF ONE MILLION DOLLARS' WORTH OF MOTOR VEHICLES

Industry[a]	Output requirements[b]	Requirements per million dollars of output of industry listed on left		Requirements per million dollars of final output of motor vehicles	
		Capital	Labor	Capital	Labor
1	2	3	4	5	6
	(Thousands of dollars)	(Thousands of dollars)	(Man years)	(Thousands of dollars)	(Man years)
26. Motor vehicles (145)	1,457.45[c]	565.8	60.340	824.6	87.942
15. Iron and steel	235.14	1,026.3	77.777	241.3	18.288
19. Other fabricated metal products	118.25	713.5	95.335	84.5	11.273
16. Nonferrous metals	78.69	1,001.6	55.715	78.8	4.384
25. Other electrical machinery	75.50	551.1	102.638	41.6	7.749
22. Other non-electric machinery	60.70	775.7	96.579	47.1	5.862
10. Chemicals	57.95	592.7	49.779	34.3	2.885
12. Rubber products	56.19	493.1	90.172	27.7	5.067
31. Railroad transportation	50.18	3,343.3	153.640	167.8	7.710
11. Products of petroleum and coal	46.85	1,397.2	29.843	65.5	1.398
4. Textile mill products	39.29	493.6	110.563	19.4	4.344
14. Stone, clay and glass products	33.64	1,026.3	128.539	34.5	4.324
8. Paper and allied products	31.95	564.1	64.805	18.0	2.071
34. Trade	31.82	984.9	165.876	31.3	5.278
30. Coal, gas and electric power	29.50	2,222.6	99.318	65.6	2.930
1. Agriculture and fisheries	27.53	2,524.4	82.025	69.5	2.258
21. Metalworking machinery	27.48	1,246.9	130.705	34.3	3.592
33. Other transportation	23.88	928.3	121.576	22.2	2.903
9. Printing and publishing	19.72	436.0	114.038	8.6	2.249
38. Business services	18.44	144.5	97.543	2.7	1.799
39. Personal and repair services	18.10	681.8	183.503	12.3	3.321
6. Lumber and wood products	15.98	537.9	141.540	8.6	2.262
5. Apparel	13.74	262.2	108.795	3.6	1.495
29. Miscellaneous manufacturing	11.26	439.4	100.364	4.9	1.130
37. Rental	10.68	8,156.5	16.324	87.1	.174
28. Professional and scientific equipment	10.35	841.8	133.129	8.7	1.378
2. Food and kindred products	9.98	361.9	43.143	3.6	.431
36. Finance and insurance	9.83	28.2	92.242	.3	.907
35. Communications	6.21	4,645.4	163.097	28.8	1.013
44. Eating and drinking places	6.02	688.0	125.365	4.1	.755
27. Other transportation equipment	5.11	759.0	122.419	3.9	.626
13. Leather and leather products	5.06	264.0	109.629	1.3	.555
23. Motors and generators	4.99	404.3	117.771	2.0	.588
24. Radios	4.65	449.0	124.097	2.1	.577
7. Furniture and fixtures	4.28	485.1	116.923	2.1	.500
18. Fabricated structural metal products	3.79	441.9	83.300	1.7	.316
20. Agriculture, mining and construction machinery	3.65	838.6	87.794	3.1	.320
17. Plumbing and heating supplies	2.67	509.9	99.388	1.4	.265
40. Medical, educational and non-profit org's.	2.05	2,689.5	253.044	5.5	.519
3. Tobacco manufactures	.53	557.6	40.539	.3	.021
41. Amusements	.10	1,082.9	166.899	.1	.017
Total requirements in all industries per million dollars of final output of motor vehicles				2,104.8	201.476

[a] See footnote b for table 2.

[b] The output required from each industry in order to produce one million dollars' worth of motor vehicles for export or domestic consumption. See Evans and Hoffenberg, "The Interindustry Relations Study for 1947," *The Review of Economics and Statistics* **34**: Table 6, 1952.

[c] This figure includes the "back feed" within this industry, i.e., the automotive industry's purchases from itself, as well as the million dollars' worth of motor vehicles going to final consumers and the amounts needed by the various other industries to meet their output requirements. For detailed explanation of the technical point involved, see, Evans, W. Duane and Marvin Hoffenberg, *loc. cit.*, 137 and 140.

of which trade their products directly on the international market).

III. CAPITAL AND LABOR INPUTS

The second and the third sets of our statistical data (columns 3 and 4, table 1) show the direct capital and labor requirements of each industry. These figures are based on detailed information which tells us, for example, that to produce an additional million dollars' worth of finished cars, our automobile industry would have to invest in 175 thousand dollars' worth of new buildings, 266 thousand of additional machinery and many other fixed items. It also would have to increase its inventories of raw materials and "goods in process" by 124 thousand dollars. All together this adds up to 566 thousand dollars which represent the total additional capital (in 1947 prices) which would have to be invested in the American automobile industry if its capacity were raised so as to enable us to produce an additional million dollars' worth of cars per year.

But this is only one part of the total additional capital which would have to be invested in the American economy in order to enable it to produce—say, for export purposes—these additional automobiles. As we saw before, the input of steel into the automobile industry will have to increase by 235 thousand dollars and the input of textile by 39 thousand. This, of course, means additional investment in both the steel and textile industries. The magnitude of each of these capital requirements can be computed. To do so one must simply multiply the amount of capital which each of these two industries requires per million dollars of its capacity by the additional demand for its product indirectly generated by the million dollar rise in automobile output. The amounts of additional capital which each one of the various sectors of the economy would need in order to enable the United States to increase its automobile export by one million dollars are listed in column 5 of table 1. These add up to 2,105 thousand dollars which is the total amount of capital which the United States economy of 1947 had to invest for every million dollars' worth of cars produced for export or final domestic use.

Like the top of an iceberg, visible above the surface of the water, the part invested in the automobile industry itself constitutes only a small portion of the total—26 per cent to be exact; the rest is distributed among the other 42 productive sectors of the economy. Similar computations have been performed for each category of commodities and services which we export or import (in competition with domestic output).

Labor is the other primary factor, the availability of which must obviously have a decisive role in establishing the pattern of specialization which determines the composition of our foreign trade. Not unlike capital, the man years which go into the production of, say, one million dollars' worth of automobiles are partly absorbed by the automobile industry itself but are partly employed also by all the other sectors of the economy. The computation of such direct and indirect labor requirements is quite analogous to the computation of the direct and indirect demand for capital (see columns 3 and 5, table 1).

The summary of total quantities of capital and labor required for domestic production of each of the many types of commodities exported and imported by the United States is entered in columns 2 and 3, table 2. In this table most of the 38 large industry and commodity groups are broken down into their components, described in terms of the more detailed 200 industry input-output classification.

The figures entered in columns 2 and 3 were actually arrived at in two steps. First the indirect capital and labor requirements generated by one million dollars' worth of demand for the product of each of the composite 38 sectors were computed. This computation (essentially a solution of corresponding systems of linear equations) was performed in terms of the consolidated 50 industry input-output table. Next, the *total* capital and labor requirements respectively of each *particular* commodity type within the sector were obtained by adding its *specific direct* requirements to the previously computed (in a sense average) *indirect* requirements of the consolidated sector as a whole. Thus, the differences between the total capital and labor requirements of the industrial products belonging to the same consolidated sector are due entirely to the difference in their *direct* requirements, since their *indirect* requirements are assumed to be the same.

The main reason for such a two-stage procedure is economic. If based throughout on the 200×200 input-output table the computation of direct and indirect requirements would cost a thousand dollars more. The errors caused by the short cut are not likely to be of decisive importance since

TABLE 2

CAPITAL AND LABOR REQUIREMENTS PER MILLION DOLLARS OF U. S. EXPORTS AND IMPORT REPLACEMENTS [a]
1947

Industry[b]	Direct and indirect requirements per million dollars of final output		Exports per million dollars of total exports[e]	Imports per million dollars of total imports[f]	Requirements per million dollars of exports and import replacements of average (1947) composition				Comparison of export and imports requirements[g]	
					Capital		Labor			
	Capital[c]	Labor[d]			Exports	Import replace.	Exports	Import. replace.	Cap.	Lab.
1	2	3	4	5	6	7	8	9	10	11
	(Millions of dollars)	(Man years)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Man years)	(Man years)		
All industries			1,000,000	1,000,000	2,550,780	3,091,339	182.313	170.004	≤	≥
1. Agriculture and fisheries (1–10a)	4.7120	158.710	**100,987**	**257,526**	**475,851**	**1,213,463**	**16.028**	**40.872**		
2. Food and kindred products			**105,701**	**98,045**	*3,119,593*[h]	*3,349,589*	*159.847*	*183.508*	<	<
Meat packing and poultry (21)	3.0158	149.032	17,568	7,189	52,982	21,681	2.618	1.071		
Processed dairy products (22)	3.1334	165.081	15,217	2,429	47,681	7,611	2.512	.401		
Canning, preserving and freezing (23)	3.2287	206.505	11,446	48,043	36,956	155,116	2.364	9.921		
Grain mill products (24)	3.0375	146.371	45,928	1,522	139,506	4,623	6.723	.223		
Bakery products (25)	3.2447	221.331	468	32	1,519	104	.104	.007		
Miscellaneous food products (26)	3.2610	175.271	10,553	8,825	34,413	28,778	1.850	1.547		
Sugar (27)	4.1953	148.850	1,997	12,970	8,378	54,413	.297	1.931		
Alcoholic beverages (28)	3.2923	169.712	2,524	17,035	8,310	56,084	.428	2.891		
3. Tobacco manufactures (29)	3.2887	173.472	**13,245**	**21,439**	**43,559**	**70,506**	**2.298**	**3.719**		
4. Textile mill products			**56,810**	**23,657**	*2,308,032*	*2,327,539*	*213.202*	*206.662*	≤	>
Spinning, weaving and dyeing (30)	2.3114	215.250	53,758	9,796	124,256	22,643	11.571	2.109		
Special textile products (31)	2.3420	201.558	684	8,922	1,602	20,895	.138	1.798		
Jute, linen, cordage and twine (32)	2.3412	200.639	815	4,728	1,908	11,069	.164	.949		
Floor coverings (35a)	2.1591	154.206	1,553	211	3,353	456	.239	.033		
5. Apparel			**21,129**	**36,029**	*1,661,527*	*2,213,875*	*233.802*	*207.139*	<	>
Canvas products (33)	1.6106	237.848	174	0	280	0	.041	0		
Apparel except furs (34)	1.6050	250.169	15,493	12,630	24,866	20,271	3.876	3.160		
House furnishings, etc. (35b)	1.6492	188.151	4,479	1,814	7,387	2,992	.843	.341		
Furs (hunting and trapping) (10b)	2.6176	183.571	983	21,585	2,573	56,501	.180	3.962		
6. Lumber and wood products			**10,223**	**31,787**	*1,560,785*	*1,617,910*	*242.003*	*231.636*	<	>
Logging (36)	1.6383	188.365	378	9,149	619	14,989	.071	1.723		
Sawmills, planing and veneer mills (37)	1.6383	251.604	7,153	20,435	11,719	33,479	1.800	5.142		
Plywood (38)	1.3366	209.125	863	761	1,154	1,017	.180	.159		
Fabricated wood products (39)	1.3465	226.188	1,217	632	1,639	851	.275	.143		
Wood containers and cooperage (40)	1.3491	242.168	612	810	826	1,093	.148	.196		
7. Furniture and fixtures (41–43)	1.6821	233.687	**2,075**	**437**	**3,490**	**735**	**.485**	**.102**		

[a] All figures refer to 1947.

[b] The thirty-eight composite industries are found in Evans, W. Duane, and Hoffenberg, Marvin, "The Interindustry Relations Study for 1947," *The Review of Economics and Statistics* **34:** 97–142, 1952. The component industries are based on Bureau of Labor Statistics, Division of Interindustry Economics, *Interindustry Relations Study, 1947 Emergency model classification;* 1–25, 1952. In column 1, the numbers in parentheses correspond to this latter classification.

Some of the 200-order industries were split in the process of aggregating them into the 50-order classification. These industries are indicated by *a* or *b* following the 200-order industry number. Their composition in terms of the Standard Industrial Classification is as follows:

200-order industry	SIC No.
10a Fisheries	091
10b Hunting and trapping	0741
35a Floor coverings	2274, 2295
35b House furnishings, etc.	2391–2399
100a Boiler shop products	3443
100b Fabricated pipe	3592
112a Tractors	3521
112b Industrial trucks	3565
135a Electrical appliances	3621
135b Heating appliances	3581, 3583, 3584, 3589
186a Radio broadcasting	771
186b Advertising	731

[c] The derivation of these figures is given in the text (see page 335). The basic data on the direct capital requirements (capital coefficients) of individual industries were computed by the Harvard Economic Research Project. For a general description of methods, see Leontief, Wassily, and members of the Harvard Economic Research Project, *Studies in the Structure of the American Economy*, Chapter 6, New York, Oxford University Press, 1952.

[d] See text, page 335, for the derivation of these figures. The direct labor requirements (labor coefficients) were computed by the Harvard Economic Research Project from B. L. S. and census data.

[e] Export figures are based on Bureau of Labor Statistics, Division of Interindustry Economics, Table I—Interindustry flow of goods and services by industry of origin and destination, section 6, October 1952. Exports are valued at producers' value: transportation, insurance and trade margins are charged separately as export items. The total value of exports in 1947 was $16,678.4 million; the actual value of the exports of each industry can be obtained by multiplying each item in column 4 by $16,678.4.

[f] Import figures are based on Bureau of Labor Statistics, *op.cit.* All import figures refer to competitive imports only. Imports are valued at domestic port value, i.e., foreign port value plus transportation, insurance, etc., plus duties. The total value of competitive imports in 1947 was $6,175.7 million; column 5 times $6,175.7 gives the actual value of each type of competitive import.

[g] The sign " > " indicates that the export requirement exceeds the corresponding requirements for import replacement; " < " shows the opposite. The signs " ≥ " and " ≤ " mark differences amounting to less than 2 per cent of the larger of the two italicized figures.

[h] For the meaning of the italicized figures, see page 347 in text.

[i] These two industries are numbered 38 and 41, respectively, in Table 1. They are numbered consecutively here because the intervening industries do not directly participate in international trade.

[j] Both the capital and labor coefficients for "Other nonferrous mining" (15) must be considered unreliable (too high) since they were based on output statistics which probably did not include operations performed under the authority of the Atomic Energy Commission.

TABLE 2—*Continued*

Industry[b]	Direct and indirect requirements per million dollars of final output		Exports per million dollars of total exports[e]	Imports per million dollars of total imports[f]	Requirements per million dollars of exports and import replacements of average (1947) composition				Comparison of export and imports requirements[g]	
					Capital		Labor			
	Capital[c]	Labor[d]			Exports	Import replace.	Exports	Import. replace.	Cap.	Lab.
1	2	3	4	5	6	7	8	9	10	11
	(Millions of dollars)	(Man years)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Man years)	(Man years)		
8. Paper and allied products			**9,743**	**103,616**	*1,726,891*	*1,859,722*	*165.764*	*161.346*	<	>
Pulp mills (44)	1.8611	152.803	1,337	42,732	2,488	79,529	.204	6.530		
Paper and paper board mills (45)	1.8611	167.325	4,401	60,447	8,191	112,498	.736	10.114		
Converted paper products (46)	1.5346	169.389	4,005	437	6,146	671	.678	.074		
9. Printing and publishing (47)	1.3216	196.597	**4,329**	**1,425**	**5,721**	**1,883**	**.851**	**.280**		
10. Chemicals			**49,153**	**105,398**	*2,337,851*	*2,390,120*	*167.681*	*147.602*	<	>
Industrial inorganic chemicals (48)	2.2968	171.293	7,693	9,748	17,669	22,389	1.318	1.670		
Industrial organic chemicals (49)	2.8055	161.081	7,303	4,340	20,489	12,176	1.176	.699		
Plastic materials (50)	2.5614	159.740	3,082	97	7,894	249	.492	.015		
Rubber (51)	2.5208	141.238	342	55,751	862	140,537	.048	7.874		
Synthetic fiber (52)	2.9200	212.841	1,739	2,720	5,078	7,942	.370	.579		
Explosives (53)	2.2814	197.963	342	0	780	0	.068	0		
Drugs and medicines (54)	2.1666	184.150	9,329	1,457	20,212	3,157	1.718	.268		
Soap and related products (55)	2.1417	146.365	2,524	405	5,406	867	.369	.059		
Paints and allied products (56)	2.0430	152.411	3,663	340	7,484	695	.558	.052		
Gum and wood chemicals (57)	2.4267	184.907	2,140	3,854	5,193	9,353	.396	.713		
Fertilizers (58)	2.3700	180.631	450	356	1,067	844	.081	.064		
Vegetable oils (59)	2.0071	128.889	2,734	20,063	5,487	40,268	.352	2.586		
Animal oils (60)	2.0062	136.738	1,079	2,672	2,165	5,361	.148	.365		
Miscellaneous chemical industries (61)	2.2467	170.497	6,733	3,595	15,127	8,077	1.148	.613		
11a. Crude petroleum and natural gas (17)	3.2118	108.844	**6,248**	**37,372**	**20,067**	**120,031**	**.680**	**4.068**		
11b. Products of petroleum and coal			**34,566**	**21,730**	*2,600,946*	*2,674,929*	*94.110*	*93.465*	<	>
Petroleum products (62)	2.5514	94.011	32,881	19,658	83,893	50,155	3.091	1.848		
Coke and products (63)	3.8708	87.760	1,355	2,040	5,245	7,896	.119	.179		
Paving and roofing materials (64)	2.3237	131.557	330	32	767	74	.043	.004		
12. Rubber products			**10,199**	**389**	*1,817,051*	*1,801,799*	*194.823*	*205.656*	≥	<
Tires and inner tubes (65)	1.8305	185.087	6,044	49	11,064	90	1.119	.009		
Miscellaneous rubber products (66)	1.7975	208.989	4,155	340	7,469	611	.868	.071		
13. Leather and leather products			**5,054**	**5,974**	*1,667,016*	*1,668,681*	*233.874*	*227.151*	≤	>
Tanning and finishing (67)	1.6900	183.095	1,901	2,817	3,213	4,761	.348	.516		
Other leather products (68)	1.6395	271.302	749	1,360	1,228	2,230	.203	.369		
Nonrubber footwear (69)	1.6574	262.612	2,404	1,797	3,984	2,978	.631	.472		
14. Stone, clay and glass products			**12,788**	**27,560**	*1,961,425*	*2,345,091*	*192.211*	*177.794*	<	>
Stone, sand, clay and abrasives (18)	2.5821	226.822	330	3,854	852	9,951	.075	.874		
Sulphur (19)	2.5821	139.703	1,385	0	3,576	0	.193	0		
Other nonmetallic minerals (20)	2.5821	154.790	881	17,456	2,275	45,073	.136	2.702		
Glass (70)	1.9293	199.932	4,419	1,295	8,526	2,498	.883	.259		
Cement (71)	2.4944	167.940	1,043	0	2,602	0	.175	0		
Structural clay products (72)	1.7718	271.334	959	49	1,699	87	.260	.013		
Pottery and related products (73)	1.3682	261.934	929	2,477	1,271	3,389	.243	.649		
Concrete and plaster products (74)	1.6727	205.466	246	65	412	109	.051	.013		
Abrasive products (75)	1.4890	159.882	1,127	1,765	1,678	2,628	.180	.282		
Asbestos products (76)	1.4890	176.167	600	32	893	48	.106	.006		
Other miscellaneous nonmetallic minerals (77)	1.4948	179.324	869	567	1,299	848	.156	.102		
15a. Iron ore mining (11)	3.1683	212.434	**552**	**7,675**	**1,749**	**24,317**	**.117**	**1.630**		
15b. Iron and steel			**37,732**	**4,695**	*2,724,880*	*2,655,654*	*181.305*	*151.438*	>	>
Blast furnaces (78)	2.6394	142.525	396	3,676	1,045	9,702	.056	.524		
Steel works and rolling mills (79)	2.7599	180.703	35,585	955	98,211	2,636	6.430	.173		
Iron foundries (80)	2.0344	232.540	672	32	1,367	65	.156	.007		
Steel foundries (81)	2.0349	236.564	90	16	183	33	.021	.004		
Iron and steel forgings (92)	2.0311	179.672	989	16	2,009	33	.178	.003		
16a. Nonferrous metal mining			**468**	**47,154**	*4,402,991*	*4,372,254*	*286.325*	*281.885*	≥	≥
Copper mining (12)	3.2280	197.862	0	5,263	0	16,989	0	1.041		
Lead and zinc mining (13)	2.6210	230.618	12	5,360	32	14,049	.003	1.236		
Bauxite mining (14)	2.6948	221.395	114	3,757	307	10,124	.025	.832		
Other nonferrous mining (15)[i]	5.0347	310.689	342	32,774	1,722	165,007	.106	10.183		
16b. Processing nonferrous metals			**9,516**	**57,759**	*2,402,427*	*2,445,386*	*149.222*	*127.461*	≤	>
Primary copper (82)	2.4334	121.184	2,788	22,216	6,784	54,060	.338	2.692		
Copper rolling and drawing (83)	2.4348	155.831	1,565	49	3,811	119	.244	.008		
Primary lead (84)	2.4340	120.806	30	6,720	73	16,357	.004	.812		
Primary zinc (85)	2.4350	166.224	1,379	2,672	3,358	6,506	.229	.444		
Primary metals, n.e.c. (86)	2.4348	131.553	396	18,913	964	46,049	.052	2.488		
Nonferrous metal rolling, n.e.c. (87)	2.4349	148.977	983	16	2,394	39	.146	.002		
Primary aluminum (88)	3.2849	144.156	204	761	670	2,500	.029	.110		
Aluminum rolling qnd drawing (89)	2.1816	177.628	1,769	0	3,859	0	.314	0		
Secondary nonferrous metals (90)	2.4355	125.398	282	6,396	687	15,578	.035	.802		
Nonferrous foundries (91)	2.1821	244.406	120	16	262	35	.029	.004		

TABLE 2—*Continued*

Industry[b]	Direct and indirect requirements per million dollars of final output		Exports per million dollars of total exports[e]	Imports per million dollars of total imports[f]	Requirements per million dollars of exports and import replacements of average (1947) composition				Comparison of export and imports requirements[g]	
					Capital		Labor			
	Capital[c]	Labor[d]			Exports	Import replace.	Exports	Import. replace.	Cap.	Lab.
1	2	3	4	5	6	7	8	9	10	11
	(Millions of dollars)	(Man years)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Man years)	(Man years)		
17. Plumbing and heating supplies			**3,202**	**49**	*2,048,157*	*2,046,700*	*211.118*	*204.647*	≥	>
Metal plumbing and vitreous fixtures (97)	2.0510	223.913	1,085	0	2,225	0	.243	0		
Heating equipment (98)	2.0467	204.647	2,117	49	4,333	100	.433	.010		
18. Fabricated structural metal products			**4,053**	**179**	*1,748,187*	*1,796,648*	*182.087*	*178.771*	<	≥
Structural metal products (99)	1.6954	183.767	2,518	49	4,269	83	.463	.009		
Boiler shop products (100a)	1.8348	178.945	1,535	130	2,816	239	.275	.023		
19. Other fabricated metal products			**16,531**	**1,262**	*2,011,342*	*1,971,712*	*203.738*	*207.607*	≥	≤
Tin cans and other tinware (93)	2.1458	174.998	791	32	1,697	69	.138	.006		
Cutlery (94)	2.0414	241.579	1,229	178	2,509	363	.297	.043		
Tools and general hardware (95)	2.0421	227.946	3,130	259	6,392	529	.713	.059		
Hardware, n.e.c. (96)	2.0459	228.406	1,811	16	3,705	33	.414	.004		
Metal stampings (101)	1.8530	202.075	2,075	453	3,845	839	.419	.092		
Metal coating and engraving (102)	2.0457	264.165	0	0	0	0	0	0		
Lighting fixtures (103)	2.0419	195.244	2,140	16	4,370	33	.418	.003		
Fabricated wire products (104)	2.0401	169.167	3,286	49	6,704	100	.556	.008		
Metal barrels, drums, etc. (105)	2.0397	164.918	486	130	991	265	.080	.021		
Tubes and foils (106)	2.0399	206.580	282	32	575	65	.058	.007		
Miscellaneous fabricated metal products (107)	2.0406	190.366	258	65	527	133	.049	.012		
Steel springs (108)	2.0397	172.761	0	0	0	0	0	0		
Nuts, bolts and screw machine products (109)	1.8550	216.333	1,043	32	1,935	59	.226	.007		
20. Agriculture, mining and construction machinery			**34,518**	**5,667**	*2,083,252*	*2,115,952*	*193.059*	*202.400*	≤	<
Tractors (112a)	2.1098	185.783	11,722	1,457	24,731	3,074	2.178	.271		
Farm equipment (113)	2.1183	208.218	5,504	4,194	11,659	8,884	1.146	.873		
Construction and mining machinery (114)	2.0541	188.271	12,081	16	24,816	33	2.275	.003		
Oil field machinery and tools (115)	2.0541	204.419	5,211	0	10,704	0	1.065	0		
21. Metal working machinery (116–117)	2.1793	212.211	**12,633**	**227**	**27,531**	**495**	**2.681**	**.048**		
22. Other non-electric machinery			**58,836**	**3,238**	*1,901,679*	*1,978,413*	*195.442*	*192.712*	<	≥
Fabricated pipe (100b)	1.6724	176.071	0	0	0	0	0	0		
Steam engines and turbines (110)	1.6334	234.085	1,409	16	2,302	26	.330	.004		
Internal combustion engines (111)	1.6334	183.850	6,212	389	10,147	635	1.142	.072		
Industrial trucks (112b)	1.8509	175.047	851	0	1,575	0	.149	0		
Special industrial machinery (118)	2.1146	202.576	19,684	1,943	41,624	4,109	3.988	.394		
Pumps and compressors (119)	1.8797	179.349	4,335	0	8,149	0	.777	0		
Elevators and conveyors (120)	1.8754	181.040	2,452	0	4,599	0	.444	0		
Blowers and fans (121)	1.8744	182.857	396	0	742	0	.072	0		
Power transmission equipment (122)	1.8749	204.820	162	0	304	0	.033	0		
Industrial machinery, n.e.c. (123)	1.8748	170.428	2,494	648	4,676	1,215	.425	.110		
Commercial machines and equipment, n.e.c. (124)	1.8185	224.616	7,051	32	12,822	58	1.584	.007		
Refrigeration equipment (125)	1.6074	169.170	6,697	0	10,765	0	1.133	0		
Valves and fittings (126)	2.2257	211.626	2,782	0	6,192	0	.589	0		
Ball and roller bearings (127)	2.2110	233.258	1,457	32	3,221	71	.340	.007		
Machine shops (128)	2.2131	212.277	156	0	345	0	.033	0		
Electrical appliances (135a)	1.6404	170.386	2,698	178	4,426	292	.460	.030		
23. Motors and generators (131)	1.3747	202.568	**4,383**	**97**	**6,025**	**133**	**.888**	**.020**		
24. Radios and related products (139)	1.5768	249.783	**6,763**	**130**	**10,664**	**205**	**1.689**	**.032**		
25. Other electrical machinery			**15,794**	**193**	*1,767,716*	*1,771,503*	*218.121*	*202.073*	≤	>
Wiring devices and graphite products (129)	1.7708	200.531	1,745	16	3,090	28	.350	.003		
Measuring instruments (130)	1.7748	224.339	714	16	1,267	28	.160	.004		
Transformers (132)	1.7713	204.589	971	0	1,720	0	.199	0		
Control apparatus (133)	1.7731	214.419	1,679	0	2,977	0	.360	0		
Welding apparatus (134)	1.7717	183.887	1,289	49	2,284	87	.237	.009		
Heating appliances (135b)	1.7181	179.511	1,163	0	1,998	0	.209	0		
Insulated wire and cable (136)	1.7663	172.350	1,457	16	2,574	28	.251	.003		
Engine electrical equipment (137)	1.7690	297.422	971	0	1,718	0	.289	0		
Electric lamps (138)	1.7678	226.812	726	32	1,283	57	.165	.007		
Tubes (140)	1.7763	297.568	947	0	1,682	0	.282	0		
Communication equipment (141)	1.7744	231.621	2,147	32	3,810	57	.497	.007		
Storage batteries (142)	1.7695	154.318	576	16	1,019	28	.089	.002		
Primary batteries (143)	1.7697	209.119	486	0	860	0	.102	0		
X-ray apparatus (144)	1.7742	276.505	923	16	1,638	28	.255	.004		
26. Motor vehicles			**61,151**	**1,085**	*2,104,799*	*2,104,799*	*201.779*	*201.476*	=	≥
Motor vehicles (145)	2.1048	201.476	59,892	1,085	126,061	2,284	12.067	.219		
Truck trailers (146)	2.1048	216.227	1,259	0	2,650	0	.272	0		
Automobile trailers (147)	2.1048	210.641	0	0	0	0	0	0		

TABLE 2—*Continued*

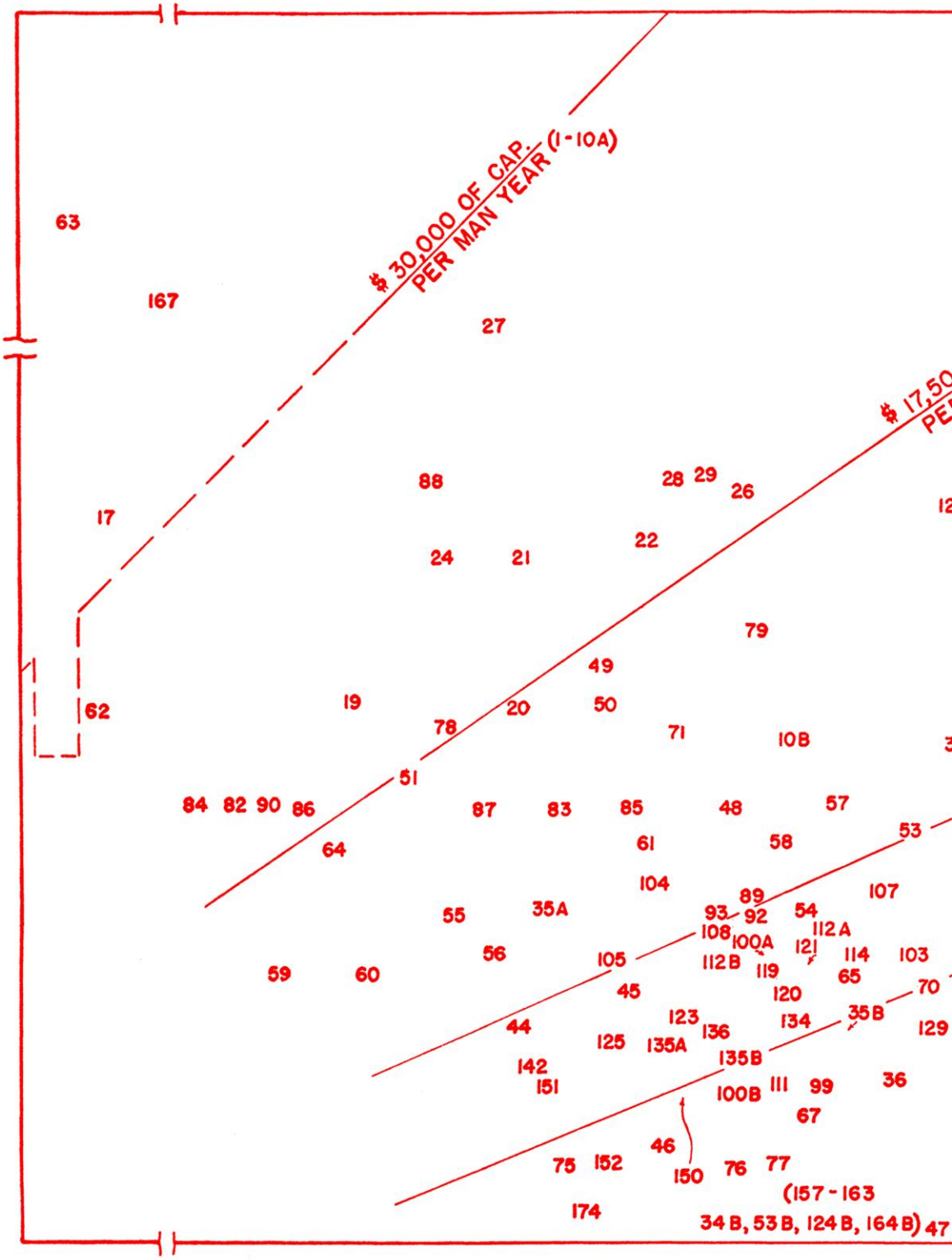
Industry[b]	Direct and indirect requirements per million dollars of final output		Exports per million dollars of total exports[e]	Imports per million dollars of total imports[f]	Requirements per million dollars of exports and import replacements of average (1947) composition				Comparison of export and imports requirements[g]	
					Capital		Labor			
	Capital[c]	Labor[d]			Exports	Import replace.	Exports	Import. replace.	Cap.	Lab.
1	2	3	4	5	6	7	8	9	10	11
	(Millions of dollars)	(Man years)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Man years)	(Man years)		
27a. Other transportation equipment			**20,236**	**1,247**	*1,678,459*	*1,528,148*	*189.761*	*169.206*	>	>
Aircraft and parts (148)	1.7328	235.024	7,525	130	13,039	225	1.769	.031		
Locomotives (150)	1.6663	170.126	4,731	16	7,883	27	.805	.003		
Railroad equipment (151)	1.6663	158.126	6,433	0	10,719	0	1.017	0		
Motorcycles and bicycles (152)	1.5019	161.216	1,547	1,101	2,323	1,654	.249	.177		
27b. Ships and boats (149)	2.1404	263.615	**5,360**	**810**	**11,473**	**1,734**	**1.413**	**.214**		
28a. Professional and scientific equipment			**6,566**	**11,529**	*1,844,913*	*1,840,559*	*251.904*	*238.442*	≥	>
Scientific instruments (153)	1.8465	266.625	3,748	65	6,921	120	.999	.017		
Medical and dental instruments and supplies (155)	1.8437	229.939	2,039	97	3,759	179	.469	.022		
Watches and clocks (156)	1.8405	238.387	779	11,367	1,434	20,921	.186	2.710		
28b. Optical, ophthalmic and photo equipment (154)	1.8465	311.213	**4,707**	**680**	**8,692**	1,256	**1.465**	**.212**		
29. Miscellaneous manufacturing (157–163)	1.4382	186.429	**10,762**	**23,771**	**15,478**	**34,188**	**2.006**	**4.432**		
30. Coal, gas and electric power			**22,083**	**1,133**	*1,790,214*	*3,702,030*	*209.573*	*136.805*	<	>
Coal mining (16)	1.7821	209.883	22,011	259	39,226	462	4.620	.054		
Electric light and power (167)	4.2709	115.066	72	874	308	3,733	.008	.101		
Natural, manufactured and mixed gas (168)	2.2676	97.194	0	0	0	0	0	0		
31. Railroad transportation (169)	3.9285	186.879	**40,957**	**0**	**160,900**	**0**	**7.654**	**0**		
32. Ocean transportation (172)	2.6324	165.090	**80,361**	**40,157**	**211,542**	**105,709**	**13.267**	**6.630**		
33. Other transportation			**20,068**	**2,364**	*2,007,843*	*2,151,946*	*165.238*	*150.592*	<	>
Trucking (170)	1.1152	152.922	9,018	0	10,057	0	1.379	0		
Warehousing and storage (171)	3.9155	376.255	1,529	0	5,987	0	.575	0		
Other water transportation (173)	4.2776	119.141	3,933	696	16,824	2,977	.469	.083		
Air transportation (174)	1.2650	163.866	4,976	1,668	6,295	2,110	.815	.273		
Pipeline transportation (175)	1.8485	127.555	612	0	1,131	0	.078	0		
Local and highway transportation (178)	1.0436	173.106	0	0	0	0	0	0		
34. Trade			**62,302**	**0**	*1,417,208*		*185.452*			
Wholesale trade (176)	1.4157	185.346	62,158	0	87,997	0	11.521	0		
Retail trade (177)	2.0683	228.730	144	0	298	0	.033	0		
35. Communications			**2,272**	**0**	*5,097,887*		*246.360*			
Telephone and telegraph (179)	5.0979	246.360	2,272	0	11,582	0	.560	0		
Radio broadcasting (186a)	.8310	57.460	0	0	0	0	0	0		
36. Banking, finance and insurance (181)	.4699	134.774	**8,106**	**16,516**	**3,809**	**7,761**	**1.092**	**2.226**		
37. Business services[i] (186b–187)	1.6345	240.990	**156**	**0**	**255**	**0**	**.038**	**0**		
38. Amusements[i] (190)	2.2801	237.204	**7,687**	**0**	**17,527**	**0**	**1.823**	**0**		

the similarity of their structural relationship to the rest of the economy constituted the guiding principle in the aggregation of the individual industries into the larger sectors. What is even more important, whatever errors do occur in these basic computations, can have no biasing effect on the final results of our numerical analysis. The disregard of differences between the *indirect* capital and labor requirements of industries belonging to the same group has, furthermore, a theoretical reason which will become clear in the course of the later argument.

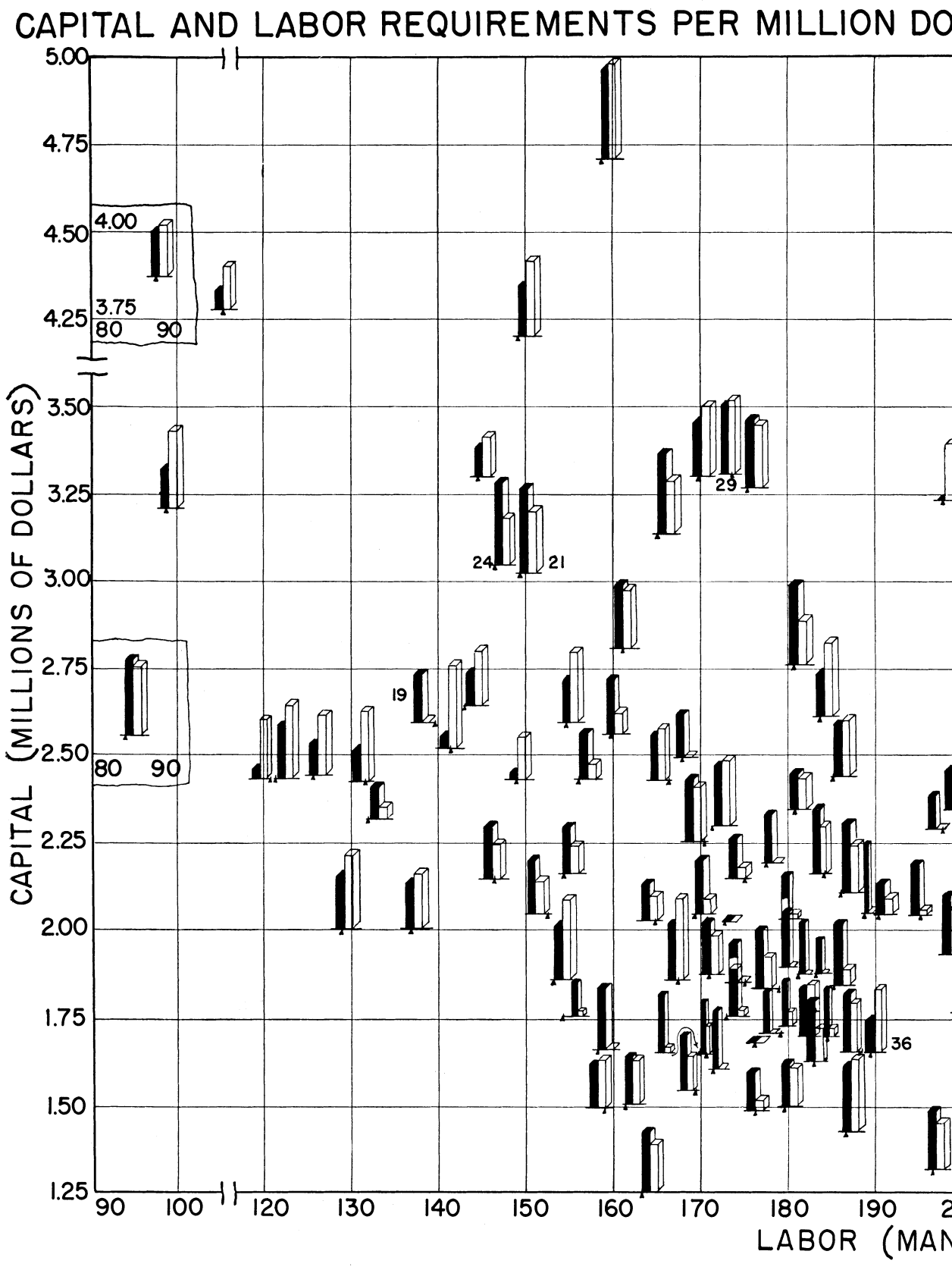
IV. COMPUTATION OF EXPORT AND OF IMPORT REPLACEMENT COSTS

Now we are ready to find out whether it is true that the United States exports commodities the domestic production of which absorb relatively large amounts of capital and little labor and imports foreign goods and services which—if we had produced them at home—would employ a great quantity of indigenous labor but a small amount of domestic capital.

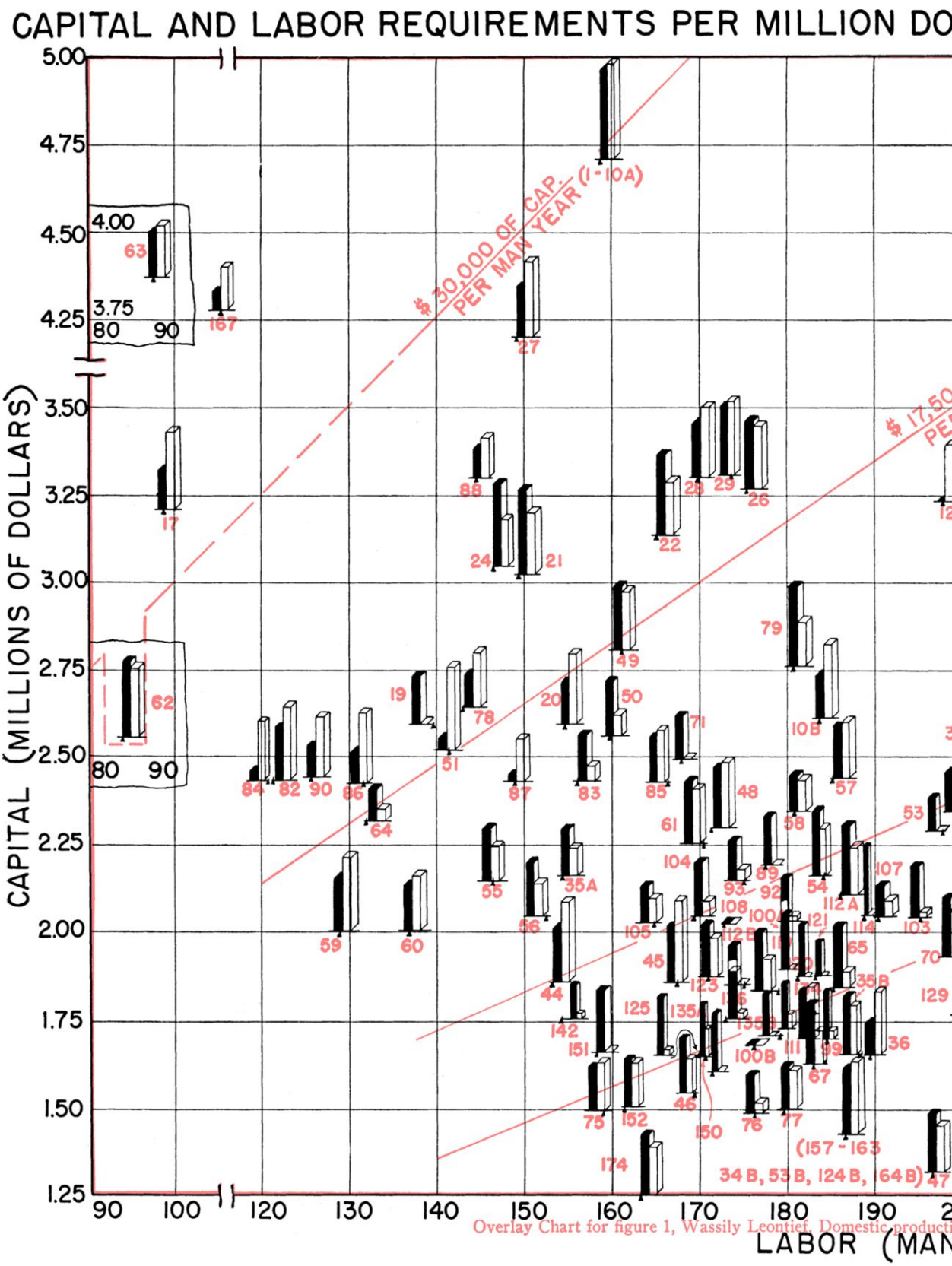
Let us imagine a situation in which the United States, for some reason wanted to reduce its de-



Overlay Chart for figure 1, Wassily Leontief, Domestic producti



FIG



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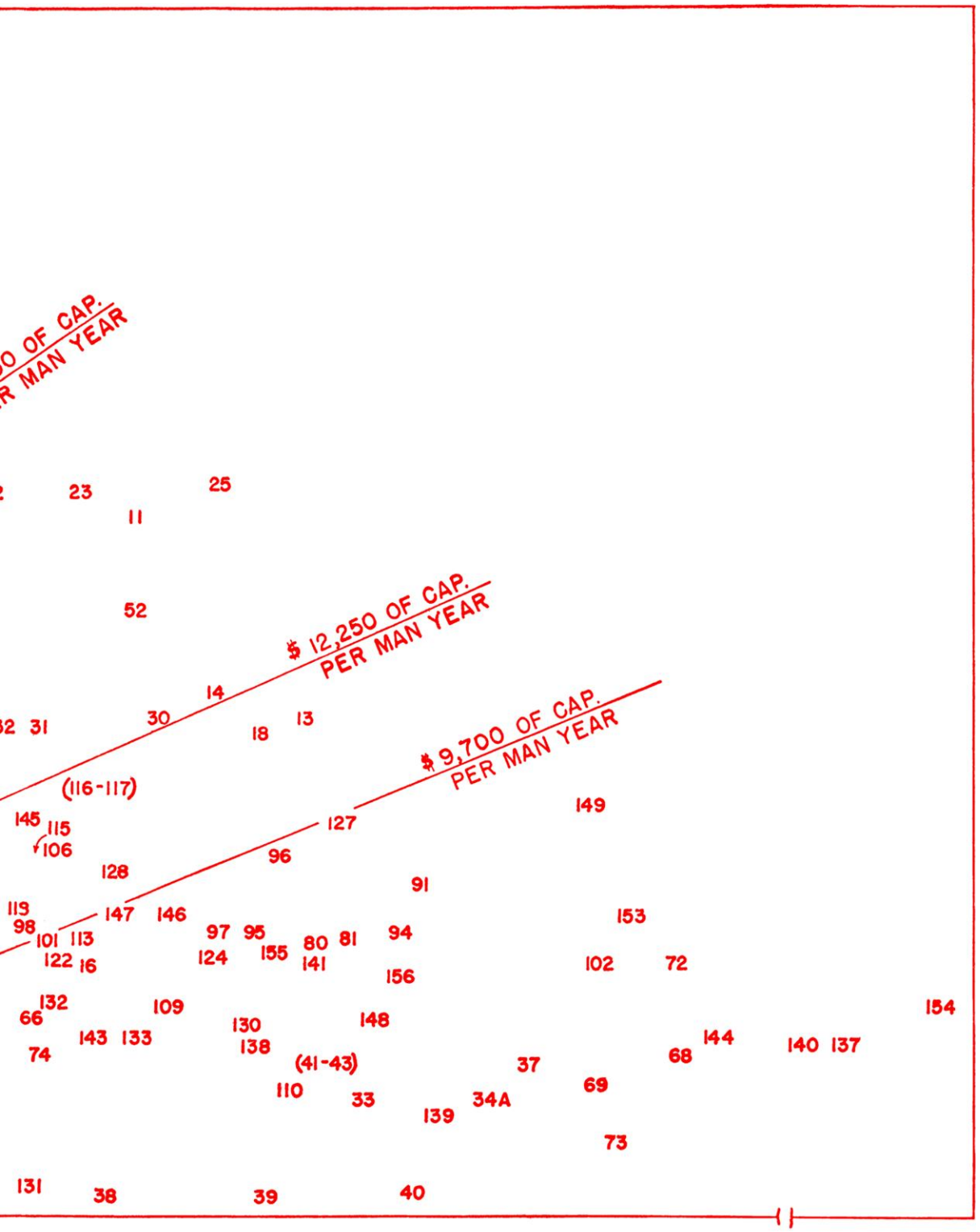

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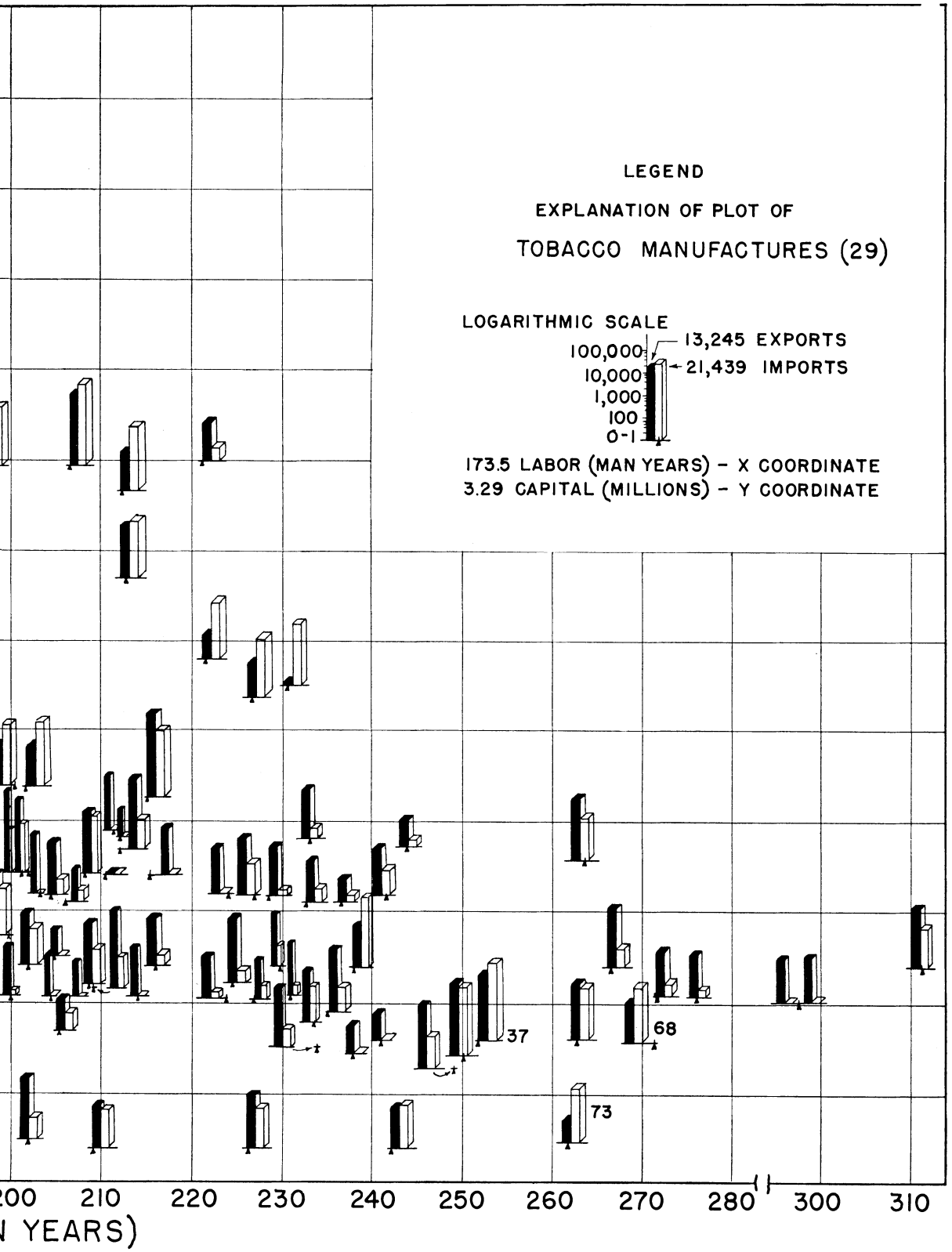
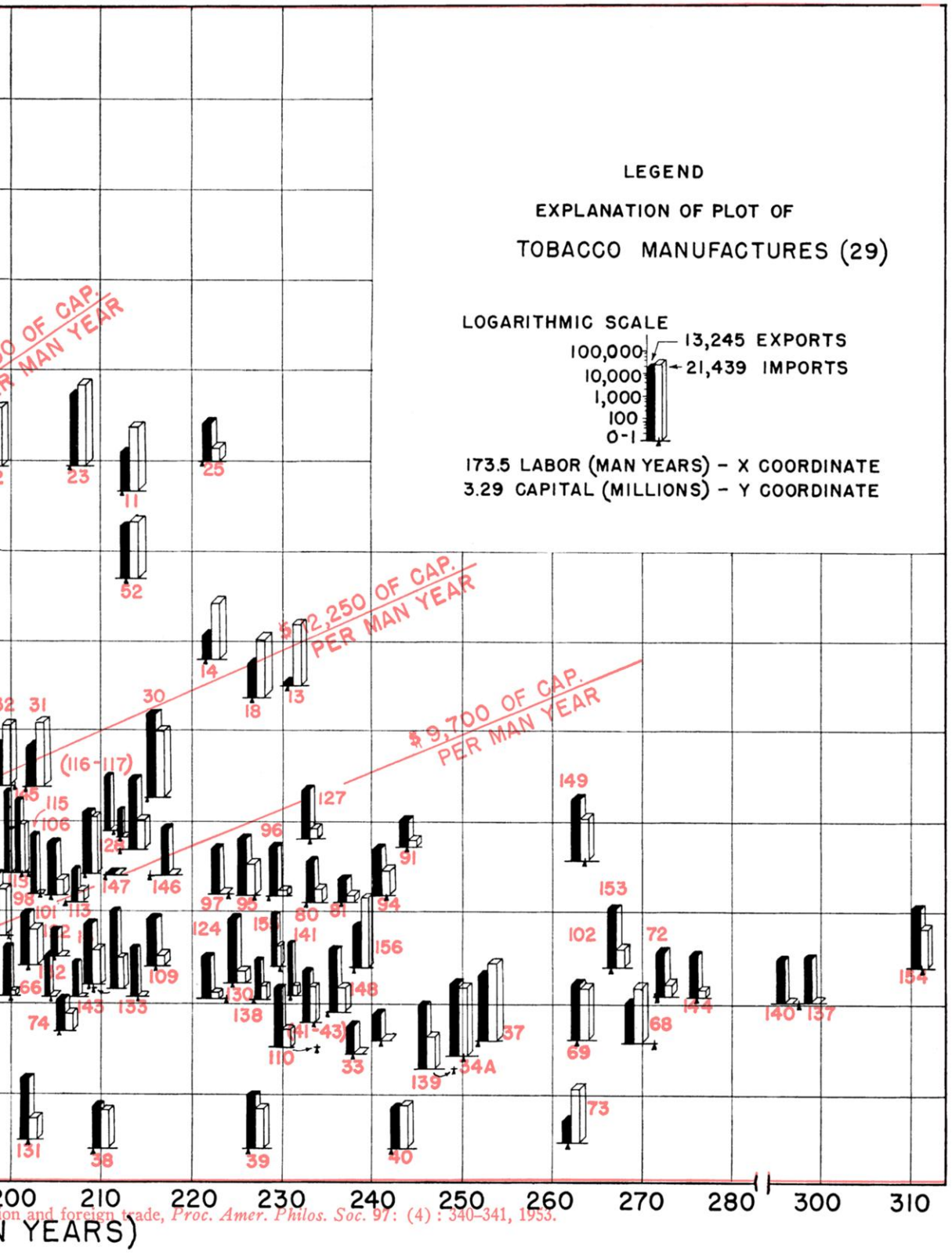
LLARS OF U.S. EXPORTS AND IMPORT REPLACEMENTS



G. 1

OLLARS OF U.S. EXPORTS AND IMPORT REPLACEMENTS



on and foreign trade, *Proc. Amer. Philos. Soc.* 97: (4) : 340–341, 1953.

G. 1

pendence on foreign countries and, to achieve this end, decided to decrease both its imports and exports by one million dollars each. Let us, in particular, examine the rather plausible case in which the reduction of exports is to be achieved by an equal proportional cut in each export commodity so that after the reduction the percentage composition of exports remains unchanged. The same procedure can be applied to so-called competitive imports, i.e., imports of commodities which can be and are, at least in part, actually produced by domestic industries. The level of non-competitive imports which, conventionally, are taken to comprise coffee, tea, jute (but not rubber, which can now be commercially synthesized) and a few other, minor items, is assumed to remain at the same time unchanged. Such an exemption obviously has a good common sense basis. Moreover, within the context of the present analysis, it also has the closely related reason that labor and capital requirements for the domestic production of, say, coffee, cannot be realistically assessed. For later reference, one might observe that hot houses and heating installations would in any case require inordinately large capital investment per million dollars' worth of competitively produced Florida or California coffee.

To replace a million dollars' worth of imports we would have to raise the output of the corresponding United States industries. If competitive imports were, as has been assumed, cut proportionally all along the line, the domestic production of the specific goods involved would have to expand by the amounts equal to the reduction in the corresponding imports, i.e. by the same proportional amounts. If, for example, newsprint constituted twenty per cent of all competitive imports, and woolens ten, then in replacing the total of one million dollars' worth of competitive imports, the domestic output of newsprint would have to be increased by two hundred thousand dollars and the production of woolens by one hundred thousand dollars.

Such domestic production for replacing imports would mean additional direct and indirect capital and labor requirements. These can be determined in the following way.

The large 200 industries input-output table of the American economy for the year 1947 shows the competitive imports for that year classified by the commodity groups into which they would fall if they had been produced by our domestic industries. Dividing each one of these figures by the aggregate dollar value of all competitive imports gives us the amounts by which the domestic outputs of these goods and services would have to be increased if our economy proceeded to replace commodity by commodity an aggregate million dollars' worth of (proportionally reduced) competitive imports. Column 5 in table 2 shows the composition of an average million dollars' worth of competitive imports. To compute the total amount of capital which would be required to produce domestically this particular collection of commodities, one has only to multiply each of these figures by the corresponding capital requirements listed in column 2 and then find the sum total of the resulting products. The products—one for each kind of the competitive imports—are entered in column 7.

An analogous computation yields the corresponding labor requirements. Column 9 shows the number of American man years which, in combination with the capital entered in column 7, would have to be employed to replace the foreign goods and services listed in column 3 with similar goods produced domestically.[5]

[5] For the purposes of the present analysis, we were able to utilize the previously completed computation which shows the effects of any given change in "final demand" on the levels of output of all American industries. (See Evans and Hoffenberg, *ibid.*) The results of these original computations must, however, be subjected to a quantitatively not very significant but in principle very important adjustment.

Common sense reasoning as well as actual experience shows that whenever any one of the American industries expands or contracts, the level of its operation tends to increase (or to decrease) its demand for imported inputs in a way analogous to the increases (or decreases) in its requirements for materials and services of domestic origin. An increase in the rate of our domestic outputs will, therefore, in general, lead to a rise in the volume of the dependent imports. The usual input-output computations thus present the United States' imports as depending on the level of final demand which, in particular, implies that any rise in exports would necessarily require an increase in imports.

For the purposes of the present analysis, this conclusion should certainly be retained in respect to inputs which are unlikely to be replaced by a supply coming from domestic sources. Coffee, jute, tin, and a number of other raw materials can be safely included in this "non-competitive" category. In evaluating the effect of increased exports on domestic capital requirements, it seems to be reasonable to assume that whatever additional indirect demand for the above type of goods will arise, it will be satisfied by foreign sources. In other words, in contemplating any possible changes in the level and the composition of our exports and imports—as they would result from alternative patterns of American foreign economic policy—it is reasonable to assume that the volume of such *non-*

The quantities of capital and of labor absorbed by the American economy per million dollars of its 1947 exports can be determined exactly in the same way. Column 4 in table 2 shows the composition of an average million dollars' worth of the United States' exports. The quantities of capital and labor required to produce the indicated amount of each export—obtained by multiplying each figure in column 4 by the corresponding figure in columns 2 and 3—are entered in columns 6 and 8, respectively.

V. EMPIRICAL FINDINGS AND THEIR INTERPRETATION

The principal findings of the quantitative factual analysis described above are summarized in the following figures:

DOMESTIC CAPITAL AND LABOR REQUIREMENTS PER MILLION DOLLARS OF U. S. EXPORTS AND OF COMPETITIVE IMPORT REPLACEMENTS (OF AVERAGE 1947 COMPOSITION)

	Exports	Import Replacements
Capital (dollars, in 1947 prices)	2,550,780	3,091,339
Labor (man years)	182.313	170.004

These figures show that an average million dollars' worth of our exports embodies considerably less capital and somewhat more labor [6] than would be required to replace from domestic production an equivalent amount of our competitive imports. America's participation in the international division of labor is based on its specialization on labor intensive, rather than capital intensive, lines of production. In other words, this country resorts to foreign trade in order to economize its capital and dispose of its surplus labor, rather than *vice versa*. The widely held opinion that—as compared with the rest of the world—the United States' economy is characterized by a relative surplus of capital and a relative shortage of labor proves to be wrong. As a matter of fact, the opposite is true.

What is the explanation of this somewhat unexpected result? The conventional view of the position which the United States occupies today in the world economy is based—as has been previously explained—first, on an empirical observation and second, on a factual assumption. The observation is that the United States possesses more productive capital per worker than any other country. It can hardly be disputed.

To reach the conclusion that this means that there exists a comparative surplus of capital and

competitive imports will be in the future as in the past directly determined by structurally conditioned domestic requirements.

With the typical competitive imports—such as cars, most other highly manufactured products, and also some raw materials such as, for example, crude oil—the situation is entirely different. If the problem of comparative costs, i.e., the question of possible alternative patterns of trade is to have any meaning in respect to such commodities, one must explicitly consider stepped-up domestic production as being an alternative to imports and *vice versa*. In this context, an increase in final demand and particularly an increase in export demand should not be assumed to result in an automatic rise in competitive imports. On the contrary, the domestic repercussion—for example, the change in domestic capital and labor requirements—of additional exports must first of all be computed on the assumption that whatever virtual demand for competitive importation might arise, it will be satisfied entirely and only through expansion of domestic output. The possibility of increasing the imports of such competitive commodities has to be considered as a separate alternative. The capital saving effects of such imports are explicitly taken into account when one separately postulates the expected changes in the level of specific competitive imports and computes the repercussion of such imports on domestic capital requirements.

In a very open economy, such, for example, as the British, the difference between the domestic reactions computed first on the assumption of an automatically induced change in the level of competing imports and then without such induced changes might be quite large; in the case of the United States—the most self-sufficient of the modern western economies—such discrepancy will be quite small. It was still, however, taken into account in the present study.

[6] There exists a good reason to believe that the excess of the labor requirements per million dollars' worth of American exports over the labor requirements for the equivalent amount of imports replacing output is actually larger than our computations shows it to be.

Part of the labor input entering in both of these figures consists of agricultural labor. Agricultural employment figures are well-known to be biased in the upward direction partly because many persons living on the farms do not actually work on them and partly because a very large portion of agricultural labor input is absorbed, one could nearly say wasted, in marginal subsistence farming.

Since the agricultural employment contributes less to the labor requirement of our exports than it does to the replacement requirements for our competitive imports, any downward revision in that figure would tend to increase the difference between these two figures.

The labor requirements shown in the summary table presented above are split between the agricultural and all other labor as follows:

AGRICULTURAL AND NON-AGRICULTURAL LABOR REQUIREMENTS PER MILLION DOLLARS OF U. S. EXPORTS AND OF COMPETITIVE IMPORT-REPLACEMENT (OF AVERAGE 1947 COMPOSITION)

	Exports	Import Replacements
Agricultural labor (man years)	22.436	40.934
Non-Agricultural (man years)	159.872	129.069
Total	182.308	170.003

a scarcity of labor in this country, the conventional argument must combine the foregoing observation with the implicit assumption that the *relative* productivity of capital and labor—if compared industry by industry—is the same here and abroad. Concretely, this assertion means that if in the United States we can transform ten pounds of yarn into a corresponding amount of finished cloth by using, say, one man year and two thousand dollars' worth of machinery, and transform a barrel of oil into gasoline by using one man year and twenty thousand dollars' worth of equipment, the corresponding foreign industries can perform each of these two operations either with exactly identical inputs of capital and labor or—if this is not the case—at least with inputs differing in both (and all the other) industries in the same proportion. So, for example, if in India one could weave ten pounds of yarn by using two man years and four thousand dollars' worth of machinery (instead of one man year and two thousand dollars as in the United States) the cracking of one barrel of oil could also be accomplished by using a double quantity of both factors, i.e., two man years and forty thousand dollars' worth of equipment.

Only on the basis of such an assumption, will the comparative costs argument necessarily lead to the conclusion that a country possessing a large stock of capital and a relatively small number of workers will find it advantageous to specialize in industries which, in terms of its own productive possibilities, require much capital and relatively little labor.

Let us, however, reject the simple but tenuous postulate of comparative technological parity and make the plausible alternative assumption that in any combination with a given quantity of capital, one man year of American labor is equivalent to, say, three man years of foreign labor. Then, in comparing the relative amounts of capital and labor possessed by the United States and the rest of the world—a comparison used for the explanation of their respective specialization in capital or labor intensive industries respectively—the total number of American workers must be multiplied by three, which would increase our 1947 labor force from 65 million to three times that number, i.e., 195 million of "equivalent" foreign man years. Spread trice as thinly as the unadjusted figures suggest the American capital supply per "equivalent worker" turns out to be comparatively smaller, rather than larger, than that of many other countries.

This, I submit, is the analytical explanation of the results of our empirical findings. In terms of the relative production possibilities here and abroad, the United States is rich in man power and poor in capital. This country resorts to foreign trade to save its capital and to dispose of its relative surplus labor.

Our data obviously cannot explain why American labor is more productive than foreign labor. The problem of productivity is so intricate and has been so thoroughly discussed elsewhere that no casual remarks can possibly advance its solution. The following negative observation, however, has a direct bearing on the subject of the present analysis and on the possible interpretation of its principal findings.

The extent to which the high relative efficiency of American man power causes this country to exchange goods which absorb relatively little capital for those which would require more capital if we chose to produce them at home, *cannot* be due simply to the large amount of capital which American industry uses per employed worker.

The fact that workers are frequently replaced by machines cannot be denied. But such technological substitution, if profitable in United States, would in general be profitable also in the corresponding industries abroad. The argument that the comparative shortage of capital might prevent the use of the same labor-saving technology by foreign countries would only hold if international trade, i.e., the international division of labor, did not exist. Actually, it does take place and if it were simply the problem of substituting capital for labor, foreign countries could and would imitate the American production practice industry by industry. At the same time, their production would be concentrated on those commodities which, both there as well as in the United States, require relatively little capital and large amounts of labor. The United States would for similar reasons concentrate on capital intensive industries and the trade between it and the rest of the world would consist in an exchange of American capital intensive against foreign labor intensive goods.[7] Our

[7] To clarify the internal logic of the argument leading to this assertion, let us consider—from the point of view of the world as a whole—the double problem of, first, allocating capital and labor between the various industries and, second, of locating the various industries in specific countries endowed with different relative amounts of capital and labor.

empirical findings indicate that in fact the opposite is true.

Thus, without denying that capital can be substituted for labor, we must still look for some other reason in explaining the high productivity of labor in America as compared with the labor employed by similar industries abroad.

Entrepreneurship and superior organization have often been mentioned in this connection. In accepting this most plausible explanation, we must, however, make the following comment. Both these, as well as such other factors as education or the general climate of our production oriented society do certainly make the American economy more efficient in the sense that it is able to achieve the same output of finished commodities and services with smaller inputs of capital and labor. There exists a definite statistical evidence that the man hour and the capital investment both measured per unit of output have been reduced in many of our industries through better utilization of equipment and more rational use of labor.[8] To explain the comparative surplus of labor which our figures unmistakably reveal, we must, however, also infer that entrepreneurship, superior organization and favorable environment must have increased—in comparison with other countries—the productivity of American labor much more than they have raised the efficiency of American capital.

From the point of view of sheer arithmetic, the American comparative capital shortage and labor surplus—as revealed in our figures—could, of course, be equally well explained if instead of assuming that American man years are more productive than foreign man years we took the labor productivity to be the same here and abroad, but at the same time assumed the United States' capital to be less productive than its dollar equivalent in foreign countries. Such an alternative explanation, implying an absolute inferiority of the American productive technology, hardly would pass the test of empirical scrutiny; it is plainly contradicted by the fact an average American man year receives a much higher remuneration than the man year of labor employed in most other countries.

VI. EMPIRICAL ANALYSIS OF SUBSIDIARY RELATIONSHIPS

Before directing your attention to the wider economic implications of these general conclusions, it is well to examine once more their empirical background.

Although computed on the basis of a rather detailed industrial classification, the amounts of capital and labor used in the production of Ameri-

If in accordance with the conventional argument, but in contradiction to the argument presented in this paper, one considers the technological possibilities to be the same throughout the world, i.e., if one assumes that with a given amount of capital and a given number of indigenous man years, every industry in England, in India or anywhere else is able to produce an output equal to that which the corresponding American industry *could* achieve with the *same* amount of capital and an equal number of (American) man years, that double task can be accomplished in the following two steps.

First, considering the total stock of capital and the combined supply of labor of all countries and taking in account the total world demand for various commodities and services, the proverbial "invisible band" of competitive adjustment would determine—on the basis of the uniform technological possibilities of the world as a whole—the proper amounts of capital and labor which each industry would best use per, say, every million dollars' worth of its respective output. Barring certain special, unusual situations, this decision could and would be made without any regard to the actual distribution of the combined labor and capital resources of the world between the different countries. This distribution could be taken into account separately in the next step in which all the individual industries would be actually assigned to the separate countries. In accordance with the "comparative supply of factors" considerations described in the first section of this paper, this second step will result in placing the industries requiring relatively large amount of capital into the countries comparatively well supplied with that particular factor and in locating the labor intensive lines of production in the areas having a comparatively larger supply of labor.

As a final result of such efficient "comparative costs" allocation, the capital rich countries must specialize on the production and export of capital intensive goods, while the labor rich areas will produce and export labor intensive commodities, while importing goods which, when produced at home, would absorb comparatively large amounts of capital and little labor.

It is particularly important to observe that under the assumption of technological parity the combination of capital and labor used in each industry—having been decided in the first stage of the two stage allocation procedure described above—will necessarily be the same in all the countries. For example, any specific textile product requiring much capital and little labor when made in the United States would require the same combination of these two factors also, if it had been produced in England, in India or in any other country. Being short of capital, i.e., of the factor which this product uses most, these other countries would, however, manufacture only relatively small amounts of that particular textile or even none at all.

[8] See Leontief, Wassily, Machines and man, *Sci. Amer.* **187**: 150–160, 1952. A different point of view is presented in the detailed factual study by Rostas, L., *Comparative productivity in British and American industry,* Cambridge Univ. Press, 1948.

can exports and those required for the replacement of competitive imports have been compared above only in terms of the over-all averages. If the explanation which has been given to these quantitative findings is correct, similar relationships should also be discovered within separate commodity groups.

A visual presentation of the quantitative relationships revealed by the figures contained in the first four columns of table 2 is given in figure 1. Since we deal here with essentially four-dimensional phenomena, they cannot possibly be described in an ordinary two-dimensional graph. Each one of the black-white blocks on the graph, figure 1, must be visualized as standing on the flat surface of the paper not unlike a diminutive skyscraper rising above the base map in a three-dimensional model of New York City. Each block represents a separate commodity type. Its position, or more exactly the position of its base, on the flat surface of the map reflects the capital-labor combination per million dollars of output required for its production in the United States; the capital requirement being measured upward along the scale marked along the left hand side of the chart, and the labor requirements—horizontally, along the man years scale entered along the bottom margin.

The length of the black strip in each block (in a truly three-dimensional figure it would be measured by its height above the capital-labor plane) represents the level of exports and the white strip, the imports of commodities of particular kind (see, for example, the explanation of the plot of Tobacco Manufactures (29) as given in the legend on the figure).

To facilitate the identification of all the individual blocks on the graph, their numbers—entered in brackets after the name of each industry in column 1 of table 2—are printed on a separate transparent sheet which can be superimposed on the graph. To make it possible to distinguish at a glance the proportions in which capital and labor are combined in the U. S. production of the various commodities, red reference lines are entered on the same overlay sheet showing the capital/labor ratios of $30,000 per man year, $17,500 per man year, and so on. The capital/labor ratios, i.e., the slopes of these four lines are chosen so as to include as nearly as possible one fifth of the total U. S. foreign trade turnover (i.e., of exports per million dollars of total exports plus imports per million dollars of total imports, as listed in column 4 and column 5 of table 2) into each of the resulting five radial segments in figure 1.

One can clearly see that in the upper left hand part of the map, i.e., in the sectors containing goods which require for their production larger amounts of capital and comparatively small quantities of labor, the white parts tend to be taller than the black parts of the same blocks. As one moves towards the lower right hand corner, the black strips tend to become higher than the corresponding white strips; the tendency to export goods requiring much labor and little capital for their domestic production and to import those which demand much capital and little labor can in other words be as clearly discerned in this detailed picture as it is reflected in the over-all averages presented above.[9]

The results of this visual examination are substantiated by the following numerical compilation.

EXPORTS AND IMPORTS COMPARED BY SECTORS WITH DIFFERENT CAPITAL INTENSITY

Capital Per Man Year (In Dollars)	Trade Turnover[a] (In Dollars)	Percentage of Turnover	
		Exports	Imports
1	2	3	4
More than 30,000	411,103	27.39	72.61
30,000–17,750	394,465	47.90	52.10
17,750–12,250	372,425	48.31	51.69
12,250– 9,700	395,028	61.76	38.24
Less than 9,700	393,869	69.62	30.38
Aggregate	1,965,890	50.82	49.18

[a] Turnover within the line segments is not exactly equal since they had to be summed for integral industries. Aggregate turnover differs from two million dollars due to rounding and the omission of the Other Nonferrous Mineral Mining industry—*cf.* footnote f, table 2.

It shows that as the capital/labor ratio goes down, exports make up an ever larger and imports a smaller fraction of the corresponding foreign trade turnovers.

We have examined the over-all choice which the American economy makes when it allocates its capital and labor to produce a million dollars' worth of the average combination of exportable

[9] The following ten service industries are omitted from presentation in our figure: Railroad Transportation (31), Trucking (170), Warehousing and Storage (171), Pipeline Transport (175), Local and Highway Transportation (178), Wholesale Trade (176), Retail Trade (177), Banking, etc. (36), Amusements (38), Communications (35), and Other Water Transportation (173). Being essentially non-transportable, the products of these industries cannot enter in any direct competition with imputed products of the same kind.

goods instead of using them to replace an equivalent average combination of imports. Behind it are subsidiary choices based on differences in the labor and capital requirements of specific export and import goods belonging to the same commodity group and because of that directly competing with each other. The presence of direct competitive relationships—or at least of more direct competitive relationships than those which exist among all commodities entering international trade—is of the essence for the existence of such separate subsidiary allocation problems. A proper isolation and detailed quantitative description of such "internally competitive" groups constitutes the necessary prerequisite for their empirical analysis.

The study of this particular aspect of our primary data has not yet been completed.[10] A careful perusal of the composition of American exports and imports as listed in columns 4 and 5 of table 2 enables us, nevertheless, to delineate a number of commodity groups which might reasonably, i.e., on the basis of the general knowledge one has about them, qualify for preliminary analysis. As should be expected, they correspond rather closely to the thirty-eight consolidated industries described above. Some of the latter, however, had to be broken down so as to separate important sets of obviously non-competing operations, such as, for example, the mining and final fabrication of metals; from some others, single non-competitive components had to be eliminated. A large number of export and import goods (although all of these, of course, were included in the computation of the over-all average capital and labor requirements) had to be omitted from the following analysis because they either did not fall into any definite competitive set, or formed small sets containing only two or three items.

Most commodities were actually combined in "internally competing" groups and each set was subjected separately to the same analysis which was previously applied to all exports and all competitive imports taken together. The average amount of capital and the average quantity of labor required to produce a million dollars' worth of exports falling within each such commodity group were computed; similar computations were performed for the corresponding sets of competitive—in this case directly competitive—imports. In each instance the average was obtained by weighting the capital and labor requirements of an individual product (as listed in columns 2 and 3 of table 2) in proportion to the value of the exports and imports of that particular product per million dollars of the exports and imports respectively for the group into which it belongs as a whole. The results of these computations are entered (in italics) in columns 6, 7, 8, and 9 opposite the names of the groups listed on the left in column 1.

To facilitate the interpretation of these subsidiary computations, the results of the comparison of the capital and labor requirements for export and import replacement within each of the twenty-six distinct "internally competitive" groups are shown in the last two columns (columns 10 and 11) of table 2. The sign ">" indicates that the export requirement exceeds the corresponding requirement for import replacement, "<" shows that the import replacement requirement is the larger of the two. To mark very small differences (amounting to less than 2 per cent of the larger of the two figures) which should perhaps be interpreted as equalities, we used the signs "$\geqslant$" and "$\leqslant$".

The following box scores summarize the final results showing the values of exports and competitive imports which fall within each of the distinct

Exports (Unit: one thousand dollars)

Labor \ Capital	<	$\leq$ $\geq$	>	Total
<	106	45	0	150
$\leq$ $\geq$	97	78	0	176
>	145 (+309)	97	58	300 (+309)
Total	348 (+309)	220	58	

[10] This study leads directly toward the problems involved in generalized formulation of interregional input-output theory. The distinction between typically "domestic" and the predominately "international" commodities is as fundamental for such analysis as the lower order distinction between "national" and "regional" commodities used in the study of the regional structure of the United States' economy. (See, Leontief, Wassily, *et al., Studies in the structure of the American economy,* Chap. 4 and 5.)

Competitive imports (Unit: one thousand dollars)

Labor \ Capital	<	≤ ≥	>	Total
<	98	6	0	104
≤ ≥	25	50	0	75
>	308 (+408)	99	6	413 (+408)
Total	431 (+408)	155	6	

"comparative cost types" per million dollars of all exports and competitive imports, respectively. Only 63 per cent of all exports and 59 per cent of imports fell into specific competitive groups. The rest which did not fit into any one of them constitutes, so to say, a separate group. On the basis of its comparative labor and capital requirements for exports and import replacements, this residual group falls in the lower left box. It is represented by the bracketed figures.

The examination of these figures shows that the direct competition between exports and imports belonging to the same commodity groups is dominated by our relative capital shortage and labor surplus, as is the over-all average picture of American foreign trade which we have considered before. Goods of the type requiring comparatively more American man years (but a smaller amount of capital) on the export side have a lion's share ($145 + $309 thousand) of our exports, while our competitive imports consist primarily of goods ($308 + $408 thousand) which, if they were produced at home, would absorb relatively large quantities of capital but smaller amounts of American labor. Disregarding the labor requirement entirely, we also see that commodities requiring for their production relatively small amounts of capital dominate our exports ($348 +$309 thousand) while the capital intensive commodities—irrespective of their labor intensity—are preponderant among competitive imports ($431 + $408 thousand).

Invisible in all these tables but ever present as a third factor or rather as a whole additional set of factors determining this country's productive capacity and, in particular, its comparative advantage *vis-a-vis* the rest of the world, are the natural resources: agricultural land, forests, rivers, and our rich mineral deposits. Absence of systematic quantitative information, similar to that which has been collected, organized, and used in this paper with respect to capital and labor, prevents us as yet from introducing this important element explicitly into this preliminary analysis.

However, indirect but clear signs of the influence of natural resources can easily be traced in the capital and labor input figures presented in table 2 and depicted in our graph. This influence is revealed mostly in their deviation from the dominant pattern reflecting the comparative capital shortage and labor surplus of the American economy. Without embarking on a detailed but necessarily conjectural examination of such special cases, let me point to only a few of them as seen in figure 1.

Near its lower right hand corner we find a few entries in which, contrary to the general tendency prevailing in that part of the graph, the white part of the block is taller than its black part. Consulting table 2, we find that these labor intensive and capital extensive industries showing such unusually weak position *vis-a-vis* competitive foreign imports comprise, Sawmill (37), Pottery (73), and Leather Products other than Shoes (68); all of them are based on natural materials in which the United States is obviously short as compared with the foreign countries. On the other side of the cluster among the capital intensive and labor extensive commodities of which we import as a rule more than we export, Sulphur (19), Meat Packing (21), and Grain Mill (24) products show a considerable export surplus. The United States is apparently comparatively well situated with respect to the domestic supply of such specific mineral and agricultural natural resources as are required in the production of these particular goods.

Without the necessary additional information any further pursuit of this line of reasoning is bound to become highly speculative. Conjecture about facts is intriguing but—at least in the field of economics—essentially futile in the long run. Since the facts pertaining to this particular subject are now being collected and organized, it might be well to refrain from further speculation, however tempting it may be.

VII. SOME GENERAL IMPLICATIONS

This study has been designed to ascertain the structural basis of the United States' trade with the rest of the world. We find that, contrary to widely held opinion, our exchange of domestically produced goods for competitive imports serves as a means to compensate for the comparative shortage of our domestic capital supply and a corresponding over-supply of American labor.

Without attempting a systematic exploration of the possible wide-reaching implications of these empirical findings, let me merely mention here a few questions, the answers to which might be seriously affected by the results of this preliminary investigation.

Foremost among them is the problem of the changing position of the United States in the world economy. A richly abundant supply of natural resources—as compared with capital and labor—dominated our early development and our trade relations with foreign countries up to about 1910. From the fact that at the present time capital appears to be comparatively more scarce than labor, one might surmise that this scarcity has dominated our entire economic development until now. This would mean that—in terms of a comparison with the rest of the world—our capital supply, while steadily growing, has still not caught up with the increase in our labor force, if the peculiarly high effectiveness of that labor force is taken into account. A larger supply of domestic capital, if not matched by a corresponding increase in domestic man power, will, in any case, reduce rather than increase the comparative advantage in labor supply on which our present exchange of goods and services with foreign countries seems to be based. In other words, a more rapid rise in our average productive investment per worker would diminish rather than increase the advantage derived by the United States from its foreign trade. Only a spectacular additional increase in domestic capital stock could tip the balance of comparative advantage to the other side and thus bring about conditions which by common assumption are already supposed to exist, i.e. a situation in which the United States would actually find it advantageous to use its foreign trade as a means to save American labor and to dispose of surplus American capital. In view of the determined effort of many so-called backward countries to increase their own capital stock, such tipping of the scale will take some time. On the other hand, the factors, whatever they may be, which are responsible for the peculiarly high relative productivity of American labor might soon become operative in other economies and thus accelerate the elimination of disparity between the effective comparative supply of capital and labor here and in foreign countries. This signifies, of course, a reduced incentive to the continued exchange of commodities and services between the United States and the rest of the world.

Since no discussion of foreign trade is considered to be well rounded off without some mention of free trade and protection, I conclude with an observation on that timeless subject. An increase in the United States' tariff must obviously reduce the volume of our competitive imports below what it otherwise would have been; by restricting the effective foreign demand for American goods, it would bring about also a corresponding cut in our exports. Since the exchange of goods and services with foreign countries serves as a means to relieve the pressure of our domestic labor surplus and our capital shortage, a partial closing of that valve will tend to increase such pressure. In other words, protectionist policies are bound to weaken the bargaining position of American labor and correspondingly strengthen that of the owners of capital.