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CONCEPT AND STATISTICAL MEASUREMENT OF VERTICAL INTEGRATION

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WE OFTEN speak of a firm as being highly integrated vertically, of one industry as being more integrated than a second, of either a firm or an industry as becoming more integrated or less integrated in the course of time. Once we speak in terms of greater and less, we have spoken in terms of quantity and have indicated the need of measuring quantity.

This need is emphasized by the fact that one commonly used measure of size and of concentration, the amount of sales, has a well-known shortcoming. This measure does not indicate the degree of vertical integration; for example, a manufacturer selling $1 million worth of goods is a much larger firm than a retailer selling the same amount. Firms of such dissimilar structure should not be classified together upon the basis of size of sales. It is a mistaken though common practice to analyze firms statistically by computing the percentage of their sales that is allocated to research, wages, or other purposes. Also, it is a regrettable fact that the "concentration ratios" developed by the Temporary National Economic Committee can be stated only in terms of sales; however, as a measure of oligopoly rather than of concentration, this is not nearly so objectionable. Furthermore, ambiguities arise when attempts are made to measure the trend of concentration through time.[1]

It seems clear that there is some kind of relationship, at least of a formal kind, between integration and concentration. The object of this paper is to develop the formal relationship as an aid to the study of the real one. Accordingly, two requirements have been set up for defining any measure of vertical integration. First, it must be an extension of, and consistent with, accepted economic doctrine. Second, it must be operational and capable of statistical treatment. Two such measures will be proposed and used here. Their use suggests that size is positively correlated with the degree of vertical integration, but the relation is not a simple one.

1. *Ratio of Income to Sales*

THE first proposal employs the concept of the ratio of income to

[1] M. A. Adelman, "The Measurement of Industrial Concentration," *Review of Economics and Statistics*, November 1951, pp. 272, 291.

sales. Every firm is confronted by a choice between purchasing or selling on the one hand and additional processing[2] on the other: make *or* buy, sell *or* process further. The decision depends upon the particular economies of each course of action. Through vertical integration the firm by-passes or, more accurately speaking, encompasses a market nexus. Administrative direction replaces the bargaining of the market. In the widest sense all firms, even small ones, are vertically integrated in that they could conceivably be divided into two or more firms, earlier stages selling to the later.[3]

Now, were all firms and industries *completely* integrated, there would be no sales except to final consumers. A tableau of the Leontief type[4] (but arranged on a firm rather than on an establishment basis) would be collapsed into the lowest line and the extreme right-hand column. The total sales of business firms to consumers would be equal to the income originating in the business sector of the economy. There is, of course, a whole family of income measurements, each with a different degree of netness; but assuming consistency in use, complete vertical integration would mean that the ratio Y/S (where Y denoted income, and S sales) would equal unity. The less integrated the business system, the more interfirm transactions there would be, the larger would S become, and the smaller would be the ratio.

If the firm instead of the whole economy is considered, the situation is largely but not wholly the same. The sales of the firm, whether to consumers or to other firms, are equal to the total income generated up to that point of sale. The income originating within the firm is its own contribution to that total. Thus the ratio Y/S defines the degree of integration only up to the point of sale and takes no account of operations past this point. For example, suppose that in a given industry there are three firms: a primary production firm, a manufacturing firm, and a distribution firm; each contributes one-third of total value added by the industry. The primary producer—on the unrealistic assumption that he buys nothing from other firms—would have a ratio of 1.0; the manufacturer, a ratio of .50; the distributor, one of .33. If the manufacturer integrated backward to absorb primary production, the new

[2] The word "process" or "make" means any productive activity, not merely extractive or manufacturing activity.

[3] R. H. Coase, "The Nature of the Firm," *Economica*, November 1937, p. 389.

[4] W. W. Leontief, *The Structure of American Economy* (Harvard University Press, 1941), pp. 15-20, and Tables 5 and 6.

firm would have a ratio of 1.0; if he integrated forward to absorb distribution, the new firm would have a ratio of .67.

Thus the ratio of income to sales, when calculated for the single firm, does not have the simplicity and accuracy it has when calculated for the whole business economy. The nearer we go to primary production, the less sensitive the index becomes to changes in the degree of integration. This is a serious limitation, but it can also be turned to good use. Thus, if our completely integrated primary producer has integrated forward and his ratio of income to sales has actually decreased, it follows that he must now be very asymmetrical, with the later stages buying a considerable amount from outside sources. Again, if two firms of apparently identical function show a significant difference in ratios, the identity must be spurious.

The measure of integration in an industry is in concept midway between those involving the economy and the firm. Thus, if every individual producer in the industry were completely integrated or if, as a special case of complete integration, the industry were monopolized, there would be no sales within the industry. But if the industry were finely subdivided into as many firms as there were successive processes, the amount of sales would be very much larger. Thus the ratio of sales to value added is again an index of the degree of vertical integration. But for the industry the ratio reflects two separate characteristics: one is the "stretch" of the whole industry from material entry to product exit; the other is the degree of subdivision between these two points. And for the purposes of any particular investigation, it may make a good deal of difference which characteristic is responsible for the ratio.

2. *Ratio of Inventory to Sales*

A SECOND proposed or alternative measure of vertical integration is the ratio of inventory to sales. The longer the production line and the more successive processes are operated by one firm, the higher the ratio. This is a derived measurement rather than a direct one. There is no limiting value which would signify complete integration, and all figures are of purely relative significance. The accuracy of this measure would probably be improved if it included only goods in process, since this would be closer to the length of the production line. The ratio of inventory to sales has one particular virtue as a measure of integration: it is not distorted by the nearness of the firm to primary production; the other ratio or measure is. On the other

hand, the ratio of inventory to sales is more susceptible to meaningless comparisons.

3. *Divergent, Convergent, and Successive Functions*

AT THIS point it is useful to consider an earlier attempt at quantitative measurement of integration, both horizontal and vertical. Monograph 27 of the Temporary National Economic Committee classified multiplant firms into five broad types.[5] The most common type consisted of firms performing a "uniform function"; this illustrates the most obvious form of horizontal integration. The least common type engaged in "unrelated functions," or conglomerate integration. Of the 5,600 multiplant firms recorded by the Bureau of the Census in 1937, 2,100 controlled plants in more than one industry, but only 95 firms controlled plants without visible functional relationship among themselves. Even this number the monograph considers as an overestimate resulting from the lack of time and money to delve further.[6] Types of integration involving "uniform" and "unrelated" functions are outside the scope of this study. The other three broad classifications may be considered in detail, since they are involved to some extent in this analysis.

The "divergent functions" performed by one group of firms include: (a) "Joint products," which are defined as goods made from the same raw material or subassembly. This would seem to be horizontal rather than vertical integration. (b) "By-products," which are really joint products as commonly defined in economic theory; that is, they are technically inseparable, so that the firm cannot produce one without the other. The possession of an establishment for further processing a by-product is vertical integration. (c) "Like processes," or producing goods which are different in the physical and market sense, such as woolen and cotton woven goods. This constitutes horizontal integration.

The "convergent functions" of another group are also subdivided: (a) "Complementary products," where two or more specialized plants supply the several components of the finished product. (b) "Auxiliary products," where one plant supplies a product or products of another. Both of these seem to involve that progression from earlier to later stages of production which constitutes vertical integration and would be reflected in our two ratio measurements. (c) "Like

[5] Willard L. Thorp and Walter F. Crowder, *The Structure of Industry*, Temporary National Economic Committee, Monograph 27, 1941, Part II, Chap. 3.

[6] *Ibid.*, pp. 206-207.

markets," where physically unlike products result. This would be classified as horizontal integration.

The "successive functions" of the fifth group illustrate vertical integration in the narrowest sense.

The monograph lists, by major industrial groups, the number of central offices (of multiplant firms) operating in each group, according to the function of the central office. Although this information is interesting, it is not a measure of the degree of integration. Each central office was counted once, whether it controlled two establishments or two hundred; there is no indication of the number of employees or of the amount of value added by the establishment controlled by the central office. The total number of establishments involved is not given. Even if these data were available, this would by no means solve the problem. A "plant" is sometimes an arbitrary grouping and may as properly be called two (or more) as one. A single plant does not necessarily perform a single function or produce a single product. Thus most large firms in the rubber industry would on common-sense grounds be considered vertically integrated, but the integration or the succession of functions takes place within very large plants, so that the mere counting of plants and of central offices performing vertical functions would not indicate vertical integration.[7]

4. *Statistical Data*

WITH these various concepts in mind, we turn to the statistical evidence. Table 1 summarizes census data on multiplant production, which reflect both horizontal and vertical integration for 1939 and 1947. The change between these years is not significant; the number of establishments of the multiplant firms, as would be expected in so expansionary a period, did not increase as much as the total number of establishments of all firms, but the percentage of value added of multiplant firms[8] scarcely diminished. The establishments of the multiplant firms are substantially larger than the average establishment in terms of the number of employees and still larger in terms of value added. Thus since multiplant production is unmistakably associated with size and also with vertical and horizontal integration, these data constitute evidence of some positive association between

[7] *Ibid.*, pp. 196-197.

[8] This is not a measure of change in concentration, however, because the census does not give us the total number of manufacturing firms or the number of multiplant firms for either year.

size and vertical integration. But this association is extremely loose; nothing more precise can be obtained from the census data.

Table 2 presents a comparison of the income-sales ratios for a sample of 183 large manufacturing corporations, and Table 6 shows the same comparison for the manufacturing corporate universe. The sample was selected from available data in annual reports; for this reason the proportion of income thus accounted for varies widely among industries. For both the sample and for the universe, the denominator of the ratio is sales. This would require for strict comparability a similarly gross concept of income; hence the best numerator would be one which comprehends the whole spread between purchases of goods and services from other firms and sales. Unfortunately, such data are available in only a few of the corporate reports; therefore, income has been defined as the total of (a) payrolls, including supplemental employee payments and "fringe" benefits, (b) profits before federal income taxes, (c) interest, and (d) depreciation.

For the universe and the industry subdivisions, the denominator is corporate sales as estimated by the Department of Commerce.[9] The numerator is, in effect, income originating in the corporate sector by major industrial groups.[10] The largest element is the Commerce estimate of "wages and salaries" by industry. For each industrial grouping, the estimate has been multiplied by a factor repre-

[9] The advantage of using Commerce data arises from their conformity with the national income concept. But they are based on *Statistics of Income*, Bureau of Internal Revenue; and to the extent that corporate income tax returns are not completely consolidated, certain amounts appear as sales which are really intracorporate transfers. Hence there must be an upward bias in the sales figure and a downward bias in the Y/S ratio.

The extent of this bias is suggested by comparison of *Statistics of Income* with the *Quarterly Industrial Financial Report Series, 1949*, Federal Trade Commission and Securities and Exchange Commission, since large corporations in the latter are completely consolidated. For all manufacturing, the *Quarterly Industrial Financial Report Series, 1949* total is about 15 per cent below that of the Bureau of Internal Revenue. Unfortunately, there seem to be some factors other than consolidation involved here. The discrepancy is least in the big-business industries and largest in the small-business industries, although the importance of consolidation is just the contrary. It has so far proved impossible to devise an adjustment.

[10] This is the first attempt to construct such a table, so far as I am aware, and some revision is necessary before it can be considered satisfactory. Such refinement would be well worth while, in my opinion, because these statistics could then be used for other purposes—most notably to extend John Lintner's valuable study of corporate profits and national income, *Corporate Profits in Perspective* (American Enterprise Association, Inc., 1949).

senting the corporate share of total employee compensation in the industry. The factor is derived largely from *Census of Manufactures, 1947* and from some miscellaneous subsidiary sources. Corporate interest is the figure taken from the Bureau of Internal Revenue reports, since the Commerce estimates of interest are much too net—they measure "the payments less the receipts of relevant payer groups" rather than the interest outpayments of corporations, with which we are concerned. Corporate profits are those estimated by the *Quarterly Industrial Financial Report Series,* since the adjustments made by the Department of Commerce to fit the national income concept make its estimates less comparable with the sample and the Bureau of Internal Revenue data were not available at the time of writing.

There is a question as to whether interest should be counted as income originating within the firm, since it might be considered simply a payment for services, perhaps comparable with a payment for electric power service. Our view is that creditors should be counted as members of the corporate family. Profits plus interest include the return on the property of the corporation; to exclude interest would be to have income determined by the fortuitous effect of the company's particular capital structure, which is a matter largely of the discretion of management.

Corporate reports usually do not show the amount of rents and royalties paid out, but these items would be excluded in any event, since they are payments for services by outside persons or agencies. If the firm bought rather than rented, it would be more highly integrated and the return to capital would be higher; similarly, the firm has a choice between paying patent royalties or setting up a research department, so that payment would be shifted from royalties to salaries and to property income. Nor is the matter different in the case of the firm without any such choice. The best-known example of this is found in shoe machinery,[11] where the payments to the lessee of shoe machinery are clearly to be imputed to the latter.

No two corporate reports are exactly alike, and a host of small adjustments were necessary to keep the data comparable. An important defect of Table 2 results from the volatility of corporate profits over time and their variability among firms. The more capital-intensive the firm and the higher the ratio of property income to

[11] *United States* v. *United Shoe Machinery Corp.*, Commerce Clearing House, 1953, par. 67,436.

labor income generated, the wider the margin of possible error. And the more unsettled the general price level, the less precision of meaning do the profit data have: for this reason, the year 1949 was used in Tables 3A, 3B, and 4. If there were a systematic and strong association between size and profitability, there might be as a diminished echo an association between size and vertical integration. This does not seem to be the case during periods of high employment.[12]

For most branches of manufacturing, the Commerce industry groupings are at least as broad as the fields of activities of the large corporations in the sample. But some difficulties were encountered. Employee income, which is the major part of total income, is given on an establishment basis in our national income statistics, so that employee income originating in the nonmanufacturing activities of a predominantly manufacturing concern appears in the nonmanufacturing sector. But corporate profits, as recorded by the Bureau of Internal Revenue and adapted by the Department of Commerce, are shown by firms and not by establishments. This is comparable to the reports used in our sample but not comparable to the other national income statistics.[13]

The best procedure might have been to estimate, for each nonmanufacturing industry, the total of all activities operated by concerns predominantly engaged in manufacturing, in order to obtain a "mixed" universe comparable with the "mixed" sample. Since this was impossible, it was necessary to include in the activities of certain manufacturing industries those of the whole nonmanufacturing industry which supplies them, as explained in the notes to Table 3A.

Table 4 presents the ratio of the value of inventories to sales computed from data given in *Statistics of Income* for the years 1940 and 1949. Since inventories are a relatively unstable item of assets, affected not only by changes in business activity and in price but also by anticipations of both, it is desirable to choose years when these were at a minimum. During 1940 the sum of the absolute values of the inventory valuation adjustment, for all corporations and for each component of the business economy, was the lowest for any year of the period 1929-1951 (with the exception of 1935, for which

[12] Joseph L. McConnell, "Corporate Earnings by Size of Firm," *Survey of Current Business*, Dept. of Commerce, May 1945, and "1942 Corporate Profits by Size of Firm," *Survey of Current Business*, January 1946; Sidney S. Alexander, "The Effect of Size of Manufacturing Corporation on the Distribution of the Rate of Return," *Review of Economics and Statistics*, August 1949, pp. 233-235.

[13] *National Income Supplement, 1951, Survey of Current Business*, Dept. of Commerce, p. 85.

statistics are not otherwise as satisfactory).[14] The data for 1940 are unsatisfactory for two reasons: (1) 1940 is more than a decade past; (2) because consolidated tax returns were not permitted between 1934 and 1941, the figures result in an artificial equalization of firm size and an artificial increase in sales. For these reasons, it is desirable to use data for a later year. There was the smallest inventory distortion for 1949 of all nonwar years since 1940.

5. *Size Associations*

TABLE 1 suggests that large corporations are more integrated vertically than are small corporations; this is not satisfactorily verified in Table 2. The reasons for this inconclusive result are fairly obvious: (a) the diversity within each two-digit industry group and (b) the small number of corporations within each subgrouping. Certain such subgroups are purely formal or residual; for example, the group "Stone, clay, and glass" contains four diverse and noncomparable kinds of enterprise.

Some of the industry detail is comparable, however. In meat packing and in dairy products, there seems to be a mild association between size and degree of integration. The rest of the food firms and the tobacco firms are too diverse in their output to allow any meaningful comparison. No textile group shows any trend. No relation is observable in paper production or in chemicals, rubber, or petroleum refining. The homogeneity of the major oil companies is striking, but Standard Oil of California is substantially more integrated than any other. In primary iron and steel, among the first eight concerns, there appears to be a positive relation; and the same may be said of electrical machinery, if we exclude a rather specialized firm like Raytheon.

The transportation equipment group is perhaps the most interesting. It has long been known that General Motors (like Ford) is considerably more integrated than Chrysler; according to the table, this is in the proportion of 5 to 3. Yet one would hesitate to conclude that there was any tendency *in general* for larger automobile companies to be more integrated than smaller, for there is no significant difference between Chrysler and the other, much smaller, automobile assemblers (even if Nash-Kelvinator is disregarded as being too much a part of the electrical machinery group). The large parts makers like Briggs, Budd, and Borg-Warner are, as was to be expected, more integrated than the automobile builders other than General Motors.

[14] *Ibid.*, Table 22.

TABLE 1

Corporate Multiplant Firms by Manufacturing Industry Groups, 1939 and 1947
(PERCENTAGES REFER TO TOTAL OF INDUSTRY GROUP)

Industry Group	ESTABLISHMENTS OPERATED Number 1939	Number 1947	Per Cent 1939	Per Cent 1947	Per Cent of All Production Workers 1939	1947	Per Cent of All Wages and Salaries 1939	1947	AVERAGE NUMBER OF PRODUCTION WORKERS In Corporate Multiunit Establishments[a] 1939	1947	In All Others 1939	1947
Food and kindred products	9,273	8,016	21.2	20.1	53.3	54.1	n.a.	54.9	46	74	11	16
Tobacco manufactures[b]	119	211	15.6	19.3	73.3	78.9	n.a.	80.9	539	386	51	25
Textile mill products	1,921	1,742	29.8	21.4	59.5	55.0	n.a.	54.1	335	364	97	80
Apparel and related products	1,431	1,669	7.1	5.4	28.1	23.9	n.a.	19.5	148	139	29	25
Lumber and lumber products (except furniture)[c]	1,957	2,169	16.1	8.3	39.6	30.3	n.a.	33.9	80	83	23	17
Furniture and fixtures[c]	463	459	9.1	6.0	27.4	26.1	n.a.	27.5	115	161	30	29
Paper and allied products	1,275	1,422	38.9	34.7	66.3	68.6	n.a.	69.2	138	188	44	46
Printing and publishing	1,223	1,202	4.9	4.1	25.2	29.3	n.a.	32.6	67	107	10	11
Chemicals and allied products	3,047	2,858	33.1	28.4	77.7	73.3	n.a.	72.0	73	120	10	17
Petroleum and coal products	643	614	65.0	44.3	92.9	85.5	n.a.	85.9	152	236	21	32
Rubber products	161	180	27.1	20.6	69.4	74.7	n.a.	76.7	520	890	85	78
Leather and leather products	627	647	17.9	12.2	48.9	44.5	n.a.	41.4	256	240	58	42
Stone, clay and glass products	1,835	1,520	26.1	13.0	57.7	55.7	n.a.	58.8	90	149	23	18
Primary metal industries[d]	(571)	1,261	21.7	23.5	54.7	77.2	n.a.	77.5	223	618	51	56
Fabricated metal products[c]	(1,318)	1,523	13.7	9.1	44.0	47.4	n.a.	47.0	144	256	29	29
Machinery (except electrical)	1,253	1,559	13.2	8.7	52.2	53.4	n.a.	53.0	218	426	30	35
Electrical machinery	441	885	21.9	22.3	67.0	73.2	n.a.	74.7	389	529	54	55
Transportation equipment	564	615	26.8	16.6	80.6	80.4	n.a.	81.3	986	1,290	70	63
Instruments and related products[c]	183	275	16.0	10.6	50.5	58.1	n.a.	59.2	211	384	39	33
Miscellaneous manufactures[c]	505	992	6.6	7.0	27.6	33.8	n.a.	35.6	103	135	19	20
Total	29,500	29,566	16.0	12.3	54.6	54.8		56.4	146	221	29.4	25

See page 292 for footnotes.

TABLE 1 (*continued*)

(*dollars in thousands*)

Industry Group	*Per Cent of Total Value Added by Manufacturers*		AVERAGE VALUE ADDED BY MANUFACTURE				AVERAGE VALUE ADDED PER PRODUCTION WORKER			
			In Corporate Multiunit Establishments[a]		*In All Others*		*In Corporate Multiunit Establishments*		*In All Others*	
	1939	*1947*	*1939*	*1947*	*1939*	*1947*	*1939*	*1947*	*1939*	*1947*
Food and kindred products	57.7	59.4	$ 218	$ 669	$ 43	$115	$ 4.7	$ 9.0	$ 4.0	$ 7.3
Tobacco manufactures[b]	87.7	89.9	2,581	2,720	67	75	4.8	7.1	1.3	3.0
Textile mill products	59.5	55.7	564	1,710	163	368	1.7	4.7	1.7	4.6
Apparel and related products	24.8	20.6	240	548	55	120	1.6	3.9	1.9	4.8
Lumber and lumber products (except furniture)[c]	42.0	35.4	146	407	39	67	1.8	4.9	1.7	3.9
Furniture and fixtures[c]	30.5	30.1	287	904	66	133	2.5	5.6	2.2	4.6
Paper and allied products	70.5	72.7	481	1,469	128	293	3.5	7.8	2.9	6.4
Printing and publishing industries	29.3	33.4	423	1,186	53	102	6.3	11.1	5.1	9.2
Chemicals and allied products	77.4	74.8	477	1,405	69	187	6.5	11.7	6.6	10.8
Petroleum and coal products	92.6	83.4	973	2,738	144	432	6.4	11.6	6.7	13.6
Rubber products	72.8	75.6	1,835	5,474	255	457	3.5	6.1	3.0	5.9
Leather and leather products	49.9	43.2	464	1,024	102	187	1.8	4.3	1.7	4.5
Stone, clay, and glass products	67.1	63.0	333	956	58	84	3.7	6.4	2.5	4.8
Primary metal industries[d]	62.5	78.1	646	3,570	107	308	2.9	5.8	2.1	5.5
Fabricated metal products[c]	45.7	47.4	469	1,530	88	170	3.2	6.0	3.0	6.0
Machinery (except electrical)	50.8	51.4	799	2,578	117	232	3.7	6.1	3.9	6.5
Electrical machinery	72.5	75.3	1,643	3,315	175	311	4.2	6.3	3.2	5.6
Transportation equipment	83.2	81.3	2,646	7,758	196	355	3.3	6.0	2.8	5.7
Instruments and related products[c]	57.8	60.4	962	2,371	134	184	4.6	6.2	3.4	5.6
Miscellaneous manufactures[c]	28.0	37.0	261	780	48	100	2.5	5.8	2.5	5.0
Total	59.4	58.2	$ 497	$1,464	$ 65	$147	$ 3.4	$ 6.6	$ 2.2	$ 5.8

n.a. = not available.

Notes to Table 1

[a] "Production workers" and "multiunit" are designations used in 1947. They are treated as equivalent to the "wage earners" and "controlled by central office" designations used in 1939.

Multiunit establishments include only those owned by corporations. Those owned by individuals and partnerships have been classified with "all others," because they resemble the latter much more closely. In 1947 two industry groups, "electrical machinery" and "miscellaneous manufactures," include under multiunit all types of organization in order to avoid disclosure. In both groups, however, the distortion is negligible.

[b] This includes in 1947 the designation "tobacco stemming and redrying," which was not included in 1939 and for which no 1939 figures are available. Of 1,086 firms in "tobacco manufactures," 163 were in this subgroup; therefore the data for the two years are not completely comparable.

[c] These industry groups were reclassified from 1939 to 1947, and as a consequence a retabulation of 1939 data was necessary. In a few cases figures for the individual industry groups were not available. The error introduced on account of this difficulty is, however, less than 10 per cent.

[d] These industry groups were reclassified from 1939 to 1947. Because of the disclosure rule, data for certain of the industries for 1939 were not available; hence the total given here is incomplete and not comparable with the 1947 data. Where the column entries are ratios rather than absolute numbers, the 1939 entries can be considered as a sample, although probably not a representative one, of the 1939 industry group.

Source: *Census of Manufactures: 1939*, Bureau of the Census, Vol. 1, Chap. v; *Census of Manufactures: 1947*, Vol. 1, Chap. iv.

Table 4 is based on the complete universe of manufacturing corporations, and the trend which is indicated in Tables 2 and 3 is much more striking here. Table 4 shows that in every case there is a strong trend toward higher ratios between the value of inventories and sales as the size of the firm increases. But for total manufacturing and for fifteen out of twenty industry groups in 1949,[15] firms with the largest inventories had a lower ratio than the group immediately preceding. Possibly this might be explained by the correlation of LIFO (last-in, first-out) accounting (which would understate inventories) with size of firm.[16] But the same tendency is observable in thirteen industry groups for 1940, despite the artificial equalization of firm size. Assuming, at least for the sake of the argument, that a more normal period would show the same phenomenon, how can this be interpreted? One explanation might be that, where the marketing of the product becomes an important consideration, the advantages of carrying a full line impel the larger firms not only to process to completion but also to buy semifinished products and to

[15] This is true also for 1948, although the data for that year have been omitted.

[16] J. Keith Butters, *Effects of Taxation: Inventory Accounting and Policies* (Harvard University Press, 1949), Chap. II.

TABLE 2

Ratio of Corporate Income to Corporate Sales for 183 Large Manufacturing Corporations, 1949
(dollars in millions; ratios in per cent)

CODE	NAME OF FIRM	INCOME: *Sales*	*Wages and Salaries*	*Profits before Taxes*	*Interest Paid*	*Depreciation*	*Total Excluding Depreciation*	*Total Including Depreciation*	RATIO OF INCOME TO SALES: *Excluding Depreciation*	*Including Depreciation*
		Food and Kindred Products								
201	Swift and Company	$2,213	$249	$46	$ 3	$13	$298	$311	13.4	14.1
201	Armour and Co.	1,848	203	2	6	8	211	219	11.4	11.9
201	Wilson and Co.	709	75	7	1	3	83	86	11.6	12.1
201	Cudahy Packing	559	49	—7	1	2	43	45	7.6	8.1
201	John Morrell	293	30	[a]	1	1	31	32	10.5	10.9
202	National Dairy	898	157	57	2	15	216	231	24.0	25.7
202	Borden Co.	614	110	35	1	10	146	156	23.7	25.4
202	Beatrice Foods	192	26	8	[a]	1	34	35	17.8	18.2
202	Pet Milk[b]	138	19	7	[a]	2	26	28	18.8	20.3
203	California Packing Co.	169	45	16	[a]	4	62	66	36.6	39.1
204	General Mills	410	44	18	[a]	3	62	65	15.1	15.9
204	Corn Products Refining Co.	145	26	23	[a]	3	49	52	33.4	35.9
205	National Biscuit[b]	296	101	39	[a]	6	140	146	47.3	49.3
205	Sunshine Biscuit	101	27	13	[a]	1	39	40	39.0	39.6
205	Continental Baking	154	51	9	[a]	2	60	62	39.1	40.3
206	American Sugar Refining	277	23	13	[a]	2	37	39	13.2	14.1
206	National Sugar Refining	132	8	4	[a]	[a]	13	13	9.5	9.8
206	American Crystal Sugar Co.	32	6	3	[a]	1	8	9	25.1	28.1
208	Schenley Industries	201	48	40	3	4	92	96	45.6	47.8
208	Brown Forman Distributors	27	4	7	[a]	1	11	12	42.4	44.4
208	Anheuser-Busch	135	30	24	[a]	4	53	57	39.4	42.2
209	General Foods	475	69	45	1	5	114	119	24.1	25.1
	TOTAL SAMPLE	$10,018	$1,400	$409	$19	$91	$1,828	$1,919	18.2	19.2
		Tobacco[c]								
2111	P. Lorillard	$ 85	$ 8	$11	$1	$1	$20	$21	23.4	24.7
2111	Philip Morris[d]	131	11	25	2	1	38	39	29.3	29.8
	Total Sample	$216	$19	$36	$3	$2	$58	$60	26.9	27.8

See page 301 for footnotes.

TABLE 2 (*continued*)

CODE	NAME OF FIRM	INCOME							RATIO OF INCOME TO SALES	
		Sales	*Wages and Salaries*	*Profits before Taxes*	*Interest Paid*	*Depreciation*	*Total Excluding Depreciation*	*Total Including Depreciation*	*Excluding Depreciation*	*Including Depreciation*
					Textiles					
221	J. P. Stevens Co.	$278	$ 71	$35	n.a.	$ 4	$106	$110	38.1	39.6
221	Pacific Mills	99	27	6	a	2	33	35	33.6	35.4
222	West Point Manufacturing	84	23	10	a	1	33	34	39.5	40.5
223	Dan River Mills	65	26	5	n.a.	2	31	33	47.5	50.8
227	Bigelow Sanford Carpet Co.	67	26	5	a	1	31	32	45.5	47.8
227	Alexander Smith	70	29	3	n.a.	1	31	32	44.2	45.7
227	Armstrong Cork	163	54	17	n.a.	5	71	76	43.4	46.6
	Total sample	$826	$256	$81		$16	$336	$352	40.7	42.6
					Lumber					
242	Weyerhaeuser Timber Co.	$156	$49	$39	n.a.	$11	$ 88	$ 99	56.3	63.5
242	Long Bell Lumber	81	20	11	a	4	31	35	38.5	43.2
	Total Sample	$237	$69	$50		$15	$119	$134	50.2	56.5
					Furniture					
251	Simmons Co.	$110	$38	$9	a	$1	$48	$49	43.2	44.5
	Total Sample	$110	$38	$9		$1	$48	$49	43.2	44.5
					Paper					
261	International Paper	$416	$ 94	$89	n.a.	$15	$183	$198	44.1	47.6
261	Crown Zellerbach	168	45	34	a	6	80	86	47.4	51.2
261	St. Regis Papere	144	33	24	$1	4	58	62	40.2	43.1
261	Champion Paper and Fibre	81	27	16	a	3	44	47	54.3	58.0

261	West Virginia Pulp and Paper	88	27	14	[a]	5	42	47	47.1	53.4
261	Rayonier	49	15	9	[a]	3	25	28	51.5	57.1
264	Marathon Corp.	60	23	7	[a]	3	30	33	50.3	55.0
267	Container Corp. of America	115	24	15	n.a.	3	38	41	33.4	35.7
	Total Sample	$1,121	$288	$208	$1	$42	$500	$542	44.6	48.3
				Chemicals						
282	E. I. duPont	$1,025	$335	$334	n.a.	$57	$669	$726	65.2	70.1
282	Dow Chemical	200	61	41	$2	20	104	124	51.9	62.0
282	Allied Chemical	364	86	62	n.a.	17	147	164	40.5	45.1
282	Monsanto	166	45	28	1	9	74	83	44.5	50.0
282	Hercules Powder	121	38	17	n.a.	6	55	61	45.1	50.4
282	American Home Products	148	35	19	[a]	2	54	56	36.5	37.8
282	Air Reduction	90	27	11	1	4	39	43	43.0	47.8
282	International Minerals	53	14	7	[a]	3	21	24	40.1	45.3
282	Liquid Carbonic	38	16	2	[a]	2	18	20	47.4	52.6
282	Diamond Alkali	48	17	5	[a]	3	22	25	45.3	52.1
282	Virginia-Carolina	60	11	6	[a]	2	18	20	29.3	33.3
282	Commercial Solvents	33	8	5	n.a.	1	13	14	40.1	42.4
282	U.S. Industrial Chemicals	51	8	1	[a]	1	10	11	19.5	21.6
283	Abbott Laboratories[b]	74	20	19	[a]	1	39	40	52.6	54.1
283	Merck and Co.	74	22	11	n.a.	3	34	37	46.1	50.0
283	E. R. Squibb	82	18	12	[a]	1	30	31	36.3	37.8
283	Rexall Drug[b]	154	36	4	1	2	41	43	26.5	27.9
284	Colgate Palmolive	204	34	16	n.a.	2	50	52	24.5	25.5
289	Eastman Kodak	396	187	76	[a]	17	263	280	66.3	70.1
289	General Aniline and Film	80	33	5	1	3	38	41	47.5	51.3
289	American Viscose	195	71	34	n.a.	11	104	115	53.5	59.0
289	Celanese Corp.	171	61	34	3	11	98	109	57.1	63.7
	Total Sample	$3,827	$1,183	$749	$9	$178	$1,941	$2,119	50.7	55.4

TABLE 2 (*continued*)

CODE	NAME OF FIRM	INCOME							RATIO OF INCOME TO SALES	
		Sales	*Wages and Salaries*	*Profits before Taxes*	*Interest Paid*	*Depreciation*	*Total Excluding Depreciation*	*Total Including Depreciation*	*Excluding Depreciation*	*Including Depreciation*
		Petroleum and Coal†								
2911	Standard Oil (N.J.)	$2,892	$537	$442	$10	$184	$988	$1,172	34.1	37.1
2911	Standard Oil (Ind.)	1,158	219	139	7	44	364	408	31.4	35.2
2911	Socony Vacuum	1,227	228	116	5	42	349	391	28.4	31.9
2911	Texas Company	1,077	168	158	5	59	331	390	30.7	36.2
2911	Standard Oil (Calif.)	743	131	181	3	76	315	391	42.4	52.6
2911	Gulf	970	168	113	5	52	286	538	29.5	34.8
2911	Shell	816	159	102	3	48	264	312	32.3	38.2
2911	Sinclair	584	86	74	4	36	165	201	28.1	34.4
2911	Phillips	486	84	60	3	30	147	177	30.2	36.4
2911	Sun	462	98	31	a	21	129	150	27.8	32.5
2911	Atlantic Refining	446	78	33	1	27	112	139	25.1	31.2
2911	Tidewater	355	51	34	a	22	86	108	24.0	30.4
2911	Continental Oil	315	34	46	a	18	81	99	25.6	31.4
2911	Standard Oil (Ohio)	255	41	22	1	12	65	77	25.3	30.2
2911	Union Oil (Calif.)	200	34	22	2	25	58	83	29.1	41.5
2911	Skelly	164	16	32	a	13	49	62	29.8	37.8
2911	Richfield	123	20g	25	1	9	46	55	37.0	44.7
2911	Lion	66	9	12	1	4	22	26	33.3	39.4
299	Koppers Co.	191	50	12	1	5	63	68	33.0	35.6
299	Flintkote Co.	68	20	9	a	2	29	31	42.9	45.6
	Total sample	$12,598	$2,231	$1,663	$52	$729	$3,949	$4,678	31.3	37.1

				Rubber					
3011	Goodyear Tire	$634	$190	$42	$4	$20	$237	$257	37.3	40.1
3011	U.S. Rubber	518	184	23	3	13	210	223	40.4	43.1
3011	Firestone Tire	580	167	35	2	15	205	220	35.3	37.9
3011	General Tire and Rubber	93	29	2	[a]	2	31	33	34.0	35.5
	Total sample	$1,825	$570	$102	$9	$50	$683	$733	37.4	40.2
				Leather					
314	International Shoe	$199	$77	$19	n.a.	$2	$97	$99	48.7	49.7
	Total sample	$199	$77	$19		$2	$97	$99	48.7	49.7
				Stone, Clay, and Glass					
322	Pittsburgh Plate Glass	$281	$88	$59	n.a.	$7	$147	$154	52.2	54.8
322	Libbey Owens	134	46	38	n.a.	6	84	90	62.4	67.2
322	Anchor Hocking	71	27	8	[a]	2	35	37	49.0	52.1
3241	Lone Star Cement	64	14	16	n.a.	2	30	32	47.0	50.0
3241	Lehigh Portland Cement	41	12	10	n.a.	2	23	25	55.2	61.0
3272	U.S. Gypsum	138	26	35	n.a.	5	61	66	44.1	47.8
3272	National Gypsum	59	16	9	[a]	2	26	28	44.2	47.5
3292	Johns Manville	163	61	22	[a]	5	83	88	51.1	54.0
329	Minnesota Mining	115	32	24	n.a.	5	56	61	49.0	53.0
329	Harbison-Walker	43	17	8	n.a.	2	25	27	57.9	62.8
329	Carborundum Co.	39	19	1	[a]	1	21	22	53.8	56.4
	Total sample	$1,148	$358	$230		$39	$591	$630	51.5	54.9

TABLE 2 (*continued*)

CODE	NAME OF FIRM	INCOME							RATIO OF INCOME TO SALES	
		Sales	*Wages and Salaries*	*Profits before Taxes*	*Interest Paid*	*Depreciation*	*Total Excluding Depreciation*	*Total Including Depreciation*	*Excluding Depreciation*	*Including Depreciation*
		Primary Iron and Steel								
331	U.S. Steel	$2,293	$946	$295	$2	$97	$1,243	$1,340	54.2	58.4
331	Bethlehem Steel	1,267	477	171	5	33	654	687	51.6	54.2
331	Republic Steel	652	207	81	2	15	291	306	44.5	46.9
331	Jones and Laughlin	386	147	35	2	17	184	201	47.6	52.1
331	National Steel	425	105	77	1	13	183	196	42.9	46.1
331	Youngstown Sheet and Tube	335	85	52	1	10	137	147	40.9	43.9
331	Armco Steel	341	99	51	2	10	152	162	44.4	47.5
331	Inland Steel	346	88	41	2	10	131	141	37.9	40.8
331	Wheeling Steel Corp.	143	58	14	1	6	73	79	50.6	55.2
331	Colorado Fuel and Iron	138	51	16	[a]	3	68	71	48.9	51.4
331	Crucible	99	43	2	1	3	45	48	45.4	48.5
331	Allegheny Ludlum Steel Corp.	106	40	3	n.a.	2	43	45	41.0	42.5
331	Pittsburgh	80	33	1	[a]	2	35	37	43.4	46.3
331	Sharon Steel Corp.	90	29	5	[a]	2	34	36	38.3	40.0
331	Lukens	56	17	4	[a]	1	21	22	37.7	39.3
331	Granite City	46	10	5	[a]	1	15	16	32.1	34.8
331	Alan Wood	36	11	4	[a]	2	15	17	41.0	47.2
331	Copperweld	43	10	3	[a]	1	13	14	29.5	32.6
331	Interlake Iron	57	8	10	n.a.	2	18	20	19.3	35.1
331	Continental	23	7	2	n.a.	1	9	10	41.1	43.5
331	Rotary Electric	17	3	2	[a]	[a]	5	5	30.6	29.4
331	Detroit Steel	28	3	5	n.a.	1	8	9	28.7	32.1
	Total sample	$7,007	$2,477	$879	$19	$232	$3,377	$3,609	48.2	51.5
		Primary Nonferrous Metals								
332	Aluminum Co. of America	$347	$143	$41	n.a.	$16	$184	$200	52.9	57.6
332	Calumet and Heclab	47	14	7	[a]	2	22	24	46.4	51.1
332	Scovill Manufacturing	74	34	4	n.a.	3	37	40	49.9	54.1
	Total sample	$468	$191	$52		$21	$245	$266	52.4	56.8

		Fabricated Metals								
3411	American Can	$468	$112	$48	a	$11	$160	$171	34.2	36.5
3411	Continental Can	336	86	19	$2	7	107	114	32.0	33.9
343	American Radiator	206	70	29	a	3	99	102	47.7	49.5
343	American Steel Foundries	75	27	11	n.a.	1	38	39	50.4	52.0
349	Yale and Towne	57	24	2	a	1	26	27	45.8	47.4
	Total sample	$1,142	$319	$109	$2	$23	$430	$453	37.7	39.7
		Machinery (except Electrical)								
352	International Harvester	$909	$325	$94	$1	$19	$420	$439	46.2	48.3
352	Deere and Co.	362	91	70	1	6	162	168	44.8	46.4
352	Allis-Chalmers	351	100	33	1	3	134	137	38.1	39.0
357	National Cash Register	167	106	23	1	4	129	133	77.6	79.6
352	Caterpillar Tractor	255	77	30	1	5	108	113	42.2	44.3
357	Remington Rand	148	82	17	2	5	100	105	67.4	70.9
352	J. I. Case	156	45	30	a	3	75	78	48.2	50.0
357	Burroughs Adding Machine	82	54	11	n.a.	1	65	66	78.8	80.5
356	Link Belt	88	35	13	n.a.	1	47	48	53.5	54.5
352	Oliver Corp.	101	30	10	a	3	41	44	40.2	43.6
3551	Food Machinery and Chemical	82	26	7	a	3	33	36	39.9	43.9
356	Fairbanks Morse	78	27	3	a	1	31	32	40.3	41.0
353	Dresser Industries	81	21	6	a	2	28	30	34.2	37.0
353	Bucyrus-Erie	62	16	11	n.a.	1	27	28	43.4	45.2
	Total sample	$2,924	$1,035	$358	$7	$57	$1,400	$1,457	47.9	49.8
		Electrical Machinery								
361	General Electric	$1,614	$650	$204	$5	$47	$858	$905	53.1	56.1
361	Westinghouse	946	376	111	4	14	490	504	51.8	53.3
366	Western Electric	858	348	69	2	17	420	437	48.9	50.9
366	Radio Corp. of America	396	141	42	1	7	184	191	46.4	48.2
366	Electric AutoLite	218	75	18	1	4	94	98	43.3	45.0
366	Sylvania Electric	103	39	5	1	2	45	47	43.6	45.6
366	Raytheon Manufacturing	56	26	2	a	1	28	29	50.2	51.8
	Total sample	$4,191	$1,655	$451	$14	$92	$2,119	$2,211	50.6	52.8

TABLE 2 (*continued*)

CODE	NAME OF FIRM	INCOME							RATIO OF INCOME TO SALES	
		Sales	*Wages and Salaries*	*Profits before Taxes*	*Interest Paid*	*Depreciation*	*Total Excluding Depreciation*	*Total Including Depreciation*	*Excluding Depreciation*	*Including Depreciation*
		Transportation Equipment								
371	General Motors	$5,701	$1,441	$1,125	$9	$110	$2,574	$2,684	45.1	47.1
371	Chrysler	2,085	349	213	a	19	563	582	27.0	27.9
371	Studebaker[b]	503	110	23	1	3	133	136	26.3	27.0
371	Nash-Kelvinator	364	86	45	1	3	132	135	36.3	37.1
371	Packard	213	40	13	n.a.	3	53	56	25.0	26.3
371	Willys-Overland	142	34	5	n.a.	2	39	41	27.3	28.9
371	Fruehauf Trailor	78	22	4	1	1	27	28	34.3	35.9
371	Mack Trucks	78	29	—6	a	2	23	25	29.9	32.1
371	Kaiser-Frazer	104	41	—39	2	11	43	14	41.3	13.5
371	Briggs Manufacturing	338	123	22	n.a.	5	146	151	43.0	44.7
371	The Budd Company	267	82	26	1	5	108	113	40.6	42.3
371	Borg-Warner	252	68	36	a	4	103	107	41.0	42.5
371	Thompson Products	108	41	9	a	2	50	52	46.9	48.1
371	Eaton Manufacturing	102	27	13	n.a.	1	40	41	39.5	40.2
371	Houdaille Hershey	53	23	3	a	1	26	27	49.4	50.1
371	Stewart Warner	55	22	4	n.a.	1	26	27	46.7	49.1
372	Boeing Airplane[b]	307	135	24	a	1	159	160	51.7	52.1
372	Bendix Aviation	183	79	18	n.a.	3	97	100	53.0	54.6
372	North American Aviation	124	69	12	a	1	81	82	65.0	66.1
372	Douglas Aircraft	117	68	11	a	2	79	81	67.1	69.2
372	Lockheed	118	63	7	a	1	69	70	59.0	59.3
372	Grumman	60	23	7	n.a.	a	31	31	51.4	51.7
373	Newport News Shipbuilding and Drydock	78	35	8	n.a.	1	43	44	55.3	56.4
374	Pullman, Inc.[1]	286	63	13	n.a.	2	76	78	26.4	27.3
374	American Locomotive	147	39	9	a	2	48	50	32.5	34.0
374	Baldwin Locomotive	119	35	6	a	1	41	42	34.4	35.3
374	Westinghouse Air Brake	76	30	16	n.a.	1	46	47	60.6	61.8
374	American Brake Shoe	92	30	6	n.a.	3	37	40	39.8	43.5
	Total sample	$12,150	$3,207	$1,633	$15	$191	$4,853	$5,044	39.9	41.5

		Instruments								
3821	The Sperry Co.	$116	$63	$8	a	$2	$72	$75	61.9	64.7
384	Johnson and Johnson	136	40	16	n.a.	2	55	57	40.6	41.9
	Total sample	$252	$103	$24		$4	$128	$132	50.8	52.4
		Miscellaneous								
3983	Diamond Match	$76	$23	$5	a	$1	$29	$30	37.7	39.5
3989	Remington Arms	38	17	3	n.a.	1	20	21	53.3	55.3
	Total sample	$114	$40	$8		$2	$49	$51	43.0	44.7

n.a. = not available.
[a] Less than $500,000.
[b] 1950 data.
[c] Sales figures are exclusive of federal excise taxes.
[d] Fiscal year ending March 31, 1950.
[e] 1947 data.
[f] Corporate sales figures are exclusive of federal and state taxes on gasoline and lubricants.
[g] Estimated.
[h] 1951 data.
[i] 1948 data.

Note: The industry code numbers approximate those used in the Census of Manufactures, Bureau of the Census. Total income is computed from unrounded data so that subtotals will not necessarily add to totals.

Source: Annual reports.

TABLE 3A

Ratio of all Corporate Income to all Corporate Sales by Manufacturing Industry Groups, 1949
(*dollars in millions; ratios in per cent*)

Industry Group	*Wages and Salaries*	*Profits before Taxes*	*Interest Paid*	*Total Income*	*Sales*	*Ratio of Income to Sales*
Food and kindred products	$4,103	$1,600	$71.2	$5,775	$36,167	16.0
Tobacco manufactures	218	250	20.6	488	1,714	28.5
Textile mill products	3,134	596	31.6	3,761	10,602	35.5
Apparel and related products	2,086	142	7.4	2,235	7,896	28.3
Lumber and lumber products (except furniture)	970	228	7.6	1,204	3,061	39.4
Furniture and fixtures	1,218	97	6.6	1,320	3,082	42.8
Paper and allied products	1,496	547	22.6	2,066	5,301	39.0
Printing and publishing	2,444	249	13.3	2,707	6,067	44.6
Chemicals and allied products	2,504	1,475	38.7	4,017	13,355	30.0
Petroleum and coal products	2,041	2,446	126.8	4,614	18,450	25.0
Rubber products	785	181	10.1	977	3,088	31.6
Leather and leather products	900	83	5.6	988	2,750	35.9
Stone, clay, and glass products	1,421	522	8.7	1,952	3,917	49.8
Iron and steel and their products	6,123	2,042	83.1	8,253	19,921	41.4
Nonferrous metals and their products	1,604	477	28.2	2,109	5,587	37.8
Machinery (except electrical)	4,635	1,305	21.9	5,962	13,139	45.4
Electrical machinery	2,496	629	16.6	3,140	8,466	37.1
Transportation equipment	4,426	2,199	16.0	6,642	18,963	35.0
Miscellaneous manufactures	1,366	290	18.3	1,673	3,229	51.8

Source: *Census of Mineral Industries: 1939*, Bureau of the Census; *Statistics of Income for 1946*, Bureau of Internal Revenue; *Quarterly Industrial Financial Report Series* for 1946 and 1949, Federal Trade Commission and Securities and Exchange Commission; *Census of Manufactures: 1947*, Bureau of the Census; *National Income Supplement, 1951, Survey of Current Business*, Department of Commerce.

Derivation of the data for mixed mining-manufacturing industries: The industry group "Iron and steel and their products" includes the iron-ore mining industry and part of the bituminous-coal mining industry, while "Nonferrous metals and their products" includes nonferrous metal mining. The data for the narrower definitions of these industry groups, excluding the mining industries, were obtained in the following manner: (1) Wages and salaries for 1949 were taken from the *National Income Supplement, 1951, Survey of Current Business.* (2) To this figure was applied the ratio of corporate to total wages and salaries, derived from a previous amalgamation of figures for the individual industries of *Census of Manufactures: 1947*, into those for industry groups corresponding to "Iron and steel and their products" and "Nonferrous metals and their products." In 1947, 97 per cent of all wages and salaries paid in the iron and steel industry and 95 per cent in nonferrous metals were paid by corporations. It was assumed that there had been no change up to 1949, and the *National Income Supplement, 1951* total industry group figures were so divided. (3) Profits before taxes were also taken from the *National Income Supplement, 1951*, and adjusted upward 2 per cent to compensate for the discrepancy between figures in the *National Income Supplement, 1951* and in the *Quarterly Industrial Financial Report Series*, the

latter being used for most of the other industry groups. (4) Interest paid in 1949 was derived as follows: Interest paid in 1946 was obtained from the *Statistics of Income for 1946* and inflated according to the percentage change in interest-bearing liabilities, obtained from a sample of published reports, from 1946 to 1949.

To the figures obtained for the narrow industry definitions for iron and steel and their products and for nonferrous metals and their products were added those for appropriate portions of the mining industries. The procedures used for computing figures for metal mining and bituminous coal mining were similar to those outlined above, with the exception of the second step. An estimate of the approximate division between corporate and noncorporate shares of wages and salaries was made, using the *Census of Mineral Industries: 1939*. This is the most recent source of any figures or statistics of this kind, although at some future date a new census of mining will be published in conjunction with the 1950 census. Corporate firms paid 94 per cent of the total payrolls in bituminous coal mining and 95 per cent in metal mining. Since there were no later figures or indications that these percentages had been substantially altered, they were applied to the 1949 data in the *National Income Supplement, 1951*.

Metal mining data were divided between iron and steel and their products and nonferrous metals and their products on the basis of the proportion of the wages and salaries paid by iron mines to the total industry wages and salaries. Thus, 30 per cent of industry wages was paid in iron and steel and 70 per cent in nonferrous metals. Approximately 19 per cent of wages paid in bituminous coal mining was assumed to be paid in the iron and steel industry on the basis of the ratio of coal production to coal used in iron and steel production in 1949.

The figures for the industry group "Petroleum and coal products" were derived in the same way as the figures for the majority of the industrial groups. However, the figures for crude petroleum and pipeline transportation industries were added to this group. The data for the crude petroleum and natural gas industry were obtained in the same manner as those for iron and steel and nonferrous metals, again with the exception of the second step of the procedure. Corporate firms paid 88 per cent of total wages and salaries. For pipelines the figure was an estimate based on data in *Petroleum Facts and Figures, 1950*, American Petroleum Institute, and the 1939 census; corporations paid about 94 per cent of the total. The classification of natural gas was removed from the crude petroleum and natural gas industry and natural gas transmission from pipelines by using the ratio of gas wells to oil wells and to oil and gas wells in 1939, as given by the *Census of Mineral Industries: 1939*. The resulting figures were checked by later figures given in *Petroleum Facts and Figures, 1950*. Thus, 94 per cent of wages paid in each industry was credited to the industry group "Petroleum and coal products."

assemble on a large scale. This is particularly true of the automobile companies; indeed, the most striking decline of the ratio in the top size classes, both in 1940 and in 1949, is observable in the automobile group.

However, if we are too cautious to accept the idea of an actual decline in the degree of vertical integration as one approaches the top size class, it does seem clear that we cannot speak of any observable increase. It may not be too farfetched to say that, even if such a trend toward a decline existed, we would not know it. After all, there are only about 140 manufacturing firms with total assets

TABLE 3B

Illustration of the Derivation of Corporate Income and Sales by Manufacturing Industry Groups, 1949
(*dollars in millions*)

Operation and source — *Food and Kindred Products*	*Data*
1. Total wages and salaries, 1949, Department of Commerce, *National Income Supplement, 1951*	$4,632.00
2. Total wages and salaries, 1947, *Census of Manufactures*	3,789.00
3. Corporate wages and salaries, 1947, *Census of Manufactures*	3,357.00
4. Line 3 divided by line 2	88.60%
5. Line 4 multiplied by line 1: estimated corporate wages	$4,103.00
6. Profits before taxes, 1949, *Quarterly Industrial Financial Report Series, 1949*	1,600.00
7. Corporate interest paid, 1946, *Statistics of Income, 1946*	59.30
8. Long- and short-term indebtedness, 1st quarter 1947, *Quarterly Industrial Financial Report Series, 1947*	1,708.00
9. Long- and short-term indebtedness, 4th quarter 1949, *Quarterly Industrial Financial Report Series, 1949*	2,092.00
10. Line 9 divided by line 8	1.2%
11. Line 7 multiplied by line 10: estimated interest paid 1949	$ 71.20
12. Income originating in corporate business: lines 5 plus 6 plus 11	5,774.00
13. Corporate sales, 1949, Department of Commerce, *National Income Supplement, 1951*	36,167.00
14. Ratio of income to sales: line 12 divided by line 13	.1597%

Source: *Statistics of Income for 1946*, Bureau of Internal Revenue; *Quarterly Industrial Financial Report Series, 1946* and *1949*, Federal Trade Commission and Securities and Exchange Commission; *Census of Manufactures: 1947*, Bureau of the Census; *National Income Supplement, 1951, Survey of Current Business*, Department of Commerce.

TABLE 4

Ratio of Value of Inventories to Gross Sales by Manufacturing Industry Groups and Asset Size Classes, 1940 and 1949

Asset Size Class (*thousands of dollars*)	*Total Manufacturing* 1940	*Total Manufacturing* 1949	*Food and Kindred Products* 1940	*Food and Kindred Products* 1949	*Beverages* 1940	*Beverages* 1949
I. Under $50	.007	.075	.050	.042	.080	.094
II. $50-$100	.104	.094	.064	.053	.078	.097
III. 100-250	.124	.105	.078	.063	.093	.091
IV. 250-500	.147	.116	.089	.065	.109	.101
V. 500-1000	.164	.127	.099	.070	.141	.113
VI. 1000-5000	.191	.148	.123	.083	.128	.122
VII. 5000-10,000	.216	.167	.145	.107	.250	.146
VIII. 10,000-50,000	.224	.175	.160	.102	.267	.222
IX. 50,000-100,000	.260	.173	.221	.119	.417	.196
X. Over $100,000	.194	.157	.181	.094		.224
Total	.189	.152	.116	.091	.177	.177

TABLE 4 (*continued*)

Asset Size Class (thousands of dollars)	Tobacco Manufactures		Textile Mill Products		Apparel and Related Products	
	1940	*1949*	*1940*	*1949*	*1940*	*1949*
I. Under $50	.116	.148	.073	.064	.056	.053
II. $50-$100	.162	.197	.114	.094	.083	.085
III. 100-250	.220	.191	.137	.113	.104	.103
IV. 250-500	.195	.199	.165	.126	.146	.121
V. 500-1000	.300	.238	.189	.138	.151	.138
VI. 1000-5000	.347	.408	.219	.163	.206	.157
VII. 5000-10,000	.238	.286	.272	.184	.295	.192
VIII. 10,000-50,000	.521	.409	.327	.223	.247	.193
IX. 50,000-100,000	.433	.486	.355	.234		.249
X. Over $100,000	.424	.490		.184		
Total	.421	.502	.233	.179	.129	.131

Asset Size Class (thousands of dollars)	Lumber and Lumber Products (except furniture)		Furniture and Finished Lumber Products		Paper and Allied Products	
	1940	*1949*	*1940*	*1949*	*1940*	*1949*
I. Under $50	.098	.081	.117	.099	.102	.075
II. $50-$100	.140	.108	.159	.126	.114	.096
III. 100-250	.170	.125	.176	.126	.125	.103
IV. 250-500	.191	.144	.195	.143	.141	.109
V. 500-1000	.229	.157	.210	.152	.155	.110
VI. 1000-5000	.243	.186	.236	.159	.178	.118
VII. 5000-10,000	.189	.179	.257	.190	.176	.141
VIII. 10,000-50,000	.262	.164	.260	.161	.182	.138
IX. 50,000-100,000		.151	.272	.136	.145	.130
X. Over $100,000	.154	.069			.202	.117
Total	.208	.157	.208	.148	.167	.125

Asset Size Class (thousands of dollars)	Printing and Publishing		Chemicals and Allied Products		Petroleum and Coal Products	
	1940	*1949*	*1940*	*1949*	*1940*	*1949*
I. Under $50	.044	.042	.122	.120	.061	.064
II. $50-$100	.067	.055	.130	.112	.045	.053
III. 100-250	.080	.063	.128	.108	.052	.060
IV. 250-500	.090	.071	.156	.105	.072	.062
V. 500-1000	.094	.083	.183	.122	.107	.074
VI. 1000-5000	.108	.097	.195	.141	.103	.075
VII. 5000-10,000	.071	.094	.223	.157	.164	.101
VIII. 10,000-50,000	.071	.086	.195	.172	.169	.137
IX. 50,000-100,000	.107	.077	.216	.171	.171	.115
X. Over $100,000	.043	.046	.138	.166	.185	.131
Total	.082	.080	.182	.157	.174	.127

TABLE 4 (*continued*)

Asset Size Class (*thousands of dollars*)	*Rubber Products*		*Leather and Leather Products*		*Stone, Clay, and Glass Products*	
	1940	*1949*	*1940*	*1949*	*1940*	*1949*
I. Under $50	.081	.083	.091	.090	.125	.098
II. $50-$100	.126	.091	.109	.101	.127	.094
III. 100-250	.133	.086	.125	.107	.146	.100
IV. 250-500	.153	.103	.170	.117	.163	.096
V. 500-1000	.158	.087	.202	.149	.154	.107
VI. 1000-5000	.165	.115	.306	.175	.187	.132
VII. 5000-10,000	.193	.102	.218	.217	.237	.168
VIII. 10,000-50,000	.327	.207	.271	.181	.239	.172
IX. 50,000-100,000		.290	.296	.252	.138	.156
X. Over $100,000	.250	.199		.247	.144	.101
Total	.229	.177	.215	.166	.183	.136

Asset Size Class (*thousands of dollars*)	*Iron, Steel, and Their Products*		*Nonferrous Metals and Their Products*		*Primary Metals*	
	1940	*1949*	*1940*	*1949*	*1940*	*1949*
I. Under $50	.101	n.a.	.099	n.a.	n.a.	.066
II. $50-$100	.127	n.a.	.122	n.a.	n.a.	.063
III. 100-250	.147	n.a.	.137	n.a.	n.a.	.076
IV. 250-500	.159	n.a.	.159	n.a.	n.a.	.095
V. 500-1000	.181	n.a.	.180	n.a.	n.a.	.103
VI. 1000-5000	.207	n.a.	.191	n.a.	n.a.	.133
VII. 5000-10,000	.218	n.a.	.173	n.a.	n.a.	.143
VIII. 10,000-50,000	.219	n.a.	.211	n.a.	n.a.	.170
IX. 50,000-100,000	.293	n.a.	.233	n.a.	n.a.	.151
X. Over $100,000	.277	n.a.	.277	n.a.	n.a.	.156
Total	.229	n.a.	.201	n.a.	n.a.	.151

Asset Size Class (*thousands of dollars*)	*Fabricated Metal Products*		*Electrical Machinery and Equipment*	
	1940	*1949*	*1940*	*1949*
I. Under $50	n.a.	.096	.149	.131
II. $50-$100	n.a.	.114	.142	.147
III. 100-250	n.a.	.125	.155	.151
IV. 250-500	n.a.	.142	.155	.159
V. 500-1000	n.a.	.155	.182	.172
VI. 1000-5000	n.a.	.172	.201	.184
VII. 5000-10,000	n.a.	.196	.205	.190
VIII. 10,000-50,000	n.a.	.186	.212	.174
IX. 50,000-100,000	n.a.	.160		.125
X. Over $100,000	n.a.	.166	.223	.199
Total	n.a.	.165	.206	.184

TABLE 4 (*continued*)

Asset Size Class (*thousands of dollars*)	*Machinery (except Electrical and Transportation Equipment)*		*Automobiles and Equipment (except Electrical)*	
	1940	*1949*	*1940*	*1949*
I. Under $50	.131	.108	.112	.117
II. $50-$100	.162	.137	.130	.139
III. 100-250	.177	.155	.125	.128
IV. 250-500	.198	.187	.175	.165
V. 500-1000	.206	.193	.159	.145
VI. 1000-5000	.250	.224	.152	.188
VII. 5000-10,000	.286	.236	.187	.147
VIII. 10,000-50,000	.310	.247	.153	.161
IX. 50,000-100,000	.296	.237	.180	.151
X. Over $100,000	.355	.245	.117	.103
Total	.267	.228	.132	.116

Asset Size Class (*thousands of dollars*)	*Transportation Equipment (except Automobiles)*		*Other Manufacturing*		*Manufacturing Not Allocable*	
	1940	*1949*	*1940*	*1949*	*1940*	*1949*
I. Under $50	.112	.097	.105	.106	.126	n.a.
II. $50-$100	.118	.141	.145	.124	.142	n.a.
III. 100-250	.152	.153	.163	.133	.158	n.a.
IV. 250-500	.186	.178	.188	.148	.164	n.a.
V. 500-1000	.220	.163	.208	.166	.213	n.a.
VI. 1000-5000	.273	.186	.254	.193	.201	n.a.
VII. 5000-10,000	.235	.248	.328	.196	.266	n.a.
VIII. 10,000-50,000	.288	.179	.293	.205	.327	n.a.
IX. 50,000-100,000	.495	.241		.299		n.a.
X. Over $100,000	.307	.244	.311			
Total	.335	.220	.230	.174	.191	n.a.

Asset Size Class (*thousands of dollars*)	*Ordnance and Accessories*	*Scientific Instruments, Photographic Equipment, Watches, Clocks*
	1949	*1949*
I. Under $50	.169	.137
II. $50-$100	.205	.114
III. 100-250	.195	.188
IV. 250-500	.107	.177
V. 500-1000	.423	.229
VI. 1000-5000	.220	.239
VII. 5000-10,000	.674	.260
VIII. 10,000-50,000	.321	.277
IX. 50,000-100,000		.300
X. Over $100,000	.378	.228
Total	.352	.249

n.a. (not available)

Source: *Statistics of Income* for 1940 and 1949, Bureau of Internal Revenue. Complete tabulations for years following 1947 were unpublished in 1952. Access to the unpublished data was by courtesy of Joseph R. Pechman of the Treasury Department.

over $100 million; within the group, the variation from lowest to highest is over 4,000 per cent; and if we subdivide by industries, the samples become, in almost every case, so small as to lose any reliability. Or, what amounts to the same thing, the large firm is so much a historically individual one that the general influences are merged and hidden in the particular situation. And, of course, the large firms often cross industry boundaries, which makes the samples even less reliable.

6. *Trends over Time*

TABLES 5 to 8 measure the trend of integration through time. Table 5 indicates no perceptible change in the degree of vertical integration among manufacturing plants (not firms) since 1849; Table 6, covering all firms since 1929, also shows no change. This is our only evidence for the long-term trend of integration over large areas of the economy. It is obvious but bears repeating that these are broad averages that indicate nothing about individual subgroups.[17]

Table 7 measures vertical integration of the U.S. Steel Corporation since 1902. Fortunately, both variants of income are available: (1) the spread between total sales and total payments to other firms and (2) the total of wages, profits before taxes, interest, and depreciation. There are no significant discrepancies between the two series shown in columns 4 and 12 in Table 7. As noted earlier, the ratio of income to sales is much more sensitive to changes in backward integration than to changes in forward integration. If U.S. Steel had become more integrated after 1902, it would probably have been forward integration, for it began operations nearly self-sufficient in raw materials. Hence an increase in the ratio would be evidence of a real increase in integration greater than the apparent increase. But no significant increase is discernible. U.S. Steel has acquired many companies since 1902 and built many plants for itself, but it is no more nor less self-sufficient, that is, no more nor less dependent on the market, than it was fifty years ago.

However, this stability of the statistics is consistent with at least two hypotheses. Suppose that the product mix of U.S. Steel changed, with products requiring relatively little fabrication replacing products requiring much fabrication. This would tend to lower the ratio. But over the same period, suppose also that U.S. Steel acquired more capacity in later stages, becoming more integrated vertically and increasing its ratio of income to sales. Two such opposing

[17] See the three principal qualifications discussed below.

tendencies could exist and precisely offset each other, leaving the ratio unchanged. This hypothesis is certainly not absurd, but until it is supported by further evidence, it is less tenable than the much simpler hypothesis that there has not been much change in the vertical integration of U.S. Steel.

Table 8 presents the results (omitting the computation) for ten major steel companies other than U.S. Steel. The data are not amenable to any formal manipulation, but for the larger producers, from Bethlehem to Inland, there seems to be no marked trend over time. Some of the smaller companies, like Wheeling Steel Corporation, may be increasing their degree of vertical integration.

Certain qualifications must be borne in mind when using data of this kind.[18] The ratio of value added to value of products or of income to sales can be affected not only by the integration of manufacturing processes but also by three broad types of fortuitous developments which are discussed below.

1. The first of these involves price movements. The price changes of raw materials, manufactured fuels, and imported semimanufactures purchased may differ from the price movements of manufactured goods. An increase in the prices of raw materials purchased would result in a change of roughly the same order of magnitude in value of products but would have a much smaller effect, and that only of an indirect kind, upon value added. Over the long run, this is not an important qualification, because there is no reason to believe that since 1849 the long-term price movements of raw materials and other purchases have differed significantly from the long-term movement in prices of manufactured goods. The only way to test this hypothesis is to compare the statistics on agricultural and nonagricultural prices; the comparison does not support such a hypothesis.

However, it is obvious that the short-term price movements of manufactured products differ markedly from those of nonmanufactured raw materials. This is essentially a cyclical movement. If the census of manufactures were taken annually, or oftener, comparisons could be made from peak to peak or trough to trough. Since this is not the case, one might look for cyclical movements which happened to coincide roughly with the census years. A better procedure would be to take averages of prices for decades or for overlapping decades, as the National Bureau of Economic Research

[18] My obligation to Maxwell R. Conklin is great, but he bears no responsibility for any errors in the following discussion.

usually does. It is a nice question how many such overlapping decades one needs to consider. In general, the less variable the ratio, the fewer the number of observations needed to establish its constancy apart from random fluctuations.

2. The second possible distortion of these ratios would be caused by shifts in the pattern of output.

a. First, it might be the case that in each individual industry integration was, say, decreasing but that there was a shift from the less to the more integrated industries. In such a situation the ratio for every industry would show a decline, although the ratio for manufactures as a whole might be stable or even show an increase. Each individual industry would be becoming less integrated, but the economy as a whole would be becoming more integrated.

b. In the second situation, if the industries in which the prices of materials consumed were very high were to expand more rapidly than those industries in which the prices of materials were very low, the ratio of value added to value of products would decrease, and vice versa. This would be not a paradox but a statistical mirage. However, there are two reasons for doubting that the results would be significantly distorted in this way. First, a constant shift from lower- to higher-priced raw materials, or vice versa, would, over the years, be reflected in an upward or downward movement of raw material prices relative to others. This must be the case, if the average of raw material prices is a weighted average. Second, even if there were a real possibility of such distortion occurring between any two given industries, it would become of negligible importance when scores or hundreds of groups are involved. The larger the number of separate forces, the less the influence of random events.

3. Finally, the Bureau of the Census may classify as two plants a production unit that was treated as a single plant in earlier censuses. The effect of such action would be to increase the value of products without any increase in value added. It is hardly conceivable that such distortions could affect the figures for manufactures as a whole, but they might well be significant for a given minor industry group.

In summary it can be said that the ratio of income to sales as a measure of integration may be distorted by random "errors" (in the statistical, not the computational, sense), and it certainly is distorted by cyclical divergences in price movements. Obviously, comparisons among small industrial groups are dangerous unless

it can be established that each group is homogeneous in all aspects which may affect the ratio. Even for all manufactures, comparisons over a short period are misleading as often as not.

Our aim at this point is not the measurement of secular trend but the much more modest objective of determining whether the trend differs significantly from zero. For this very limited purpose the length of the time period, especially for Tables 5 and 7, makes it difficult to imagine an accumulation of random errors which would just offset some tendency one way or the other, leaving the horizontal trend line we are able to observe. For more precise answers, the ratio must be adjusted in various ways; if these adjustments cannot be made, the ratio cannot be used.[19]

The ratio is, even for the individual firm, an aggregative measure in that it reflects the net outcome of all internal and external forces influencing the degree of vertical integration. It indicates nothing about any particular market or source of supply.

7. *Paradoxes of Technical Change*

THE statistical measures of vertical integration proposed here are not necessarily better or worse than the more traditional concepts. But they are different from those measures and do not serve only as an approximation to them. Furthermore, the ratio Y/S depends on a certain concept of *size* in economics; if that concept is unacceptable, the ratio is invalid.

The size of any part of the economic world is defined as the amount of income generated there or of factor cost absorbed.[20] Measurement of the size of fixed assets by the cost of acquisition (adjusted for price changes if need be) is only a variant of the income approach: it is the cumulation of past factor cost totals. Size is a value magnitude, and relative size is a ratio of two or more values.

Thus, it appears that the large firms' percentage of total value added is about the same as their share of total employee compensation (see Table 1). The large firms use more capital per employee but

[19] Because the meaning of the total "value of products" standing alone is limited and because this figure was continually misused over the years, the Bureau of the Census, after extensive consultation, reluctantly decided not to publish the figure for the 1947 and later censuses of manufactures. The Bureau has, however, informed the author that "the 1947 ratio, as compared to that for 1939, does not show evidence of increasing integration of plants."

[20] For our purpose, we need not consider the problem of income at market value or factor cost.

TABLE 5

Ratio of Value Added by Manufacture to Total Value of Products, Selected Years, 1849-1939
(dollars in billions; ratio in per cent)

Year	*Total Value of Products*	*Value Added by Manufacture*	*Ratio of Value Added to Total Value*
1849	$ 1.0	$ 0.4	40.0
1859	1.9	0.8	42.1
1869	3.4	1.4	41.2
1879	5.4	2.0	37.0
1889	9.4	4.2	44.7
1899[a]	13.0	5.7	43.8
1899[b]	11.0	4.6	41.8
1904	14.3	6.0	41.9
1909	19.9	8.2	41.2
1914[a]	23.4	9.4	40.1
1914[b]	23.0	9.2	40.0
1919	60.0	23.7	39.5
1921	41.6	17.3	41.6
1923	58.2	24.6	42.3
1925	60.8	25.7	42.3
1927	60.3	26.3	43.6
1929	68.0	30.6	45.0
1931	39.8	18.6	46.7
1933	30.6	14.0	45.8
1935	45.0	18.6	41.3
1937	60.7	25.2	41.6
1939	56.8	24.7	43.5

[a] Old basis.
[b] New basis.
Source: *Census of Manufactures*, Bureau of the Census. Data for 1947 are not available. See discussion in text.

no more capital per unit of wage. If the measure of capital intensity is the hybrid ratio of value units to physical units, then large firms are more "capital intensive"; if the measure is the ratio of two value units, they are not. The latter ratio seems more meaningful and useful. In this case, it has a clear implication for the study of cost behavior. The cost structures of large and small manufacturing firms are not significantly different; large firms do not usually have higher overhead or capital costs, and lower labor costs, per unit of output than do small firms in the same broad industrial group.

Some paradoxes arise in studying technical change. Suppose that the steel industry installs the continuous casting process, eliminating the pouring of steel ingots, reheating, and rough shaping before fabrication. Costs and prices would fall, in the long run, by about the same amount; so would Y and S, and hence the ratio Y/S, as shown in tables such as 7 and 8, would decline; steel manufacture

TABLE 6

Ratio of all Corporate Income to all Corporate Sales, 1929-1951
(dollars in billions; ratios in per cent)

Year	*Sales*	*Total Income*	*Ratio of Income to Sales*
1929	$138.6	$45.2	32.6
1930	118.3	38.2	32.3
1931	92.4	28.1	30.4
1932	69.2	18.3	26.4
1933	73.0	17.2	23.5
1934	89.6	23.2	25.9
1935	102.0	27.0	26.5
1936	119.5	32.0	26.8
1937	128.9	37.3	29.0
1938	108.6	32.0	29.4
1939	120.8	36.0	29.8
1940	135.2	42.2	31.2
1941	176.2	56.5	32.0
1942	202.8	72.9	35.9
1943	233.4	88.2	37.9
1944	246.7	90.8	36.8
1945	239.5	82.8	34.6
1946	270.9	87.2	31.1
1947	347.8	105.8	30.4
1948	388.7	121.4	31.2
1949	370.1	116.5	31.5
1950	423.9	131.2	31.0
1951	484.9	152.3	31.4

Source: *National Income Supplement, 1951, Survey of Current Business*, Department of Commerce; *Survey of Current Business*, July 1952, Tables 12, 29.

would be said to be less integrated. Most of the reduction would come in capital costs; the labor used might well be more skilled and highly paid; the steel industry would be less capital-intensive and more labor-intensive.

Another example: a grocery supermarket is a larger and costlier distribution unit than any of the stores it replaces. Yet the cost of moving a given unit of food through the supermarket is roughly half that of moving it through a service store;[21] hence an integrated distributor who was also a manufacturer (as a few chains are) became less integrated by changing to supermarkets. And the wages of clerks are greater per unit of "output" in a supermarket than in an old-fashioned store, so the glittering modern supermarket is more labor-intensive than its predecessor.

Such decreases in integration, I would maintain, are genuine and

[21] The reason is not only that capital and labor are used much more efficiently but also that the consumer has taken over the function of collection of goods, of delivery, and to a considerable extent, of holding inventory.

TABLE 7

Ratio of Two Variants of Income to Sales, U.S. Steel Corp., 1902-1952
(dollars in millions; ratios in per cent)

Year	*Purchases* (1)	*Sales* (2)	*Income A (Margin)* (2—1) (3)	*Ratio of Income A to Sales* (4)	*Wages and Salaries* (5)	*Profits after Taxes* (6)	*Federal Income and Excess Profits Taxes* (7)	*Profits before Taxes* (6+7) (8)	*Interest Paid* (9)	*Depreciation* (10)	*Income B* (5+8+9+10) (11)	*Ratio of Income B to Sales* (11÷2) (12)
1902	$160.8	$423.1	$262.3	62.0	$120.5	$90.3		$90.3	$21.3	$27.8	$259.9	61.4
1903	164.1	398.2	234.1	58.8	120.8	55.4		55.4	25.6	29.3	231.1	58.0
1904	142.3	324.9	182.6	56.2	101.0	30.2		30.2	30.1	18.2	179.5	55.2
1905	151.1	409.2	258.1	63.1	128.1	68.6		68.6	29.8	28.0	254.5	62.2
1906	168.7	484.0	315.3	65.1	147.8	98.1		98.1	29.4	35.6	310.9	64.2
1907	169.1	504.4	335.3	66.5	160.8	104.6		104.6	29.4	35.1	329.9	65.4
1908	104.9	331.6	226.7	68.4	120.5	45.7		45.7	31.3	23.8	221.3	66.7
1909	138.4	441.1	302.7	68.6	151.7	79.0		79.0	31.5	31.8	294.0	66.7
1910	157.1	491.8	334.7	68.1	175.0	87.4		87.4	30.6	32.5	325.5	66.2
1911	146.3	431.7	285.4	66.1	161.6	55.3		55.3	31.1	27.8	275.8	63.9
1912	214.3	533.9	319.6	59.9	189.6	54.2		54.2	32.6	33.7	310.1	58.1
1913	191.6	560.8	369.2	65.8	207.5	81.2	$ 1.9	83.1	33.3	34.0	357.9	63.8
1914	153.7	412.2	258.5	62.7	162.7	23.4	1.2	24.6	33.2	26.6	247.1	59.9
1915	189.8	523.7	333.9	63.8	177.3	75.9	1.8	77.7	32.8	34.3	322.1	61.5
1916	265.3	902.3	637.0	70.6	263.9	271.5	12.2	283.7	32.0	43.0	630.2	69.8
1917	345.9	1,284.6	938.7	73.1	347.9	224.2	233.5	457.7	31.0	83.3	919.9	71.6
1918	339.2	1,344.6	1,005.4	74.8	453.0	125.3	274.3	399.6	30.7	98.8	982.1	73.0
1919	364.5	1,122.6	758.1	67.5	479.7	76.8	52.0	128.8	30.1	89.9	728.5	64.9
1920	413.6	1,290.6	877.0	68.0	581.8	109.7	37.5	147.2	29.3	80.0	838.3	65.0
1921	249.9	726.0	476.1	65.6	332.2	36.6	2.4	39.0	28.5	40.1	439.8	60.6
1922	334.7	809.0	474.3	58.6	323.4	39.6	2.5	42.1	28.4	47.1	441.0	54.5
1923	377.4	1,096.5	719.1	65.6	470.4	108.7	15.8	124.5	28.0	56.9	679.8	62.0
1924	266.9	921.4	654.5	71.0	443.6	85.1	11.6	96.7	27.3	53.2	620.8	67.4

1925	333.6	1,022.0	688.4	67.4	458.2	90.6	13.3	103.9	27.1	61.6	650.8	63.7
1926	346.7	1,082.3	735.6	68.0	469.3	116.7	17.1	133.8	26.8	70.4	700.3	64.7
1927	323.1	960.5	637.4	66.4	412.7	87.9	11.5	99.4	26.1	64.4	602.6	62.7
1928	338.4	1,005.3	666.9	66.3	402.9	114.1	15.0	129.1	25.7	73.2	630.9	62.8
1929	350.0	1,097.4	747.4	68.1	410.2	197.5	17.2	214.7	14.9	69.8	709.6	64.7
1930	234.8	828.4	593.6	71.7	371.7	104.4	12.0	116.4	5.6	63.8	557.5	67.3
1931	187.2	548.7	361.5	65.9	258.4	13.0	0.1	13.1	5.5	50.4	327.4	59.7
1932	141.8	287.7	145.9	50.7	138.5	—71.2	0.1	—71.1	5.3	41.6	114.3	39.7
1933	161.4	375.0	213.6	57.0	167.9	—36.5	0.1	—36.4	5.2	45.3	182.0	48.5
1934	140.5	420.9	280.4	66.6	214.8	—21.7	2.6	—19.1	5.1	46.4	247.2	58.7
1935	191.2	539.4	348.2	64.6	253.9	1.1	3.9	5.0	5.0	49.8	313.7	58.2
1936	287.5	790.5	503.0	63.6	339.0	50.5	11.2	61.7	4.9	59.0	464.6	58.8
1937	342.6	1,028.4	685.8	66.7	447.1	94.9	29.5	124.4	5.1	64.1	640.7	62.3
1938	228.3	611.1	382.8	62.6	294.4	—7.7	2.9	—4.8	8.3	50.3	348.2	57.0
1939	293.5	846.0	552.5	65.3	386.5	41.1	13.0	54.1	9.3	63.4	513.3	60.7
1940	358.3	1,079.1	720.8	66.8	464.3	102.2	26.3	128.5	13.6	72.6	679.0	62.9
1941	604.6	1,622.3	1,017.7	62.7	628.3	116.2	118.7	234.9	6.0	98.6	967.8	59.7
1942	673.4	1,863.0	1,189.6	63.9	782.7	71.2	153.1	224.3	6.2	128.2	1,141.4	61.3
1943	730.6	1,972.3	1,241.7	63.0	912.9	62.6	84.3	146.9	6.3	134.0	1,200.1	60.8
1944	814.4	2,082.2	1,267.8	60.9	957.2	60.8	65.0	125.8	5.0	139.0	1,227.0	58.9
1945	670.1	1,747.3	1,077.2	61.6	825.5	58.0	30.0	88.0	3.5	123.4	1,040.4	59.5
1946	560.4	1,496.1	935.7	62.5	704.5	88.6	32.0	120.6	4.8	68.7	898.6	60.1
1947	839.4	2,122.8	1,283.4	60.5	903.6	127.1	91.0	218.1	2.5	114.0	1,238.2	58.3
1948	1,008.9	2,481.5	1,472.6	59.3	1,035.7	129.6	109.0	238.6	2.4	146.0	1,422.7	57.3
1949	885.7	2,301.7	1,416.0	61.5	945.9	165.9	126.0	291.9	2.3	119.7	1,359.8	59.1
1950	1,118.8	2,956.4	1,837.6	62.2	1,179.4	215.5	234.0	449.5	2.2	143.9	1,775.0	60.0
1951	1,327.9	3,524.1	2,196.2	62.3	1,374.5	184.3	398.0	582.3	2.0	162.1	2,121.0	60.2
1952	1,307.6	3,137.4	1,829.8	58.3	1,322.1	143.7	117.0	260.7	1.9	176.9	1,761.6	56.1

Source: *Annual Report* for 1950 and 1952, U.S. Steel Corp. Data in column 7 supplied by U.S. Steel Comptroller's Office. (They vary slightly from *Study of Monopoly Power*, House Subcommittee on Monopoly Power, Serial No. 14, Part 4-13, Exhibit S-239, p. 570.)

TABLE 8

Ratio of Income to Sales, Ten Major Steel Companies, 1905-1952
(*per cent*)

Year	Bethlehem Steel	Republic Steel	National Steel	Armco Steel	Youngstown Sheet and Tube	Jones and Laughlin	Inland Steel	Wheeling Steel Corp.	Sharon Steel Corp.	Allegheny Ludlum Steel Corp.
1905	47.6									
1906	31.4									
1907	27.5									
1908	38.1									
1909	45.7									
1910	49.8									
1911	47.7									
1912	48.1									
1913	51.0									
1914	51.2									
1915	32.2									
1916	54.7									
1917	51.3									
1918	51.0	43.6								
1919	64.1	48.1								
1920	59.6	50.6								
1921	57.0	24.5								
1922	54.3	39.9								
1923	56.0	53.2								
1924	56.4	53.9								
1925	56.4	48.8								
1926	56.7	52.9		55.1						
1927	58.2	52.7		53.5						
1928	57.4	n.a.		49.8						
1929	58.6	n.a.		44.0						

1930	59.2	59.5		35.6						
1931	55.0	39.3		32.7						
1932	47.1	34.4		39.0						
1933	52.6	41.6		39.6						
1934	56.8	45.0		40.9						
1935	59.9	47.6	46.6	41.4						
1936	58.4	46.8	46.3	41.4			47.2			
1937	57.6	49.2	48.3	42.3			47.3			
1938	60.1	48.9	48.8	38.7		48.3	49.0			37.7
1939	56.8	51.1	45.5	42.3		50.6	50.4			44.8
1940	55.6	50.1	45.9	41.8		52.5	46.8	49.9	35.8	47.3
1941	57.6	49.7	46.9	44.4	47.9	50.3	n.a.	49.5	43.1	47.0
1942	59.6	52.1	49.6	44.4	50.8	56.1	47.2	50.3	43.0	48.5
1943	60.8	46.6	44.3	42.6	46.9	54.2	45.2	50.4	42.0	48.3
1944	62.3	48.4	43.7	44.8	42.5	52.3	43.9	51.8	42.1	50.2
1945	59.9	45.9	41.5	44.3	40.8	48.3	41.7	48.2	43.6	48.3
1946	61.4	50.4	50.5	48.4	45.3	53.2	42.6	54.0	43.9	52.7
1947	53.2	47.6	47.3	46.2	44.3	52.5	42.8	56.4	43.7	49.3
1948	53.4	47.8	47.9	44.3	45.8	49.8	41.5	56.8	44.4	47.8
1949	54.9	49.8	50.3	47.1	45.0	51.4	40.8	54.2	40.2	42.7
1950	58.1	51.4	50.2	51.8	47.5	52.6	41.9	59.7	43.9	44.1
1951	56.2	50.8	50.1	48.3	43.0	53.2	42.1	59.4	44.5	45.1
1952		47.3	44.5		41.0	49.3	37.2	56.3	39.5	42.8

Note: Fully consolidated statements were used for all companies. Where reported, total employment costs (including social security taxes and fringe benefits) have been included. Sales figures are net in all cases.

not merely statistical. If the input of resources necessary for a given process should decline and the process occupy less economic space relative to earlier processes than it formerly did, then the firm would rely more on the market and less on its own contribution for the final product. It would be less self-sufficient and less integrated.

The same paradox relates to labor or capital intensiveness. It is difficult to avoid the impression of capital intensiveness when the operating units are physically large and impressive. But, again, size in economics is not a physical but a value dimension, and in our capital-rich civilization we can and do treat as cheap, because they are plentiful, capital instruments which are scarce and therefore expensive in other societies. In commenting on the ancient protectionist argument against cheap foreign labor, one wit has pointed out that foreign protectionists might with equal logic inveigh against being flooded with the products of cheap American capital. I suspect that research would show many American exports and perhaps exports as a whole to be really labor-intensive, as that term is defined here.

8. *Possible Correlation with Expansion*

ASSUMING, then, that the ratios of income to sales and of inventory to sales are logically sound, what interpretation can be made of the apparent rough correlation between size and the degree of vertical integration?

George J. Stigler has come nearer than anyone else to formulating a law of vertical integration.[22] Treating integration as the opposite of specialization, Stigler expects disintegration to be characteristic of an expanding industry, integration of a contracting one. As the industry (the market) expands, economies of scale become possible in the various processes and these tend to split off to be separately performed. Hence, in the absence of attempts at market control, there should be decreasing integration; this would be reflected in falling ratios.

Stigler doubts that we need a distinctive theory of vertical integration; this leads me to interpret the above situation as a pattern of industry development rather than a logical necessity. As a pattern, it is plausible and will doubtless be borne out in many instances. But in my opinion Stigler's analysis (correctly) contrasts a mature or large-scale industry with a small-scale industry, *not* an expanding

[22] "The Division of Labor Is Limited by the Extent of the Market," *Journal of Political Economy*, June 1951, pp. 185-193.

industry with a contracting one. The distinction between process and result seems to be of crucial significance: I would guess that an expanding industry is more highly integrated than a relatively stable one. If we start with an industry in its earliest years, when it is an innovation, it is at first adapted to and fills a niche in the existing structure of markets and of factor supply. It is essentially a rearrangement of known and available resources. Few can discern its large possibilities for growth and for pushing the capacity of supplying industries and firms. The railroads were originally feeders to canals and turnpikes, and, later, pipe lines and trucks were considered as feeders to railroads; the automobile was a rich man's toy; wireless transmission of signals was intended for ship-to-shore telegraphy; and many other examples might be given.

As the firms and their industry grow, they do so under the forced draft of demand chronically in excess of supply at prevailing prices. This economic tension is transmitted to the factor markets as the firms bid not only for increasing amounts but for changing composition of factors. As larger quantities are needed, some factors become relatively scarce and substitution must be resorted to, often by painful trial and error. Economies of scale now appear, as Stigler rightly insists; my point is that they appear unforeseen and generally lagging behind a keenly felt need. A sluggish response will often force the growing firm to provide its own supplies and/or marketing outlets.

It may be regarded as axiomatic that integration takes place only in response to imperfections of competition in supplying or receiving markets. A firm does not normally integrate into a market where it can buy unlimited quantities at the going price and where the producers are receiving a normal (or subnormal) return. A firm does integrate into a broadening market whose service is scarce and expensive. The scarcity and the high price may be the result of monopoly control in the invidious sense, by a single seller or by a group whose several minds have but a single thought. But the scarcity may exist simply because of the time lag in supplying the new factor. A small, uncertain, and fluctuating supply is peculiarly subject to recurrent "corners" and extortion. Also, there may be considerable monopoly profit. Even when this is not the case, if the factor is expensive or unsuitable, so that it takes additional costly processing before being ready for use or is uncertain in amount, the impact on the expanding firm is much the same. Thus the very expansion of demand which induces economies of scale in the associated markets

also induces the firms in the growing industry to occupy the associated markets. Once established, the pattern perpetuates itself, unless the (private) diseconomies of integration are considerable.

An industry in rapid growth throws the process into boldest relief, but it is only the most extreme example of a more general problem. Given an expanding and changing economy, there must necessarily at any instant be a host of markets out of equilibrium into which it becomes profitable to integrate. This would explain the existence of vertical integration even in the absence of attempts to pre-empt an essential resource in order to prevent competitors from using it or to insure the "right" kind of price policy at later stages.

Given imperfect competition and no sharply defined loci of least-cost output, so that a firm may be well away from the optimum scale without ceasing to exist, then the half-forgotten history of an industry plus the power of inertia may largely explain its existing pattern of vertical integration. Chance alone may be no small part of the explanation. Imagine an industry comprising n stages with no economies or diseconomies of vertical integration. The joining of functions would then be purely random. There would be 2^{n-1} possible varieties or degrees of vertical integration; the "average" firm would encompass $(n+1)/2$ stages, with $\sqrt{n-1}/2$ standard deviation.[23] Thus, with only a half dozen stages, one would find 32 possible patterns; the average number of stages encompassed would be $3\frac{1}{2}$, but this could be in any one of several patterns; furthermore, there would be one chance in three of any given firm encompassing less than $2\frac{1}{2}$ or more than $4\frac{1}{2}$ stages.

9. *Four Developmental Patterns*

THE foregoing sketch is not, I think, inconsistent with the evidence. The smallest firms appear to be specialists in a particular process. As the firm grows, it does not merely duplicate its activities; it takes over additional functions, performing some of the services it formerly purchased. Hence, both ratios would increase. But for the firm which has grown into a large part of its available market, the trend to self-sufficiency may be reversed by the marketing necessity to carry a full line. Hence the firm purchases many finished or nearly finished goods to be marketed in conjunction with those it processes over a greater length of production line. This decreases the two ratios, but even with this reversal the large firm is more integrated than the small. A similar development takes place in the

[23] My thanks on this point are due to Robert M. Solow.

fully developed industry, where with the passage of time certain diseconomies of integration are slowly realized and certain functions are discontinued. For any growing industry or firm, the trend is to increasing integration, but this is counteracted both by the constant growth of new, less integrated industries and firms and by the reversal of the trend in highly mature industries.

Thus we have about four developmental patterns of vertical integration. For any given firm at any given time, they may be mutually exclusive but not over longer periods. Nor are they exhaustive. It would be most unfortunate if we looked for *the* typical pattern and tried to make of it a general theory of vertical integration. What we need is to increase our knowledge of various patterns and to multiply hypotheses while trying to practice some orderly housekeeping among them. The ratios proposed here, when used in conjunction with other evidence, may serve as useful tools in this task.[24]

Appendix

CERTAIN sources other than those discussed above were investigated, but they proved unworkable. They are briefly indicated in this Appendix, as a warning to those interested in further research in this area. *The Structure of the American Economy*[25] contains two interesting tabulations of census data. One of them concerns the 200 largest manufacturing concerns, grouped by fives; the other gives concentration data (the largest four and the largest eight producers) in several hundred industries. For each group the value added and also the value of products is indicated. Unfortunately, the latter is given on a combined rather than consolidated basis, so that sales are overstated, in ratio loosely proportional to the number of plants. It is impossible to calculate and allow for bias from this source, since a firm with many horizontally related plants would show little or no overstatement, while a plant with even two vertically related plants might show a very large overstatement. If Monograph 27[26] showed the number of establishments involved in the several relationships discussed above, it might be possible to calculate the bias; unfortunately, as already seen, the monograph shows only the number of central offices (firms) involved.

Another source which was not useful was tabulation by the Office

[24] Cf. the able Ph.D. thesis by Frederick E. Balderston, *Scale, Vertical Integration, and Costs in Residential Construction Firms* (Princeton University Press, 1953).

[25] Leontief, *op. cit.*

[26] Thorp and Crowder, *op. cit.*

of Price Administration of wartime manufacturing corporate finance, which was published by the FTC in 1947.[27] The basic trouble with these data, for our particular purpose, is that the gross is too gross, and the net too net. Only purchases of raw materials are indicated, so that the spread between total purchases and sales includes more than value added by the firm. Proceeding contrariwise, corporate profits are available, as well as interest; but the wage total is incomplete and a very large part of total cost is unclassified general manufacturing expense. Hence, income generated is understated. Another defect, for our particular purpose, is that certain large subsidiaries were not consolidated with their parents; this results in an overstatement of sales.

Monograph 27 also presents concentration data for 1,807 narrowly classified industries, each producing what approximates a "product" in the market sense. Unfortunately, concentration is given in terms of sales in dollars and in physical units but not in terms of value added, so that no ratio can be calculated.

Finally, there are the tables computed for the Celler Subcommittee from the 1947 census.[28] Here, too, concentration is shown in terms of sales, except for twelve industries for which it is given in terms of value added. Nowhere, however, do we have both.

[27] *Report on Wartime Profits and Costs for Manufacturing Corporations*, FTC 1947.

[28] Letter from the Secretary of Commerce to Representative Emanuel Celler, December 1, 1949, Table v appended.

COMMENT

IRSTON R. BARNES, Federal Trade Commission

VERTICAL integration is normally understood to refer to an organization of production under which a single business unit carries on successive stages in the processing or distribution of a product which is sold by other firms without further processing. Vertical integration results in by-passing a market or having a position on both sides of the market: making a product instead of buying it, carrying it to a later stage instead of selling it. Thus, bringing together under one managerial direction a raw material producer and the manufacturer using that raw material, a producer of an intermediate product and a manufacturer using that intermediate product, or a

NOTE: The views expressed in this comment are the writer's and not necessarily those of the Federal Trade Commission.

manufacturer of the finished product and a distributor of that product, are examples of vertical integration. In a practical sense, integration must be examined with respect to the particular product or products which a firm manufactures, not with respect to products generally; full integration with respect to all products which a manufacturer fabricates probably exists nowhere in the real economy.

It is, of course, commonplace that a large proportion of industry involves two or more successive steps in production which might theoretically, though not practicably, be split among two or more producers. However, attention is generally focused on those situations where successive stages of production are brought under a single managerial supervision and where markets are by-passed or straddled.

It is not fruitful for present purposes to make a prolonged inquiry as to whether vertical integration is fundamentally different, either in objectives or in consequences, from other coherent forms of integration. We may simply note in passing that the questions raised by all coherent forms of integration are essentially similar.

RATIO OF INCOME ORIGINATING TO SALES

STATISTICAL attempts to measure vertical integration have yielded less than satisfactory results. After noting many of the deficiencies, Adelman proposes two measures of vertical integration. He would measure vertical integration by the ratio of income originating within the corporation (or within the industry) to its sales. He also offers an alternative measure of integration: the ratio of inventory to sales.

Throughout his paper Adelman appears to identify his concept of integration with the measures which he advocates. These measures are offered as general-purpose yardsticks, and the implication is that the magnitude measured may be accepted as an accurate index of integration for any and all purposes.

Adelman appears to be drawn to his proposed measures because theoretically and conceptually the larger the value added by the manufacturer, or the greater the income originating within the firm, the farther the firm carries its processing of the product. Unfortunately this conceptually neat identification of integration does not yield results which are useful in resolving the real problems which arise with respect to integration.

Adelman recognizes most of the deficiencies inherent in the application of his two measures; yet he nevertheless advocates the re-

finement of the statistical series which he uses and holds out the hope that the measures may be made to work. Where the author has been so diligent in pointing out the deficiencies in his own analytical tools, it is somewhat gratuitous for the critic to affirm the defects which have been noted. Nevertheless, a skepticism amounting almost to conviction that Adelman's ratios of income originating to sales and of inventory to sales will not prove useful in resolving the practical problems associated with integration prompts a warning that others refrain from following this path. In short, neither of these measures of integration yields reliable or consistent results. Indeed, each reflects a complex of factors, many of which—such as the profit level of the firm or industry—are quite unrelated to integration.

Some of the deficiencies associated with the income-sales ratio may be examined briefly:

1. Adelman offers a theoretical example of integration involving a primary producer, a manufacturer, and a distributor, each of which by assumption contributes one-third of the total value of the product. The application of the income-sales ratio yields an index of 100 for the primary producer, 50 for the manufacturer, and 33 for the distributor; yet by definition all are equally "integrated." In this instance the ratio reflects the stage in the productive process which is being measured rather than the degree of integration. This characteristic alone deprives the index of any real value in making comparisons between industries or even in comparing different producers in the same industry, where they are not at exactly the same stage in the productive process.

The question commonly arises as to what effect an acquisition or merger has upon the degree of integration before and after the merger. The same example illustrates another deficiency. If the manufacturer absorbs the primary producer, that is, if he integrates backward, the index of integration increases from 50 to 100 and the manufacturer is fully integrated. On the other hand, the primary producer, whose index of 100 indicates that he is already fully integrated, might absorb the manufacturer; if so, the index of integration would still be 100. However, if the manufacturer absorbs the distributor, that is, integrates forward, an equal degree of forward vertical integration yields an index of 67. Thus in these instances the index of integration measures, not the degree of integration but the direction of integration, yielding higher magnitudes for backward integration than for forward integration.

2. The infirmities revealed by the theoretical example lead Adel-

man to conclude that comparisons are possible only when dealing with the same economic function or with closely similar functions, and he warns against comparing the integration of a mining company with that of a retailer. Yet there will seldom exist that similarity or identity of function which would render the use of this index dependable. Indeed, it is the fundamental purpose of vertical integration to combine different functions, and different mergers will effect different combinations of functions. However, the index is not available for these simple and direct comparisons. If one knows enough to use the income-sales index with safety, he knows more that is significant about the companies concerned than the index can ever reveal.

3. A high index of integration as indicated by the income-sales index may reflect the intensiveness of the productive process as well as the vertical extension of the productive operation over successive stages. The employment of skilled labor and expensive machinery normally gives rise to a greater value added by the manufacturing operations, even though only a single productive stage is involved. Thus, without calculating the index of integration, we should expect to find a higher index for a watch company than for a company engaged in a relatively simple metal-fabricating operation.

4. Income originating, or value added, includes sales less expenditures for raw materials, fuel, and power. Specifically it includes corporate profits. Hence the greater the corporate profits, the higher the degree of integration which the index will show, and, conversely, the larger the corporate losses, the lower the degree of integration which the index will record. Thus, of two companies carrying on identical manufacturing operations, the more successful will show a higher index of integration. In this instance differences in the indexes of integration measure differences in the competence of management or in the profit-making possibilities of the two companies. Hence the index is not a reliable measure of integration even with respect to two companies operating at the same stage in the same industry.

The lack of comparability between companies performing the same function renders Adelman's caution against comparisons between companies in different industries somewhat misleading. In fact, the same lack of similarity which he accepts with respect to interindustry comparisons is inevitably present within most two-digit industries. Furthermore, comparisons might be rendered invalid by integration which carries different companies in the same

industry across different industry lines. In short, a statistical measure of integration which is applicable only within the narrowest confines has very limited utility. Many critical questions respecting integration which demand answers refuse to be neatly pigeonholed, as the proposed index would require.

5. When the income-sales measure is applied to reveal changes in integration from year to year, new difficulties are encountered. Differential changes in the level of prices introduce aberration. Without any change whatever in the productive processes carried on within the firm, a lower index of integration may result from an increase in the costs of materials, fuel, and power. Or without any change in the physical processes of production, a higher index of integration may result from an increase in the prices at which the product is sold, from a greater increase in prices than in costs, or from a greater reduction in costs than in prices.

6. Adelman presents an array of indexes of integration for two-digit industries. In the light of the deficiencies already noted, comparisons between industries have no discoverable significance. Moreover, the two-digit industries comprehend so many different productive operations that it may not be assumed that the industry's index is an average which is characteristic of any of the companies comprising the industry.

7. Adelman presents a tabulation of the indexes of integration for the U.S. Steel Co. from 1902 to 1950. To the uncritical reader, the index yields curious results. The index is lower during the depression years than during the years before and after the depression. What changes in the realities of integration occurred during these years is not known, but if there were no changes, the same results might be expected from changes in cost-price relationships.

RATIO OF INVENTORY TO SALES

AN ALTERNATIVE index of integration, the ratio of inventory to sales, is presented as a derived measure of integration. The theoretical justification lies in the observation that the longer the productive line and the more successive processes performed within the same firm, the higher the ratio will be. Adelman notes that this measure is "more susceptible to meaningless comparisons" than the income-to-sales ratio. His warning is necessary, for this ratio appears to be no better than the income-to-sales measure. It is subject to many of the objections already considered as well as to a number of ad-

ditional deficiencies. Only three new objections are commented on here:

1. The inventory-sales index is simply the ratio of inventory to sales without respect to the stage at which the inventory is held. Thus, if the inventory is at the final-product stage, the index could be as high for the unintegrated producer of the final product as for an integrated producer whose operations cover several stages in production.

2. The index yields confusing results where the productive process is continuous. If there are no intermediate products or if production moves continuously, as in some of the chemical and paper companies, the amount of the inventory is minimized. Hence the more highly integrated producers, whose visible inventory consists primarily of low-value raw materials, may show a lower index of integration than a partially integrated firm whose first inventories are in the form of intermediate products. An index which makes a partially integrated firm appear to be more highly integrated than a fully integrated firm is a measure which should be discarded, not refined.

3. The index of integration will vary according to the marketing practices of companies within the same industry. For example, if they are successful in moving finished cars directly from the production line to their dealers, the larger and more highly integrated automobile manufacturers may show lower indexes of integration than smaller, less integrated competitors who are less successful in inducing their dealers to carry their inventories.

In summary, it does not appear that either of the two ratios proposed, income originating within the firm to sales or inventory to sales, can be helpful in dealing with any of the real problems of vertical integration, whether the problems arise with respect to specific firms or to industries.

A SIMPLE PROPOSAL

MANY problems in connection with vertical integration relate to the effects of such integration upon a competitive organization of industry and upon competitive markets. Some of these problems can be illuminated by the development of measures which would show the degree to which different companies are dependent upon markets at specific stages in the processes of production and distribution. An unambiguous and simple measure of the degree of vertical integration of the individual firm with respect to different market levels

can be constructed for any product or class of products, with separate measures showing the degrees of forward and backward integration. To make the example specific, one might seek to measure integration with respect to the pulp-producing and pulp-consuming operations of a paper company. In this instance one would measure the interplant transfers of pulp by the company as a percentage of its total shipments and interplant transfers of pulp; this would supply an index of the degree of forward integration. Or, the consumption of pulp by a paper company from its own pulp mills might be expressed as a percentage of its total consumption of pulp. This would reflect the degree of backward vertical integration. This measure would facilitate comparisons of the degree of integration of different companies in the same industry and would be equally serviceable in showing the degree of integration of the same company at different periods of time.

Where suitable universe data are available, as they are in the paper industry, the same type of measure may be used to determine the degree of vertical integration between successive market levels or between the same markets at different periods of time. Or, one may compare the degree of vertical integration of specific companies with the degree of vertical integration for the market as a whole.

The complement of the measure of vertical integration for an individual company shows its dependence on the market for sales or purchases of the products in question. The complement of the measure of forward integration indicates the degree to which the producing firm at any particular stage is dependent on the market for the disposition of its product. The complement of the measure of backward integration shows the degree to which any consuming unit in the company depends upon the open market to supply it with the product in question.

The complement of the measure of forward vertical integration for the market as a whole states the percentage of the industry's output of the product which is available to open-market purchasers. And the complement of the measure of backward vertical integration for the market shows the percentage of the consumption of the material or product which is derived from open-market purchases.

No statistical measure of vertical integration is without its disadvantages. Two immediately apparent disadvantages of the measure here proposed may be briefly noted:

1. Suitable universe figures are collected for only a limited num-

ber of industries, and within those industries for only a limited number of products. Thus, figures for total shipments or for the total of sales or purchases in markets, particularly regional markets, may not be available.

2. The measurement of interplant transfers does not yield an unambiguous figure, for different companies, even within the same industry, may value their interplant transfers on different bases. The valuation of interplant transfers is essentially a matter of managerial decision. Some companies value interplant transfers at cost, others value them at market price at the time of the transfer, and others appear to split the final sales price according to an individual management formula.

The principal advantages of the proposed alternative measure arise from the fact that it is concerned with real problems of integration:

1. The percentage of market measure will yield consistent results both through time and as applied to different companies.

2. Full forward or backward vertical integration with respect to a product will yield an index of 1. This would mean that a company sold none of its output of the product in question on the open market or made no purchases of material on the market.

3. A company selling all its output of a product and using none of it, or buying all its requirements of a product, would have a vertical integration measure of zero.

4. The indexes are additive, that is, the individual company fractions can be totaled to give a sum which indicates the degree of market integration. Thus, if the degree of vertical integration for some of the largest producers or consumers of a product is known and if corresponding figures are available for the market, it is possible to infer the degree of vertical integration for other companies as a group. This may be helpful in characterizing particular markets, and it may also illuminate some of the competitive problems facing other producers and consumers in that market.

5. The percentage of market index can be applied either to quantity figures or to dollar figures, whichever are available.

6. The index will not be distorted by changes in price levels, since equivalent values are used for any given period of time.

7. Finally, the percentage of market index expresses the commonly accepted concept of vertical integration rather than defining vertical integration in terms of the measure employed.

There are many problems relating to vertical integration where

judgments must rest on some fairly reliable measure of the position of individual companies with respect to other companies and to the market as a whole. The critical questions relating to vertical integration must be asked before suitable measures of integration can be devised. Further work in the construction and refinement of measures of integration should await a clinical examination of the problems of vertical integration and should be directed at yielding useful and unambiguous results.