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Appendix VIII

Scale of Manufacturing Operations

Various data are available in Census of Manufactures records and from other sources that indicate the scale of manufacturing operations, and a considerable literature on this subject has been published.¹ Hence it is not discussed extensively in this monograph. But the subject is not without interest in a study of the manufacturing structure, even within so restricted an area as our own. Accordingly, in this Appendix are presented certain materials bearing on the size of manufacturing establishments. Table VIIIa summarizes data relating to establishments classi-

Table VIIIa

Measures of the Scale of Manufacturing Operations, 1929

Value of Product per Establishment (thousands of dollars)	Establish- ments	Wage Earners (percentage of total)	Value of Product	Value Added by Manufacture
5- 19.9	32.9	2.3	1.1	1.5
20- 99.9	35.7	7.8	5.1	6.5
100- 499.9	20.9	18.9	14.2	16.2
500- 999.9	4.9	12.7	10.3	11.1
1000-2499.9	3.5	18.2	16.2	16.9
2500-4999.9	1.2	12.5	12.2	12.7
5000 and over	.9	27.6	40.9	35.1
Total	100.0	100.0	100.0	100.0

fied according to the magnitude of the value of their products. Comparison of these ratios for 1929 with those for 1919 indicates no major changes. The industrial integration that took

¹ See particularly W. L. Thorp, *The Integration of Industrial Operations*, published as 14th Census Monograph III. More recently have appeared *The Modern Corporation and Private Property*, A. A. Berle and Gardiner Means (Macmillan, 1933); 'Concentration of Corporate Control', by W. L. Crum, *Journal of Business*, University of Chicago, July 1935, pp. 269-83; *Big Business, Its Growth and Place* (Twentieth Century Fund, 1937).

place during these post-War years was not accompanied by any change in the size of manufacturing establishments. Rather it took the form of binding together single establishments under a system of common ownership and control. On this development the records on size of establishments throw little light.²

Data on size of establishments help, however, to identify industries in which large scale operations predominate. The 'mass production' industry has taken its place in our productive economy and, while perhaps not common, is dramatically typical of some of our more important industries. One requirement of this type of production is a large establishment, employing a large working force. We can roughly identify such industries by selecting those in which the majority of the wage earners work in plants employing a relatively large number of workers. While this method of selection is crude, because it ignores the possibilities of large scale operations in industries where the volume of output does not make possible the employment of a large force, this is probably not a serious defect.

The 1929 Census of Manufactures reports, by industries, the number of wage earners classified by size of establishment. Irregular class intervals are used for convenience in tabulating, but the variation in size of manufacturing plant is evident.³ Location of the interval that marks the lower limit of half the

² Special compilations of the 1933 Census, furnished by the Bureau of the Census to the Twentieth Century Fund, grouped wage earners in establishments under the same ownership in 84 industries. The number of wage earners in the largest enterprises in each industry, expressed as a percentage of all wage earners, made possible the following comparison of degree of concentration.

In 5 industries over 90 per cent of the wage earners were employed by the largest 6 concerns: cigarettes (99.4 per cent in the largest 8, 91.4 per cent in the largest 4 concerns), typewriters, asphalted-felt-base floor covering, smelting and refining copper, sewing machines. In a sixth industry, corn sirup, over 90 per cent of its wage earners were employed by 7 concerns. Some of the other industries were: 80-90 per cent, photographic apparatus, explosives, matches, firearms, watchcases, cash registers and adding machines, rayon, motorcycles (7 concerns), beet sugar refining; 70-80 per cent, motion pictures, aircraft, motor vehicles, tires and tubes, cane sugar refining, aluminum products, pencils, tin cans, wrought pipe, agricultural implements (8 concerns), soap (8 concerns), zinc refining, steam and electric railroad cars. The least concentration in the 84 industries studied, according to this method of comparison, was in the women's clothing industry, where but 3.7 per cent of all wage earners were employed by the largest 6 concerns (*Big Business, Its Growth and Place*, pp. 41-7).

³ Occasionally an establishment may mean more than one plant. Two or more plants in the same town or city owned by one individual or corporation, for which one set of account books is kept, are reported as a single establishment by the Census of Manufactures. As a result, the size of the industrial unit may be slightly overstated.

wage earners of each industry supplies a measure of relative industrial concentration. Each figure is roughly a weighted median of the establishment distribution. In Table VIIIb the 326 manufacturing industries are tabulated according to these median groups, as well as the number of establishments and wage earners in each size division. Entries in the last two columns are as reported by the Census, and are not derived from the industry classifications.

Table VIIIb

Size of Manufacturing Establishments, 1929

Wage Earners per Estab- lishment (1)	Industries with at least Half their Workers in Given Group and Over (2)	Establishments at Given Ratio (thousands) (3)	Wage Earners in Establish- ments of Col. (3) (thousands) (4)
1-5	1	95.8	280
6-20	23	53.5	596
21-50	57	25.0	814
51-100	63	12.5	892
101-250	80	10.2	1,589
251-500	49	3.9	1,331
501-1000	29	1.7	1,177
1001-2500	16	.8	1,145
2501 or more	8	.2	1,015
Total	326	211.0*	8,839

* Includes 7.4 thousand establishments reporting no wage earners.

Many small manufacturing establishments with few workers employ in the aggregate only a small percentage of all manufacturing wage earners. On the other hand, the largest 206 establishments employed 1,015 thousand wage earners in 1929, or 11.5 per cent of the total. The smallest 95,767 establishments⁴ employed only 3.2 per cent of all wage earners.

⁴ The very small establishments are excluded from the Census tabulations, since only concerns with an annual product of \$5,000 or more are reported. In 1919 the number of wage earners in 60,215 plants with a value of product of more than \$500 but less than \$5,000 was only 0.5 per cent of the number of wage earners in plants with products valued at \$5,000 or more.

In one industry, cheese making, the dominant size of establishment is extremely small: over half the workers were employed in plants with no more than 5 employees. At the other extreme, in 8 industries over half the 1929 working force were employed in plants with more than 2,500 employees: cash regis-

Table VIIIc

Relation of Size of Plant and Proportions of Value Added distributed as Wages, 1929

Manufacturing Industries (entries are number of industries)

Wages as a Percentage of Value Added	Median Number of Employees per Establishment									Total
	1 to 5	6 to 20	21 to 50	51 to 100	101 to 250	251 to 500	501 to 1000	1001 to 2500	2501 or more	
0-4.9
5.0-9.9	1	..	..	2	..	..	..	3
10.0-14.9	..	2	6	3	1	..	3	..	..	15
15.0-19.9	..	1	9	3	3	3	2	..	..	21
20.0-24.9	..	3	3	9	4	2	..	..	1	22
25.0-29.9	1	3	3	8	12	8	4	..	2	41
30.0-34.9	..	4	7	8	10	2	3	3	1	38
35.0-39.9	..	3	7	9	24	13	3	3	2	64
40.0-44.9	..	3	8	11	13	8	6	6	..	55
45.0-49.9	..	2	7	8	7	7	1	1	..	33
50.0-54.9	..	1	4	3	4	2	4	3	1	22
55.0-59.9	2	1	2	1	..	..	1	7
60.0-64.9	..	1	..	..	..	..	2	..	..	3
65.0-69.9
70.0-74.9
75.0-79.9
80.0-84.9
85.0-89.9	1	1	..	..	2
Total no. of industries	1	23	57	63	80	49	29	16	8	326
Median percentage of value added	27	34	35	35	37	38	40	42	35	37

ters and business machines, locomotives, motor vehicles, phonographs, rayon, mechanical refrigerators, rubber tires and tubes, and watches and watch movements. The median size of plant for most industries (80) falls in the group employing 101-250 employees.

It is an interesting possibility that variations in the ratio of

Table VIII d

Twenty-four Manufacturing Industries with
Large Scale Operations, 1929

(one-half the industry's wage earners employed in plants with
over 1,000 wage earners)

	Wage Earners in Industry	Wage Earners in Plants with over 1000 Wage Earners (per cent of total)	Average Number of Wage Earners per Establishment, Entire Industry
Agricultural implements	41,663	53.5	142
Aluminum manufactures	21,210	50.5	141
Ammunition and related products	7,223	60.3*	344
Billiard and pool tables	1,390	70.6*	35
Boots and shoes, rubber	25,659	84.4	1,166
Carpets and rugs, wool	32,623	60.1	487
Cash registers and adding, calcu- lating, and card-tabulating machines	16,840	64.3*	366
Clocks, clock movements, etc.	10,401	55.1	186
Collars, men's	2,952	51.8*	197
Electrical machinery, apparatus, and supplies	328,722	57.4	182
Engines, turbines, tractors, water wheels	61,148	60.4	307
Iron and steel: steel works and rolling mills	394,574	70.8	812
Locomotives	11,045	85.7	690
Motor vehicle bodies and parts	221,332	65.7	192
Motor vehicles	226,116	83.9	927
Optical goods	9,701	57.0	83
Phonographs	14,416	66.3*	244
Photographic apparatus and materials	12,967	63.0*	113
Rayon and allied products	39,106	86.3	1,348
Refrigerators, mechanical	16,883	91.1	497
Rubber tires and inner tubes	83,263	82.0	915
Sewing machines and attachments	10,467	63.1*	268
Typewriters and parts	16,945	66.5*	652
Watches and watch movements	10,738	90.7	1,342
Total	1,617,384		

* In reporting the number of wage earners by size groups, the Bureau of the Census frequently combines the figures of adjoining size groups in order to avoid disclosing data for individual establishments. The percentages to which this note is appended are based on estimates for industries affected by this rule, and are therefore not exact measurements. The estimate rests on the assumption that the average number of wage earners, per establishment, in the lower size groups was the same as the mid-value of the group.

wage payments to total value added may in some way be related to variations in size of plant. Wage payments by size of plant are not available, but Table VIIIb classifies industries by size of plant, and Table VIIIc compares the wage payments ratios of Table 19 with the size of gradations of industries. From Table VIIIc it is clear that there is considerable scatter in the ratio of wage payments to value added for both small and large scale industries, and some drift to higher ratios appears as we pass to industries where large scale operations are more common. The median ratios for the lower size groups are in general somewhat below those of the larger scale units but, in view of the wide variation about these medians, there is no strong evidence that a size relationship holds in the ratio of wages to value added.

If, to the 8 industries in which over half their wage earners were employed in plants with more than 2,500 workers, we add the 16 industries included when the limit is lowered to 1,000 wage earners per plant, 24 industries are characterized by large scale operations (Table VIIIId).⁵ The majority of these large scale industries make consumption goods. Six of the 24 can be termed capital producing: iron and steel, electrical machinery, engines and turbines, agricultural implements, cash registers, etc., locomotives. Certain of these industries, particularly steel works, are operated on a large scale because of their physical requirements; this is probably true also of locomotives. But for most of the industries the operation of such large plants is related to mass production methods, and in almost every instance the good produced is one that can be made in great quantities from standardized parts. This characteristic of modern production is plainly evident.

It is notable also that with few exceptions these products of large scale operation are durable goods. Absent are the perishable products in whose processing little effort need be expended and for which concentration of activity into large plants would be inefficient. Also absent are products in which taste and style play an important role; the scale of operation we have

⁵ In that the Census industry classifications are sometimes quite broad, it may happen that an activity marked by high plant concentration is merged with one where plant size is low. The combination, therefore, may not appear in our list of industries with large scale operations.

described requires strict adherence to the production of standardized products.

An examination of the Census records for 1919 reveals that in 28 industries more than half the wage earners work in establishments with over 1,000 workers. Seven industries on the 1929 list do not appear in 1919: agricultural implements, aluminum manufactures, clocks and clock movements, engines, turbines, etc., optical goods, rayon, and mechanical refrigerators. Eleven industries lost their ranking and were, in 1929, no longer in the large scale group: steam railroad cars, emery wheels, firearms, pencils, petroleum refining, saws, wood screws, shipbuilding, slaughtering and meat packing, steam fittings and steam and hot water heating apparatus, and sugar refining. Since some of the 7 industries classed as having large scale operating units in 1929 but not in 1919 are new industries with new markets, there seems to be clear evidence of no tendency to concentration of manufacturing activities in very large plants during this post-War period. This conclusion is supported by the absolute decline between 1919 and 1929 in the number of workers in establishments employing over 1,000 men (2,398 thousand in 1919 to 2,160 thousand in 1929). But the decline is not pronounced, and the more important industries classed as large scale in 1929 were equally so in 1919. Where the causes of the concentration lie deep, where monopoly or heavy investment thrust off threatened competition, and where economies of mass production continue, then this aspect of the structure of manufacturing production changes but slowly.⁶

⁶ These conclusions agree with findings of W. L. Thorp, in *The Changing Structure of Industry*, Part 3 of Ch. II, *Recent Economic Changes* (National Bureau of Economic Research, 1929), pp. 167-75. Arranging 321 industrial groups in order of average number of wage earners per establishment, he finds a high degree of persistence in rank. Coefficients of rank correlation are: 1914-19, +.946; 1919-21, +.975; 1921-23, +.980; 1923-25, +.986. If the 321 industries were in identical rank in successive years the coefficient would be + 1.0.

Our basis is less satisfactory for time comparisons, since the point of reference is a fixed number of employees per plant, 1,000. Nevertheless, in 1914, when output was well below that of 1929, in 18 industries more than half the employees were working in plants with over 1,000 men, and 13 of these appear in the 1929 listing of 23 (counting motor vehicles as one industry). In 7 of these 13 industries the percentage of total employment in the large plants was greater in 1914 than in 1929. The 18 industries, with the percentages of total employment in plants of over 1,000 wage earners, are:

Table VIIIe

Average Value of Product and Value Added
per Manufacturing Establishment,
by Industries, 1929

Dollars per Establishment (thousands)	Number of Industries ¹ classified by						
	Value of Product			Value Added by Manufacture			Largest 40 In- dustries
	Total	Con- sumption Goods	Capital Goods	Total	Con- sumption Goods	Capital Goods	
0.0- 99.9	50	39½	10½	115	96½	18½	9
100.0- 199.9	61	50	11	75	59	16	6
200.0- 299.9	46	38	8	37	26	11	5
300.0- 399.9	35	25	10	26	18	8	4
400.0- 499.9	15	13	2	17	15	2	3
500.0- 599.9	17	12	5	4	3	1	2
600.0- 699.9	15	14	1	13	11	2	2
700.0- 799.9	11	6	5	6	4½	1½	3
800.0- 899.9	7	5	2	3	3	..	..
900.0- 999.9	6	3	3	3	2	1	1
1000.0-1099.9	6	6	..	5	3	2	..
1100.0-1199.9	8	7	1	1	1	..	..
1200.0-1299.9	5	4½	1½	2	1	1	1
1300.0-1399.9	3	3	..	1	1	..	..
1400.0-1499.9	2	2	..	2	..	2	..
1500.0-1999.9	6	5	1	4	2	2	1
2000.0-2499.9	9	4	5	2	..	2	..
2500.0-2999.9	6	5	1	3	2	1	..
3000.0-3499.9	..	..	..	3	2	1	1
3500.0-3999.9	2	1	1	1	1	..	1
4000.0-4499.9	2	2	..	2	2	..	..
4500.0-4999.9	3	3	..	..	..	..	..
Over 5,000.0 ²	11	6	5	1	1	..	1

Median (thousands
of dollars per
establishment) 317 299 365 164 152 214 300

¹ Lumber products and electrical machinery have been placed in both capital and consumption goods groups with half weight.

² The 11 industries with an average establishment value of product over \$5 million are (sales given in thousands of dollars):

Rayon	5,157	Linoleum	8,179
Locomotives	5,241	Rubber tires and tubes	8,463
Petroleum refining	6,768	Smelting and refining, lead	12,217
Steel works and rolling mills	6,925	Motor vehicles	15,257
Iron and steel, blast furnaces	7,347	Sugar refining, cane	24,161
		Smelting and refining, copper	38,261

The one industry with value added per establishment over \$5 million is motor vehicles (\$5,415 thousand). The averages for other industries are given in Appendix II.

Table VIII

Average Wages and Cost of Materials per Manufacturing Establishment, by Industries, 1929

Dollars per Establishment (<i>thousand</i>) (1)	Wages Paid			Number of Industries ¹ classified by			Number of Wage Earners in Industries of Col. (2)-(4) (<i>thousand</i>)		
	Total (2)	Consump- tion goods (3)	Capital goods (4)	Total (5)	Consump- tion goods (6)	Capital goods (7)	Total (8)	Consump- tion goods (9)	Capital goods (10)
0-9.9	14	12	2	9	8	1	106	99	7
10-19.9	51	42	9	11	8	3	513	492	21
20-29.9	47	42	5	19	14	5	840	807	33
30-39.9	28	20½	7½	19	14½	4½	814	597	217
40-49.9	22	16	6	14	13	1	354	313	41
50-59.9	20	16	4	8	6	2	397	315	82
60-69.9	9	9	..	13	12	1	335	335	..
70-79.9	14	10	4	11	9	2	115	68	47
80-89.9	10	7	3	6	4	2	592	117	475
90-99.9	3	2	1	12	7	5	215	136	79
100 and over	108	77½	30½	204	158½	45½	4558	3027	1531
0-90	218	176½	41½	122	95½	26½	4281	3279	1002
100-199	60	47	13	74	58	16	1468	1273	225
200-299	17	13½	3½	37	28	9	1090	803	287
300-399	11	7	4	18	15	3	895	490	405
400-499	5	1	4	12	9	3	155	7	148
500-599	2	1	1	7	4½	2½	44	32	12
600-699	1	..	1	10	10	..	17	..	17
700-799	1	1	..	8	6	2	17	..	17
800-899	2	1	1	5	5	..	31	14	..
900-999	1	..	1	1	1	..	15	..	15
1000 and over	8	6	2	32	22	10	790	391	405

0-999	318	248	70	294	232	62	8043	5916	2128
1000-1999	8	6	2	16	12	4	796	391	405
2000-2999	..	..	..	4	3	1	..	..	..
3000-3999	..	..	..	5	3	2	..	..	..
4000-4999	..	..	..	1	1	..	..	..	..
5000 and over ²	..	..	..	6	3	3	..	..	..
Total industries	326	254	72	326	254	72	8839	6306	2533
Median (thousands of dollars per establishment)	50.5	46.6	72.5	155.4	154.3	159.4			

¹ See Table VIIIc.

² The 6 industries with material costs of more than \$5 million per establishment are: petroleum refining, \$5,209; iron and steel, blast furnaces, \$5,812; motor vehicles, \$9,842; smelting and refining, lead, \$10,733; sugar refining, cane, \$20,876; smelting and refining, copper, \$35,398. The 8 industries in which wage payments averaged over \$1

million for each establishment are, in order of magnitude of the average: watches, rayon, motor vehicles, steel works and rolling mills, tires and tubes, rubber boots and shoes, linoleum and locomotives—all industries we have already identified with large scale operations. The figures for each industry are given in Ap. II.

The preceding analysis has been based on measures of the dominant size characteristics of manufacturing industries. Frequently, as Table VIII d indicates, the over-all averages are somewhat at variance with the measures we have given. Accordingly, summaries of the per establishment figures of Appendix II are presented in Tables VIII e and f.

(Footnote 6 concluded)

Concentration greater in 1914 than in 1929	Concentration less in 1914 than in 1929
Ammunition (70.3).*	Automobiles (63.8).
Carpets and rugs, other than rag (60.2).	Boots and shoes, rubber (56.3).
Cash registers and calculating machines (77.3).	Steel works and rolling mills (53.6).
Collars and cuffs, men's (53.4).*	Locomotives (79.0).
Phonographs (88.7).*	Typewriters and supplies (53.5).*
Photographic materials (80.7).*	Watches (68.3).
Sewing machines and attachments (67.6).*	

* See footnote to Table VIII d.

Also included in the 1914 list are cars, steam railroads, not including operations of railroad companies (63.8), jute goods (58.2), wood screws (72.7), shipbuilding (63.6), tobacco, chewing and smoking, and snuff (54.8). The 10 industries in the 1929 but not in the 1914 list can be found by comparing this list with Table VIII d.

The lower limit used in reporting manufacturing activities in 1914 (a value of product over \$500 instead of over \$5,000 as in 1929) affects these comparisons somewhat, serving to cause a relative understatement of the concentration of employment. In all industries, however, only 1.8 per cent, or 130 thousand wage earners, were employed in plants reporting less than \$5,000 value of product and which therefore should be excluded in order to make a proper comparison with the 1929 figures.