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Size of Firm and the Capital-Output Ratio

The impact of changes in the size structure of industry upon the capital-output ratio cannot be measured with any reasonable degree of precision because the data are fragmentary and too crude for this purpose. The probable direction of the impact, however, can be inferred, particularly for the period 1880 to 1919.

To show the relationship between asset size and the capital-output ratio, we draw upon the unpublished dissertation of Stanley S. Schor.[33] His computations are based on data from the "Source Book" of *Statistics of Income for 1947*. From this source it is possible to compute ratios by major and minor industries by ten asset-size classifications, separately for net income and no net income corporations. Our analysis is restricted to net income corporations; in 1947 the vast majority of corporations in all industries were in this category. The particular ratio computed by Schor is the ratio of fixed capital to gross sales. The latter is a close approximation of our definition of output.

The following are ten asset-size groups (in thousands of dollars) for which ratios are calculated:

Under $50	$1,000 & under $5,000
$50 & under $100	$5,000 & under $10,000
$100 & under $250	$10,000 & under $50,000
$250 & under $500	$50,000 & under $100,000
$500 & under $1,000	$100,000 & over

To reduce the detail to manageable proportions, we work with 22

[33] "The Capital-Product Ratio and Size of Establishment for Manufacturing Industries" (Ph.D. dissertation, University of Pennsylvania, 1952).

major industry groups and with unweighted average ratios for the following four size groups (in thousands of dollars):

Under $100
$100 & under $1,000
$1,000 & under $10,000
$10,000 & over

The evidence is unmistakable (Table 12). In all except food and kindred products, beverages, and tobacco products, i.e. in 19 of the 22 industry groups, the ratio of the largest group is substantially higher than the ratio for the smallest group. For all manufacturing industries the ratio for the largest corporations exceeds the ratio for the smallest corporations by 126 per cent. In the three exceptional industries, inventories constitute a relatively important element in the total capital structure. If the total capital-output ratio is used in place of the fixed capital-output ratio, the average ratio for the largest corporations exceeds the average ratio for the smallest corporations.[34] In a very real sense, then, it can be said there are no exceptions to the generalization that for major industry groups the capital-output ratio tends to increase with increasing asset size. As additional evidence we point to the fact that the highest ratios occurred in the largest corporations in 18 of the 22 industry groups and the lowest ratios are found in corporations with less than $100,000 of assets in 13 groups and in corporations with less than $1 million in 18 groups.

These empirical findings agree with a priori inferences. It is argued that "the scope for using labor-saving machinery increases with size; [that] large firms are likely to be in a better bargaining position vis-a-vis the producers of equipment and therefore obtain the latter at more favorable prices than do small firms; [and that] the factor limiting size of small firms is usually their limited access to capital, whereas the size of large firms is limited by various other considerations. Capital

[34] Total capital-output ratios by asset size are:

	Under $100,000	*$100,000 to $999,999*	*$1,000,000 to $9,999,999*	*$10,000,000 and over*
Food & kindred products	.246	.262	.294	.304
Liquor & beverages	.446	.498	.463	.489
Tobacco products	.566	.364	.719	.768

TABLE 12

Ratios of Fixed Capital to Output of Net Income Corporations by Asset Size All and Twenty-two Major Manufacturing Industries, 1947 (Based on Reported Values)

—Lowest ratio
=Highest ratio

	FIXED CAPITAL-OUTPUT RATIO OF FIRMS WITH ASSETS OF			
	Under $100,000	*$100,000 to $999,999*	*$1,000,000 to $9,999,999*	*$10,000,000 & over*
All manufacturing industries	.098	.116	.154	.221
Food & kindred products	.112	.111	.108	.101
Liquors & beverages	.228	.258	.204	.130
Tobacco products	.118	.066	.172	.077
Cotton textile products	.076	.111	.139	.151
Other textile mill products	.098	.124	.162	.236
Apparel	.035	.028	.044	.090
Leather & leather products	.047	.046	.066	.073
Rubber products	.133	.130	.180	.153
Lumber & basic timber products	.117	.160	.310	.633
Furniture & finished wood products	.088	.116	.168	.180
Pulp, paper, & products	.096	.131	.224	.368
Printing, publishing, & allied industries	.129	.169	.250	.456
Petroleum refining	.140	.121	.158	.405
Chemicals & allied products	.104	.122	.168	.286
Stone, clay, & glass products	.170	.225	.348	.366
Iron & steel & their products	.132	.144	.160	.249
Nonferrous metals & their products	.094	.105	.112	.286
Electrical machinery & equipment	.077	.100	.114	.136
Other machinery & equipment	.160	.152	.147	.203
Motor vehicles, complete or parts	.090	.092	.120	.156
Other transportation equipment	.130	.146	.121	.219
Miscellaneous manufactures	.090	.121	.168	.210

theory suggests that this difference in the limit to size makes for the use of more capital-intensive methods of production in the large firm."[35]

[35] Tibor Scitovsky, "Economic Theory and the Measurement of Concentration" (Paper prepared for Conference on Business Concentration and Price Policy of the Universities-National Bureau Committee for Economic Research held at Princeton University, June 1952 [mimeographed]), p. 15.

These reasons appear so cogent as to suggest that throughout the period analyzed in this paper a rising capital-output ratio would have been associated with increasing asset size of plant or of firm. Unfortunately, there are no reliable statistics by asset size over a long-term period and therefore this generalization cannot be empirically tested.[36] It is possible, however, to compare the differential changes in the capital-output ratio by asset size in 1937 and 1947. Once again we draw on Schor's computations of ratios of fixed capital to sales for net income corporations by major industry groups and use the four asset-size classes. In each year we express the ratios of each of the three larger classes as a per cent of the ratio of the smallest class (Table 13). The difference between the ratio of the smallest firms and of the larger firms was appreciably reduced in 1947 compared with 1937. This was true not only in manufacturing as an aggregate but also in each of the 15 industry groups.

Another way of expressing the change is to say that the fixed capital-output ratio of large firms declined more rapidly between 1937 and 1947 than did the ratio of small firms. This suggests that the more capital per unit of output, the greater are the possibilities for capital-saving innovations.[37]

Knowing the relationship between size of firm and ratio of fixed capital to output, we could evaluate the effect of a change in size of

[36] Schor has analyzed the capital-output ratios for 1904 by size of establishment with size measured in terms of output. In 22 of 40 industries that Schor surveys he finds that the ratio of the smallest establishments is larger than the ratio for the largest establishments. It is difficult to know how much weight to place on these results for 1904. There are several reasons for skepticism. The computations are based on no net income companies as well as net income companies, and in a depression year such as 1904 small companies may not have fared as well as the larger companies. There is reason for believing that the number of establishments in many of the larger size classes is small, and the ratios, therefore, may not be stable. It seems likely, although proof is lacking, that in 1904 the practice of depreciation accounting was largely restricted to the larger corporations. If this was true, it would operate in the direction of a declining ratio with increasing size.

[37] We find a similar relationship in Section 7, where we discuss the change in capital-output ratios by industries between 1919 and 1948. Some part of this larger differential rate of decline in capital-output ratios among the larger firms may be caused by the higher price level implicit in the book value of assets in 1947 for which no adjustment is made. For example, because of the price rise, a firm with assets of $100,000 in 1947 would be a smaller firm measured in "real" capital than a firm with $100,000 assets in 1937. And the smaller the firm is, the lower the capital-output ratio.

TABLE 13

Fixed Capital-Output Ratios in Larger Net Income Firms Relative to Ratio of Smallest Firms in All and Fifteen Major Manufacturing Industries 1937 and 1947 (Based on Reported Values)

	INDEX OF FIXED CAPITAL-OUTPUT RATIO IN FIRMS WITH ASSETS OF		
	$100,000 to $999,999	*$1,000,000 to $9,999,999*	*$10,000,000 & over*
	(Ratio in firms less than $100,000 assets = 100)		
All manufacturing			
1937	162	260	360
1947	118	157	226
Food & kindred products			
1937	136	157	175
1947	99	96	90
Liquors & beverages			
1937	127	149	
1947	113	90	57
Tobacco products			
1937	154	136	201
1947	56	146	65
Textile mill products			
1937	249	455	
1947	127	160	214
Apparel			
1937	165	535	492
1947	80	126	257
Leather & leather products			
1937	159	274	
1947	98	140	155
Rubber products			
1937	161	221	245
1947	98	135	115
Forest products			
1937	181	415	
1947	137	253	616
Pulp, paper, & products			
1937	176	406	612
1947	136	233	383
Printing, publishing, & allied industries			
1937	147	187	191
1947	131	194	354

TABLE 13 *(cont.)*

	INDEX OF FIXED CAPITAL-OUTPUT RATIO IN FIRMS WITH ASSETS OF		
	$100,000 to $999,999	*$1,000,000 to $9,999,999*	*$10,000,000 & over*
	(Ratio in firms less than $100,000 assets = 100)		
Petroleum refining			
1937	101	222	414
1947	86	113	289
Chemicals & allied products			
1937	167	272	390
1947	117	162	275
Stone, clay, & glass products			
1937	152	310	302
1947	132	205	215
Metals & metal products, except motor vehicles			
1937	153	206	418
1947	109	113	175
Motor vehicles, complete or parts			
1937	218	260	288
1947	102	133	173

firm on over-all or industry ratios if we could measure the changes in the size structure of manufacturing industries between 1880 and 1948. Unfortunately precise measures of this aspect of the problem cannot be made with available data. However, there can be little doubt that the average size of establishment increased between 1880 and 1919. For example, the unweighted average capital (in 1929 prices) per establishment for a sample of 34 industries comprising about two-thirds of all manufacturing was $94,000 in 1880, $415,000 in 1900, and $860,000 in 1919.[38] On our assumption of a rising ratio with increasing size, the rising capital-output ratio that characterized these decades could be partly explained on the statistical level by the trend toward larger estab-

[38] We have minimized, but not eliminated, the lack of comparability among censuses in the total number of establishments covered by adjusting the number of establishments in 1880 to eliminate custom and repair shops and factory establishments with value of product of less than $500. By using an unweighted average, we eliminate the effect on the average of the shifting relative importance of the individual industries.

lishments. On the level of economic analysis, however, change in size cannot be considered as an independent variable, for many of the technological innovations of the period that caused a rising capital-output ratio also resulted in larger establishments.

After 1919, to judge by aggregative data, there was little change in size structure until 1929, but a resumption of the trend toward larger establishments between 1929 and 1937. The average number of wage earners per establishment was 40.1 in 1919, 40.5 in 1929, and 51.4 in 1937.[39] Thus size structure was a neutral factor in the decline in the ratio between 1919 and 1929, but the decline between 1929 and 1937 occurred despite the indicated trend toward larger establishments. The number of employees per establishment in 1937 and 1947 suggests that there was virtually no change in size structure between those years — 58.7 and 59.3, respectively.[40] On this basis we tentatively conclude that change in size was again a neutral factor in the continued decline of the ratio between 1937 and 1948.

[39] *Temporary National Economic Committee Monograph No. 27,* "The Structure of Industry" (1941), p. 4.

[40] *1947 Census of Manufactures,* Vol. I, Table 1. It is necessary to use all employees because of the shift from wage earners to production workers between 1937 and 1947.