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# 2

## Growth of Manufacturing Capital, 1880-1948

The development of manufacturing industries is a familiar story in terms of output and employment,<sup>22</sup> and the broad outlines of the story are not altered when it is told in terms of the stock of capital. For this reason we show only two measures of the development of manufacturing industries since 1880. One is a measure of the annual rate of change between benchmark years of book value of total capital expressed in 1929 prices in all manufacturing industries and in the 15 major groupings (Chart 1 and Table 4).

TABLE 4

Dates of Troughs and Peaks in Secular Swings in Gross National Product per Worker and in Total Capital in All Manufacturing Industries (1929 Prices), 1873-1948

<i>Level</i>	<i>GNP per Worker (1)</i>	<i>Total Manufacturing Capital (2)</i>	<i>Annual Rate of Change (geometric average, %) (3)</i>
Trough	1873		
Peak	1884	1880-1890	+8.8
Trough	1892	1890-1900	+5.3
Peak	1903	1900-1904	+6.5
Trough	1912	1909-1914	+3.0
Peak	1926	1914-1919	+4.6
Trough	1932	1929-1937	-1.6
Peak	1945	1937-1948	+3.7

*Source:*

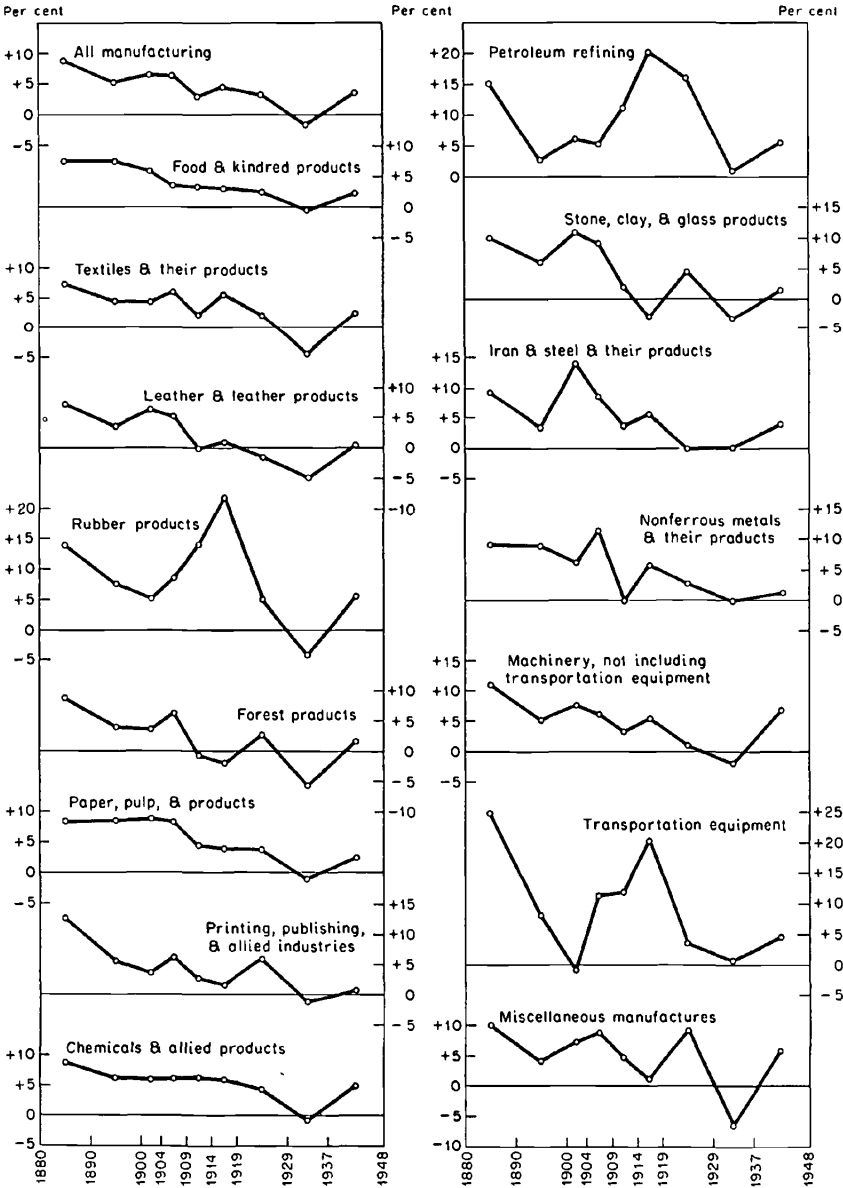
Column 1 Simon Kuznets, "Swings in the Rate of Secular Growth," Work Memorandum No. 37, p. 19, Table 6 (mimeographed, National Bureau of Economic Research, March 1952).

2 & 3 Table 5 of this paper.

<sup>22</sup> See, for example, two monographs by Solomon Fabricant, *The Output of Manufacturing Industries, 1899-1937* and *Employment in Manufacturing, 1899-1939* (National Bureau of Economic Research, 1940 and 1942, respectively).

**CHART 1**

**Annual Average (Geometric) Rate of Change  
in Total Capital (1929 Prices) between Benchmark Years  
All Manufacturing and Fifteen Major Manufacturing Industries, 1880-1948**



As one would expect, the highest annual rate of growth (geometric average) of the stock of manufacturing capital occurred during 1880-1890, the first decade covered by the statistics, when modern manufacturing in general was emerging from its earlier beginnings, although some part of this rise must be attributed to the under-reporting of capital in 1880. The annual rate of growth has tended to decrease as we approach the present period.<sup>23</sup> However, it would be wrong to infer from this that the rate of growth decreases continuously and never reverses itself. Certainly, in the case of the stock of capital there have been alternating periods of relatively high and low rates of increase. The downward drift results from the fact that each succeeding peak rate and each succeeding trough rate are at lower levels.

The dating of these alternating periods cannot be determined precisely with our data since we are restricted to average annual percentage changes between benchmark years. Despite this crudity, the evidence suggests that the alternating periods of relatively high and low rates of increase in capital stock coincide with relatively high and low rates of increase in the economy's output as measured by gross national product (GNP) per worker in 1929 prices (Table 4). The noncoincidence of the 1926 peak in GNP per worker and the relatively high rate of manufacturing capital in 1914-1919 is more apparent than real. If the latter figure for 1914, for example, were extrapolated by Chawner's estimates of capital expenditures for manufacturing plant and equipment in constant prices for the years 1915-1940,<sup>24</sup> the long-term peak based on a nine-year moving average computed from the resulting annual estimates would appear in 1926.

The existence of alternating periods of relatively high and low rates of change in the capital stock is another complicating factor in any projection of the current rate of growth into the future. It is essential that the estimator establish whether the current rate represents a relatively high or low position in the long swings in accumulated capital.

How pervasive is this pattern of alternating periods of high and

<sup>23</sup> If we assume that the capital estimates are more and more net of depreciation as we move forward from 1880 to 1919, this would have a damping effect on the rate of growth; if the opposite has been true, which we doubt, the rate of growth has been exaggerated.

<sup>24</sup> *Survey of Current Business*, March 1941, p. 11.

low rates of expansion? Is the pattern for total manufacturing capital a result of averaging diverse or similar chronologies? An answer is suggested by comparing the chronology of the long swings in each of the 15 major groups with the chronology for all manufacturing industries (Tables 5 and 6). A date in parentheses indicates that the turning point for a given industry group differs from that for all manufacturing.

In only 2 of the 15 major industry groups, leather and leather products and machinery, are the chronologies of the secular swings identical with the one for all manufacturing. Differences in timing occur most frequently between 1890 and 1919. Only two industry groups failed to show a peak rate of growth between 1880 and 1890, and only one failed to show a low rate of change between 1929 and 1937. On the other hand, all industry groups developed at a relatively high rate between 1937 and 1948. Extended swings due to prolonged expansions occurred in two industry groups related to the revolution in road transportation: transportation equipment, which includes automobiles, and rubber products. In these industries expansion was initiated in 1900-1904 and continued until 1914-1919. Other groups that reached a peak during the World War I period rather than in the twenties were petroleum refining, the metal industries, textiles, and leather products — all industries in which substantial military orders were added to regular civilian demands. Those groups closely connected with building construction — such as forest products and stone, clay, and glass products — were depressed during World War I, since these activities had a low priority, but were booming during the twenties when restrictions were removed.<sup>25</sup>

Thus the development of manufacturing has not always proceeded at an even pace, and at certain periods some branches of manufacturing have lagged behind and others have forged ahead. This uneven rate of growth is shown by our second measure of relative changes in manufacturing development. For selected benchmark years, total capital in each minor industry is expressed as a per cent of total capital in all

<sup>25</sup> In Clarence Long's investigation there is a trough in 1917-1919 and a subsequent peak in 1924-1927. (*Building Cycles and the Theory of Investment* [Princeton University Press, 1940], p. 136, Table 11, quoted in Simon Kuznets' "Swings in the Rate of Secular Growth," Work Memorandum No. 37, p. 22, National Bureau of Economic Research, 1952).

TABLE 5

Annual Average (Geometric) Rate of Change in Total Capital (1929 Prices) between Benchmark Years  
All and Fifteen Major Manufacturing Industries, 1880-1948 (Per Cent)

	1880- 1890	1890- 1900	1900- 1904	1904- 1909	1909- 1914	1914- 1919	1919- 1929	1929- 1937	1937- 1948
All manufacturing industries	8.8	5.3	6.5	6.4	3.0	4.6	3.2	-1.6	3.7
Food & kindred products	7.4	7.4	5.8	3.5	3.4	3.1	2.4	-0.5	2.2
Textiles & their products	7.3	4.5	4.3	5.9	2.2	5.5	2.0	-4.6	2.5
Leather & leather products	6.9	3.4	6.2	5.0	-0.1	0.9	-1.5	-5.0	0.5
Rubber products	13.7	7.5	5.1	8.4	13.8	21.6	4.9	-4.0	5.4
Forest products	8.7	3.9	3.7	6.2	-0.7	-1.9	2.6	-5.7	1.7
Paper, pulp, & products	8.3	8.6	8.9	8.4	4.5	4.1	3.9	-1.0	2.5
Printing, publishing, & allied industries	12.5	5.6	3.5	6.1	2.7	1.5	5.8	-1.1	0.7
Chemicals & allied products	8.8	6.2	6.0	6.2	6.3	6.0	4.3	-0.8	4.9
Petroleum refining	15.1	2.6	5.9	5.2	11.0	20.1	16.0	0.8	5.3
Stone, clay, & glass products	10.1	6.1	10.9	9.1	2.0	-2.9	4.5	-3.3	1.4
Metals & metal products	10.4	5.1	9.3	8.0	3.6	7.1	1.2	-0.4	4.6
Iron & steel & their products	9.2	3.3	13.8	8.3	3.7	5.4	-0.1	0.1	3.9
Nonferrous metals & their products	9.1	8.9	6.2	11.3	-0.1	5.8	2.7	-0.1	1.1
Machinery, not including transportation equipment	10.9	5.2	7.6	6.2	3.3	5.4	1.0	-1.9	6.8
Transportation equipment	24.8	8.0	-1.0	11.2	11.8	20.1	3.4	0.7	4.5
Miscellaneous manufactures	10.0	4.1	7.2	8.8	4.7	1.1	9.1	-6.6	5.9

Source: Based on data described in Section 1.

TABLE 6

Alternating Periods of High and Low Rates of Change in Total Capital (1929 Prices)  
Fifteen Major Manufacturing Industries Compared with All Manufacturing, 1880-1948\*

	High 1880-1890	Low 1890-1900	High 1900-1904	Low 1909-1914	High 1914-1919	Low 1929-1937	High 1937-1948
Food & kindred products (1890-1900)							
Textiles & their products	1880-1890	(1900-1904)	(1904-1909)	1909-1914	1914-1919	1929-1937	1937-1948
Leather & leather products	1880-1890	1890-1900	1900-1904	1909-1914	1914-1919	1929-1937	1937-1948
Rubber products	1880-1890	(1900-1904)			1914-1919	1929-1937	1937-1948
Forest products	1880-1890	(1900-1904)	(1904-1909)	(1914-1919)	(1919-1929)	1929-1937	1937-1948
Paper, pulp, & products			1900-1904			1929-1937	1937-1948
Printing, publishing, & allied industries	1880-1890	(1900-1904)	(1904-1909)	(1914-1919)	(1919-1929)	1929-1937	1937-1948
Chemicals & allied products	1880-1890	(1900-1904)	(1909-1914)			1929-1937	1937-1948
Petroleum refining	1880-1890	1890-1900	1900-1904	(1904-1909)	1914-1919	1929-1937	1937-1948
Stone, clay, & glass products	1880-1890	1890-1900	1900-1904	(1914-1919)	(1919-1929)	1929-1937	1937-1948
Metals & metal products	1880-1890	1890-1900	1900-1904	1909-1914	1914-1919	1929-1937	1937-1948
Iron & steel & their products	1880-1890	1890-1900	1900-1904	1909-1914	1914-1919	(1919-1929)	1937-1948
Nonferrous metals & their products	1880-1890	(1900-1904)	(1904-1909)	1909-1914	1914-1919	1929-1937	1937-1948
Machinery, not including transportation equipment	1880-1890	1890-1900	1900-1904	1909-1914	1914-1919	1929-1937	1937-1948
Transportation equipment	1880-1890	(1900-1904)			1914-1919	1929-1937	1937-1948
Miscellaneous manufactures	1880-1890	1890-1900	(1904-1909)	(1914-1919)	(1919-1929)	1929-1937	1937-1948

\* A date in parentheses indicates that the turning point for a given industry group differs from that for all manufacturing.

Source: Based on data described in Section 1.

TABLE 7

Per Cent Distribution of Total Capital (1929 Prices)  
by Manufacturing Industry, Selected Years, 1880-1948

	1880	1900	1919	1948	
				<i>Excluding Net Investment in Emergency Facilities</i>	<i>Including Net Investment in Emergency Facilities</i>
All manufacturing industries	100	100	100	100	100
1. Food & kindred products	18.5	20.6	16.4	14.6	14.2
Bakery & confectionery products	1.0	1.5	2.4	1.6	
Canned products	0.3	0.8	1.0	1.5	
Mill products	6.7	2.5	2.1	1.0	
Packing house products	1.8	2.5	3.1	1.8	
Sugar refining	1.0	2.7	1.2	0.7	
Liquor & beverages	5.0	6.7	2.0	2.8	2.8
Nonalcoholic beverages	0.1	0.3	0.3	0.7	
Malt liquors & malt	3.9	5.9	1.6	1.0	
Wines	0.1	0.1	<sup>b</sup>	0.1	
Distilled liquors	0.9	0.4	0.1	1.0	
Tobacco products	1.5	1.5	1.6	2.1	2.1
Other food products	1.2	2.5	3.0	3.0	
2. Textiles & their products	20.6	16.4	14.5	9.2	9.0
Cotton goods	8.4	6.3	5.0		
Silk & rayon goods	0.7	1.0	1.2		
Woolen & worsted goods	4.0	3.2	2.0		
Carpets, floor coverings, etc.	0.8	0.6	0.4	0.4	
Knit goods	0.6	1.0	1.2	0.8	
Clothing	3.9	3.1	3.4	2.7	2.6
Hats, except cloth & millinery	0.3	0.3	0.3	0.1	
Men's & boys' clothing, except fur & rubber	3.0	1.9	1.9	1.3	
Women's clothing, chil- dren's & infants' wear, except fur & rubber	0.3	0.6	1.0	1.3	
Millinery	0.3	0.3	0.2	<sup>b</sup>	
Textiles, n.e.c.	2.2	1.2	1.2		

TABLE 7 (cont.)

	1880	1900	1919	1948	
				<i>Excluding Net Investment in Emergency Facilities</i>	<i>Including Net Investment in Emergency Facilities</i>
Textiles and their products (cont.)					
Cotton + silk & rayon + woolen & worsted goods + textiles, n.e.c.	(15.4)	(11.7)	(9.5)	(5.3)	
3. Leather & leather products	6.8	4.6	3.0	1.1	1.0
Boots & shoes	1.9	1.4	1.2	0.6	
Other leather products	4.9	3.2	1.8	0.5	
Leather, tanned, cur- ried, & finished	3.2	2.4	1.3	0.3	
Leather products, n.e.c.	1.8	0.8	0.5	0.2	
4. Rubber products	0.3	0.6	2.1	1.8	1.8
5. Forest products	17.6	12.9	6.8	3.8	3.7
Sawmills & planing mill products	10.7	7.7	4.3	2.4	2.3
Other wood products	6.9	5.2	2.5	1.4	1.4
Wooden containers	1.2	0.9	0.5	0.2	
Wood products, n.e.c.	5.7	4.3	2.0	1.3	
6. Paper, pulp, & products	1.9	2.6	3.3	3.3	3.3
Paper, pulp, & paper- board mills	1.6	2.0	2.5	2.2	
Paper bags, containers, & boxes	0.1	0.3	0.4	0.6	
Other paper products	0.2	0.3	0.4	0.5	
7. Printing, publishing, & allied industries	3.0	4.6	3.3	3.4	3.3
Book & job, including lithography	2.5	1.6	1.3	1.1	
Newspaper & periodicals	"	2.6	1.7	1.8	
Allied industries	0.5	0.4	0.3	0.5	

TABLE 7 (cont.)

	1880	1900	1919	1948	
				<i>Excluding Net Investment in Emergency Facilities</i>	<i>Including Net Investment in Emergency Facilities</i>
8. Chemicals & allied products	4.3	5.0	6.0	8.1	8.1
Chemicals proper, acids, compounds, etc.	1.5	1.7	2.2	2.4	
Fertilizers	0.6	0.7	0.7	0.3	
Allied chemical substances	2.2	2.7	3.1	5.4	
Drugs, medicines, & cosmetics	0.4	0.6	0.7	1.1	
Soaps & cleaning & polishing preparations	0.5	0.4	0.5	0.5	
Paints & varnishes	0.5	0.6	0.6	0.8	
Other chemical substances	0.8	1.0	1.3	3.0	
9. Petroleum refining	0.8	1.1	3.0	13.7	13.9
10. Stone, clay, & glass products	3.2	4.0	3.6	2.8	2.8
Cement, lime, & concrete products	0.2	0.6	1.1	0.9	
Clay & pottery products	1.4	1.8	1.2	0.5	
Glass & glass products	0.8	0.8	0.7	0.6	
Cut stone & products	0.7	0.6	0.3	0.1	
Stone, clay, & glass products, n.e.c.	0.1	0.2	0.3	0.7	
Metals & metal products	21.1	25.6	35.9	35.4	35.9
11. Iron & steel & their products	9.8	9.1	14.5	11.9	12.4
Iron & steel	7.9	6.9	11.4	8.7	
Blast furnaces, steel works, & rolling mills	7.1	6.0	9.0	5.6	
Ordinance & accessories	0.3	0.2	0.6	0.2	
Tin cans & other tinware			0.6	0.5	
Iron & steel, n.e.c.	0.5	0.6	1.2	2.4	
Metal building materials & supplies	0.3	1.0	1.7	2.1	

TABLE 7 (cont.)

	1880	1900	1919	1948	
				<i>Excluding Net Investment in Emergency Facilities</i>	<i>Including Net Investment in Emergency Facilities</i>
Iron and steel & their products (cont.)					
Hardware, tools, etc.	1.5	1.2	1.4	1.1	
12. Nonferrous metals & their products	2.4	3.5	3.9	3.0	3.2
Clocks, watches, & parts	0.2	0.3	0.2	0.2	
Jewelry, silverware & plating	0.6	0.6	0.7	0.3	
Smelting, refining, & alloying	0.7	2.0	2.4	2.1	
Nonferrous metal prod- ucts, n.e.c.	0.9	0.6	0.6	0.4	
13. Machinery, not including transportation equipment	8.6	11.0	12.0	13.4	13.2
Electrical machinery & equipment & radios	0.1	1.0	2.5	4.4	4.4
Agricultural machinery	2.2	1.9	0.9	1.6	
Office equipment	0.2	0.3	0.4	0.7	
Factory, household & misc. machinery	6.1	7.8	8.2	6.7	
14. Transportation equipment	0.4	2.0	5.3	7.0	7.2
Motor vehicles, complete or parts		0.4	4.2	5.2	5.1
Locomotives & railroad equipment	0.4	1.6	1.1	0.8	
Aircraft & parts			<sup>b</sup>	1.0	
15. Miscellaneous manufactures	1.8	1.9	2.0	2.7	3.0
Professional, scientific, photographic, & opti- cal instruments	0.1	0.2	0.3	0.9	
Misc. manufactures, n.e.c.	1.7	1.7	1.7	1.8	

<sup>a</sup> Not covered by the Census of 1880.

<sup>b</sup> Less than one-tenth of one per cent.

Source: Based on data described in Section 1.

manufacturing industries (Table 7). We have selected 1880 the first year for which reliable statistics are available, the beginning of the century, and years that closely follow the termination of World Wars I and II. For these particular years it is possible to distinguish 65 minor industries.

Even by 1900 the industries that had been among the first to be mechanized were losing ground to familiar commodities then newly produced by the factory system with mechanical power and manipulation and to newly developed products. Thus the textile, leather, and forest products industries failed to expand as rapidly as all manufacturing industries on the average. Capital in these three major industry groups constituted 45 per cent of all manufacturing capital in 1880 and 34 per cent at the turn of the century. Within these old industries new branches were emerging, particularly in textiles, as a result of the transfer of household activities to the factory. This was the case with women's, children's, and infants' clothing and knit goods, and these two minor industries had a better than average rate of expansion between 1880 and 1900.

The same sort of transfer explains the relative rise in food products; bakery products, canning, and slaughtering and meat packing were being rapidly shifted from the household to the market economy. Milling, on the other hand, which had been a factory process for many decades, declined sharply in relative importance during these two decades.

The largest relative expansion occurred in new industries that were still at the threshold of tremendous growth: transportation equipment; electrical machinery and equipment; metal building materials and supplies; smelting, refining, and alloying of nonferrous metals; cement, lime, and concrete products; paper bags, containers, and boxes; and rubber products. In the succeeding twenty-year period it was this very same group of industries together with petroleum refining and iron and steel that expanded rapidly — nearly doubling their share of manufacturing capital, from 15.5 per cent in 1900 to 29.9 in 1919. The old industries — textile, leather, and forest products — continued in a state of relative decline, accounting for a third of the total in 1900 and a quarter in 1919.

Some of the industries with a better than average rate of capital

expansion before 1919 had a less than average rate by 1948. This was true of the basic metal industries, both ferrous and nonferrous, and rubber tires and tubes. Some of the metal-using industries, on the other hand, such as electrical machinery and equipment including radios and television sets; automobiles; airplanes; office equipment; professional, scientific, and optical instruments; and metal building materials and supplies continued to expand at a better than average rate. However, by all odds the largest relative gains occurred in petroleum refining, while the increased share of chemical and allied products was also impressive.<sup>28</sup>

The paper and printing industries accounted for about the same per cent of manufacturing capital in 1948 as in 1919. Food and kindred products as a group declined in relative importance, although the minor industries of canning and deep-freezing and tobacco products continued their capital formation at a faster rate than that for all manufacturing industries. The old established industries continued to wane, using only a seventh of all manufacturing capital in 1948 compared with a fourth in 1919. Indeed, the decline in leather and forest products had proceeded to the point where in absolute terms (constant prices) less capital was being utilized after World War II than after World War I. In textiles the rise of synthetic fabrics, which cannot be shown separately, failed to offset the relative and absolute loss of capital in the primary textile industries. Throughout this period the only textile industry of growing importance in terms of capital was the manufacture of women's, children's, and infants' clothing.

To summarize the trends in the stock of capital over this seventy-year period, the older industries such as textile, leather, and forest products have declined in importance while the newer ones such as the metal-producing and using industries, chemicals, and petroleum refining have increased in importance. Do these differential rates of growth help to explain differential movements in capital-output ratios? We shall explore this possibility after we establish the trends in the capital-output ratios.

<sup>28</sup> The inclusion of investment in emergency facilities in 1948 does not alter the basic trends.

# 3

## Trends in Capital-Output Ratios

### *Capital-output ratios in reported and constant values for all manufacturing, 1880-1948*

The amount of capital invested per dollar of output rose steadily from 1880 to 1914, according to the record of reported values (capital in book values and output in current prices; see Chart 2 and Table 8). The amount of capital invested per output dollar began to fall in 1914 and continued until 1948. The capital-output ratio for 1919 was sharply

CHART 2

**Ratios of Capital to Value of Product in Reported, 1929, and Current Values and of Capital to Value Added (1929 Prices)**  
All Manufacturing, Selected Years, 1880-1948

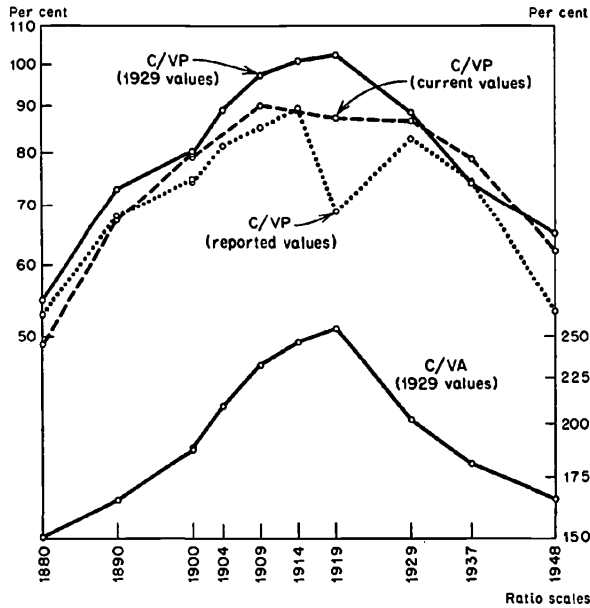


TABLE 8

Ratios of Capital to Output in Reported, 1929, and Current Values  
and of Capital to Value Added (1929 Prices)  
All Manufacturing, Selected Years, 1880-1948

Benchmark Years	RATIOS OF			
	<i>Capital (book value) to Output (in current prices) (1)</i>	<i>Capital (in 1929 prices) to Output (in 1929 prices) (2)</i>	<i>Capital (in current prices) to Output (in current prices) (3)</i>	<i>Capital (in 1929 prices) to Value Added (in 1929 prices) (4)</i>
1880	.528	.547	.489	1.506
1890	.679	.730	.670	1.651
1900				
Comparable with preceding years 1900	.748	.803	.795	1.878
Comparable with following years	.743	.794	.790	1.882
1904	.815	.891		2.093
1909	.851	.972	.900	2.321
1914	.894	1.008		2.460
1919	.688	1.022	.873	2.555
1929	.829	.885	.867	2.020
1937	.744	.741	.787	1.809
1948	.532	.648	.621	1.655

*Source:*

Column 1 Appendix Table A-1.

2 Appendix Table A-2.

3 &amp; 4 Based on underlying data and methods of price adjustment described in Section 1.

below the peak ratio because the inflation of product prices greatly exceeded the inflation of capital book values. Similarly, the inflation of post-World War II caused a sharp drop in the ratios between 1937 and 1948. Contributory factors were the unusually high rate of capacity utilization and the inability of management to expand capacity to desired levels because of continued shortages.

The 1937 ratio is of critical importance in establishing the downward trend. Although business activity in 1937 was at a cyclical peak, there is considerable evidence for believing that the rate of capacity utilization

in 1937 was less than that in 1929. If this were the only factor that had changed, one would expect the 1937 ratio to be higher than the 1929 ratio; the fact that it is lower suggests that other factors were operative.

Since price changes are incorporated more rapidly into value of output than into book value of capital, this distortion should be eliminated for a true perspective. This is most effectively accomplished by expressing both output and book values of capital in constant (1929) prices. Introduction of the constant price base raises the level of the ratios for 1919 and 1948 and produces smoother trend movements. With the elimination of price changes (but not revaluation of capital assets), the capital-output ratio rises until 1919 and at a faster rate than the uncorrected ratio, declining thereafter until 1948 but at about the same rate as the uncorrected ratio.<sup>27</sup>

On this evidence we can say that manufacturing has developed along the following course: In the earlier decades an increasing fraction of a dollar of capital was used to produce a dollar of output; in more recent decades a decreasing fraction of a dollar of capital has been sufficient to produce a dollar of output. This is consistent with the interpretation that in the earlier decades capital innovations on balance probably served more to replace other factor inputs than to increase output. More recently the balance has been in the other direction — capital innovations serve more to increase the efficiency of capital, hence to increase output, than to replace other factor inputs.

### ***Effect of data deficiencies on trend***

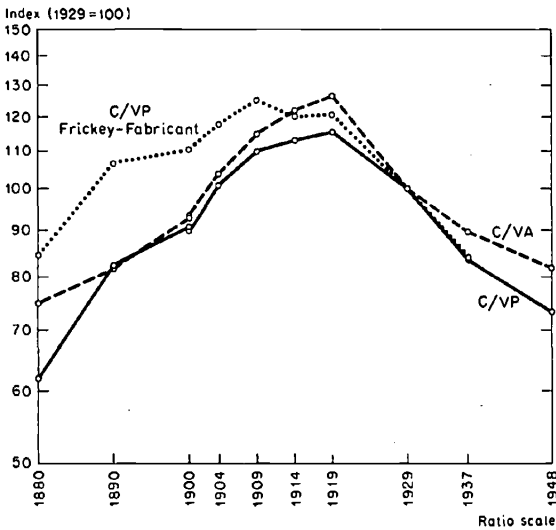
The apparent reversal in the trend of the capital-output ratio is our cardinal finding and it is important, therefore, that its empirical validity be above challenge. For this reason we consider the probable impact on this result of some of the deficiencies in the data and in our procedures.

The reversal in trend cannot be attributed to the adjustment for price changes because the reversal also appears in the ratios based on

<sup>27</sup> Another way to minimize price distortion is to relate capital in current prices (i.e., replacement cost) to output in current prices. This procedure has the advantage of reducing the errors of estimate, since no adjustments are made to the reported value of output. It is significant that the path traced by the ratios in current prices is very similar to the one traced by the ratios in constant prices except for 1919 (Chart 2 and Table 8, column 3).

reported values. Moreover, the adjustment for price changes alters the ratios in the direction demanded by logic. Some might argue that the appropriate denominator of the capital-output ratio is value added by manufacturing in order to eliminate interfirm transactions from the value of product. Since there is some merit in this claim, we show also in Chart 3 the relationship of capital to value added, both in constant prices. This ratio, too, traces virtually the same pattern as the ratio of capital to output. If we substitute the output indexes prepared by Frickey and Fabricant for our own estimates of output in constant prices, the resulting ratios show a definite reversal in direction beginning in 1909 instead of 1919 (Chart 3).

**CHART 3**  
**Indexes of Ratios of Capital to Value of Product**  
**and to Value Added (1929 Prices)**  
**All Manufacturing, 1880-1948**



If the downward movement in the ratios between 1919 and 1929 is suspect because of the shift in the source of our data — from *Census of Manufactures* to *Statistics of Income* — we point to the continued decline in the ratios between 1929 and 1948, when the ratios for all years are based on data from *Statistics of Income*.

While the precise impact of the shift in the treatment of depreciation

on the trend in capital-output ratios is difficult to assess because of serious gaps in our information, some important conclusions can be made with certainty. There have been, for example, no significant changes in the treatment of depreciation beginning with 1919. Therefore the declining movement in the capital-output ratios after 1919 cannot be due to changes in the treatment of depreciation.<sup>28</sup>

What of the rising trend in the ratios between 1880 and 1909? There is no reason for believing that any important shift in the practice of depreciation accounting occurred before the inception of the corporate income tax, i.e. before 1909. Whatever bias stems from the situation, however, serves to minimize the rise in the capital-output ratio and thus to strengthen the firmness of our finding. If one believes, as we do, that capital was reported on an increasingly net basis as formal depreciation accounting became more widespread, the rise in the capital-output ratio is understated. Between 1909 and 1914 this conservative bias should be pronounced because of the widespread acceptance of depreciation accounting following the introduction of the corporate income tax. If capital expenditures treated as operating expenditures were excluded from the reported figures on invested capital in 1909 and earlier years, the level of the capital-output ratios in those years would be lower than the "true" level. The trend of the ratios to 1909 would not be affected unless there was a trend in the percentage of these expenditures to the stock of capital. Since the important changes in capital accounting in manufacturing occurred after 1909, we conclude that there probably was no strong trend in this direction and that the estimates of capital-output ratios have a conservative bias.

Can the rise in the ratios between 1900 and 1904 be attributed to the inflation of capital assets resulting from the mergers of that period? Undoubtedly part of the rise can be traced to this development. Mergers were most important in iron and steel and their products and in tobacco products, and these were the only industries in which the rise in the capital-output ratios based on reported values from 1900 to 1904 was spectacularly large — an increase of 39 per cent for iron and steel and their products and of 133 per cent for tobacco.<sup>29</sup> However, even if we

<sup>28</sup> For the effect of another aspect of depreciation during recent decades, see pp. 47-48 below.

<sup>29</sup> The relative importance of mergers in major industry groups is measured by relating the cumulative authorized capital stock by major groups as reported by Myron

exclude these two major groups from the computation, the capital-output ratio for 1904 is still 4 per cent higher than the 1900 ratio, and for 1909 the ratio is 10 per cent above 1900. Including these two major groups the percentage increases were 10 and 15. This suggests that not all of the rise between 1900 and 1904 and 1909 can be explained by promoters' revaluation of assets of industrial combinations.

Thus the rising trend in the ratios between 1880 and 1909-1919 is no accounting mirage; and the declining trend after 1919 cannot be attributed merely to the shift in depreciation practices.

What can be said of the biases in the capital estimates based on *Statistics of Income*, which include intangible assets such as patent rights and good will in the estimates for 1929 and later years? Exclusion of these intangible assets in the earlier years has the effect of raising the level of the ratios for 1929 and after. Our finding of a decline in the capital-product ratios for this period is not, therefore, affected by the slight shift in the definition of capital.

Another element of incomparability is the fact that the ratios for 1929, 1937, and 1948 are based on balance sheet data of corporations only, while the ratios for earlier years are based on data for all firms, incorporated and unincorporated alike. Unincorporated firms have smaller assets per firm than the average corporation and, as we show in Section 6, the smaller the firm, the smaller the capital-output ratio.<sup>80</sup> This element of incomparability gives an additional conservative bias to our results.

And this is also the effect on the 1948 ratio of our treatment of the wartime emergency facilities subject to accelerated amortization. We assume that these facilities are subject only to normal depreciation, but because of the specialized character of some of them the rate of obsolescence must have been above average. Thus the 1948 estimate of

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W. Watkins (*Industrial Combinations and Public Policy* [Houghton Mifflin, 1927], Appendix II) to the 1905 *Census of Manufactures* figure on capital by major groups. In iron and steel and their products authorized capital stock was 98 per cent of census capital in 1904 and in tobacco products 128 per cent. For all other industries authorized capital stock amounted to one-third of capital reported in the 1905 census.

<sup>80</sup> Unincorporated firms accounted for 8.5 per cent of value added in manufacturing in 1929 and for 8.1 in 1947. See *Censuses of Manufactures* for these years.

capital is overstated by a small amount, and on this score, too, the "true" capital-output ratio would be slightly lower than our estimate.

During the more recent decades depreciation accounting beclouds our view of the secular movement of capital. Some argue, for example, that statutory depreciation charges are based on length-of-life estimates that are too low. That is, the depreciation charges are too high and consequently net capital is understated. In this view the understatement becomes progressively larger as the stock of capital expands. Could this understatement cause the decline in the capital-output ratio after 1929? This possibility can be explored by adding the amount of the understatement of the stock of capital in each benchmark year to the reported values and then computing the capital-output ratios. However, there is no estimate of the amount of the understatement, and we are obliged to assume varying amounts of understatement. Let us start with the extreme assumption that there is no capital consumption and that the understatement is equal to the entire depreciation reserve. What are the resulting ratios?

The ratios of gross total capital to output (both in constant prices) are 1.199, 0.998, and 0.856 for 1929, 1937, and 1948. Under this extreme assumption the downward trend is clear and substantial, and it would be pointless to experiment with smaller amounts of understatement of net capital. Therefore, the downward trend of the ratios based on capital net of depreciation cannot be attributed to a progressive understatement of the net capital accounts.

Our appraisal of the statistical materials we are obliged to use fails to disclose any weakness of a magnitude that shakes our confidence in the validity of the trend in the capital-output ratios, particularly when our interest is centered in the broad pattern of movement.

The ratios we have presented thus far are based on aggregative data — fixed and working capital combined, all industries, and all firms regardless of size. Can the reversal in the trend of the ratios be caused by the shifting importance of the components of the aggregates? Fortunately there is sufficient evidence for definitive answers on the first two types of change (type of assets and industry shifts), and we turn now to this evidence.