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## Effect of Changing Industrial Composition on the Ratio for Total Manufacturing

Did industries with relatively high capital-output ratios in 1880 expand more rapidly until 1919 than those with relatively low ratios and thus cause the ratio for all manufacturing to rise? Similarly, after 1919 did industries with relatively low ratios become more important in later benchmark years than those with high ratios and so cause the ratio for all manufacturing to decline?

### *Price adjustments and their effect*

Before we analyze the ratios of minor manufacturing industries and shifts in their relative importance, it is helpful to consider whether our method of adjusting for price changes in the book values of capital would in itself impose a common pattern of change on the ratios of the minor industries. Our method consists in deriving a series of composite indexes, one for each of 15 major industry groups, from (1) an index of building costs based on a fifty-year life, which is identical for all industries; (2) an index of prices of machinery and equipment differently weighted in each major group according to the length of life typical of the industry; and (3) an index of wholesale prices of the output of each major industry group as a deflator of working capital. The composite index for a given major industry is applied to all minor industries classified under the given major industry. Variations in the composite index by major divisions is limited to different weights used in combining the three indexes, differences in lengths of life of machinery and equipment which serve only in determining weights, and differences in the deflating index of working capital which is differently constituted in each major group.

Chart 4 shows the indexes used to adjust book values to 1929 prices for all 15 groups. That there is a strong resemblance among



these indexes cannot be denied, and this result is to be expected in view of the procedure. However, it does not necessarily follow that these indexes differ by substantial margins from the movements of indexes based on more complete price data, since producers' prices of many commodities move in sympathy over the longer term. This view gains support from the movement of the implicit price indexes used in expressing output in 1929 prices (Chart 5). Here also the individual indexes, except for rubber products, show only small deviations from a common pattern, despite the fact that each group index is based on wholesale price quotations of a different roster of commodities.

In Chart 6 we show for each major industry two sets of capital-output ratios, one based on reported values and one on 1929 values. The principal difference resulting from the price adjustments is the raising of the 1919 and 1948 ratios, which are "too low" when based on reported values because the rapid price rises culminating in both years affected the value of output more than the book value of capital. Only in 2 of the 15 groups, rubber products and petroleum refining, is it probable that the price adjustments have seriously distorted the movements of the ratio before 1929. It is important to note that the reversal in direction of the capital-output ratios exists in the unadjusted ratios, and the price adjustment has the effect in many cases of dating the peak at 1919 rather than at an earlier benchmark year.

### ***Capital-output ratios in constant prices by minor industries, 1880-1948***

The ratios for the major industry groupings are in effect averages of the ratios of the minor industries comprising the major groupings. In Appendix Table A-2 we present the capital-output ratios in 1929 prices for 39 minor industries for all benchmark years. At this point we merely indicate the distribution of the peak ratios according to the year of occurrence, disregarding peak ratios that occur in 1904 and 1914, years of business contraction.

No. of minor industries	<i>Year in Which Peak Capital-Output Ratio Occurred</i>							
	1880	1890	1900	1909	1919	1929	1937	1948
	0	3	4	7	17	7	1	0

In 31 industries, about four-fifths, the highest ratios occurred before 1929 and in nearly half, the peak ratio was reached in 1919. On closer

inspection then our earlier generalization still applies: typically the capital-output ratio continued to rise until the beginning or end of World War I. That the ratio began to decline after 1919 is also borne out by the more detailed information. It follows by definition that the 1929 ratio is lower than the 1919 ratio in all 31 industries with peak ratios before 1929. More significant is the fact that in all except 3 of the 39 industries the 1937 ratios were lower than the 1929 ratios, and in all except 4 of the 39 industries lower than the 1919 ratios.

### ***Trend in capital-output ratios of industries classified by ultimate use of output***

The reversal in trend of the capital-output ratios appears also when the minor industries are grouped in terms of the ultimate use of the product — consumption goods, construction materials, capital equipment, and producers' supplies. Industries in the last three categories produce commodities that enter into the stock of manufacturing capital.<sup>31</sup>

The peak ratio for industries producing capital equipment was reached in 1909 and in 1919 for industries turning out producers' supplies which form part of unfinished inventories (Table 10). In the production of construction materials the peak ratio occurred in 1929, which is also the date of the peak ratio in lumber and basic timber products, an industry with heavy weight in this category. Thus in all the industries contributing to the stock of reproducible wealth of the consumption goods industries, the "real" capital cost per unit of output first increased up to 1909 or 1929 and then decreased. It would be strange indeed if the same trends did not appear in the consumption goods industries, which have accounted for well over half of all capital invested in manufacturing. The statistical record does in fact show that the capital-output ratio in the consumption goods industries increased until 1919 and then began to decline.

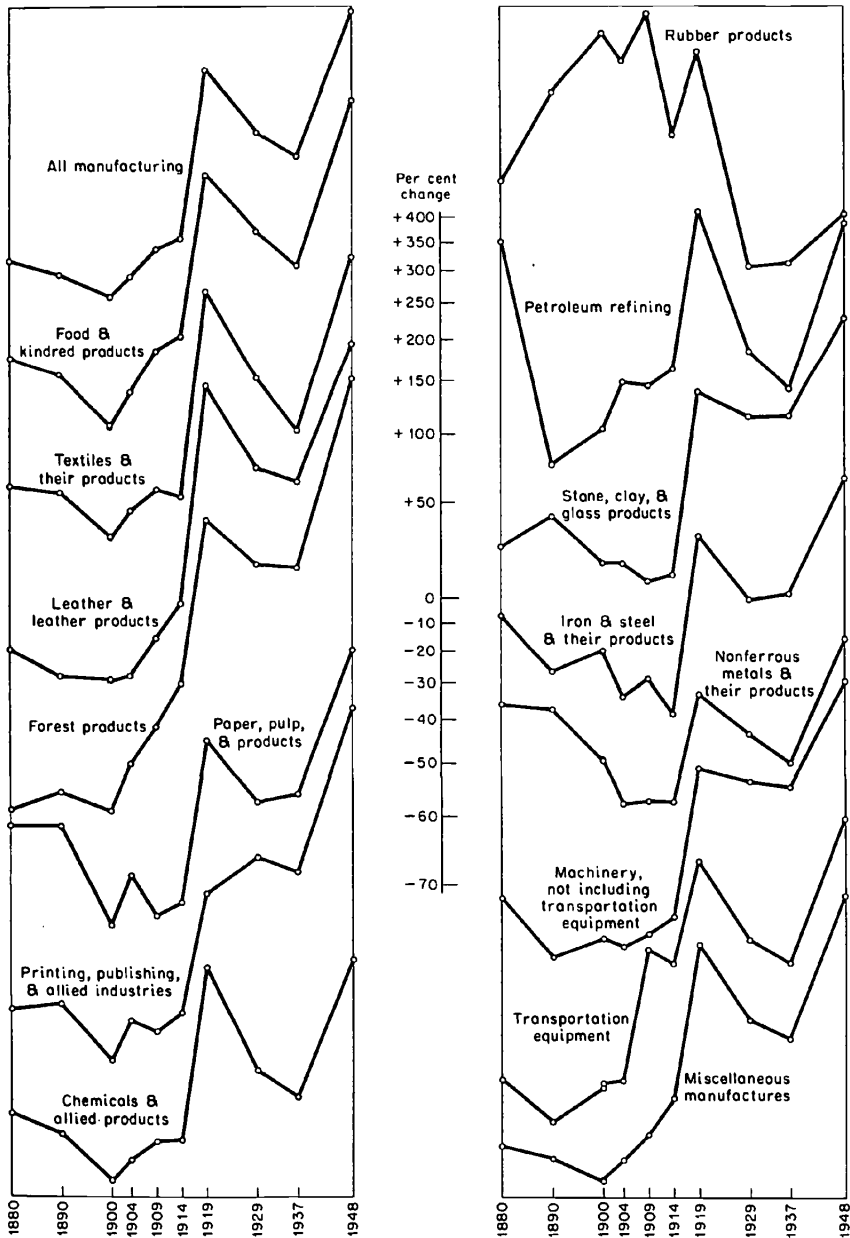
### ***A measure of the role of changing composition of manufacturing***

A general pattern of a rising capital-output ratio followed by a declining one is also suggested by the following computations measuring

<sup>31</sup> The grouping of industries is based on the classifications prepared by Charles A. Bliss, *The Structure of Manufacturing Production* (National Bureau of Economic Research, 1939), Appendix I, pp. 141-66.

CHART 5

Price Indexes of Output, All and Fifteen Major Manufacturing Industries 1880-1948



# CHART 6

## Ratios of Capital to Output in Reported and 1929 Values All and Fifteen Major Manufacturing Industries, 1880-1948

—○— 1929 values  
- - -○- - Reported values

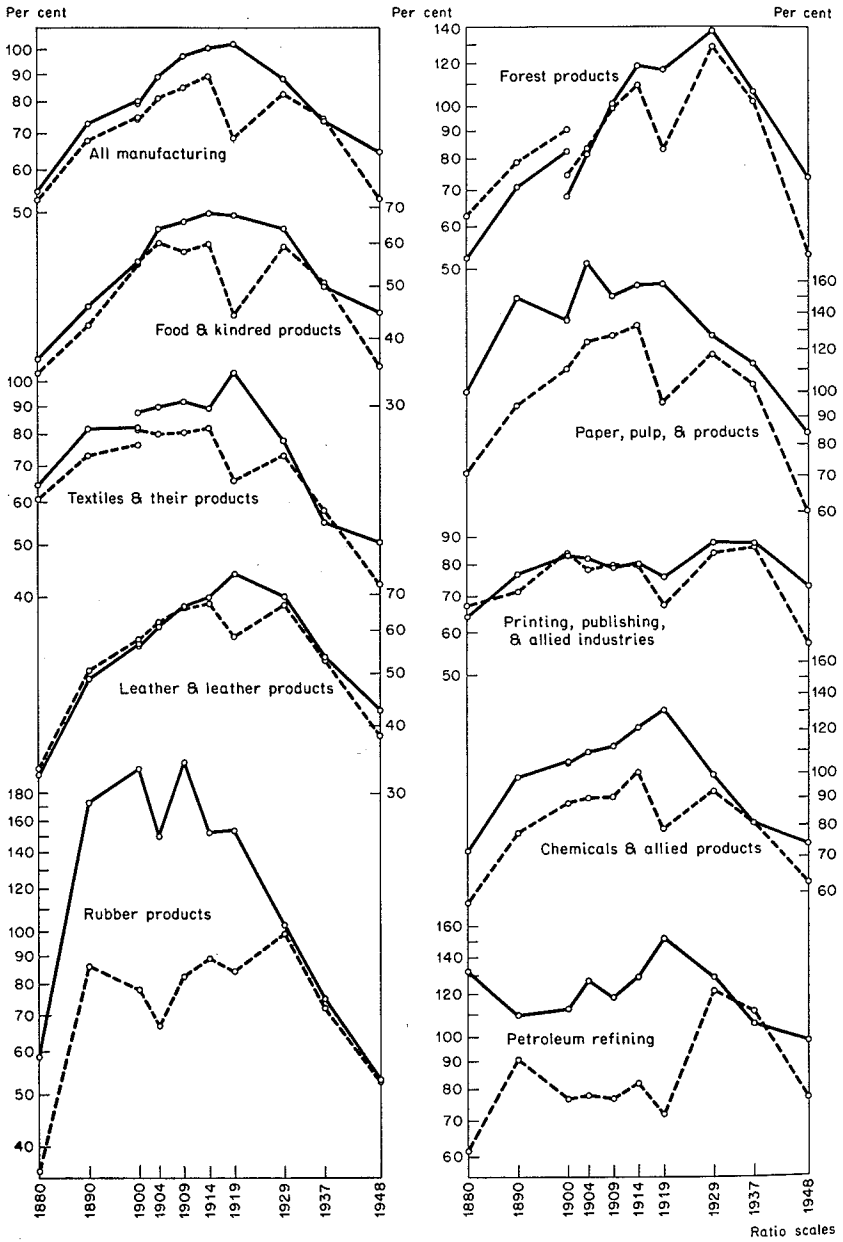
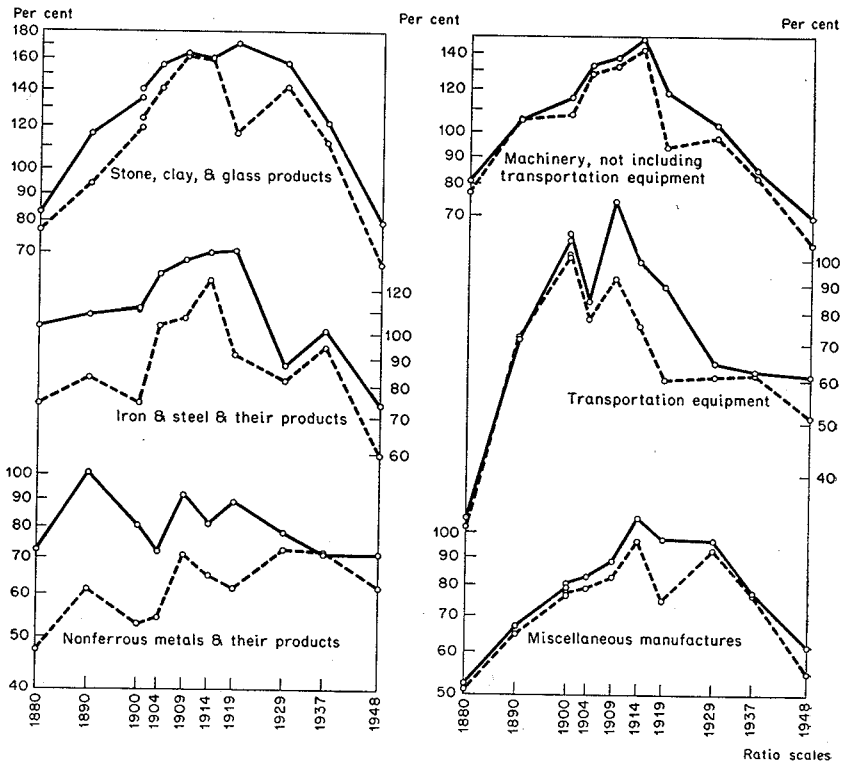


CHART 6 (concl.)

—○— 1929 values  
 - - -○- - Reported values



the effects of the changing composition of manufacturing on the capital-output ratio of aggregate manufactures (Table 11). This effect can be indicated both for the rising and the declining phases. For the rising phase we compare the average capital-output ratio in 1880 with the average of the 1880 ratios for 38 minor industries weighted by 1919 outputs, the year in which peak ratios occurred in roughly half of the industries. The actual average ratio for 1880 is 0.547; the hypothetical average ratio of the 1880 ratios weighted by 1919 outputs is 0.629; and the actual average ratio in 1919 is 1.022. Thus the ratio for all manufacturing increased by 87 per cent between 1880 and 1919 whereas the hypothetical average for 1919, which allows only for the changed importance of industries, increased by 15 per cent over the 1880 ratio. Thus about one sixth of the rise between 1880 and 1919 can be attributed to the altered composition of the manufacturing total. This is



TABLE 10

**Capital-Output Ratios for Industries Classified by Use of Product  
Selected Years, 1880-1948  
(Based on 1929 Prices)**

<i>Benchmark Years</i>	CAPITAL-OUTPUT RATIOS IN 1929 PRICES IN INDUSTRIES PRODUCING			
	<i>Consump- tion Goods</i>	<i>Construc- tion Ma- terials</i>	<i>Capital Equip- ment</i>	<i>Producers' Supplies</i>
1880	.467	.570	.868	1.357
1890	.619	.773	1.059	1.655
1900				
Comparable with preceding years	.681	.944	1.052	1.691
1900				
Comparable with following years	.692	.801	1.055	1.695
1909	.794	1.198	1.267	1.607
1919	.860	1.329	1.218	1.695
1929	.775	1.410	.921	1.282
1937	.614	1.109	.929	1.071
1948	.562	.798	.733	.873

*Source:* Based on underlying data described in Section 1.

equivalent to saying that throughout the structure of manufacturing industries basic changes occurred in the relationship of capital to output during the years 1880 to 1919.

There is, however, some merit to the objection that output and, to a lesser extent, capital investment in 1919 was distorted by the war and post-war inflation. The inflation also causes additional difficulties in obtaining values in constant prices. The use of 1919 output weights, therefore, might yield fortuitous results. Accordingly, in the matter of weights we substitute 1909 output for 1919 output. The hypothetical average ratio for 1909 is 0.608 compared with the actual average ratios of 0.972 in 1909 and 0.547 in 1880. That is, of the 78 per cent rise in ratios between 1880 and 1909, only about a seventh is explained by the changing composition of manufacturing industries. Thus whether the term of comparison is 1909 or 1919, the inference is the same: there were important alterations in the relation of output to capital throughout manufacturing industries.

TABLE 11

**Effect of Changes in Internal Composition of Manufacturing Industries  
on Capital-Output Ratio of Aggregate Manufacturing  
Selected Years, 1880-1937 (Based on 1929 Prices)**

A.		
<i>Actual capital-output ratios*</i>		
a.	1880	0.547
b.	1909	0.972
c.	1919	1.022
d.	1937	0.755
 <i>Hypothetical capital-output ratios*</i>		
e.	1880 ratios weighted by 1909 outputs (38 minor industries)	0.608
f.	1880 ratios weighted by 1919 outputs (38 minor industries)	0.629
g.	1909 ratios weighted by 1937 outputs (39 minor industries)	1.098
h.	1919 ratios weighted by 1937 outputs (41 minor industries)	1.096
 B.		
<i>Change between —</i>		<i>Per Cent</i>
i.	1880 actual ratio and 1880 weighted by 1909 outputs $\frac{e-a}{a} \times 100$	+11.2
j.	1880 actual ratio and 1909 actual ratio $\frac{b-a}{a} \times 100$	+77.7
k.	Relative importance of change in internal composition $i \div j$	14.4
l.	1880 actual ratio and 1880 weighted by 1919 outputs $\frac{f-a}{a} \times 100$	+15.0
m.	1880 actual ratio and 1919 actual ratio $\frac{c-a}{a} \times 100$	+86.8
n.	Relative importance of change in internal composition $l \div m$	17.3
o.	1909 actual ratio and 1909 weighted by 1937 outputs $\frac{g-b}{b} \times 100$	+13.0
p.	1909 actual ratio and 1937 actual ratio $\frac{d-b}{b} \times 100$	-22.3
q.	1919 actual ratio and 1919 weighted by 1937 outputs $\frac{h-c}{c} \times 100$	+7.2
r.	1919 actual ratio and 1937 actual ratio $\frac{d-c}{c} \times 100$	-26.1

\* Output figures for 1937 were not adjusted for net physical change in inventories.

Source: Based on Appendix Table A-2.

Similar computations are made for the years after 1909 and 1919, when the capital-output ratio for all manufacturing industries was declining. In this set of computations we weight by 1937 output<sup>32</sup> first the minor industry ratios in 1909 and then those in 1919, and compare the respective hypothetical averages with the actual averages in 1909, 1919, and 1937. The actual ratio for all manufacturing industries fell 26 per cent between 1919 and 1937. If, however, we assume that individual industry ratios in 1937 were identical with those in 1919 but accept whatever shifts have occurred in the relative importance of the individual industries, the ratio of aggregate manufacturing for 1937 would have increased 7 per cent over the 1919 ratio. In other words, the decline in the actual ratios occurred despite the changing composition of industry. When 1909 ratios are used in place of 1919, very similar results are obtained. Again the inference is clear for the period of declining ratios: it is a trend that has characterized most minor industry groups.

<sup>32</sup> We use 1937 output in place of 1948 for the same reasons we substitute 1909 output for 1919.