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Chapter Title: Trends in Capital-Output Ratios

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Trends in Capital-Output Ratios

THE relationship between capital and output can be investigated by relating either the change in capital to the associated change in output (the marginal ratio of capital to output) or the stock of capital existing in a given period to the total output of the period (average ratio of capital to output). When output is increasing—which generally has been the case during these decades—the movement of one ratio can be inferred from the movement of the other. There is no need, therefore, to analyze changes in both.[1] We use the average ratios.[2]

Capital-Output Ratios in Reported and Constant Prices, All Manufacturing (1880–1953) and Mining (1870–1953)

In all manufacturing industries the amount of capital invested per dollar of output rose steadily from 1880 through 1914 (see Chart 4 and Table 11; capital is measured in book values and output in current prices, magnitudes that owe little to our statistical processing). The amount of capital invested per output dollar began to fall after 1914 and continued to do so through 1948. The capital-output ratio for 1919 was sharply below the peak ratio because the inflation of output prices greatly exceeded the inflation of capital in 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 substantial expansion in capital between 1948 and 1953 eliminated many of the bottlenecks of the early postwar years and exceeded the sharp rise in output. As a result, the 1953 capital-output ratio, without adjustment for price changes, exceeded that for 1948 by nearly 7 per cent.

The 1937 ratio is of critical importance in establishing the downward trend. Although business activity in 1937 was at a cyclical peak, the rate of capacity utilization in 1937 was less than that in 1929. Were

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[1] It can be shown algebraically that if output increases, a rise in the average ratios means that the marginal ratio is higher than the larger of the two average ratios bounding the interval; if output increases, a decline in the average ratios means that the marginal ratio is lower than the smaller of the two average ratios. It follows from this that the marginal ratios fluctuate more widely than the average ratios. These relationships were brought to our attention by Simon Kuznets (see Introduction, note 5, above).

[2] The use of average ratios obviates the problem of dealing with negative changes in one term of the ratio.

this the only factor that had changed, then the 1937 ratio would be higher than the 1929 ratio. Since it is lower, other factors may have been operative.

Since price changes are incorporated more rapidly into the value of output than into the book value of capital, they should be eliminated for a truer perspective. This is most effectively accomplished by deflating both output and book values of capital. We express them in

CHART 4

Ratios of Capital to Output and to Value Added, Selected Valuations, All Manufacturing, Selected Years, 1880–1953
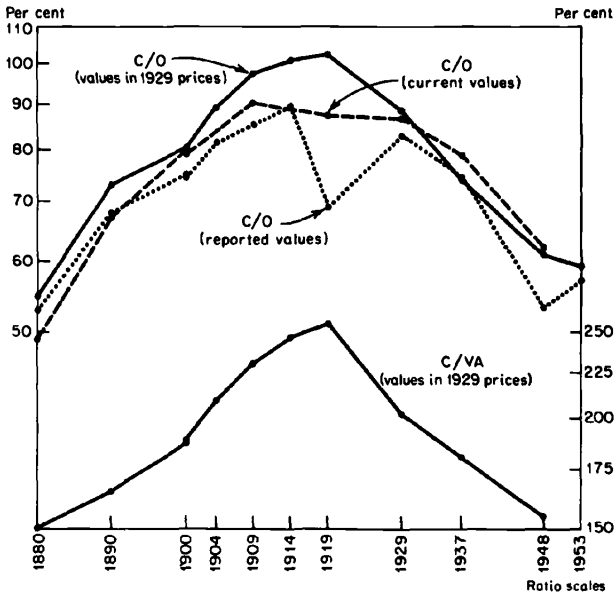
C/O = capital-output ratio.
C/VA = capital value added ratio.
Source: Table II.

1929 prices. Introduction of the constant price base raises the level of the ratios for 1919 and 1948 and produces smoother trend movements. With price changes eliminated (but not revaluations of capital assets), the capital-output ratio rises through 1919 at a faster rate than the uncorrected ratio, and declines thereafter (until 1948), again at a faster

TABLE 11

Ratios of Capital to Output and to Value Added, Selected Valuations,
All Manufacturing, Selected Years, 1880–1953

	Ratio Of			
Benchmark Years	*Capital (book value) to Output (current prices)* (*1*)	*Capital to Output (1929 prices)* (*2*)	*Capital to Output (current prices*[a]*)* (*3*)	*Capital to Value Added (1929 prices)* (*4*)
1880	0.528	0.547	0.489	1.506
1890	0.679	0.730	0.670	1.651
1900				
Comparable with preceding years	0.748	0.803	0.795	1.878
Comparable with following years	0.743	0.794	0.790	1.882
1904	0.815	0.891	n.a.	2.093
1909	0.851	0.967	0.900	2.309
1914	0.894	1.008	n.a.	2.460
1919	0.688	1.022	0.873	2.555
1929	0.829	0.885	0.867	2.020
1937	0.744	0.741	0.787	1.809
1948	0.532	0.609	0.621	1.550
1953[b]	0.570	0.590	n.a.	n.a.

n.a. = not available.
[a] Capital in current prices is equivalent to replacement costs in the given year.
[b] If privately operated, government-owned facilities are excluded from total capital,
the respective ratios are 0.549 and 0.570 (see Table 26, note b).

Source

Column	*Appendix Table*	*Remarks*
1	A-8 and A-15	1953 output from worksheets
2	A-13 and A-15	
3	A-10 (output only)	capital from worksheets (see App. A, sec. B, part 3 for derivation)
4	A-10	

rate than the uncorrected ratio.[3] Despite the rapid expansion in real capital between 1948 and 1953, the ratio decreased by about 3 per cent.

Some might argue that the appropriate denominator of the capital-output ratio is value added, in order to eliminate interfirm transactions

[3] Another way to minimize price distortion is to relate capital in current prices (i.e., replacement cost) to output in current prices. This procedure reduces the errors of estimate, because no adjustments are made in the reported value of output. Significantly, 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 4 and Table 11).

from the value of product. Since this claim has some merit, we show (Chart 5) the ratio of capital to value added in manufacturing, both in constant prices. This ratio, too, traces virtually the same pattern as the capital-output ratio based on values in constant prices.[4] However, ratios based on the indexes of manufacturing output prepared by Frickey

CHART 5

Indexes of Ratios of Capital to Output and to
Value Added, All Manufacturing, Selected Years,
1880–1948

(based on values in 1929 prices)
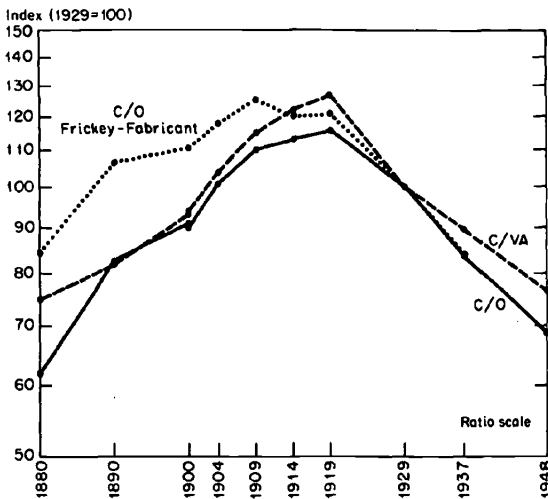
C/O = capital-output ratio.
C/VA = capital-value added ratio.
Source: Appendix Tables A-8 and A-10.

and Fabricant show a definite reversal in direction beginning in 1909 instead of 1919.

On the basis of 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

[4] In mining, also, the trend movements are similar whether the denominator is value of product or value added (Table 36, below).

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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

CHART 6

Capital-Output Ratios, by Major Mining Industries, Selected Years, 1870–1953
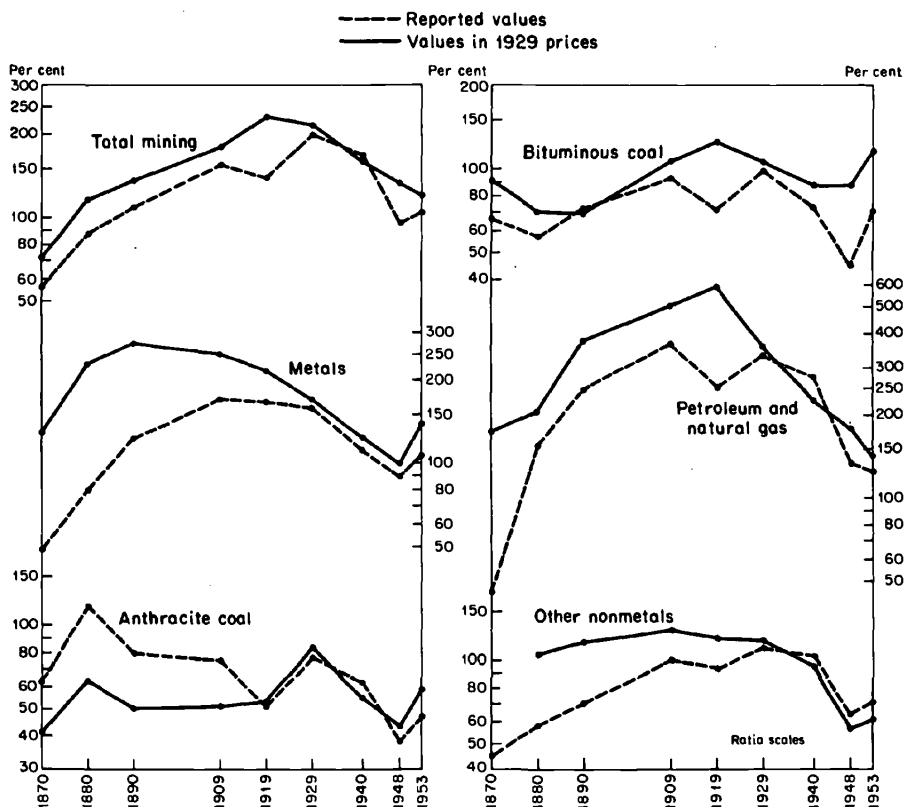
Source: Based on Table 23.

efficiency of capital and hence, to increase output, rather than to replace other factor inputs.

Trend movements in the capital-output ratio were much the same in mining as in manufacturing. The general configuration of the trend movements is similar whether the ratios are based on reported values or on values in 1929 prices (Chart 6 and Table 12).[5] However, the ratio

[5] See Chapter II, note 9

based on deflated values reached a peak around 1919. It has continued downward through 1953, the final year of our estimates. On the other hand, the ratios based on reported values have a steeper rise, a sharper decline, and a hollow in 1919. The reason for these differences is that 1870, 1919, and 1940–1948 were years of war or postwar inflation, when price increases were incorporated into the market value of the product

TABLE 12

Capital-Output Ratios: All Mining, Selected Valuations,
Selected Years, 1870–1953

Benchmark Years	Capital-Output Ratios based on:	
	Values in 1929 Prices	Reported Values
1870	0.72	0.56
1880	1.16	0.87
1890	1.36	1.09
1909	1.80	1.55
1919	2.30	1.39
1929	2.14	1.99
1940	1.59	1.68
1948	1.34	0.96
1953	1.26	1.16

Source: Appendix Tables B-7 to B-11.

more promptly than into the book value of capital. Thus, the ratios based on reported values are too low in those years. The capital-output ratios, especially the plant[6]-output ratios, based on reported values are useful chiefly as a check on the results of the adjustment for the varia-tion in price levels. Their only virtue is that they are based on figures obtained by less statistical processing than those based on values in 1929 prices.

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 finding 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

[6] Net value of structures and equipment.

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reported values. Moreover, the adjustment for price changes alters the ratios in the direction demanded by logic.

If the downward movement in the ratios between 1919 and 1929 is suspect because of the shift in the source of our data—from the *Census of Manufactures* to *Statistics of Income*—we point to the continued decline in the ratios between 1929 and 1948, when all the ratios 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. For example, beginning with 1919, no significant changes have taken place in the treatment of depreciation. Therefore, the fall in the capital-output ratios after 1919 cannot be due to changes in the treatment of depreciation.[7]

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, minimizes the rise in the capital-output ratio and thus strengthens our finding. If, as we believe, capital was increasingly reported on a net basis, as formal depreciation accounting became more widespread, then the rise in the capital-output ratio is understated. Between 1909 and 1914, this understatement should be especially 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 before 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 are, consequently, understated.

Can the rise in the ratios for manufacturing 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 from 1900 to 1904 in the capital-output ratios based on reported values was spectacularly large (39 per cent for

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[7] For the effect of another aspect of depreciation during recent decades, see

iron and steel and their products and 133 per cent for tobacco).[8] How-
ever, even if we 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. With these two
major groups included, the percentage increases were 10 and 15. This
suggests that not all of the rise between 1900 and 1904 or 1909 can be
explained by promoters' revaluation of the assets of industrial com-
binations.

Thus, the rising trend in the ratios between 1870 or 1880 and 1909–
1919 is no accounting mirage, and the declining trend after 1919 can-
not be attributed merely to the shift in depreciation practices.

Statistics of Income for 1929 and later years includes intangible assets
such as patent rights and good will. Exclusion of these intangible assets
in the earlier years raises the level of the ratios for 1929 and after but
does not affect the direction of movement. Our finding of a decline in
the capital-output ratios for this period is not, therefore, affected by
the slight shift in the definition of capital.

The ratios for 1929, 1937, 1948, and 1953 are based on balance sheet
data of corporations only. The ratios for earlier years are based on
data for all firms, incorporated and unincorporated alike.[9] However,
unincorporated firms have smaller assets per firm than the average
corporation, and the smaller the firm, the smaller the capital-output
ratio. Therefore, the lack of comparability adds to the firmness of our
results.

And this is also the effect on the 1948 ratio of our treatment of the
wartime emergency facilities subject to accelerated amortization.[10] 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
capital is overstated by a small amount; and on this score, too, the
"true" capital-output ratio would be slightly lower than our estimate.

[8] 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 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.

[9] Unincorporated firms accounted for 8.5 per cent of value added in manufacturing
in 1929 and for 8.1 per cent in 1947 (see *Census of Manufactures* for these years).
In mining, the unincorporated firms accounted for 9 per cent of total value of
output in 1939 (see *Census of Mining, 1939*).

[10] In mining, the value of wartime emergency facilities subject to accelerated
amortization was negligible. At its peak in 1943, accelerated amortization amounted
to only 5 per cent of normal depreciation.

Depreciation accounting since 1929 beclouds our view of the secular movement of capital. Some argue, for example, that statutory depreciation charges in manufacturing are too high (length-of-life estimates are too low). Consequently, net capital is understated, and the understatement becomes progressively larger as the stock of capital expands. Could this understatement cause the capital-output ratio to decline after 1929? This possibility could be explored in the following way. In each benchmark year, we would add the amount of the understatement of the stock of capital to the reported values. We would then compute the capital-output ratios. However, we cannot estimate the true amount of the understatement, and we are obliged to assume varying amounts of understatement. We start with the extreme assumption that there is no capital consumption and that the understatement is equal to the entire depreciation reserve. The resultant ratios of gross total capital to output (both in constant prices) are 1.199, 0.998, and 0.856 for 1929, 1937, and 1948, respectively. 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 is reassuring. It fails to disclose any weakness large enough to shake our confidence in the validity of the trend in the capital-output ratios, particularly when our interest in centered on the broad pattern of movement.

Effect of Changes in the Composition of Manufacturing Industries

Thus far, we have presented ratios based on aggregative data—fixed and working capital combined, all industries, and all firms regardless of size. Could the reversal in the trend of the ratios have been caused by the shifting importance of the components of the aggregates? Fortunately, we have sufficient evidence to give definitive answers on the effects of changes in the type of assets and of interindustry differences in growth.

A casual inspection of the deflated capital-output ratios (in percentages) by minor industries for 1880 (Appendix Table A-13) is sufficient to indicate their wide range—from 8.5 (packing house products) and 25.7 (boots and shoes) at the lower end, to 207.8 (agricultural machinery and equipment) and 211.4 (chemicals proper, acids, compounds, etc.) at the upper end. We can infer from Table 6 that the various industries have grown at different rates. Thus, the possibility exists that industries with relatively high capital-output ratios in

1880 expanded more rapidly until 1919 than those with relatively low ratios and, thus, caused the ratio for all manufacturing to rise. Similarly, after 1919, did industries with relatively low ratios become more important than those with high ratios, and so cause the ratio for all manufacturing to decline?

Price Adjustments and Their Effect

Before we investigate the foregoing problems, we must consider whether our method of deflating the book value of capital would in itself impose a common pattern of change on the ratios of the minor industries. Our method was to derive a set of composite indexes, one for each of fifteen major industry groups, from (1) an index of building costs (identical for all industries) based on a fifty-year life; (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) as a deflator of working capital, an index of wholesale prices of the output of each major industry group. The composite index for a given major industry was applied to all minor industries classified under the given major industry.
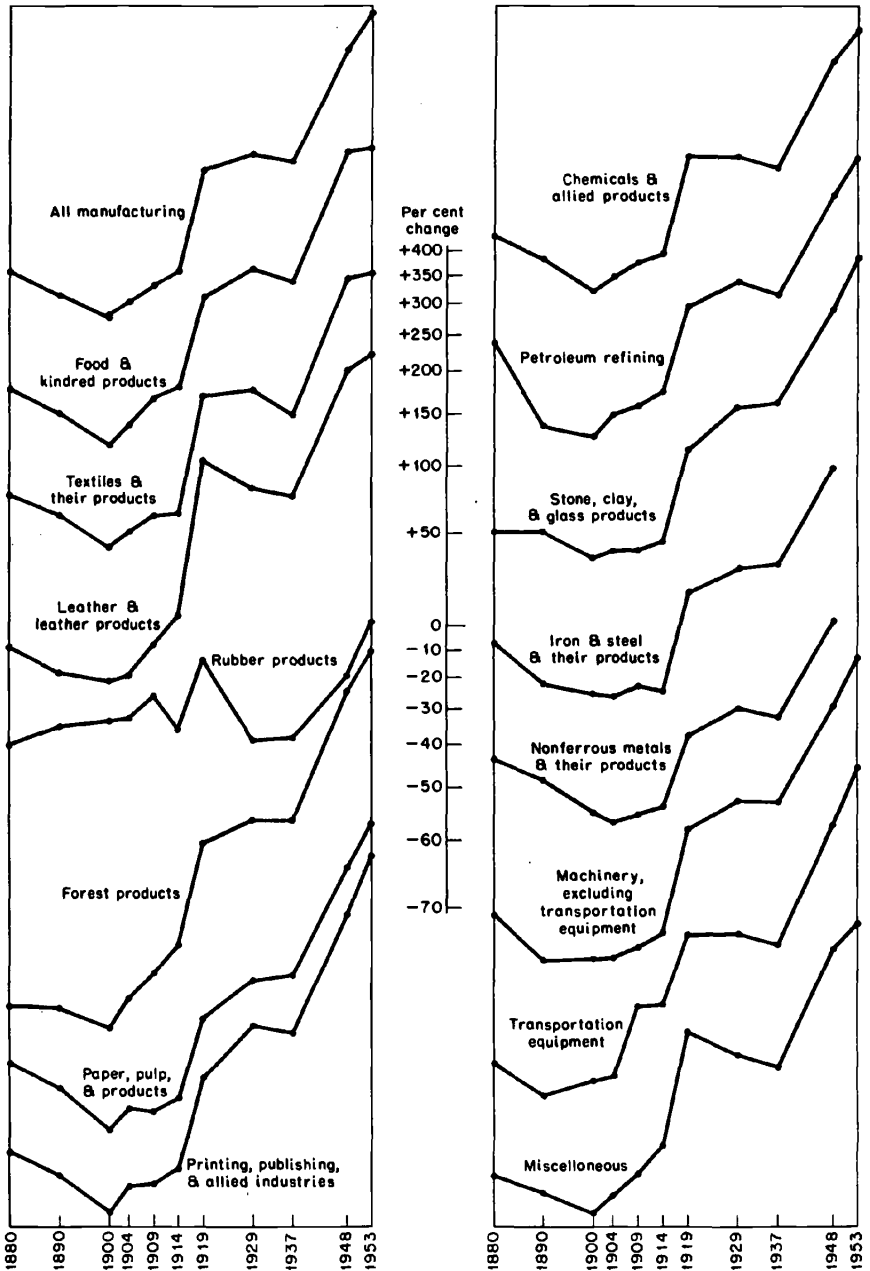
Chart 7 shows the indexes used for each of the fifteen groups to adjust book values of capital to 1929 prices. The strong resemblance among these indexes cannot be denied, and this result is to be expected in view of the procedure. However, it does not necessarily follow that these indexes differ by 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. The movement of the implicit price indexes used to express output in 1929 prices also supports this view (Chart 8). 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 for a different roster of commodities.

In Chart 9 we show, for each major industry, two sets of capital-output ratios, one based on reported values and one on 1929 prices. As a result of the price adjustments, the 1919 and 1948 ratios have been raised. These ratios are "too low" when based on reported values because, in both years, the culmination of rapid price rises affected the value of output more than it did 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.

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CHART 7

Major Manufacturing Industries: Price Indexes (Book Value) of Total Capital, Selected Years, 1880–1953

All manufacturing

Food & kindred products

Textiles & their products

Leather & leather products

Rubber products

Forest products

Paper, pulp, & products

Printing, publishing, & allied industries

Per cent change
+400
+350
+300
+250
+200
+150
+100
+50
0
−10
−20
−30
−40
−50
−60
−70

Chemicals & allied products

Petroleum refining

Stone, clay, & glass products

Iron & steel & their products

Nonferrous metals & their products

Machinery, excluding transportation equipment

Transportation equipment

Miscellaneous

1880 1890 1900 1904 1909 1914 1919 1929 1937 1948 1953

Source: Appendix Table A-11.

Note: Data for iron and steel and their products and nonferrous metals and their products are not available separately in 1953.

CHART 8

Major Manufacturing Industries: Price Indexes of Output, Selected Years,
1880–1948

Source: Appendix Table A-12.

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CHART 9

Major Manufacturing Industries: Capital-Output Ratios, Selected Years, 1880–1953

----- Reported values

——— Values in 1929 prices

Per cent

All manufacturing

Food & kindred products

Textiles & their products

Leather & leather products

Rubber products

Per cent

Forest products

Paper, pulp, & products

Printing, publishing, & allied industries

Chemicals & allied products

Petroleum refining
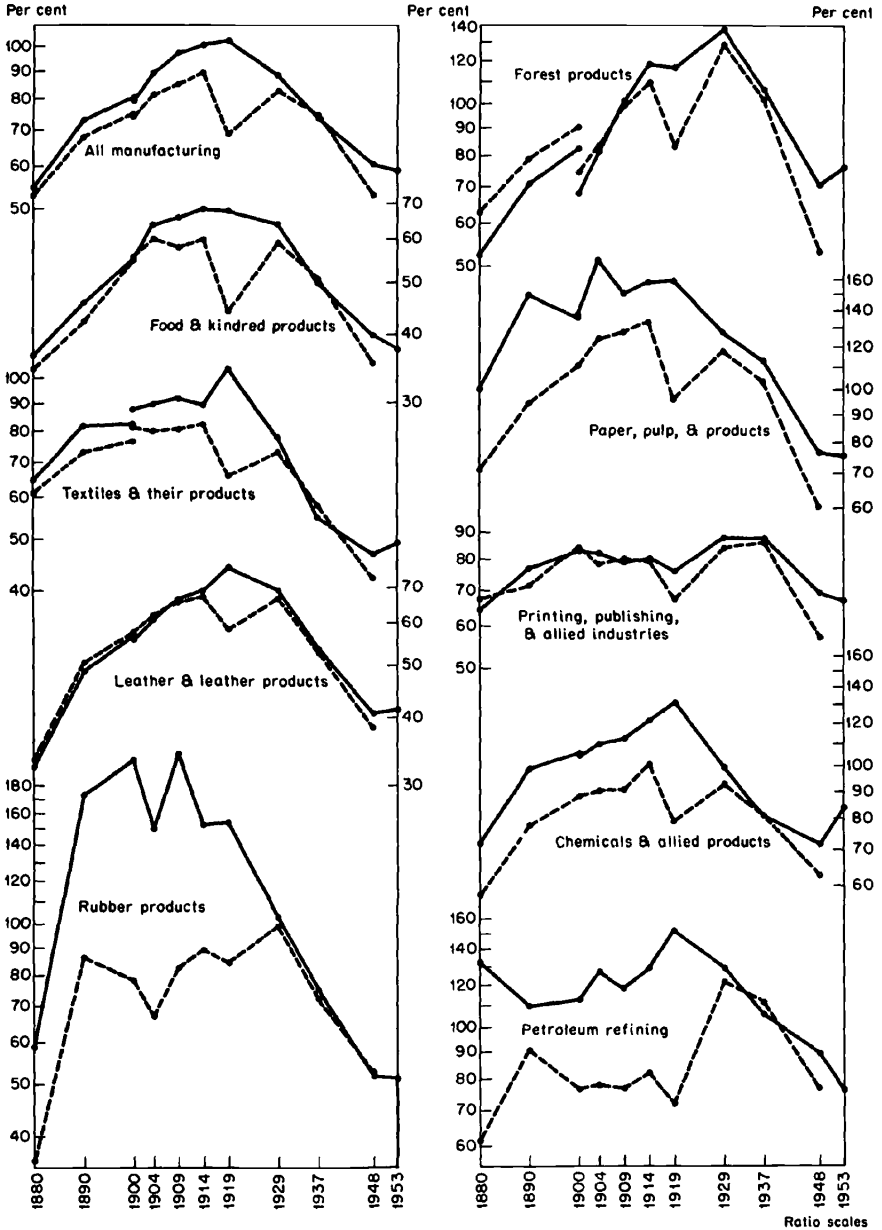
Ratio scales

CHART 9 (concluded)

- - - - - Reported values
———— Values in 1929 prices

Source: 1880–1948: for ratios based on values in 1929 prices, see Appendix Table A-13; ratios based on reported prices are derived from data in Appendix Tables A-8 and A-10; 1953: based on Appendix Table A-15.
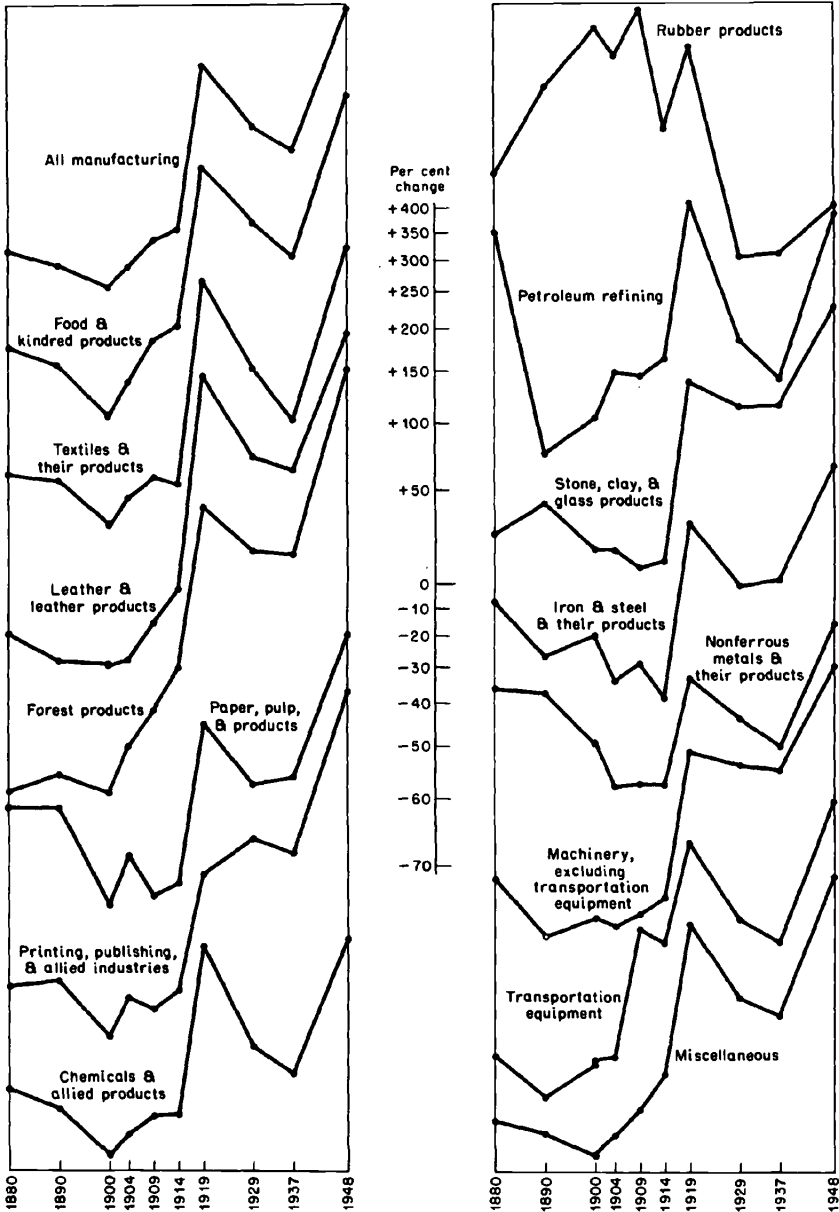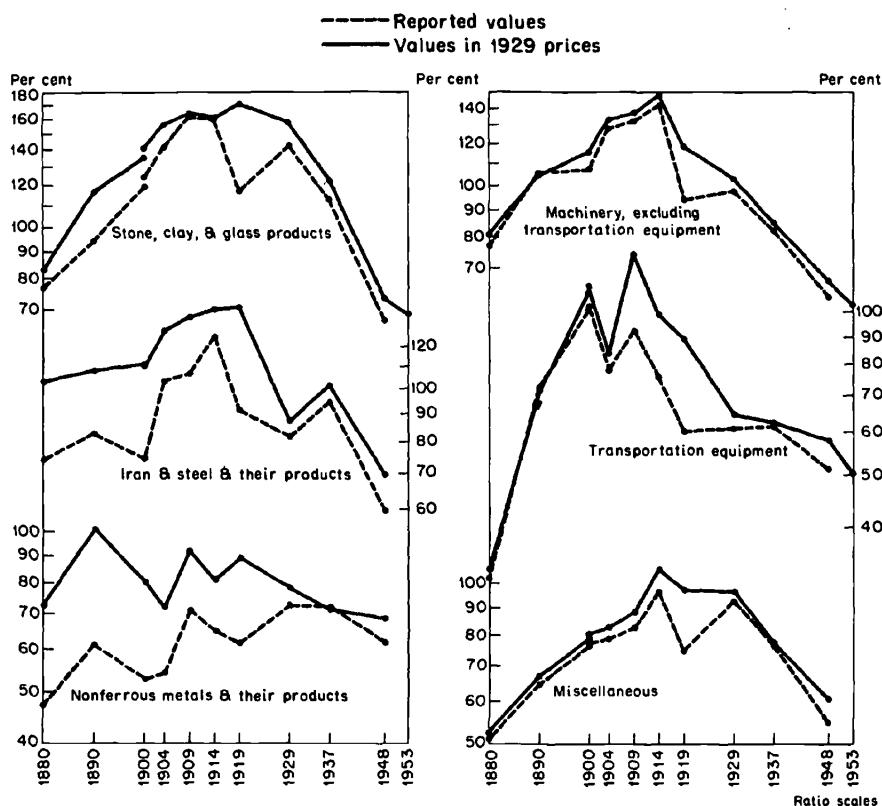
Note: Data for iron and steel and their products and nonferrous metals and their products are not available separately in 1953.

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-13, we present the capital-output ratios based on values in 1929 prices for 39 minor industries for all benchmark years.[11] At this point, we merely indicate the distribution of the peak ratios according to the year of occurrence, disregarding peak ratios that occurred in 1904 and 1914, years of business contraction.

[11] Capital-output ratios for 1953 were computed only for major industry groups, since data were not available for the minor groups at the time of writing.

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Year in Which Peak Capital-Output Ratio Occurred

	1880	1890	1900	1909	1919	1929	1937	1948
No. of minor industries	0	3	4	6	18	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. Our earlier generalization has been borne out by the more detailed information. It follows, by definition, that the 1929 ratio is lower than the 1919 ratio in the 31 industries that had peak ratios before 1929. More significantly, 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, they were lower than the 1919 ratios.

Trends in the 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 according to the ultimate use of the product—consumption goods, construction materials, capital equipment, and producers' supplies. Industries in the last three categories

TABLE 13

Capital-Output Ratios: Manufacturing Industries Classified by Use of Product,
Selected Years, 1880–1948
(*based on values in 1929 prices*)

	Capital-Output Ratios in Industries Producing—			
Benchmark Years	*Consumption Goods*	*Construction Materials*	*Capital Equipment*	*Producers' Supplies*
1880	0.467	0.570	0.868	1.357
1890	0.619	0.773	1.059	1.655
1900 Comparable with preceding years	0.681	0.944	1.052	1.691
Comparable with following years	0.692	0.801	1.055	1.695
1909	0.794	1.198	1.267	1.607
1919	0.860	1.329	1.218	1.695
1929	0.775	1.410	0.921	1.282
1937	0.614	1.109	0.929	1.071
1948	0.522	0.739	0.653	0.796

Source: Based on data in Appendix Tables A-8 and A-10. The computation was not extended to 1953 because data for minor industries were not available when this record was prepared.

produce commodities that enter into the stock of manufacturing capital.[12]

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 13). The ratios for production of construction materials reached the peak in 1929, as did those for lumber and basic timber products, an industry with heavy weight in construction materials output. Thus, in all the industries contributing to the stock of reproducible wealth of the producer goods industries, the "real" capital cost per unit of output first increased up to 1909 or 1929 and then decreased. The same trends appear in the consumption goods industries. The capital-output ratio increased until 1919 and then began to decline.

A Measure of the Effect of Changing Composition

The following computations measure the effects of the changing composition of manufacturing on the capital-output ratio for aggregate manufacturing (Table 14). They, too, suggest the general pattern of a rising capital-output ratio followed by a declining one. The effects 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 each of thirty-eight 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. In other words, throughout the structure of manufacturing industries, basic changes occurred in the relationship of capital to output during 1880–1919.

However, output and, to a lesser extent, capital investment in 1919 were distorted by the war and postwar 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, we weight the 1880 ratio by 1909 output, instead

[12] 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. 141–166).

TABLE 14

Capital-Output Ratios: Effect of Changes in Internal Composition of Industries,
All Manufacturing, Selected Years, 1880–1937

(based on values in 1929 prices)

	A
Capital-output ratios:[a]	
Actual[a]	
a. 1880	0.547
b. 1909	0.967
c. 1919	1.022
d. 1937	0.755
Hypothetical[a]	
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		
Change between:		*100 × line*	*Per cent*
i. 1880 actual ratio and 1880 weighted by 1909 outputs		$\dfrac{e-a}{a}$	+11.2
j. 1880 actual ratio and 1909 actual ratio		$\dfrac{b-a}{a}$	+76.8
k. Relative importance of change in internal composition		$i \div j$	+14.6
l. 1880 actual ratio and 1880 weighted by 1919 outputs		$\dfrac{f-a}{a}$	+15.0
m. 1880 actual ratio and 1919 actual ratio		$\dfrac{c-a}{a}$	+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		$\dfrac{g-b}{b}$	+13.0
p. 1909 actual ratio and 1937 actual ratio		$\dfrac{d-b}{b}$	−22.3
q. 1919 actual ratio and 1919 weighted by 1937 outputs		$\dfrac{h-c}{c}$	+7.2
r. 1919 actual ratio and 1937 actual ratio		$\dfrac{d-c}{c}$	−26.1

[a] Output figures for 1937 were not adjusted for net physical change in inventories.
Source: Based on Appendix Tables A-10 and A-13. The computation was not extended to 1953 because data for minor industries were not available when these estimates were prepared.

of 1919 output. The hypothetical average ratio for 1909 is 0.608, compared with the actual average ratios of 0.967 in 1909 and 0.547 in 1880. That is, of the 77 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 comparison is with 1909 or with 1919, the inference is the same. *Throughout* manufacturing in-

dustries, important alterations took place in the relation between capital and output.

Similar computations were made for the years after 1909 and 1919, when the capital-output ratio for all manufacturing industries was declining. We weight ratios in 1909 and those in 1919 by 1937 output.[13] We then compare the respective hypothetical averages with the actual averages in 1909, 1919, and 1937. The actual ratio for all manufacturing industries fell by 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 for aggregate manufacturing for 1937 would have increased by 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 those for 1919, 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.

Effect of Changes in the Composition of Mining Industries

The rates of growth of individual mining industries differ (Tables 10 and 15). It follows that changes in the capital-output ratio of all mining are not determined solely by changes in capital-output ratios within individual industries. As in manufacturing, we must investigate the effects of shifts in the relative importance of the individual industries on the movement of the aggregate capital-output ratio. Before doing so, however, we must examine the changing importance, since 1870, of the various mining industries as producers and as fields of investment. We must also know about the stability of interindustry differences in the amount of capital used per unit of output.

In 1870, the beginning of the period studied, anthracite and bituminous coal mining were the most important industries. Together they accounted for about 50 per cent of total capital and total output of all mining industries (Table 15). During the next decade, however, the precious metals industry, particularly gold mining, began to displace coal as the principal capital user.[14] In both 1880 and 1890, precious metals mining accounted for more than 40 per cent of all mining capital. (However, its share of output was considerably less. Throughout the entire period, its share of capital was larger than its

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[13] We use 1937 output in place of 1948 for the same reasons that prompted us to substitute 1909 output for 1919.

[14] The census data for precious metals mining are seriously understated in 1870. Precious metals mining may have been the leading field of investment in this year.

TABLE 15

Share of Major and Minor Mining Industries in Total Mining, Selected Years, 1870–1947
(per cent)

	1870	1880	1890	1909	1919a	1919b	1929	1940	1947
All metals:									
Output in current prices	31.0	43.9	34.5	29.9	17.5	17.0	16.0	17.6	10.6
Total capital in book values	37.7	55.5	55.8	36.1	27.0	26.4	20.4	16.0c	10.2
Capital (excluding land) in 1929 prices	29.6	42.5	38.8	31.4	17.9	17.7	12.7	11.9	8.8
Iron:									
Output in current prices	8.7	9.2	8.0	9.3	7.0	6.8	5.0	5.0	3.5
Total capital in book values	8.4	8.2	7.0	9.2	7.2	7.1	n.a.	3.1	2.7
Capital (excluding land) in 1929 prices	5.0	5.6	6.4	8.7	5.7	n.a.	n.a.	n.a.	n.a.
Copper:									
Output in current prices	3.4	3.9	4.5	10.4	5.8	5.6	7.1	5.6	4.1
Total capital in book values	3.7	5.5	5.7	9.2	12.3	12.0	n.a.	6.2	3.8
Capital (excluding land) in 1929 prices	2.1	3.2	2.7	7.1	7.4	n.a.	n.a.	n.a.	n.a.
Lead and zinc:									
Output in current prices	1.0	1.5	1.1	2.5	2.4	2.3	2.0	2.2	1.8
Total capital in book values	1.4	1.1	0.8	1.9	2.8	2.7	n.a.	1.0	0.9
Capital (excluding land) in 1929 prices	1.5	1.2	0.8	1.7	1.8	n.a.	n.a.	n.a.	n.a.
Precious metals:									
Output in current prices	17.4	29.3	20.5	7.4	2.0	2.0	0.8	3.9	0.8
Total capital in book values	23.6	40.5	41.9	15.3	4.4	4.3	n.a.	4.1	2.0
Capital (excluding land) in 1929 prices	20.4	32.4	28.6	13.4	2.8	n.a.	n.a.	n.a.	n.a.
Other metals:									
Output in current prices	0.5	n.a.	0.4	0.3	0.3	0.3	0.3	0.8	0.4
Total capital in book values	0.6	0.2	0.4	0.5	0.3	0.3	n.a.	1.1	0.8
Capital (excluding land) in 1929 prices	0.6	0.1	0.3	0.5	0.2	n.a.	n.a.	n.a.	n.a.

(continued)

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TABLE 15 (concluded)

	1870	1880	1890	1909	1919a	1919b	1929	1940	1947
Anthracite coal:									
Output in current prices	25.2	16.7	17.2	12.6	11.6	11.4	9.7	5.8	4.9
Total capital in book values	24.2	18.0	9.8	7.5	6.2	6.1	5.1	3.7	3.1
Capital (excluding land) in 1929 prices	29.5	22.6	12.7	6.1	4.3	4.2	3.7	2.2	1.9
Bituminous coal:									
Output in current prices	23.0	21.2	22.5	33.8	36.7	35.7	24.3	24.6	30.9
Total capital in book values	27.9	14.1	13.7	29.3	27.4	26.8	18.5	16.3	15.3
Capital (excluding land) in 1929 prices	24.7	13.1	12.8	20.5	18.5	18.2	12.0	10.9	12.3
Petroleum and natural gas:									
Output in current prices	12.6	9.7	11.5	14.8	28.9	28.2	39.2	42.8	46.3
Total capital in book values	4.7	7.7	12.2	20.8	34.8	34.0	48.0	57.2	65.6
Capital (excluding land) in 1929 prices	10.1	16.6	26.7	36.4	56.0	55.1	65.7	69.2	72.5
Other nonmetals:									
Output in current prices	8.2	8.5	14.3	8.9	5.3	7.7	10.8	9.2	7.7
Total capital in book values	5.5	4.7	8.5	6.3	4.6	6.7	8.0	6.8	5.8
Capital (excluding land) in 1929 prices	6.1	5.2	9.0	5.6	3.3	4.8	5.9	5.8	4.5

n.a. = not available.
a Comparable with earlier years.
b Comparable with later years.
c Includes some capital which could not be allocated by minor industries.
Source: Based on Appendix Tables B-7, B-9, and B-11.

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share of output.) The "gold period" came to an end in the 1890's. Thereafter, its relative decline was so pronounced that precious metals mining, once the largest, became one of the smaller mining industries. In 1919, it accounted for only 4 per cent of total mining capital and only 2 per cent of total mining output.

The period of relative decline in the precious metals industry coincides with that of relative increase in oil and gas production. The share of the oil and gas industry in total capital rose gradually from about 12 per cent in 1890 to about 21 per cent in 1909. Thereafter, the increase averaged more than 1 percentage point per year. The rise of its share in mining output was equally impressive. By 1948, the oil and gas industry accounted for about 68 per cent of the total capital in-

TABLE 16

Capital-Output Ratios in Mining: Major and Minor Industries,
Averages for Selected Groups of Years, 1870–1947

	1870, 1880 and 1890	*1909 and 1919*	*1937 and 1947*
	BASED ON REPORTED VALUES *(including land)*		
All mining	2.05	2.50	1.55
Metals	2.87	3.40	1.79
Iron	1.86	2.52	1.03[a]
Copper	2.63	3.59	1.12[a]
Lead and zinc	1.79	2.38	0.58[a]
Precious metals	3.39	5.26	3.09[a]
Anthracite coal	1.72	1.43	1.28
Bituminous coal	1.56	2.03	1.15
Petroleum and natural gas	1.66	3.29	1.79
Other nonmetals	1.23	1.94	1.32
	BASED ON VALUES IN 1929 PRICES *(excluding land)*		
All mining	1.08	2.05	1.33
Metals	2.11	2.33	1.17
Iron	1.15	2.08	n.a.
Copper	1.11	1.97	n.a.
Lead and zinc	0.75	1.38	n.a.
Precious metals	3.70	4.40	n.a.
Anthracite coal	0.51	0.52	0.56
Bituminous coal	0.77	1.15	0.87
Petroleum and natural gas	2.53	5.46	1.90
Other nonmetals	n.a.	1.24	0.78

n.a. = not available.
[a] 1947 only.
Source: Based on Appendix Tables B-7 through B-11, and worksheets.

vested in mining and for about 53 per cent of its production. The percentage of total capital is significantly understated because it does not include the value of leased land; the overwhelming majority of mineral lands in operation are leased.[15] Like precious metals mining, oil and gas production accounted for a greater share of capital than of output throughout most of the period.

Other industries use considerably less capital per unit of output (Table 16). The relative importance of coal output was much greater than that of capital during the whole period (except in 1870, when

TABLE 17

Capital-Output Ratios in Mining: Actual and Hypothetical, and Ratio of Actual to Hypothetical Capital, Selected Years, 1870–1948

(based on values in 1929 prices)

	1870	*1880*	*1890*	*1909*	*1919*	*1929*	*1937*	*1948*
Capital-output ratios:								
Actual	0.72	1.16	1.36	1.80	2.30	2.14	1.36	1.34
Hypothetical — assuming industry ratios as in:								
1890	1.09	1.36	1.36	1.55	1.75	2.26	2.53	2.65
1919	1.22	1.57	1.61	1.89	2.30	3.13	3.58	3.83
1948	0.68	0.78	0.80	0.90	1.00	1.18	1.28	1.34
Ratio of actual to hypothetical								
1890	0.66	0.85	1.00	1.16	1.31	0.95	0.54	0.51
1919	0.59	0.74	0.85	0.95	1.00	0.69	0.38	0.35
1948	1.05	1.47	1.70	1.99	2.30	1.82	1.06	1.00

Source: Based on Appendix Tables B-8 and B-11, and worksheets.

coal was the leading field for mining investment). From 1880 to 1919, the coal mining industry was the most important contributor to the value of total mining production; its share was about 47 per cent in 1919, while its share of capital in that year was only about 33 per cent. (During the twenties, the petroleum and gas industry became the leader in share of output.) The other nonmetals group also uses less capital per unit of output. The iron, copper, and lead and zinc industries are intermediate.

What has been the impact of these shifts on aggregate capital used in mining? Has the observed increase and subsequent decline in the aggregate capital-output ratio occurred despite the interindustry shifts?

[15] This explains why the percentages excluding land run considerably higher than those including land.

To provide an answer (Table 17), we use the same procedure as in manufacturing. We assume, first, that the capital-output ratios of the major industries remain at the 1890 level in all years. To estimate the hypothetical capital for each of these industries in all other years, we multiply this constant ratio by actual output in the year. The sum of these hypothetical capital figures for the major industries, divided by the sum of their actual value of output in the given year, gives a hypothetical aggregate ratio. This hypothetical ratio is then compared with the actual aggregate ratio. The hypothetical capital figure represents the amount of capital that would have been invested in all mining industries in the benchmark years if the capital-output ratios within the industries had remained at the 1890 level. Since the interindustry differences in the ratios have changed, we repeat the computations using the industry ratios for 1919 and for 1948.

Had industry shifts been the only influence, the aggregate mining ratio would have increased continuously during the whole period. The increase would have occurred whether the interindustry differences in the capital-output ratios had been as they were in 1890, in 1919, or in 1948, and despite the shrinkage of precious metals mining, with its high capital-output ratio. Thus, the actual increase in the aggregate ratio between 1870 and 1919 was, in part, a result of the shifts in industry weights. However, the ratio has declined since 1919 *despite* these shifts. Indeed, if the 1919 ratios for each industry had prevailed in 1948, almost 3 times as much capital would have been used in mining as actually was used in that year. This means that capital would have risen to about 3.9 times the 1919 level during those twenty-nine years compared with a rise in output to more than 2.3 times the level in 1919. Actually, capital used in 1948 was only 1.4 times that used in 1919. Even if the relatively low industry ratios of 1890 had been maintained through 1948, the volume of capital in that year would have been twice as high as it really was. And, *per contra*, if the industry's utilization of capital in the other years had been as low as it was in 1948, capital in 1919 would have been only about 43 per cent of the actual amount used in that year and, in 1890, about 57 per cent of the actual amount.

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. However, particularly for manufacturing, we can infer the probable direction of the impact for 1880–1919.

To show the relationship between asset size and the capital-output ratio, we use unpublished material, by Stanley S. Schor,[16] based on data from the "Source Book" of *Statistics of Income* for 1947. Using these data, we can 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 was in this category. To reduce the detail to manageable proportions, we work with twenty-two major industry groups and with unweighted average ratios for the following four size groups (in thousands of dollars): under $100, $100 and under $1,000, $1,000 and under $10,000, $10,000 and over.

The evidence is unmistakable (Table 18). In 19 of the 22 industry groups (the exceptions are food and kindred products, beverages, and tobacco products), the ratio for 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 nonconforming industries, inventories constitute a relatively important element in the total capital structure. If, for these, 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.[17] In a very real sense, then, the capital-output ratio for all the major industry groups tends to increase with increasing asset size. As additional evidence we note that in 18 of the 22 industry groups the highest ratios occurred in the largest corporations. In 13 groups the lowest ratios were found in corporations with less than $100,000 of assets; in 18 groups, in corporations with less than $1 million.

These empirical findings agree with a priori inferences. Scitovsky argues that "the scope for using labor-saving machinery increases with size; [that] large firms are likely to be in a better bargaining position

[16] "The Capital-Product Ratio and Size of Establishment for Manufacturing Industries" (Ph.D. dissertation, University of Pennsylvania, 1952). Schor computed the ratio of fixed capital to gross sales. Gross sales closely approximates our definition of output. The following are the ten asset-size groups (in thousands of dollars) for which ratios are calculated: Under $50, $50 and under $100, $100 and under $250, $250 and under $500, $500 and under $1,000, $1,000 and under $5,000, $5,000 and under $10,000, $10,000 and under $50,000, $50,000 and under $100,000, and $100,000 and over.

[17] Total capital-output ratios by asset size (in thousands of dollars) are:

	Under $100	$100 and under $1,000	$1,000 and under $10,000	$10,000 and over
Food and kindred products	0.246	0.262	0.294	0.304
Liquor and beverages	0.446	0.498	0.463	0.489
Tobacco products	0.566	0.364	0.719	0.768

TABLE 18

Fixed Capital-Output Ratios of Net Income Corporations, by Manufacturing
Industries: by Asset Size, 1947
(*based on reported values*)

	Fixed Capital-Ouput Ratio of Firms with Assets of ('000 omitted):			
	Under $100	$100 but under $1,000	$1,000 but under $10,000	$10,000 and over
All manufacturing	.098†	.116	.154	.221*
Food and kindred products	.112*	.111	.108	.101†
Liquors and 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 and leather products	.047	.046	.066	.073*
Rubber products	.133	.130†	.180*	.153
Lumber and basic timber products	.117†	.160	.310	.633*
Furniture and finished wood products	.088†	.116	.168	.180*
Pulp, paper, and products	.096†	.131	.224	.368*
Printing, publishing, and allied industries	.129†	.169	.250	.456*
Petroleum refining	.140	.121†	.158	.405*
Chemicals and allied products	.104†	.122	.168	.286*
Stone, clay, and glass products	.170†	.225	.348	.366*
Iron and steel and their products	.132†	.144	.160	.249*
Nonferrous metals and their products	.094†	.105	.112	.286*
Electrical machinery and equipment	.077†	.100	.114	.136*
Other machinery and equipment	.160	.152	.147†	.203*
Motor vehicles, complete or parts	.090†	.092	.120	.156*
Other transportation equipment	.130	.146	.121†	.219*
Miscellaneous	.090†	.121	.168	.210*

* Highest ratio.
† Lowest ratio.
Source: Stanley S. Schor, "The Capital-Product Ratio and Size of Establishment for Manufacturing Industries," unpublished Ph.D. dissertation, University of Pennsylvania, 1952.

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 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."[18]

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 an enterprise. Unfortunately, there are no reliable statistics by asset size over a long-term period and, therefore, this generalization cannot be empirically tested.[19] It is possible, however, to compare the interindustry changes in the capital-output ratio by asset size in 1937 and 1947 (Table 19). 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 percentage of the ratio of the smallest class. The difference between the ratio of the smallest firms and of the largest firms was appreciably reduced in 1947 compared with 1937. This was true not only in aggregate manufacturing, but also in each of the 15 industry groups.

Another way of expressing the change is to say that the fixed capital-output ratio for large firms declined more rapidly between 1937 and 1947 than did the ratio for small firms. This suggests that the more capital per unit of output, the greater are the possibilities for capital-saving innovations.[20]

If we knew the relationship between size of firm and the fixed capital-output ratio and could measure the changes in the size

[18] Tibor Scitovsky, "Economic Theory and the Measurement of Concentration," *Business Concentration and Price Policy, Special Conference Series,* Universities—National Bureau Committee for Economic Research (Princeton University Press, 1955, p. 111).

[19] 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. We have reason to believe that the number of establishments in many of the larger size classes was 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.

[20] We find a similar relationship in Chapter V, 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 (for which no adjustment has been made) implicit in the book value of assets in 1947. 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.

structure of manufacturing industries between 1880 and 1948, we could evaluate the effect of a change in the size of a firm on over-all or industry ratios. Unfortunately, precise measures cannot be made with the available data. However, the average size of establishment un- doubtedly increased between 1880 and 1919. For example, the un-

TABLE 19

Fixed Capital-Output Ratios of Net Income Corporations, by Manufacturing Industries: Largest Firms Compared to Smallest Firms, 1937 and 1947
(based on reported values)

	Index of Fixed Capital-Output Ratio in Firms with Assets ('000 omitted) of:—					
	$100 but under $1,000		*$1,000 but under $10,000*		*$10,000 and over*	
	1937	*1947*	*1937*	*1947*	*1937*	*1947*
	(ratio in firms with assets less than $100 thous. = 100)					
All manufacturing	162	118	260	157	360	226
Food and kindred products	136	99	157	96	175	90
Liquors and beverages	127	113	149	90	n.a.	57
Tobacco products	154	56	136	146	201	65
Textile mill products	249	127	455	160	n.a.	214
Apparel	165	80	535	126	492	257
Leather and leather products	159	98	274	140	n.a.	155
Rubber products	161	98	221	135	245	115
Forest products	181	137	415	253	n.a.	616
Paper, pulp, and products	176	136	406	233	612	383
Printing, publishing, and allied industries	147	131	187	194	191	354
Petroleum refining	101	86	222	113	414	289
Chemicals and allied products	167	117	272	162	390	275
Stone, clay, and glass products	152	132	310	205	302	215
Metals and metal products except motor vehicles	153	109	206	113	418	175
Motor vehicles, complete or parts	218	102	260	133	288	173

n.a. = not available.
Source: Same as Table 18.

weighted average capital (in 1929 prices) per establishment for a sample of 34 industries comprising about two-thirds of all manu- facturing was $94,000 in 1880, $415,000 in 1900, and $860,000 in 1919.[21] On our assumption of a rising ratio with increasing size, the rising

[21] To minimize the lack of comparability among censuses because of differences in the total number of establishments covered, we adjust the number of establishments in 1880 to eliminate custom and repair shops, and factory establishments with value of product less than $500. By using an unweighted average, we eliminate the effect on the average of the shifting relative importance of the individual industries.

capital-output ratio that characterized these decades could be partly explained on the statistical level by the trend toward larger establishments. 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.

To judge by aggregative data, the size of structure changed little between 1919 and 1929. The trend toward larger establishments resumed 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.[22] Thus, size structure was a neutral factor in the decline of the ratio between 1919 and 1929. However, the decline between 1929 and 1937 occurred *despite* the indicated trend toward larger establishments. The number of employees per establishment in 1937 and 1947 (58.7 and 59.3, respectively)[23] suggests that the change in size structure between those years was virtually nil. On this basis, we tentatively conclude that the change in size was again a neutral factor in the continued decline of the ratio between 1937 and 1948.

Summary of Findings

1. Up to 1919, an increasing fraction of a dollar of manufacturing capital was used to produce a dollar of output; since 1919, a decreasing fraction of a dollar of capital has been sufficient to produce a dollar of output. These trends were observed whether the capital-output ratio was based on reported or deflated values. 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. Since World War I, capital innovations serve more to increase the efficiency of capital, hence to increase output, than to replace other factor inputs.

2. Trend movements in the capital-output ratio were much the same in mining as in manufacturing. The general configuration of the trend movements is similar whether the ratios are based on reported values or on values in 1929 prices. The ratio based on 1929 prices reached a peak around 1919. It has continued downward through 1953, the final year of our estimates.

3. A review of the data deficiencies does not disclose any weakness of a magnitude that shakes our confidence in the validity of the trend

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

[23] *Census of Manufactures, 1947*, Volume I, Table 1. We use "all employees" because of the shift from "wage earners" to "production workers" between 1937 and 1947.

in the capital-output ratios, particularly when our interest is centered on the broad pattern of movement.

4. This reversal in the direction of movement of the capital-output ratio for manufacturing is found in all 39 branches, the number that can be distinguished on a reasonably comparable basis over these decades. In 31 branches, about four-fifths, the highest ratio occurred before 1929, and in nearly half, the peak ratio was reached in 1919.

5. The changing importance of particular industries accounted for about one-sixth of the total increase in the capital-output ratio for all manufacturing between 1880 and 1919. Between 1919 and 1937, the decline in the capital-output ratio occurred despite the changing composition of industry. That is, if the only change was the change in industry composition, the ratio would have risen by 7 per cent. The inference is clear: whether in the period of rising or falling capital-output ratio, the trend characterized most minor industry groups.

6. In mining also, if the only influence had been that of industry shifts, the aggregate mining ratio would have increased continuously during the whole period. Here, too, the actual increase in the aggregate ratio between 1870 and 1919 was, in part, a result of the shifts in industry weights. And the decline in this ratio since 1919 has taken place despite these shifts.

7. According to the evidence of the "Source Book" of *Statistics of Income for 1947*, the capital-output ratio in the major manufacturing groups tends to increase with increasing asset size. The highest ratios, for example, occurred in the largest corporations in 18 of the 22 industry groups. In 13 groups, the lowest ratios were found in corporations with less than $100,000 of assets; in 18 groups, in corporations with less than $1 million. The trend toward larger establishments, in the first decades of this period, would also help to explain the rising capital-output ratio of those decades. However, change in size is not an independent variable, for many of the technological innovations of the period that caused a rising capital-output ratio also resulted in larger establishments. Between 1919 and 1929 and between 1937 and 1948, the size structure appears to have been a neutral factor in the decline of the ratio. Between 1929 and 1937, the decline occurred despite the indicated trend toward larger establishments.