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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

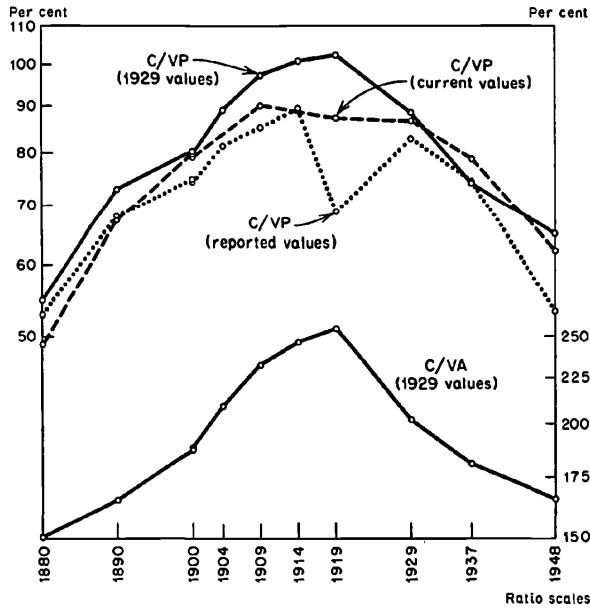


TABLE 8

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 & 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.²⁷

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

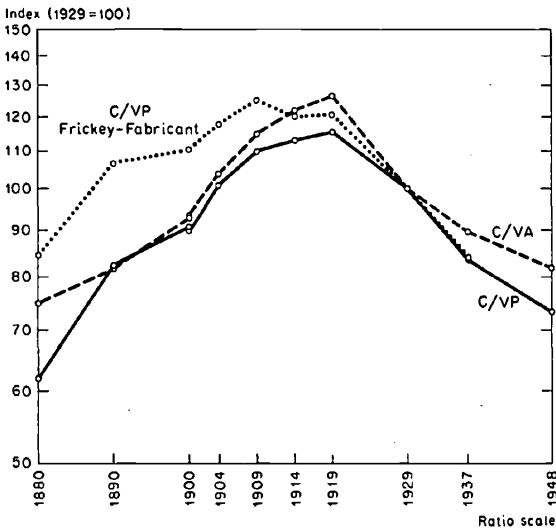
The apparent reversal in the trend of the capital-output ratio is our cardinal finding and it is important, therefore, that its empirical validity be above challenge. For this reason we consider the probable impact on this result of some of the deficiencies in the data and in our procedures.

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

²⁷ 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.²⁸

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.²⁹ However, even if we

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

²⁹ 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.⁸⁰ 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

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.

⁸⁰ 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.