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CHAPTER I

The Measurement of Manufacturing and Mining Growth

NATIONAL income statistics (Table 1) readily establish the importance of mining and manufacturing in the economy of the United States. In the first years (1869 and 1879) of the period under study, nearly 16 per cent of national income originated in mining and manufacturing. Barring periods that include the Great Depression, the proportion increased steadily and accounted for about 30 per cent of national income during 1944–1953.

Growth of Manufacturing Activity

Since the movement of the combined share is dominated by net income originating in manufacturing, it may be taken to represent

TABLE 1

Income Originating in Mining and Manufacturing as a Per Cent of National Income or Aggregate Payments, Selected Periods, 1870–1953
(*based on current prices*)

Period of Average	*Per Cent Originating in—*		
	Mining	*Manufacturing*	*Mining and Manufacturing*
	R. F. MARTIN'S ESTIMATES (AGGREGATE PAYMENTS)		
1870 and 1880	1.8	13.9	15.7
1880 and 1890	2.1	16.6	18.7
1890 and 1900	2.5	18.2	20.7
1900–1908	3.1	18.4	21.5
1904–1913	3.3	18.9	22.2
1909–1918	3.3	20.8	24.1
1914–1923	3.3	22.2	25.5
1919–1928	3.1	22.2	25.3
	NBER ESTIMATES (NATIONAL INCOME)		
1919–1928	2.5	21.9	24.4
1924–1933	1.9	19.6	21.5
1929–1938	1.7	19.4	21.1
1934–1943	1.7	24.2	25.9
1939–1948	1.6	27.1	28.7
1944–1953	1.9	28.0	29.9

Source: 1869–1948: Simon Kuznets, "Long-term Changes in the National Income of the United States of America Since 1870," in International Association for Research in Income and Wealth, *Income and Wealth of the United States, Trends and Structure*, Income and Wealth Series II, Cambridge, England: Bowes and Bowes, 1952, p. 89, Table 14; 1944–1953: based on Department of Commerce figures relating to income originating (excluding corporate taxes and including interest on government debt) from *National Income, 1954 Edition, A Supplement to the Survey of Current Business.*

TABLE 2

Selected Measures of the Growth of Manufacturing, Selected Years, 1880–1953

	1900 Comparable with—					*1948 Comparable with—*		
	1880[a]	*1880*[a]	*Following Year*[b]	*1909*[b]	*1919*[c]	*1937*[c]	*Preceding Years*[c]	*Following Year*[c]	*1953*[c]
				A. ABSOLUTE QUANTITIES (DOLLARS IN 1929 PRICES)					
1. Total assets (*mill.* $)	4,821	18,626	17,452	31,563	46,094	55,319	77,982	78,357	99,040
2. Fixed capital (*Do.*)	n.a.	9,651	n.a.	n.a.	n.a.	25,851	36,526	36,685	45,258
3. Working capital (*Do.*)	n.a.	8,975	n.a.	n.a.	n.a.	29,468	41,456	41,672	53,782
4. Value of product (*Do.*)	8,820	23,182	21,984	32,648	45,090	74,687	128,124	128,604	167,821
5. Value added (*Do.*)	3,201	9,916	9,275	13,674	18,042	30,581	50,326	n.a.	n.a.
6. No. of establishments (*thous.*)	213	457	205	265	270[b] 210[c]	167	241 (*1947*)	n.a.	n.a.
7. No. of persons engaged (*Do.*)	2,808	5,457	5,063	7,226	9,665	10,615	15,333	15,468	17,414
8. Horsepower per reporting establishment	40	65	75	99	129	281 (*1939*)	n.a.	n.a.	n.a.

B. RATE OF CHANGE PER YEAR BETWEEN BENCHMARK YEARS (PER CENT)

	1880–1900	*1900–1909*	*1909–1919*	*1919–1937*	*1937–1948*	*1948–1953*
Total assets	+7.0	+6.4	+3.9	+1.0	+3.2	+4.8
Value of product	+4.9	+4.2	+3.3	+2.8	+5.0	+5.5
Value added	+5.8	+4.1	+2.8	+3.0	+4.6	n.a.
Number of establishments	+3.9	+2.7	+0.2	−1.3	+3.4[d]	n.a.
Number of persons engaged	+3.4	+3.8	+3.0	+0.5	+3.4	+2.4
Horsepower per reporting establishment	+2.5	+2.9	+2.7	+4.4[e]	n.a.	n.a.

n.a. = not available.

[a] Includes custom and neighborhood shops.

[b] Factories producing annual value of $500 or more.

[c] Factories producing annual value of $5,000 or more. Figures for 1953 include shipbuilding; whenever possible, comparable figures were compiled for 1948.

[d] 1937 to 1947.

[e] 1919 to 1939.

Line	Source
1–5	Based on data in Appendix A. Same index used to deflate value of output and value added.
6	1880 and comparable 1900 data from *Census of Manufactures, 1900*, Vol. I, p. 23; the lower 1919 figure from *Census of Manufactures, 1939*, Vol. I, p. 20. Adjustments were made to exclude industries not covered by this study; 1948 from *Census of Manufactures, 1947*, Vol. II, Table I, p. 21.

also the relative growth of manufacturing in the economy. Table 2 clearly reveals two aspects of this growth. One is the tremendous expansion over the seventy years of all measures except the number of establishments (the least reliable of the six measures shown). For example, between 1880 and 1948, total assets (the sum of fixed and working capital) and value added by manufacturing (both in constant prices) grew to more than sixteen times the 1880 level. Despite the rapid increase in labor productivity, the number of persons in manufacturing grew to more than five times the original figure.

The other aspect, as clearly evident as the impressive growth, is the slowing up in the rate of growth after 1900 (Panel B). That is, the percentage change per year between benchmark years is lower after 1900 than during 1880–1900. These rates of change continue to diminish through 1919–1937. The first reversal appears in the decade that includes World War II and the postwar boom. It is significant that the rate of growth in the use of horsepower per establishment did not follow the general pattern. The rate of growth was virtually constant between 1880 and 1919 and accelerated between 1919 and 1939, when the series ends. The divergence in rates of growth between capital (total assets) and horsepower per establishment has an intimate connection with our findings on the trends in output and capital.

The slackening of the rate of growth was most pronounced in number of establishments. The annual percentage increase in the first decade of this century was one-half the rate of growth in the preceding twenty years and was negligible between 1909 and 1919. An absolute decrease actually occurred between 1919 and 1937. This trend suggests that during the later decades of the nineteenth century, entrepreneurial ability in manufacturing was primarily directed toward organizing new enterprises. During 1900–1937, entrepreneurial energies shifted, on balance, enlarging the scale of operations and promoting technological and managerial measures that resulted in a more efficient utilization of resources. This consideration also may help to explain our principal finding: an initial period of rising capital-output ratio has been followed by a period of decline.

NOTES TO TABLE 2, concluded.

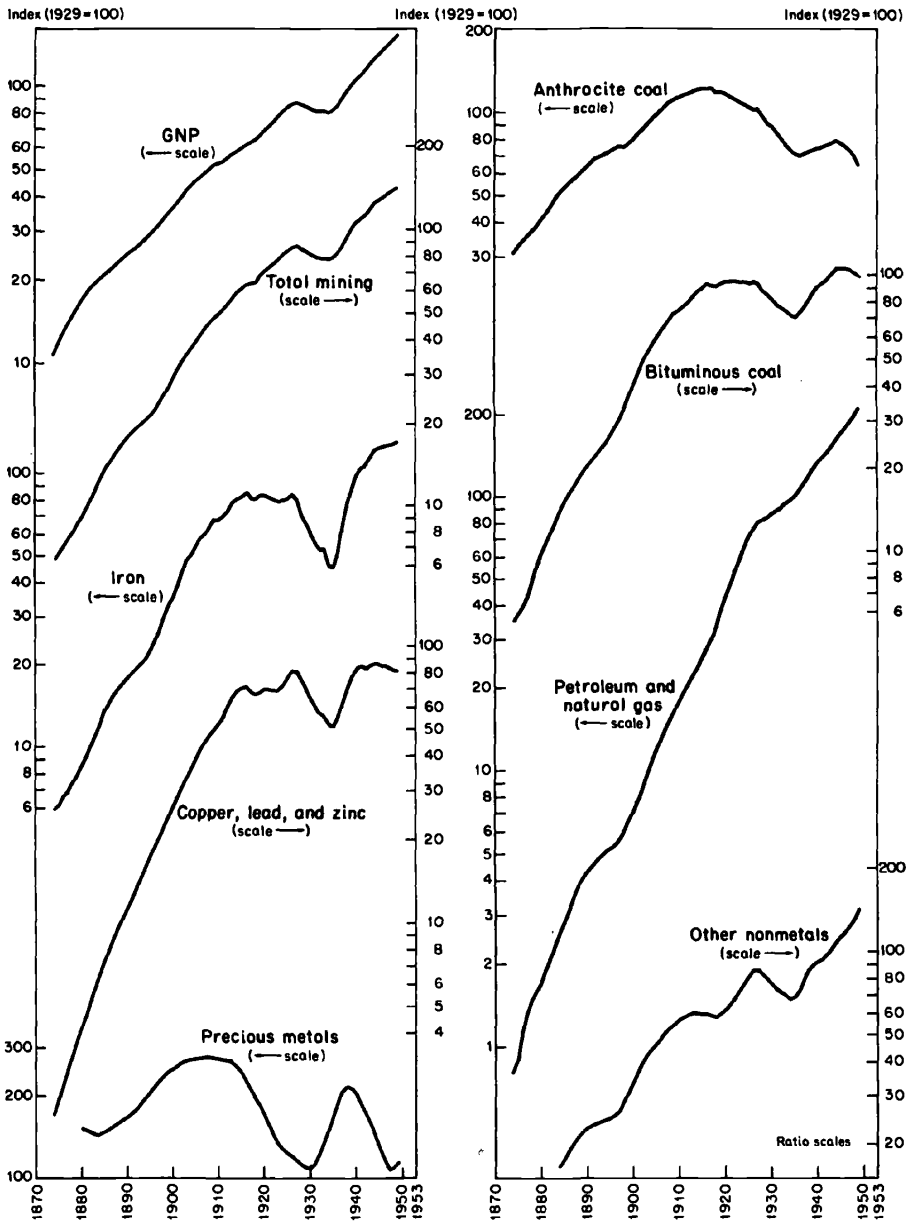
7 1880: estimated by using percentage change from 1890 to 1880 in number of wage earners as given in the *Reports on Manufacturing Industries in the United States, Tenth and Eleventh Censuses, 1880 and 1890*; 1900–1919: census data used; 1937, 1948, and 1953: sum of average number of full-time and part-time employees and number of active proprietors of unincorporated enterprises from *Survey of Current Business, National Income Supplements*, various years, Tables 25 and 27. The data were adjusted to exclude ship- and boatbuilding and repair, except in 1953.

8 Horsepower data from *Census of Manufactures, 1939*, Vol. I, p. 275, Table 1.

CHART 1

Indexes of Output by Mining Industries, and Index of Gross National Product, 1870–1953

(centered nine year moving averages based on values in 1929 prices)



Growth of Mining

The trends in mineral output are presented in Chart 1. The chart reveals a characteristic common to many of the mining series and one that seems to have an important bearing on the movement of the capital-output ratios. This common feature is the sharp retardation in the secular growth of output that occurred in the second decade of this century. As we shall find in the next section, the turning points in the movement of the capital-output ratios occurred at about the same time. Hence, except for the petroleum and natural gas industry and, possibly, other nonmetals,[1] high rates of growth in output have tended to coincide with increases in the capital-output ratio, and comparatively low rates of growth (or declines) with declines in the ratio.

We can see the growth of mineral output in better perspective by comparing output with consumption and relating mineral consumption to gross or net national product in constant prices. We describe such a ratio as a "mineral coefficient." This ratio is interesting as a measure of the nation's mineral consumption in relation to its product. Because of a high degree of substitutability among minerals, such

[1] Growth in output of other nonmetals was close to, if not below, zero between 1909 and 1919. The other nonmetals series is heavily weighted by construction materials and shows swings in the rate of growth similar to those in construction. Simon Kuznets dates the swings in the secular growth of gross construction as follows: troughs—1897, 1917, and 1935; peaks—1909, 1926, and 1945 ["Swings in the Rate of Secular Growth," Work Memorandum 37, Capital Requirement Study (mimeographed, National Bureau of Economic Research, 1952)]. A similar timing of swings in the other nonmetal series can be determined by inspection of Chart 1.

Notes to Chart 1.

Source: The gross national product series is based on Simon Kuznets' unpublished estimates.

The nine-year moving averages of mineral output are based on annual series derived by interpolating between census years. The interpolation procedures for 1929–1953 are similar to those described in the notes to Tables B-7 and B-8. The interpolations for the earlier years are based on the following annual series:

Anthracite and bituminous coal, and iron ore: Quantities reported by the Bureau of Mines (except 1870–1880, when pig iron production, reported by the same source, is used instead of iron ore.

Copper, lead, and zinc; petroleum, natural gas, and natural gasoline; gold and silver: As above; each combined group index is the sum of the individual annual quantities weighted by the price of the given mineral in 1929.

Other nonmetals: 1880–1929: Leong's index for this group (Y. S. Leong, "Index of Mineral Production," *Journal of the American Statistical Association*, March 1950, p. 28)

Total mining: 1880–1929: as above [the results are similar to the Barger and Schurr index, Harold Barger and Sam H. Schurr, *The Mining Industries, 1899–1939: A Study of Output, Employment and Productivity* (National Bureau of Economic Research, 1944)]; 1870–1880: Persons' Index of Mineral Production, Warren M. Persons, *Forecasting Business Cycles* (Wiley, 1931), p. 170.

Note: Data for Total Mining, Petroleum and Natural Gas and Other Non-Metals available through 1953 only.

TABLE 3

Mineral Production and Consumption and Gross and Net National Product, Selected Ratios, by Major Mining Industries, 1870–1952
(*per cent based on decennial averages in 1935–1939 prices*)

Period of Average	Consumption as Percentage of—		Production as Percentage of—			Consumption as Percentage of—		Production as Percentage of—		
	GNP	NNP	GNP	NNP	Consumption	GNP	NNP	GNP	NNP	Consumption
	ALL MINERALS (EXCEPT GOLD)					ALL METALS (EXCEPT GOLD)				
1870–1879	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1880–1889	n.a.	n.a.	2.72	3.08	n.a.	n.a.	n.a.	0.44	0.50	n.a.
1890–1899	n.a.	n.a.	3.16	3.65	n.a.	n.a.	n.a.	0.55	0.63	n.a.
1900–1909	3.67	4.20	3.74	4.28	1.02	0.68	0.77	0.65	0.75	0.97
1910–1919	4.30	5.00	4.46	5.18	1.04	0.77	0.90	0.80	0.93	1.03
1920–1929	4.23	4.90	4.23	4.89	1.00	0.66	0.77	0.59	0.68	0.89
1930–1939	4.17	4.88	4.13	4.84	0.99	0.59	0.70	0.41	0.48	0.70
1940–1949	4.44	5.31	4.28	5.11	0.96	0.78	0.93	0.54	0.64	0.69
1949–1952	4.44	5.38	4.04	4.91	0.91	0.73	0.88	0.44	0.54	0.61
	ALL FUEL					OTHER NONMETALS				
1870–1879	n.a.	n.a.	1.68	1.89	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1880–1889	n.a.	n.a.	1.91	2.16	n.a.	n.a.	n.a.	0.37	0.42	n.a.
1890–1899	n.a.	n.a.	2.23	2.58	n.a.	n.a.	n.a.	0.38	0.44	n.a.
1900–1909	2.51	2.88	2.66	3.04	1.06	0.48	0.55	0.43	0.49	0.88
1910–1919	3.02	3.52	3.20	3.72	1.06	0.50	0.58	0.46	0.53	0.91
1920–1929	3.04	3.52	3.14	3.63	1.03	0.52	0.61	0.50	0.58	0.94
1930–1939	3.06	3.58	3.22	3.77	1.05	0.52	0.61	0.50	0.59	0.96
1940–1949	3.05	3.65	3.15	3.76	1.03	0.61	0.73	0.59	0.71	0.97
1949–1952	2.99	3.62	2.91	3.53	0.97	0.72	0.88	0.69	0.84	0.96

n.a. = not available.

Source: Gross National Product (GNP) and Net National Product (NNP): Simon Kuznets' unpublished estimates in 1929 prices converted to 1935–1939 price values.

Production and apparent consumption, 1900–1952: *Raw Materials in the United States Economy 1900–1952*, Bureau of the Census, Working Paper No. 1 (apparent consumption is defined as primary production plus imports minus exports).

Production, 1870–1900: coal (anthracite and bituminous), petroleum, natural gas and natural gasoline, iron, copper, lead, zinc, and silver, as reported in *Raw Materials, op. cit.*, extrapolated on the basis of the quantities reported by the Bureau of Mines; other metals and other nonmetals, as reported in *ibid.*, extrapolated by Leong's index (Y. S. Leong, "Index of Mineral Production," *Journal of the American Statistical Association*, March 1950, p. 28) for the appropriate group.

mineral coefficients can be based only on broad groups of minerals. For this purpose, we divide mineral output into three groups, metals (except gold),[2] fuel, and other nonmetals (Table 3). Such historically determined mineral coefficients can be applied, in a rough way, to projected national product aggregates to obtain projections of mineral consumption; projection of these aggregates is virtually independent of the output projection of any single component.

For all major mining categories the ratio of production to both gross and net national product rose until about the decade ending in 1919. The same was true of the ratio of consumption to Gross National Product and Net National Product, as can be inferred from the record for the two decades between 1900 and 1919. The increase in the ratio of mineral consumption to national product reflects the ever-greater use of metals and other minerals in the output of goods and services. Except for other nonmetals, this steadily growing use seems to have reached a climax during 1910–1919. In this period a sharp retardation occurred in the rate of growth of all branches of mining, except petroleum and natural gas, other nonmetals, and other metal mining.

Although the factors working for a decline in mineral use per dollar of national product were certainly present before World War I, the rapid industrialization of the time—the development of railroads, public utilities, and manufacturing—seems to have had the greater impact on mineral use. It was only when the forces acting to increase mineral-use lost their impetus that other factors acting to decrease it began to play an important role in shaping the long-term movement of the ratio of mineral consumption to national product. The increasing use of scrap metals is one of the important factors. The more efficient use of mineral products, for instance, the reduction in the amount of coal required to produce a kilowatt-hour of electricity, is another. Also, the more extended fabrication which minerals undergo before reaching the final consumer generally adds to aggregate output without causing a commensurate increase in mineral input. Still another factor is the substitution of raw materials that are not mined, such as plastics and rubber products, for minerals.

This helps to explain the reversal in the movement of the ratio of mineral consumption to national product after 1919. For other nonmetals only did the ratios of consumption to GNP and NNP continue to rise after 1919; even for that group, no increase occurred during the twenties and thirties. Fuel consumption per unit of GNP remained

[2] The concepts used for consumption (changes in inventories are neglected) and for the mineral coefficient call for separate treatment of gold. The reason is that, even during the period covered by ten-year averages, the monetary uses of gold may cause large changes in gold inventories.

virtually constant, and fuel consumption per unit of NNP increased only negligibly between 1910 and 1952. Consumption of metals other than gold per unit of GNP and NNP declined drastically after 1919. The increase in the consumption of these minerals per unit of national product during the forties was no more than sufficient to bring it back to the 1909–1919 level. During 1950–1952, the most recent years for which we have data, the consumption of metals as a percentage of GNP and NNP declined once again.

Similarly, consumption of all minerals per unit of GNP and NNP declined during the twenties and thirties. However, the consumption rate was somewhat higher during the forties than during 1910–1919. In the early fifties, this higher rate was maintained with respect to GNP and was even somewhat increased with respect to NNP. During the twenties and thirties, the decline in the ratios of total mineral production to GNP and NNP was more marked than the decline in the ratios of consumption to these national product aggregates. Similarly, the rise during the forties was less pronounced and, apparently, temporary; the decline in the most recent years appears to be a continuation of the long trend starting about 1919.

Fuel production ratios to GNP and NNP after 1919 moved about the same way as, though more erratically than, the ratios of consumption to these aggregates. During 1950–1952 there is, nonetheless, a marked decline in these ratios, though the decline in the rate of consumption is almost negligible. For metals other than gold, there was a much sharper drop in the production, than in the consumption, ratio to GNP and NNP. Only other nonmetals registered an increase in the ratios of production to GNP and NNP.

After World War I, net imports of minerals became more important. The metal mining industries changed, at that time, from surplus producer to net importer. In recent decades, less than 70 per cent of demand has been met by domestic production. The fuel group continued to be a net exporter up to the late forties. Reduction of the export surplus was slight.[3] During the most recent years, however, this group has become a net importer. The ratio of production to consumption of other nonmetals continued to increase until World War II. In recent decades, however, the ratios suggest that the share of imports in domestic consumption has been stable.

Two features in the relationship between mining output and aggregate output of more general interest should be mentioned. The first,

[3] The trends are different, however, for the two components, coal, and oil and gas. Coal exports have steadily increased over imports. Surplus production of oil and gas has decreased throughout the period until, beginning with the forties, there were virtually no net exports.

indicated by Chart 1 and by the rise and subsequent decline in the ratio of mining output to aggregate output, is that retardation has been greater in mining output than in national product. This behavior bears out Burns'[4] observation that the retardation rate of the majority of individual industries is higher than the retardation rate of total production.

A second interesting feature is the timing of the turning point in the movement of the ratio of mining output to national product. The turning point occurred around 1919, and thus coincides with the turning points in the capital-output ratios of most of the mining and manufacturing industries[5] and with the retardation in the rate of growth of many branches of mining. Expressed another way, the period in which technological and other developments favored rising capital-output ratios was also the period of increased material use, while the period of declining capital-output ratios coincides with the period of reduced material use. There is no doubt that each of the trends has influenced the other.

Sources and Methods of Measurement and their Limitations

The sources of the raw data and the estimating procedures used to derive the capital-output ratios in mining and manufacturing are, for the most part, so similar that many of the estimating problems can be discussed by reference to only one of the industries. To minimize repetition, we shall base this part of the discussion mainly on the problems encountered in developing the estimates for the manufacturing branch.[6] We have no choice in selecting the basic data on output and capital. They are derived from the *Censuses of Manufactures* for 1880–1919 and from the corporation income tax returns to the Internal Revenue Service (formerly Bureau of Internal Revenue) in 1929 and in selected years thereafter. While the use of these data poses difficult problems, it is possible to obtain a workable degree of comparability over the entire span of seven decades beginning with 1880.[7]

[4] Arthur F. Burns, *Production Trends in the United States since 1870* (National Bureau of Economic Research, 1934), see esp. Chap. 6.

Mining output, of course, is an aggregate also, and its rate of growth is sharply influenced by the development of new industries. For example, recent developments in aeronautics and nuclear physics have transformed the "rare" metals into a "new" industry, just as the growth of automobile transportation made a new industry out of petroleum production. However, mining output is less comprehensive an aggregate than total production, and includes fewer new industries.

[5] For manufacturing industries, see Chapter III, below.

[6] For a discussion of similar and other problems encountered in the preparation of the estimates for mining industries, see Appendix B.

[7] See Appendix A, section A1 for our refutation of the census allegation that capital is grossly understated in the *Censuses of Manufactures*.

Definition of Capital

In the *Census of Manufactures* for 1900, the definition of capital is given in the following terms:

"Capital invested: The answer must show the total amount of capital both owned and borrowed. All the items of fixed and live capital may be taken at the amounts carried on the books. If land or buildings are rented, that fact should be stated and no value given . . . The value of all items of live capital, cash on hand, bills receivable, unsettled ledger accounts, value of raw materials on hand, materials in process of manufacture, and finished products on hand, etc., should be given as of the last day of the business year reported."[8]

In the following census years up to and including 1919, there are only minor alterations in this definition, although on some points the instructions become more explicit. While, in the earlier census years, the query on invested capital is not fully articulated, the census authorities in 1900 express the judgment that "the statistics of capital invested at the two censuses (1890 and 1900) show totals which are perfectly comparable. . . ."[9] Again, in the preceding decade, the census authorities conclude that "the questions of 1880 apparently cover the same ground as the more detailed questions in 1890." However, the qualification is added "that materials on hand, goods in process of manufacture and other items were, to some extent, overlooked."[10] This qualification bears on our analysis of the trend in the capital-output ratios. The deficiency in reported capital results in a capital-output ratio lower than the "true" ratio and exaggerates the rise in the ratio between 1880 and 1890.

In balance sheet terms, the census definition of invested capital is equal to fixed capital (land, buildings, machinery, and equipment) and working capital (cash, inventories, and accounts receivable), all in book values. This definition of invested capital can be closely matched with the balance sheet data reported to the Internal Revenue Service and published in *Statistics of Income*.[11] The equivalent definition is total assets minus investments in government and other securities.[12]

[8] *Census of Manufactures, 1900*, Part I, p. XCVII.

[9] *Ibid.*, p. XCVIII.

[10] *Census of Manufactures, 1890*, Part I, p. 10.

[11] Unpublished tabulations, called the "Source Book," show these data in greater industry detail.

[12] A formal difference in definition exists: The census definition excludes such intangible assets as patent rights and good will that are included in *Statistics of Income* for 1929 and 1937 in "other assets" and in "capital assets" for later years. However, for total manufacturing, intangible assets in 1939 represented only 3.7 per cent of total assets excluding investment in securities. As we show in Chapter III, this minor conceptual difference imparts a bias that adds to the firmness of our findings.

That there is continuity in the figures on invested capital from the two sources is suggested by the closeness of the reconciliation of the 1919 data on capital from the *Census of Manufactures* and from *Statistics of Income*. The adjustments necessary to carry out the comparison are detailed in Appendix A, section A1, part a. The two totals differ by only 6.4 per cent, the higher total being reported by *Statistics of Income*.[13] This difference, moreover, is in the expected direction. The 1919 reports to the Internal Revenue Service are on a consolidated basis. As a result, more nonmanufacturing activity was reported under manufacturing than vice versa.

It is reassuring, also, that in benchmark years, beginning with 1919, the estimates of fixed capital stock in manufacturing based on balance sheet data were very close to estimates independently derived from cumulative annual expenditures on structures and equipment.[14]

Estimates of capital derived from *Statistics of Income* are net of depreciation. Since the reconciliation of the capital estimates as of 1919 from the two sources is close, we infer that capital reported in the 1919 *Census of Manufactures* also is net of depreciation. However, a definitive answer cannot be given concerning the treatment of depreciation reserves in the earlier censuses. In the 1890 census, the respondents were instructed to make "such allowance for depreciation as may be suitable in the individual case," and the schedule for that year called for "average annual allowance since June 1, 1880, for depreciation of buildings and machinery."[15] Although "the data furnished in the individual reports relating to depreciation of manufacturing were not sufficient to form a basis for correct computations,"[16] the very presence of the query suggests that depreciation accounting was being practiced in 1890 by some firms, presumably the larger corporations. Probably, depreciation accounting was less widely practiced in 1880 and used ever more widely after 1890. Undoubtedly, the inception of the corporate income tax in 1909 caused still more firms to set aside depreciation reserves. By 1919, this practice must have been followed by virtually all manufacturing firms. In the light of these presumptions, our estimates of capital become progressively more and more net of depreciation as we come forward from 1880 to 1919. This

[13] Although the differences are larger for some of the major industrial divisions, the largest difference did not exceed 15 per cent; and in six of the ten groups the differences were 10 per cent or less.

[14] For the reconciliation of these two estimates, see Appendix A, section A, part 1b.

[15] *Census of Manufactures, 1890*, Part I, p. 10.

[16] *Loc. cit.*

possible bias in the capital estimates strengthens the analysis of Chapter 3.[17]

However, this is only a supposition, but it is the one that seems most reasonable to us. It is also conceivable that before the use of formal depreciation accounting, many capital expenditures were treated as current operating expenses and so were fully depreciated within a year or two. It is not clear how this practice would affect the figures reported to the Bureau of the Census. The respondent did not submit his balance sheet to the Bureau; he was asked, in effect, how much he paid for his assets less suitable depreciation. A reasonable answer would include those assets that were fully depreciated because they were treated as an operating expense less suitable depreciation. In this event, the capital estimates are subject to the same bias as under the first supposition. Our estimates of invested capital between 1880 and 1909 are understated to the extent that any such assets were excluded from the reported capital figures. If it is true that the use of formal depreciation accounting was gradually spreading, the relative understatement of capital diminishes, resulting in an opposite bias in the trend of the capital-output ratios between 1880 and 1909. How these suppositions could affect the interpretation of the statistical results we discuss in Chapter III.

In summary, we have estimates of capital in book values based principally on original cost less depreciation. During periods of substantial price changes or waves of company mergers, the book values doubtless reflect revaluation of assets.

The merger movement between 1889 and 1904 was extensive, and individual mergers were frequently accompanied by extravagant and highly arbitrary upward revaluations of assets. These revaluations were excluded from the 1900 census by the census authorities.[18] However, by 1904, the census authorities were no longer able to insist in all cases on their own definition of invested capital.[19] The effect of these arbitrary

[17] Several other adjustments were made to improve comparability. For example, we had to make allowance for the fact that the *Statistics of Income* data relate only to corporations submitting balance sheets, and in 1948 exclude emergency plant and equipment subject to accelerated depreciation. The biases in both adjustments strengthen the firmness of our results. (The procedure for correcting for accelerated depreciation is described in Appendix A, section A, part 2b iii.)

Capital used in manufacturing as we define it excludes rented plant and equipment. From a time series on rental payments by manufacturing firms, we infer that there has been no significant trend in the use of rented capital.

[18] Thus, for the 185 combinations formed before June 30, 1900, the census reported invested capital of $1,462 million, although these combinations had issued stocks and bonds of $3,093 million (*Census of Manufactures, 1900*, part 1, pp. lxxvii–lxxviii).

[19] Although "incorporated companies were requested to report the value of land, buildings, machinery, etc., as distinct from their capitalization, . . . a number con-

revaluations is to raise total capital above the "true" amount and thus to raise the capital-output ratio above its "true" level. However, only a minor qualification of our results is necessary because of this consideration.[20]

The same is true of revaluations caused by price changes. Fabricant argues that, in the long run, they have the same effect on the value of assets as a secular change in price level. In the short run, Fabricant's evidence for large industrial corporations for 1925–1934 shows that the maximum change represented only 3.3 per cent of capital assets.[21]

Definition of Output

Value of product is the operational definition of output for 1880–1919, when this information is taken from the *Censuses of Manufactures*; for 1929, 1937, and 1948, when the data are taken from *Statistics of Income*, it is the sum of sales, gross receipts from other operations, and the change in physical inventories valued in current prices.[22] These operational definitions are equivalent. For some purposes, particularly for dealing with total manufacturing, an output concept that eliminates or at least minimizes interfirm transactions is more meaningful. Value added (value of product minus cost of purchased materials, fuels, and containers) is one such concept. It is reported in the *Census of Manufactures* and can be readily estimated for the years when the ratios are based on *Statistics of Income*.

For the mining industries we use the *Census of Mining* classification of mining output and adjust all other estimates for comparability with census coverage. The census classifies output according to the main

tended that such a segregation was impracticable . . ." [*Manufactures*, 1905 (Special Report of the Census Office; hereafter, *Census of Manufactures*, 1905), Part I, p. lxviii].

Again in 1909 the census authorities note: "Some corporations engaged in manufacturing industries have issued capital stock and other securities in excess of the actual cost of their properties and assets, or even in excess of the capitalization of the present earning capacity of their plants according to prevailing capitalization rates. In such cases it frequently happens that an arbitrary value is assigned to the assets of the corporation in order to balance its securities, and this arbitrary value is likely to be reported to the Census Bureau rather than the actual value" [*Thirteenth Census of the United States, 1910*, Vol. VIII: *Manufactures*, 1909 (hereafter, *Census of Manufactures, 1909*), p. 22].

[20] Our reasons are given in Chapter III.

[21] Solomon Fabricant, *Capital Consumption and Adjustment*, National Bureau of Economic Research, 1938, pp. 238–240.

[22] The estimate of change in physical inventories valued at current prices is actually made by the National Income Division of the Department of Commerce on the basis of data derived from *Statistics of Income*. This item can be estimated only for total manufacturing and for the major industry groups. In none of the three years did this item amount to as much as 3 per cent of output. Output based on *Statistics of Income*, as in the case of capital, is adjusted to a level that represents all firms (see Appendix A, section B4).

mineral extracted.[23] Output includes, in addition to the main product, by-products or joint products. It excludes, however, the given mineral extracted as a by-product of other minerals. Our working definition of industrial output specifically includes the value of power sold, of miscellaneous services to other enterprises, and the value of minerals produced and used by the operating companies.[24]

Earlier censuses were not quite consistent in drawing a demarcation line between mining and manufacturing operations. However, these inconsistencies do not seriously impair the comparability of the data. Beginning with 1919, duplication of the *Census of Mining* by the *Census of Manufactures* became negligible, so that a uniform definition can apply to the data reported in the 1919, 1929, and 1939 censuses. The census definition of mining in this later period includes, generally, all activities through the point at which a marketable product is obtained. Thus, the figures include preparation activities that are frequently carried on at the mine or quarries, but do not include those that are more frequently carried on at the manufacturing plants. Specifically, the data include concentration of metallic ores; washing and sizing of coal; and crushing, grinding, pulverizing, and drying of stone, clay, gypsum, phosphate rock, etc., done at plants operated in conjunction with the quarries, pits, or mines, or at custom plants. They exclude blast furnaces, metal smelters, metal and petroleum refineries, coke ovens, plants engaged in dressing or polishing stone, etc. It should be noted that this greater uniformity of definition in the later censuses does not affect our estimates of capital during that period. Beginning with 1929, we use capital values reported by the Internal Revenue Service, after adjusting them to census coverage. This adjustment is proportional to the difference in value of product reported by the two sources. It does not take into account, however, the somewhat different character of the product reported by the two sources. The unconsolidated returns to the Census Bureau make possible a finer distinction between manufacturing and mining than do the more consolidated returns to the Internal Revenue Service. The latter uses the principle of the "predominant operation" as a basis for classification of returns. For instance, data pertaining to the smelting of metals will appear under mining statistics if the predominant activity of the given company consisted of *mining* operations; data pertaining to mining operations will appear under *manufacturing* statistics if the predominant activity of the given corporation consisted

[23] The Bureau of Mines, on the other hand, classifies output on a minerals basis in its reports on production.

[24] However, with respect to some minor items, our estimates for the period up to 1909 do not strictly correspond to this definition.

of manufacturing processes. This fact affects somewhat the comparability of the capital data between 1919 and 1929.[25]

Selection of Benchmark Years

Value of output is more sensitive to cyclical changes in business activity than is book value of capital. Consequently, the capital-output ratio is relatively high during business contractions and relatively low during business expansions. For the analysis of long-term movements it is important, therefore, to select benchmark years representing similar positions in business cycles. However, between 1880 and 1919,

TABLE 4

Level of Business Activity in Year of Census Canvass, 1880–1919

Period Covered by Census	*Level of Business Activity According to National Bureau of Economic Research Business Cycles Chronology*
June 1, 1879–May 31, 1880	A trough occurred in March 1879, terminating a depression of 65 months. The subsequent peak is dated March 1882. This census year represents the first third of a business expansion.
June 1, 1889–May 31, 1890	Between this census and the preceding one, there had been two complete cycles and an expansion phase of a third with a peak in July 1890. This census year covers the last half of a two-year expansion.
June 1, 1899–May 31, 1900	Business activity traced three complete cycles (measuring from peak to peak) between 1890 and 1900. The beginning of this census year coincides with a peak. The following trough is dated December 1900. This census year extends over the first year of an 18-month contraction.
January 1, 1904–December 31, 1904	There was one business cycle from 1901 to 1904, with the terminal trough dated August 1904. Two-thirds of this census year, then, coincides with the last stages of contraction, and one-third with the first stage of expansion.
January 1, 1909–December 31, 1909	In the quinquennium between this and the preceding census there was one business cycle and an expansion phase of another with a peak in January 1910. This census year spans the last two-thirds of that expansion phase.
January 1, 1914–December 31, 1914	A full cycle (peak to peak) and a contraction phase of a second with a trough in December 1914 are found in the 1910–1914 period. This census year covers the second half of that contraction.
January 1, 1919–December 31, 1919	The expansion phase initiated in December 1914 extended to August 1918. The next contraction was brief, ending in April 1919, followed by an equally brief expansion ending in January 1920. This census year covers the last stages of contraction and virtually the entire subsequent expansion.

[25] For an appraisal of this and other inconsistencies resulting from the change from census capital figures to values reported in *Statistics of Income*, see Appendix B.

the requisite data are available only in census years—1880, 1890, 1900, 1904, 1909, 1914, and 1919. Beginning with 1929, annual data are available. The choice of years, beginning with 1929, depends then on the cyclical position most frequently represented by the census years. This information is set out in Table 4 using the business cycle chronology of the National Bureau.

On this evidence the census years fall into the following classifications:

Extending wholly in expansion phase—1880, 1890, 1909.

Extending into contraction and expansion phases, but predominantly in expansion phase—1919.

Extending into contraction and expansion phases, but predominantly in contraction phase—1904.

Extending wholly in contraction phase—1900, 1914.

Census years 1880, 1890, 1909, and 1919 may be taken as years of business expansion. This is essentially true, also, of the census year 1900 (June 1899 to May 1900), since indexes of industrial activity for the contraction of 1899–1900 show a plateau movement from June 1899 to June 1900 and then a sharp but brief contraction. The fact that the census year 1880 represents the early stages of expansion serves as some offset to the depressive effect on the ratio of the under-reporting of capital in that year. Since all except two census years, 1904 and 1914, are years of business expansion or are near peak levels of business activity, we select years of business expansion for the more recent period, namely, 1929, 1937, 1948 and, for a more limited set of comparisons, 1953.[26] Although we present ratios for all available years before 1919, the main reliance for determining trend movements should be placed on the ratios computed from the decennial censuses between 1880 and 1919 and extended forward by ratios derived from *Statistics of Income* for peak years 1929, 1937, 1948, and 1953.[27]

Comparability of Industrial Classifications

To understand the relationship between capital and output for total manufacturing or mining, we should observe it for significant subdivisions of the total. This approach raises the problem of establishing comparable industry classifications over the seven or eight decades.

[26] Although business activity reached a cyclical peak in 1937, the scanty evidence available suggests that capacity utilization in 1937 was generally lower than in 1929. This also gives a conservative bias to our results, as we shall point out in Chapter III.

[27] The Census of Mines was not taken in all of these years and was taken in other years. A comparable listing for mining is given in Appendix B, section D.

The difficulties of achieving a workable degree of comparability for manufacturing for the census years 1880 to 1919 were relatively minor; since more than 200 individual industries are distinguished in those census reports, regrouping is facilitated. Moreover, acceptable groupings for this period appear in an unpublished manuscript by the late Daniel Carson, which we have used. The more troublesome questions arise in establishing comparable groupings after 1919 when we draw upon Internal Revenue data. The "Source Book" distinguishes only 45 manufacturing industries in 1929 and 1937 and 122 in 1948. In arranging comparable classifications over the seven decades, we are restricted, of course, by the smallest number of classes in any one benchmark year. Over the entire span, then, we are able to distinguish only 41 minor industries classified into 15 major industry groups. For a more highly selected series of benchmarks, census years 1880 to 1919 and 1948, the greater industry detail of the "Source Book" in recent years makes it possible to compare 66 minor industries within the same 15 major industry groupings. The extension of the estimates to 1953 was based on published statistics of the Internal Revenue Service, which distinguishes only the major groupings.[28]

Adjustment for Price Changes

Comparison of capital as a factor input with the associated output should be free from the distortions imposed by price changes, which have a different impact on capital than on output. To minimize the effect of price changes, we express both the numerator and the denominator in 1929 prices, in keeping with other studies in this series.

The precision of the price adjustment is conditioned, of course, by the availability of time series on prices for detailed commodity classifications. Much larger deficiencies attach to capital items than to output; hence, the adjustments for price changes in the book value of capital are cruder.

Our general procedure for deflating capital is to derive a composite index of prices underlying book values of buildings, machinery and equipment, and working capital for each of the fifteen major industrial groups.[29] For the manufacturing industries, for example, a construction cost index weighted by volume of construction depreciated over fifty years is used to represent the changes in the book value of land and

[28] The composition of the major mining groups in terms of minor industries is given in Appendix B, Table B-7.

[29] The details of constructing the deflators for book values of capital in manufacturing and mining are set forth in Appendix A, section B2 and Appendix Table B-11.

buildings.[30] This component of the composite index is identical for all fifteen groups. For machinery and equipment we are obliged to use a price index of general machinery and equipment for all fifteen groups. In each group, however, the index is weighted by volume of machinery and equipment produced, depreciated according to the length of life typical for a given industry as reported by the Internal Revenue Service.[31] Because of these changing industry weights we obtain a different deflator for machinery and equipment in each major group. The wholesale price index of the output of a given major industry is used to deflate the third component, working capital which consists of cash, inventories, and accounts receivable.

These three components are combined into a composite index, one for each major group. The weights used in the composite measure the relative importance of the three elements in the capital structure of each major group. The weights are those reported by the *Census of Manufactures* in 1890, 1900, and 1905, the only years in which the value of buildings is reported separately. Constant weights are used for all benchmark years between 1880 and 1937 because, to judge by all manufacturing, fixed capital as a percentage of total capital varied within a narrow range, from 46 to 49 per cent. In 1948 and 1953, however, fixed capital represented only about 40 per cent of total capital and the weights were appropriately adjusted. In this manner, we obtain fifteen composite price indexes for eliminating price changes in the book values of total capital. To deflate fixed capital, we use a composite index based on the index of construction costs and on the price index of machinery and equipment; again, one composite for each major industry group. The respective price deflators for total and fixed capital are identical for all minor industries within a major industry classification. At best, this procedure eliminates only the changes in book values that result from price changes affecting the original cost of capital. To our knowledge, there are no data that would make possible the elimination of changes in book values caused by a revaluation of assets.

No such problem exists, however, in dealing with output, since it is valued at current prices received by manufacturers. These price changes

[30] It is inappropriate to deflate land value by a building construction cost index, but we know of no alternative procedure and have no choice except to deflate, because the value of land, in half of the benchmark years, is not separately reported. We take some comfort from the fact that land constituted only 8 per cent of total capital in 1900, about 4.5 per cent in 1937, and about 2 per cent in 1948. In mining land presents a special problem which is discussed in Appendix B, section E.

[31] *Depreciation Studies—Preliminary Report of the Bureau of Internal Revenue* (January 1932) and *Bulletin F*, "Income Tax, Depreciation and Obsolescence, Estimated Useful Lives, and Depreciation Rates," (rev. January 1942).

are approximated by changes in quoted wholesale prices. The procedure, then, is to compile for each minor industry a wholesale price index composed of as many commodity price series as we can find that are representative of a given minor industry. The coverage, in each instance, becomes more adequate as we approach the recent decades.[32]

An alternative procedure, at least through 1937, would be to use the indexes of physical output prepared by Frickey and Fabricant.[33] As indexes of physical output our estimates are of inferior construction. However, as components of capital-output ratios our estimates are preferred, because it is essential that both the numerator and the denominator have the same industrial coverage and be derived from the same source material. These conditions would not be satisfied by using the output indexes of other investigators. As we show in Chapter III, the general conclusions are the same regardless of the output indexes used.

These indexes, in common with most price indexes, do not allow explicitly for quality changes. This does not detract from their usefulness in the making of capital estimates. Our interest centers on whether capital has become more efficient, which would result in large part from quality changes in capital itself. It is important, therefore, not to eliminate quality changes by deflation. Our procedure attempts to eliminate only the changes in book values that result from price movements. In the case of output, however, the inability to correct for quality changes is a limitation, and it probably causes output to be cumulatively understated over the period that we analyze.

[32] For the price deflators of output and the details of their construction, see Appendix A, section B4.

[33] Edwin Frickey, *Production in the United States, 1860–1914*, Harvard University Press, 1947; and Solomon Fabricant, *The Output of Manufacturing Industries, 1899–1937*, National Bureau of Economic Research, 1940.