

This PDF is a selection from an out-of-print volume from the National Bureau of Economic Research

Volume Title: Capital and Output Trends in Mining Industries, 1870-1948

Volume Author/Editor: Israel Borenstein

Volume Publisher: NBER

Volume ISBN: 0-87014-359-X

Volume URL: <http://www.nber.org/books/bore54-1>

Publication Date: 1954

Chapter Title: Appendixes

Chapter Author: Israel Borenstein

Chapter URL: <http://www.nber.org/chapters/c4709>

Chapter pages in book: (p. 61 - 83)

Appendixes

Appendix A

Basic Tables with Notes on Sources and Methods of Estimation

General Note

Throughout this paper, except in Table 1, we use the census classification of mining output and adjust all other estimates (capital, man-hours) for comparability with census coverage. The advantage of this procedure is that we are able to derive both capital and product for the earlier years from the same source and thus ensure a high degree of comparability of numerator and denominator of the capital-product ratios. It also enables us to obtain comparable data on capital growth. The census classifies output in extraction of minerals on an industry basis, as distinguished from the mineral basis used by the Bureau of Mines reports on production. Thus, output is classified according to the main mineral extracted. It includes, in addition to the main product, by-products or joint products. It does not include, however, the product of the given mineral extracted as a by-product of other minerals. Our working definition of industrial output specifically includes the value of sales at point of production corrected for net changes in inventories, the value of power sold and of miscellaneous services to other enterprises, and the value of minerals produced and used by the operating companies. (Our estimates for the period prior to 1909 do not, however, strictly correspond to this definition with respect to some minor items.) The reason for using Bureau of Mines quantity data in Table 1 is that for purposes of a mineral coefficient, output based on product is the relevant classification and comparable data on consumption and production are available in this form.

Although earlier censuses were not quite consistent in drawing a demarcation line between mining and manufacturing operations, these inconsistencies are not of a kind to impair seriously 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 period includes generally all activities through the point at which a marketable product is obtained. Thus the figures include those preparation activities which are frequently carried on at the mine or quarry site and in which the preparation plants are operated in conjunction with the mines and quarries, but do not include those preparation activities which 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 Bureau of Internal Revenue, 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 activities than do the more consolidated returns to the Bureau of Internal Revenue. 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 of manufacturing processes. This fact affects somewhat the comparability of the capital data between 1919 and 1929. (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 industries included in the major groups shown in the tables are:

1. Metals: Iron, copper, lead, and zinc; gold and silver (placer and lode); and the subgroup other metals. This subgroup is of changing composition before 1919. Beginning with 1919 it includes antimony, bauxite, chromite, manganese, molybdenum, quicksilver, rutile, tungsten, uranium, and vanadium.
2. Anthracite: Pennsylvania anthracite.
3. Bituminous: Bituminous coal, lignite, and non-Pennsylvania anthracite.
4. Petroleum and natural gas: Crude petroleum, natural gas, and natural gasoline.
5. Other nonmetals: Until 1919, stone quarrying industries — basalt, blue-stone, granite, limestone, marble, sandstone, and slate; industries supplying other construction materials — asphalt, gypsum, and magnesite; industries supplying chemicals — barite, fluorspar, phosphate rock, pyrites, and sulphur; abrasive materials — corundum, garnet, grindstones, infusorial earth, pumice, oilstones, whetstones, and tripoli; miscellaneous industries — asbestos, clay, feldspar, fuller's earth, graphite, marl, mica, millstones, mineral pigments, silica, talc, and soapstone. Beginning with 1919 the list was widened by the inclusion of sand and gravel, sand glass, sand molding, natural sodium compounds, potash, rock salt, and the production of limestone mines and quarries operated in conjunction with cement and lime plants. The inclusion of these industries from 1919 on renders the figures for the earlier and later years noncomparable for this group and restricts somewhat the comparability of the figures for total mining. (In all cases where a continuous series is used in the text, we inflate the figures for the period before 1919 by the ratio of the two appropriate sets of figures in 1919.)

Notes to Chart 1

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

The nine-year moving averages of mineral output presented in this chart are based on annual series derived by interpolating between census data. The interpolation procedures for the period 1929–1948 are similar to those described in the notes to Tables A-1 and A-2. The interpolations for the earlier years are based on the following annual series:

Coal, anthracite and bituminous: Quantities reported by the Bureau of Mines.

Iron ore: 1880–1929 as above; 1870–1880, pig iron production reported by the same source.

Copper, lead, and zinc: As above; the combined group index is the sum of the individual annual quantities weighted by the price of the given mineral in 1929.

Petroleum, natural gas, and natural gasoline: As the above subgroup.

Gold and silver: As the above subgroup.

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].

TABLE A-1
 VALUE OF OUTPUT, BY MAJOR MINING INDUSTRIES, CURRENT PRICES,
 SELECTED YEARS, 1870-1948
 (millions of dollars)

	<i>Total Mining^a</i>	<i>Metals</i>	<i>Anthra- cite</i>	<i>Bitumi- nous Coal</i>	<i>Petroleum and Natural Gas</i>	<i>Other Non- metals</i>
1870	153	47	38	35	19	13
1880	253	111	42	54	25	21
1890	419	144	72	95	48	60
1902	773	216	76	291	102	88
1909	1,186	354	149	402	176	106
1919 ^b	3,123	545	364	1,146	903	166
1919 ^c	3,204	545	364	1,146	903	247
1929	3,979	635	385	967	1,563	430
1937	3,680	615	199	866	1,697	304
1939	3,222	515	190	731	1,472	314
1940	3,592	631	208	882	1,540	330
1948	10,969	1,024	473	2,951	5,755	765

^a Because of rounding details may not add to total.

^b Comparable with earlier years.

^c Comparable with later years.

Source:

1870, 1880, 1890, 1902, 1909, 1919, 1929, and 1939: Census figures, supplemented by estimates for industries not included in a given census canvass but included in census reports for other years. The estimates were derived by adjusting Bureau of Mines data for comparability with census reports. Where necessary and possible, census data were also adjusted for comparability.

1937: Interpolated between 1929 and 1939 by Bureau of Mines data.

1940 and 1948: Extrapolated from 1939 by Bureau of Mines data.

TABLE A-2
 VALUE OF OUTPUT, BY MAJOR MINING INDUSTRIES, 1929 PRICES,
 SELECTED YEARS, 1870-1948
 (millions of dollars)

	Total Mining ^a	Metals	Anthra- cite	Bitumi- nous Coal	Petroleum and Natural Gas	Other Non- metals
1870	176 ^b	29	91	35	7	n.c.
1880	354	76	148	77	33	20
1890	673	131	235	172	65	71
1902	1,248 ^b	297	214	468	129	n.c.
1909	1,933	437	418	676	250	152
1919 ^c	2,439	465	456	829	535	155
1919 ^d	2,507	465	456	829	535	223
1929	3,979	635	385	967	1,563	430
1937	3,939	596	269	803	1,917	353
1939	3,798	517	268	715	1,908	390
1940	4,206	643	269	832	2,051	411
1948	5,804	638	299	1,073	3,199	595

^a Because of rounding details may not add to total.

^b Includes the value of other nonmetals deflated by the price deflator implicit in the figures for total mining less other nonmetals.

^c Comparable with earlier years.

^d Comparable with later years.

n.c. = not comparable.

Note: The figures for total mining can be readily converted to an index of mining output constructed by the use of fixed value weights. Since our estimates are derived largely from census data while other indexes are based on figures reported by the Bureau of Mines, a comparison with other indexes appears of interest. We find a close agreement between the index of total mining output implicit in this table and the two most comprehensive estimates available so far. A comparison with 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)] for the period 1902-1939 shows that the largest difference found — that in 1919 — does not exceed three index points. A comparison with Leong's index (Y. S. Leong, "Index of Mineral Production," *Journal of the American Statistical Association*, March 1950) for the period 1880-1948 shows similarly small differences except in 1948, when our figure is significantly lower. This difference is probably explained by the fact that Leong uses 1935-1939 weights for this segment of his series, while we use 1929 weights.

Source:

Product values in current prices were adjusted to a 1929 price base by price indexes derived from the quantities and prices reported by the Census Bureau. For years not covered by Census Bureau reports, indexes were interpolated or extrapolated by Bureau of Mines price data.

TABLE A-3
 VALUE OF CAPITAL (INCLUDING LAND), BY MAJOR MINING INDUSTRIES,
 REPORTED VALUES, SELECTED YEARS, 1870-1948
 (millions of dollars)

	<i>Total Mining^a</i>	<i>Metals</i>	<i>Anthra- cite</i>	<i>Bitumi- nous Coal</i>	<i>Petroleum and Natural Gas</i>	<i>Other Non- metals</i>
1870	212	80	51	59	10	12
1880	558	309	100	79	43	26
1890	1,067	595	105	146	130	91
1909	3,280	1,182	247	961	683	207
1919 ^b	6,956	1,877	434	1,904	2,421	319
1919 ^c	7,112	1,877	434	1,904	2,421	475
1929	11,448	2,335	585	2,116	5,491	921
1940	7,828	1,251	289	1,278	4,476	534
1948	11,893	1,124	319	1,753	8,040	656

^a Because of rounding details may not add to total.

^b Comparable with earlier years.

^c Comparable with later years.

Note: Whenever we adjusted the product prices reported by the Census Bureau for comparability with other census reports, we adjusted the capital figures also. In such cases a straight-line interpolated ratio of capital to product at earlier and later benchmarks was applied to the value of product in the given year.

Source:

1870: Census figures.

1880 and 1890: Census figures adjusted to exclude the value of leased land. The value of total land including leased land was reported by the censuses of 1880 and 1890. For some industries the census of 1890 reported the value of leased land separately. For the other industries and for 1880 this value was obtained by applying the ratio of leased land to total acreage or value, as the case might be, in the next available year to the value of total land in the given year. The value of leased land thus estimated was subtracted from the value of total land.

1909 and 1919: Census figures for producing enterprises. The 1919 capital figure for other nonmetals comparable with later years was obtained by applying the ratio of capital to value of product implicit in the figures comparable with earlier years to the value of product comparable with later years.

1929: 1930 estimates extrapolated by the percentage change in total capital (cash, notes and accounts receivable, inventories, and net capital assets including land) for total mining from 1929 to 1930 as reported by *Statistics of Income*, Bureau of Internal Revenue. The same percentage was used for each industry. For 1930 estimate see below.

1930, 1940, and 1948: Obtained by applying the ratio of the sum of cash, notes and accounts receivable, inventories, and net capital assets including land to the sum of gross sales and gross receipts reported by *Statistics of Income* (or the *Source Book*) to the product figures consistent with census reports (Table A-1 and work sheets).

The ratios for 1930 were adjusted for consolidation of returns. For years in which no sales and receipts of corporations submitting balance sheets are reported by industries, they were estimated using the ratio of the value of sales and receipts to the total value of sales and receipts for those corporations submitting balance sheets for the next available year, or the average ratio for total mining. We refrained from making adjustments for the accelerated depreciation of emergency defense facilities which began in 1940. (Accelerated amortization is a small item in mining, amounting to only 5 per cent of normal depreciation at its peak in 1943.)

TABLE A-4
 VALUE OF CAPITAL (EXCLUDING LAND), BY MAJOR MINING INDUSTRIES,
 1929 PRICES, SELECTED YEARS, 1870-1948
 (millions of dollars)

	Total Mining ^a	Metals	Anthra- cite	Bitumi- nous Coal	Petroleum and Natural Gas	Other Non- metals
1870	127	38	38	32	13	8
1880	410	174	93	54	68	21
1890	918	357	117	118	244	83
1909	3,476	1,093	211	713	1,264	194
1919 ^b	5,596	1,004	240	1,036	3,133	184
1919 ^c	5,686	1,004	240	1,036	3,133	274
1929	8,532	1,086	318	1,026	5,601	502
1940	6,699	798	148	730	4,637	386
1948	7,722	644	127	927	5,690	334

^a Because of rounding details may not add to total.

^b Comparable with earlier years.

^c Comparable with later years.

Note: For the purpose of graphical presentation in Chart 2 the figures for total mining and other nonmetal mining before 1919 were raised to make them comparable with those for the later years. As linking ratio we used the relationship between the appropriate figures in 1919.

Source:

All figures were obtained by adjusting the estimates in book values to a 1929 price base. This was done separately for equipment and improvements, and working capital, after deduction of the estimated value of land owned by the establishment. The following price indexes were used:

1. Equipment. Price index implicit in Raymond W. Goldsmith's estimates of the value of producers' durable equipment at original cost and in 1929 prices [Raymond W. Goldsmith, "A Perpetual Inventory of National Wealth," *Studies in Income and Wealth, Volume Fourteen* (National Bureau of Economic Research, 1951), Table 1] extrapolated by the price index for this group estimated by Simon Kuznets [Simon Kuznets, *National Product since 1869* (National Bureau of Economic Research, 1946), Table 4, line 7, p. 216].

2. Improvements. Goldsmith's implicit index for underground mining structures and nonfarm nonresidential structures (*op. cit.*) combined with equal weights and extrapolated by Kuznets' index for all construction (*op. cit.*).

3. Working Capital. Bureau of Labor Statistics index of wholesale prices (*Historical Statistics*, pp. 233 ff., and *Bulletin No. 1007*) converted from the 1926 to a 1929 base. (Since the censuses of 1870, 1880, and 1890 covered the period June 1, 1869, to May 31, 1870, etc., we used averages of the indexes for pairs of calendar years.)

Value of land: The value of land owned by the establishment, which is deducted, was estimated as follows:

1870: Estimated by the formula $X = \frac{C T Z}{1 - Z(1 - T)}$

where X = Value of land owned by establishment

C = Capital excluding value of leased land

T = Ratio of owned to total land in nearest available year

Z = Ratio of value of total land to capital including value of leased land in 1880.

1880: Estimated by applying the ratio of owned to total land (either acreage or value) in 1890 or the next available year to the value of total land reported by the census.

1890: Reported for some of the major industries; for the others estimated as for 1880.

1909 and 1919: Arithmetic mean of two estimates. One estimate was obtained by the formula used for 1870, but with T taken from the census data for 1909 and 1919 and Z taken as the ratio of the value of total land to capital including the value of leased land in 1890. The other was obtained by (a) inflating the amount of royalties paid reported in the censuses of 1909 and 1919 by the ratio of total to leased acreage reported; (b) multiplying the hypothetical royalties by a "year's purchase factor" using a 4 per cent rate of discount in 1909 and a 4.5 per cent rate in 1919, and assuming different lengths of life of the royalty source for each minor industry according to information on available reserves; and (c) subtracting from the given totals the capitalized value of royalties actually paid.

1929, 1940, and 1948: Obtained as a residual after deducting the estimated value of improvements and equipment, and working capital from the reported values of total capital presented in Table A-3.

Value of working capital: The book value of working capital was estimated or reported as follows:

1870: Estimated by solving the equations

$$X + Y + Z = A$$

$$\frac{X}{X_i} \div \frac{Y}{Y_i} = B_i$$

$$\frac{Z}{Z_i} \div \left(\frac{X}{X_i} + \frac{Y}{Y_i} \right) = C$$

where X = book value of improvements

Y = book value of equipment

Z = book value of working capital

X_i, Y_i, Z_i = price deflators for above three series in given year

A = capital excluding value of land

B_i = ratio of improvements to equipment in 1929 prices

C = ratio of working capital to improvements and equipment in 1929 prices in nearest available year (1880).

For X and Y , see notes to estimates of value of plant.

1880 and 1890: Reported.

1909: Same method as for 1870, but for C the ratio for 1919 was used.

1919: Estimated by applying the ratio of working capital to total capital. For coal, petroleum, and other nonmetals the ratios used are based on *National Wealth and Income* (Federal Trade Commission, 1926, p. 138, a report in response to Senate Resolution 451); for iron, copper, lead, zinc, and precious metals the ratios are based on a sample taken from *Moody's Manual of Industrials*, 1919. (A small correction was made to adjust the ratio for total metals in the Moody sample to the ratio for metals in the FTC report.)

1929: The 1930 ratio of working capital to total capital was applied to the estimated total capital in 1929.

1930, 1940, and 1948: The ratio of the sum of cash, notes and accounts receivable minus reserves for bad debts, and inventories to this sum plus net fixed capital assets as reported in *Statistics of Income*, Bureau of Internal Revenue, was applied to total estimated capital.

Value of plant: The book value of plant (improvements and equipment) was estimated or reported as follows:

1870: Estimated by deducting the estimated value of land owned and of working capital from the value of capital reported.

1880 and 1890: Reported values. For 1890 the value of improvements and of equipment was reported separately.

1909 and 1919: Same procedure as for 1870.

1929, 1940, and 1948: The ratio of the value of improvements and equipment to fixed assets was assumed in each industry to be the same in 1929 and in 1930 as in 1919. This ratio was divided by the ratio of depreciation charges to fixed assets in 1930 as given in *Statistics of Income*. The number obtained (the implicit average length of life of improvements and equipment) was multiplied in each of the years following 1930 by the ratio of depreciation charges to net fixed assets as secured from *Statistics of Income*. These annual estimates of the ratio of improvements and equipment to total assets were then averaged by periods, the averages being centered on the bench-mark years. Finally, by straight-line interpolation between the given bench-mark years, "smoothed" ratios of the value of improvements and equipment to net fixed assets were obtained; these in turn were applied to the estimated value of net fixed assets in each year. Estimated book values of plant were adjusted to a 1929 price base by combining the price indexes for improvements and equipment by varying weights. The weights were obtained on the assumption that the ratio of improvements to equipment in constant prices changed 1 per cent per decade in favor of equipment for the years before 1890 (when improvements were reported by the census) and .5 per cent per decade in the following years in each of the industries.

Appendix B

Notes on the Statistical Reliability of the Major Findings

What are the major deficiencies of our estimates? To what extent do they impair our major findings?

Two types of deficiency can be distinguished — those arising from differences in definition, coverage, classification, etc., and those arising from the fact that our capital data are based on accounting records and are therefore affected by changes in accounting practices, such as in the treatment of capitalization, depletion, and depreciation, and by revaluations stemming from changing market conditions, tax regulations, waves of company mergers, etc. The second type of deficiency was partly explored in the text in the discussion of limitations of the inferences. We shall add here a brief discussion of the more important deficiencies of the first type and concentrate on those of the second which were omitted from the text.

1. No clear-cut definition of capital is given in the *Report on Mineral Industries in the United States* for 1880 and 1890. But from explanatory remarks, we gather that these censuses tried to ascertain the current value of the total amount of business assets in use, whether owned or leased, distinguishing thereby between such types of assets as land and plant. In order to make the capital figures of these censuses comparable with those of other censuses we estimated and excluded the value of leases. We made no adjustment for the fact that the figures represent current instead of depreciated original cost, since, to judge by evidence for the later years,¹ the two valuation bases would yield identical results in these years.

The censuses of 1909 and 1919 asked for the "total amount of capital, owned and borrowed, invested by the operator in the enterprise on the last day of the business year reported as shown in the books," excluding securities and loans representing investments in other enterprises. This definition should approximately add up to the sum of cash, notes, and accounts receivable minus reserves for bad debts, inventories, and net capital assets including land, as reported by *Statistics of Income*, from which we derive our capital data for the following years. A formal difference between the censuses and *Statistics of Income* exists in that the items "patent rights" and "good will," which according to the census instructions to its agents should not have been considered as part of capital, are entered as "intangible assets" in the item "capital assets" in the *Statistics of Income* classification beginning with 1939. This conceptual difference makes for a slightly higher capital figure when the figure is taken from *Statistics of Income* than when it is taken from the census and thus imparts a slightly conservative bias to our findings.

¹ See Raymond W. Goldsmith, "A Perpetual Inventory of National Wealth," *Studies in Income and Wealth, Volume Fourteen* (National Bureau of Economic Research, 1951), Table 1.

The change from census to *Statistics of Income* data gives rise to other discrepancies that should be mentioned. First, we do not use the amount of capital reported by *Statistics of Income* directly but apply the ratio of assets to product from *Statistics of Income* to the product reported by the census in order to obtain capital comparable with the latter. Our product figures from *Statistics of Income* consist of the sum of the items "gross sales" and "gross receipts from operations." The difference between this and our working definition of industrial output is the output produced and used by the operating company and net changes in inventories. This discrepancy makes the denominator based on *Statistics of Income* somewhat lower in years when production exceeds sales and somewhat higher in years when sales exceed production. Hence the opposite is true of the capital-product ratio.

Second, *Statistics of Income* covers only corporations, whereas the census includes all establishments. Corporations are generally larger establishments: this can be seen from the fact that in 1919 they produced 94 per cent of the total output while constituting only 51 per cent of total enterprises.² Since, according to our statistical evidence, the capital-product ratio rises with the size of enterprise, one would expect estimates of capital based on *Statistics of Income* to be somewhat high. On the other hand, this bias is counterbalanced by the fact that data for many of the large integrated concerns, particularly among those engaged in oil production, appear in *Statistics of Income* under the manufacturing classification. The ratios derived from the latter may therefore underweight those of large corporations. One might have assumed that in the case of the oil industry the effect of this factor is stronger than that mentioned previously, and therefore that our capital estimates for this industry derived from *Statistics of Income* ratios have a downward bias. This is not the case, however, judging by the comparison of our capital estimates for this industry with estimates by others.³

A third and related inconsistency arises from the fact that the census reports draw a sharper demarcation line between mining and manufacturing than does *Statistics of Income* (see General Note in Appendix A). This is particularly true for metals and oil — industries in which mining and manufacturing operations are

² *Census of Mines and Quarries: 1919*, Bureau of the Census, Table 13.

³ Joseph E. Pogue and Frederick G. Coqueron [*Financial Analysis of Thirty Oil Companies for 1949 and Supplement* (Chase National Bank of the City of New York)] estimate the value of net investment in oil and natural gas producing facilities (property, plant, and equipment) in 1949 at \$6,050 million. The ratio of this aggregate to the value of the net investment in the domestic producing facilities of thirty oil companies in 1949 applied to the value of the latter in 1948 yields the sum of \$5,124 million as representing the net value of fixed assets invested in the oil and gas industry in 1948. Our estimate for 1948 was \$5,513 million. Similarly, the ratio of the 1949 aggregate to the total value of domestic and foreign producing facilities of the thirty companies applied to the value of the latter in 1940 yields \$3 billion as the net value of fixed assets in the oil and gas industry in 1940. This compares with our estimates of \$3,582 million. Another estimate for that year sets the figure at \$3,440 million (John D. Gill, taken from *Petroleum Facts and Figures, 1947*, American Petroleum Institute, p. 197).

very frequently performed by a single corporation. As a result, *Statistics of Income* data for those industries include some figures pertaining to manufacturing processes. According to our work sheets, the ratios of total capital and of capital to value added are higher in petroleum refining than in petroleum producing. Hence any bias for this industry resulting from the change from census data to *Statistics of Income* data would be in the direction of overstatement of the capital-product ratios. Similarly, the ratio of capital to value added is higher in smelting and refining of metals than in metal mining. However, if we include the value of land in the numerator, the total amount of capital used in metal mining per unit of value added is higher than that used in smelting and refining. As a result, our ratios for this industry derived from *Statistics of Income* may be somewhat low.

Although formally the capital definition used by the censuses of 1909 and 1919 is well matched by the corresponding assets items from *Statistics of Income*, the change from census to Bureau of Internal Revenue data gives rise to the question whether balance sheet data reported to the tax authorities are not to a greater extent net of depreciation and depletion than those reported to the census. In order to ascertain whether there is an actual continuity between the capital figures derived from the two sources, Daniel Creamer reconciled *Statistics of Income* and census figures for 1919 for total manufacturing and mining and found no significant difference between the capital figures reported. Creamer concludes that "the allegations of gross inaccuracy made against the reports of capital in the *Census of Manufactures* appear to be without foundation for the aggregate in 1919."⁴ A similar reconciliation for the mining figures alone would be difficult, because the corporation returns to the Bureau of Internal Revenue for the year 1919 were filed on a consolidated basis and many of the mining activities classified as such by the census appear under manufacturing in the *Statistics of Income* classification. This is particularly true for metal mining in that year. The close agreement found, however, for aggregate mining and manufacturing and for those manufacturing groups where corporations are to a lesser extent engaged in multi-industry activity is evidence that the capital-product ratios derived from census and *Statistics of Income* figures are closely comparable.

2. The limitations imposed on our data by the second type of deficiency are of a more serious character. Accounting practices vary among individual enterprises and have varied considerably over time. There is no way to ascertain trends with respect to certain aspects of accounting treatment, and we have to rely on

⁴Daniel Creamer, *Capital and Output Trends in Manufacturing Industries, 1880-1948*, Occasional Paper 41 (National Bureau of Economic Research, 1954), Appendix B. It should be noted that the census authorities have frequently referred to the reported capital figures as being liable to a wide margin of error. Examination of the figures has shown that indeed this may have been true in the case of some minor mining industries. (For this reason we work with the combined group of other non-metal mining.) With regard to major industries, however, the figures have proved to be consistent enough to serve as indicators of the very general patterns of growth. That the appraisal of reported capital figures given by the census authorities, at least that given by the census of 1919, may have been based on preconceived ideas, is suggested by Creamer's reconciliation.

suppositions which often are not universally accepted by members of the accounting profession.

There is a strong case for assuming that a trend toward wider recognition of depreciation allowances began with the period studied. With the inception of the corporate excise tax in 1909 this trend was strengthened, and the high taxes during World War I completed the process, so that by 1919 depreciation accounting was used by virtually all mining firms. If this assumption is valid, the growth of capital depicted by our figures should tend to be understated for the period prior to 1919 and correctly reflected for subsequent years. This would imply a conservative bias in our finding concerning the increase in the capital-product ratio during the earlier period.

It is also conceivable, however, that the effect of wider acceptance of depreciation accounting was counterbalanced by other factors. One such factor is the tendency toward less conservative accounting with regard to capitalization of betterments and other types of capital expenditure. Before formal depreciation accounting was adopted, many expenditures on buildings and equipment may have been treated as current operating expenses. The introduction of depreciation accounting effected a more proper allocation of those expenditures over time in the determination of income, but it may have been of little influence on the net capital values kept on the books, particularly if industry aggregates and changes over long periods of time are considered. Second, as already stated, early censuses did not ask for book values but for the "actual value" of plant and equipment. It is possible that in estimating this actual value many operators took into account cost as well as wear and tear. The figures thus reported are in a way net of depreciation and should be comparable with the figures of the latter censuses.

The effect of changes in allowing for depletion was dealt with in the text and needs little further elaboration here. Provisions for depletion were less common than provisions for depreciation before the inception of corporate taxes in 1909. Although depletion accounting spread in the following years, even today it is still less universal than depreciation accounting. Thus, unlike changes in depreciation accounting, changes in depletion accounting should have tended to introduce a downward bias in our total capital estimates throughout the period investigated. As a consequence, our finding concerning the increase in the total capital-product ratio in the earlier period would be strengthened but that concerning the decline in the total capital-product ratio in the later period, particularly during the forties when depletion charges were high, could be questioned. If we grant that our net total capital estimates (including land) are understated during the later period as a result of high depletion (and depreciation) allowances,⁵ the movement of the

⁵ This should not be true of our estimates excluding land. High depletion, depreciation, or amortization allowances during the forties could not have had a depressing effect on our capital estimates excluding land, since by our method of deriving the value of improvements and equipment, high depreciation charges should have had the effect of overstating the capital value. The method is described in the source note to Table A-4. Our estimates of the value of improvements and equipment for this period are based on the value of depreciation charges. The underlying idea is

gross total capital-product ratio (including reserves for depletion and depreciation) becomes even more interesting. Fortunately, we are able to trace this movement between 1937 and 1948.⁶ For 1937 and 1948 the ratios of gross total capital (total capital plus depreciation and depletion reserves) to output for total mining are, respectively, 3.03 and 1.79 based on book values and 3.10 and 2.63 based on values in 1929 prices.⁷ Thus they too declined, though not so markedly as the net total capital-product ratios. Hence, the latter's decline was not merely an effect of high depreciation, depletion, or amortization allowances.

The statistical evidence available for appraising the degree of distortion in our capital estimates attributable to revaluations, for the period in which our estimated ratios of capital to product were declining, is given in the text (page 19). Unfortunately, this evidence is restricted to the years 1925-1934. In the latter half of the thirties further downward revaluations presumably took place, with the result that our figures for 1940 may be understated. Downward revaluations of assets were restricted to the thirties, however, and cannot be held responsible for the decline in the capital-product ratio during the twenties and forties. Moreover, it should be noted that downward revaluations are relevant for our study only if they exceed the "real" shrinkage of capacity that has occurred. The cases in which downward adjustments were accompanied by closing of mines and reduction of capacity do not distort the behavior of the capital-product ratios. It is entirely possible that downward revaluations during the thirties did not exceed the actual shrinkage of capacity that occurred during that period. Reduction of capacity was also large where no actual closing of mines took place. We point in particular to the abandonment of the relatively older but still efficient types of equipment that occurs at times of low production levels.

There is no way to ascertain accurately the impact on our data of upward revaluations. There were apparently two waves of such revaluations. One, from 1889 to 1904 with an interruption between 1893 and 1897 but much stronger in the second cycle, was a result of the merger movement. The other, from 1915 to 1925, was presumably a result of tax regulations and price increases. It is our belief (1) that the effect of the revaluations during and after World War I was largely

that with the prevailing methods of straight-line depreciation the depreciation charges should remain in a constant relationship to the gross value of depreciable assets, assuming of course that no changes in the average length of life and in depreciation practices occurred. Since the assumption of constancy in depreciation practices in periods of high and low employment levels is not quite justifiable, our estimates of depreciable assets in the forties may be overstated rather than understated.

⁶ 1937 is the first year for which reserves for depreciation and depletion are reported by *Statistics of Income*, Bureau of Internal Revenue.

⁷ The book values of gross fixed assets (improvements, equipment, and land before reserves for depreciation and depletion) were obtained by adjusting the values reported by *Statistics of Income* to census coverage. The values in 1929 prices were obtained by adjusting the estimated book values by indexes for equipment and improvements used in our estimate of plant in 1929 prices (see source note to Table A-4).

counterbalanced by the spread of depreciation, and particularly depletion, accounting at the same time and (2) that revaluations connected with mergers were largely excluded by the *Census of Mines and Quarries: 1909* when it called for the exclusion of good will and similar items. This latter supposition can be supported as follows: The *Census of Mines and Quarries: 1902* asked for the amount of "capitalization," or the par value of outstanding capital stock (common and preferred) and bonded indebtedness of incorporated mining companies, instead of the value of assets. The reported figure for total mining is \$3.2 billion. This is equivalent to about \$3.7 billion of "watered" capital assets estimated on the assumption that the 1909 ratio of "capitalization" to current and fixed assets⁸ applies in the year 1902. The comparable figure for total capital of all mining corporations reported by the census of 1909 is \$3.1 billion. This sum is \$.6 billion lower than the figure implicit in the 1902 census report, in spite of the fact that total value of mining output in 1929 prices rose about 55 per cent between 1902 and 1909. It is evident that such a discrepancy cannot be attributed, as one might like, entirely to the fact that the 1902 census data on capitalization include some figures pertaining to manufacturing. It can be explained only by assuming that the 1909 census managed to exclude from its returns most, if not all, extravagant valuations.

⁸ Around 85 per cent in 1909, according to a sample of mining corporations drawn from *Moody's Manual*.

Appendix C

Notes on the Comparability of the Bench-Mark Years with Regard to Employment Levels

A problem in comparability of the capital-product ratios, as well as of the rates of growth of capital and output, is created by the fact that output is more sensitive to changes during business cycles than the book value of capital. Years of comparatively low employment and output levels are characterized by comparatively high capital-product and capital-wage-earner ratios. Therefore, in selecting the bench marks we must consider the level of activity in the given industry in that year. However, business fluctuations in single industries do not always conform exactly to cycles in general business. And perhaps no two years can be chosen in recent economic history which are exactly comparable with respect to their position in the cycle. Moreover, we have no freedom of choice in selection of bench marks prior to 1929, since our data are derived from the census of mines. We are therefore obliged to check to what degree our analysis is distorted by differences in the level of activity in the bench-mark years.

Such a check may be made by comparing the actual output of a given industry in a given bench-mark year with the average output of the five years centered on the bench-mark year (Table C-1). It appears immediately that, although in some bench-mark years output was above and in others below the average, differences in employment levels were not very great except in 1919, when output was generally below, and in 1929, when output was considerably above, the five-year average. If we adjust our capital-product ratios by the ratios presented in Table C-1, i.e. if we substitute in the denominator an average output of five years for the output of the given year, a rise and decline similar to those described in the text are evident. However, such an adjustment shifts the turning point for total mining from 1919 to 1929 (Table C-2).

Is there a reason for substituting averages of output for the output of a given year when we compare capital with product? Although the secular trend in output is ordinarily probably better represented by five-year averages than by single-year observations, the five-year averages have certain deficiencies too. For example, low levels of output in 1930 and 1931 heavily depress the average centered on 1929, while our capital estimate for this year remains unaffected by the considerable disinvestment which occurred afterward. Thus, if we assume that the five-year average of output centered on 1929 correctly describes the secular trend of output, it raises the question whether the single-year capital estimate for 1929 correctly describes the secular trend of capital. On the other hand, if we assume the developments in the thirties to be an interruption rather than a continuation of the long-term primary secular movement, the 1929 figure may be considered

TABLE C-1
 VALUE OF PRODUCT IN A GIVEN BENCH-MARK YEAR AS A PERCENTAGE OF THE
 FIVE-YEAR AVERAGE CENTERED ON THE BENCH-MARK YEAR, BASED ON
 VALUES IN 1929 PRICES, BY MAJOR AND MINOR MINING
 INDUSTRIES, 1870-1948

	1870	1880	1890	1909	1919	1929	1940	1948
Total mining	98 ^a	96 ^a	97	100	93	113	101	107
Metals total	104	97	100	107	93	130	104	108
Iron	110	109	106	107	101	128	105	113
Copper	106	94	96	110	90	144	105	106
Lead and zinc	100	93	99	103	91	113	103	102
Precious metals	100	93	100	105	93	104	111	102
Anthracite	100	97	98	95	94	103	97	109
Bituminous coal	87	90	93	98	90	111	100	110
Petroleum and natural gas	97	110	94	97	96	111	102	106
Other nonmetals	n.a.	n.a.	104	102	91	113	95	104

^a Excluding other nonmetals.

n.a. = not available.

Source: Value of product for bench-mark years as in Table A-2. The five-year moving averages are calculated from the series described in Notes to Chart 1 (Appendix A).

TABLE C-2
 RATIO OF CAPITAL IN A GIVEN BENCH-MARK YEAR TO THE FIVE-YEAR AVERAGE
 OF PRODUCT CENTERED ON THE BENCH-MARK YEAR, BASED ON VALUES IN
 1929 PRICES, BY MAJOR MINING INDUSTRIES, 1870-1948

	1870	1880	1890	1909	1919	1929	1940	1948
Total mining	.70	1.11	1.32	1.79	2.10	2.42	1.60	1.42
Metals	1.34	2.22	2.74	2.68	2.02	2.22	1.29	1.09
Anthracite	.42	.61	.49	.48	.50	.85	.53	.47
Bituminous coal	.79	.62	.64	1.04	1.16	1.18	.88	.95
Petroleum and natural gas	1.71	2.26	3.56	4.88	5.63	3.98	2.30	1.88
Other nonmetals	n.c.	n.c.	1.20	1.31	1.10	1.32	.89	.58

n.c. = not comparable.

Source: Capital figures as in Table A-4. Averages of output as in Table C-1.

a more correct approximation of the secular trend position of capital and output in that year than is an average affected by consecutive depression years, in which case the output average has to be considered an understatement.

Appendix D

Note on Adjustment of Book Values of Mineral Land for Comparability over Time

The value of mineral resources might be expressed in terms approximating current market prices by discounting royalties that the owners of the mineral assets can expect to receive over the lifetime of the resources. Aside from the difficulties of ascertaining the magnitude of the future income streams in their distribution through time and the appropriate rate of interest, there remains the basic question of the usefulness of such estimates for our purpose. Conceptually, there is no way of adjusting the values thus obtained for a comparison over time. In the case of reproducible goods such an adjustment means an adjustment for changes in price level of the input factors used in the production of the unit. It is made on the assumption that under competitive conditions there will be a tendency for the cost of the input factors to approximate the market value as well as the capitalized income value of the given capital asset. Obviously, however, no such equality can be assumed to exist in the case of mineral resources. Hence, as we view the problem, there is no way to obtain an index of changes in the physical volume of land on the basis of estimated market values. What appears true for market values is even more true for original cost, or book values.

An estimate of land "values" comparable over time might be derived by multiplying the amount of economically available mineral resources of a given industry at any given time by the estimated average value per unit of its reserves in a base year. The difficulty of this method, aside from the determination of the amount of economically available reserves, is that the final estimates will reflect changes in physical volume rather than changes in value dimensions in an economic sense. Obviously, the only estimate reflecting economic value, i.e. significance of the given goods in terms of services they may yield, in this case would be the estimate for the base year. All other estimates would have a quasi-economic meaning.

A conceptually more correct method might be to multiply the value of output in any given year (or average of years) in constant prices by the ratio of the estimated value of underground reserves to product (or to capacity) in the year taken as a base for price adjustment of the product values. In other words, we would assume that the price-adjusted value of the mineral resources will change in the long run in rough conformity to the change in mineral output of a given industry. Of course, this method could be used only on the assumption that the ratio of depletion to new discovery is equal to 1 and would have to be modified correspondingly if the assumption turned out to be untrue. It is clear, however, that figures obtained by this method would be useless for the purpose of this study.



HOW TO OBTAIN NATIONAL BUREAU PUBLICATIONS

The National Bureau of Economic Research is a nonprofit membership corporation organized to make impartial studies in economic science.

Its books are published and distributed (since April 1, 1953) by Princeton University Press; its *Occasional Papers* and *Technical Papers* are published and distributed by the National Bureau itself.

Publications may be obtained either on contributing subscriptions or by purchase.

A contributor of \$35 or more a year is entitled to receive a complimentary copy of each current publication — *books, Occasional Papers, Technical Papers, and the Annual Report* — in advance of release to the public. In addition, a contributor is entitled to a one-third discount on all National Bureau publications purchased.

An associate contributor of \$10 a year receives a complimentary copy of each current *Occasional Paper, Technical Paper, and the Annual Report*, and is entitled to a one-third discount on all publications purchased. Only the following are eligible to become associates: teachers, students, and libraries in recognized educational institutions; members of scientific societies or of private nonprofit research agencies.

A contributor of \$4 receives the next five *Occasional Papers* (or any *Technical Paper* issued during this period may be substituted) and the *Annual Report*.

*Contributions to the National Bureau are deductible
in calculating federal income taxes.*

NONCONTRIBUTORS should order *books* from:

Princeton University Press
Princeton, New Jersey

NONCONTRIBUTORS should order *Papers* and request the *Annual Report* from:

CONTRIBUTORS should order all *books and Papers*, and request the *Annual Report* from:

NATIONAL BUREAU OF ECONOMIC RESEARCH, INC.
261 Madison Avenue
New York 16, N. Y.