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APPENDIX C
Mining

THE indexes of output, employment, and manhours in the mining segment and the five major groups of mining industries are built upon those published by Harold Barger and Sam Schurr.[1] Their methods have had to be modified at a number of points so as to achieve consistency with other industry measures contained in this volume. Also, the Barger and Schurr estimates have had to be extended back of 1899 and forward from 1939. So far as the early period is concerned, the task of extension was made easier by several previous studies, in particular those conducted by the Works Progress Administration National Research Project (NRP).[2] It was, however, necessary to amend somewhat the estimates published in these studies; in the case of stone quarrying, it seemed preferable for our purposes to devise new methods for estimating output.

The indexes of real net capital assets are those of Israel Borenstein,[3] adjusted for consistency with our output and employment indexes and extended to 1953 by Borenstein.

The emphasis in this appendix will be placed on the modifications and extensions of the works of Barger and Schurr and Borenstein since their volumes contain full descriptions of the sources and methods that they have used. High priority was given to an effort to make our measures of output and input complete and consistent both over time and with each other. The reconciliation of the two requirements was not always easy because of the nature of the basic data.

For the purposes of this study, every form of mineral extraction carried on underground and at the surface is called mining. Thus, the segment includes quarrying of stone and production of crude petroleum and natural gas, in addition to mining proper. To avoid duplication of items included in the manufacturing segment, Barger and Schurr arranged data so that, ". . . within practical limits, a uniform definition might apply in measuring output and employment, and [so] that this definition might include all processes up to, but not beyond, the point where operations of a kind covered by the Census of Manufactures begin."[4]

[1] *The Mining Industries, 1899–1939: A Study of Output, Employment and Productivity*, New York (NBER), 1944.

[2] Especially, Vivian E. Spencer, *Production, Employment, and Productivity in the Mineral Extractive Industries, 1880–1938*, Report S-2, Philadelphia, June 1940.

[3] *Capital and Output Trends in Mining Industries, 1870–1948*, Occasional Paper 45, New York (NBER), 1945.

[4] Barger and Schurr, *op. cit.*, pp.7–8.

The classification of mining into groups of mineral industries was handled in more or less identical fashion in all our primary sources.[5] Consequently, mining industries are classified in this report as follows: metal mining, Pennsylvania anthracite coal, bituminous coal, petroleum and natural gas, nonmetallic mining and quarrying.[6]

More detailed industry classifications within the metals group raise difficulties. In this group, complex ores and concentrates are produced by single plants, and the primary sources differ as to whether data should be presented on an industry or on a product basis (a fuller discussion is presented in the section on metal mining). With this exception, definitions of industries within the mining segment introduce no intricate problems of the kind met in the manufacturing segment since the industries and products generally coincide. In this study, however, we confine ourselves to the five major groups.

The estimates in the Appendix C tables are presented for the same key years used for other groups. The selection of the key years was based mainly on two considerations: availability of data and approximate elimination of the effects of cyclical movements. Since a census of mineral industries was taken in 1902 instead of 1900, the 1899 estimates generally had to be interpolated.

At the end of the appendix will be found the summary tables showing output, the two inputs, and the output-input ratios, all in the form of index numbers for each group of mineral industries separately and for the mining segment as a whole. Text tables with footnotes contribute to the description of sources and methods.

Output

By way of introduction to the sections on individual groups of mining industries, a few points common to all will be discussed. Weighting methods closely approximate those used in the other segments. The output indexes for each group of mining industries were constructed using changing weights computed on the basis of the Marshall-Edgeworth formula.[7] The weighting factor was price, or unit mine values, whenever

[5] And in most secondary sources, the exceptions being the Paley Commission report and, to some extent, the study of Y. S. Leong, "Index of the Physical Volume of Production of Minerals, 1880–1948," *Journal of the American Statistical Association*, March 1950, pp. 15–29.

[6] It is to be noted that the fifth group, nonmetallic mining and quarrying, is recognized as such only in the SIC; the components are not combined by either the Bureau of the Census or the Bureau of Mines.

[7] The same formula was applied by Barger and Schurr, *op. cit.*, pp. 271–72, as in other National Bureau studies. Their method consists of two steps: first, comparisons were made between 1899 and 1909, 1909 and 1919, 1919 and 1929, and 1929 and 1937; second, a chain index was computed for the entire period, 1899–1939, and this annual series was fitted into the framework provided by the four comparisons mentioned.

available. We combined output indexes of the five groups into a composite index of output for the mining segment using national income per unit of output as the weighting factor (see Table C-1). The latter was obtained

TABLE C-1

Mining: Relative Unit National Income Weights for Output Indexes, by Group, Subperiods, 1919–53
(per cent)

	1919–1929	1929–1937	1937–1948	1948–1953
Bituminous coal	28.0	29.9	37.9	39.0
Pennsylvania anthracite	9.0	10.5	9.3	10.0
Metals	21.6	20.2	16.2	14.4
Oil and gas wells	33.0	30.3	27.9	28.0
Nonmetallic mining and quarrying	8.4	9.1	8.7	8.6

by dividing the national income originating in each group of mining industries by the appropriate output index in successive key years beginning with 1919. In this, as in all the aggregate index numbers in the mining segment, average 1919–29 weights were applied in earlier years.

Only in the nonmetallic mining and quarrying group was the deficiency of output coverage serious enough to justify adjustments. The nature of the coverage adjustments will be discussed in the appropriate section below. Whenever there was a compelling need to adjust either output or input figures in order to make them consistent with each other, statistical expediency required that the former should give way to the latter.[8]

A final topic of general character with respect to mining output concerns the estimates for 1869. No specific figures for quantities produced and prices are listed in the following sections because, given the paucity of information, the index numbers for that year were derived by extrapolating the 1880 index number by estimates from the Borenstein work. The latter were based on Census data supplemented by the Bureau of Mines figures.

COAL MINING

The output indexes for bituminous coal and Pennsylvania anthracite were based directly on homogeneous quantity data. Table C-2 tells the whole story. The figures on coal are probably the most complete in terms of coverage among our five groups of mining industries. There are two minor shortcomings: first, Alaskan production could not be separated

[8] Barger and Schurr, *op. cit.*, Chapter 3 and Appendix A.

and excluded until 1916; second, information was not collected on the output of mines producing less than 1,000 tons a year. However, both of these defects in coverage may be considered negligible.[9]

TABLE C-2

Coal Production, Key Years, 1880–1953
(millions of short tons)

	Bituminous	Pennsylvania Anthracite
1880	42[a]	29
1889	96	46
1899	193	60
1909	380	81
1919	466	88
1929	535	74
1937	445	52
1948	600	57
1953	457	31

SOURCE: Bureau of Mines.

[a] Including coal mines west of longitude 100 degrees West, as given in *Report on the Mining Industries of the United States, 1880*, Bureau of the Census.

METAL MINING

Table C-3 shows the quantities produced and the prices used in the derivation of output index numbers for those key years that are not covered in the Barger and Schurr study. The year 1899 has been included in order to give an overlap with the estimates presented in that study.

With respect to coverage, the metal mining group, following Barger and Schurr, contains some nonmetals (fluorspar of Illinois and Kentucky and pyrites) while a metal (placer gold) is excluded. This adjustment in classification was necessitated by peculiarities in data on labor input[10] and had to be used to preserve consistency between output and employment figures. The adjustment itself presented no difficulty for the two late key years, but for 1880 and 1889 it was virtually impossible to separate placer from lode gold. The point is of some importance, although it does appear on first sight that placering might have been negligible at the time.[11] A more thorough look into the matter reveals that hydraulic placering

[9] W. E. Hotchkiss, *et al.*, *Mechanization, Employment, and Output per Man in Bituminous-Coal Mining*, WPA-NRP Report E-9, Philadelphia, 1939, pp. 357–358; Barger and Schurr, *op. cit.*, p. 298.

[10] See Barger and Schurr, *op. cit.*, p. 315.

[11] Much the greater part of placer gold is produced by dredging operations, and these had their commercial beginnings in 1896 (*Mineral Resources, 1921*, Bureau of Mines, Part I, p. 453).

TABLE C-3

Metal Mining: Production and Unit Values, by Type of Ore, Selected Key Years, 1880–1953

		1880	1889	1899	1948	1953
Iron ore[a]	(mill. l.t.)	7.1	14.5	26.4	126.2	117.4
	($ per l.t.)	3.25	2.30	1.41	3.91	6.76
Manganese ore	(thous. l.t.)	5.8	24.2	9.9	117.0	140.7[b]
	($ per l.t.)	15.00	9.92	8.28	37.50	88.50
Manganiferous ore[a]	(thous. l.t.)		65	109	1,198	1,107[b]
	($ per l.t.)		3.50	3.25	4.62	6.28
Lode gold, early period[c]	(mill. f. oz.)	1.74	1.54	3.34		
	($ per f. oz.)	20.67	20.67	20.67		
Silver, early period[c]	(mill. f. oz.)	30.3	51.4	56.5		
	($ per f. oz.)	1.15	.94	.60		
Gold, late period						
From copper ore	(thous. f. oz.)				450	617
Outside Mississippi Valley	(thous. f. oz.)				1,170	
	($ per f. oz.)				35.00	35.00
Silver, late period						
From copper ore	(mill. f. oz.)				7.91	9.16
Outside Mississippi Valley	(mill. f. oz.)				30.1	
	($ per f. oz.)				0.905	
Copper	(thous. s.t.)	30	113	284	834	926
	($ per s.t.)	428	270	342	434	574
Lead, early period[c]	(thous. s.t.)	96	152	202		
	($ per s.t.)	100	78	90		
Zinc, early period[c]	(thous. s.t.)	23	59	129		
	($ per s.t.)	110	100	116		
Lead, late period						
Outside Mississippi Valley	(thous. s.t.)				260	
Mississippi Valley	(thous. s.t.)				130	
	($ per s.t.				358	
Zinc, late period						
Outside Mississippi Valley	(thous. s.t.)				522	
Mississippi Valley	(thous. s.t.)				108	
	($ per s.t.)				266	

(continued)

TABLE C-3 (concluded)

		1880	1889	1899	1948	1953
Fluorspar[d], Ill. and Ky.	(thous. s.t.)	4	11	16	257	
	($ per s.t.)	4.00	4.70	5.49	35.00	
Bauxites	(thous. l.t.)		.73[e]	32.9	1,376	
	($ per. l.t.)		3.25	3.56	6.69	
Mercury	(thous. flks.)[f]	60.3	26.7	30.7	14.4	
	($ per flask)	30.8	44.7	47.4	76.5	
Molybdenum	(mill. lb.)				26.7	
	($ per lb.)				.688	
Tungsten	(thous. s.t.)				4.21	9.74[g]
	($ per s.t.)				1,576	3,748

SOURCE: For 1880, 1889, and 1899: Vivian E. Spencer, *Production, Employment, and Productivity in the Mineral Extractive Industries, 1880–1938*, WPA–NRP Report S-2, Philadelphia, 1940; Nicholas Yaworski *et al.*, *Technology, Employment, and Output per Man in Iron Mining*, WPA–NRP Report E-13, Philadelphia, 1940; *Report on Mining Industries, 1880* and *Report on Mineral Industries in the United States at the Eleventh Census, 1890*, Bureau of the Census; *Mineral Resources*, 1899–1925; and Harold Barger and Sam H. Schurr, *The Mining Industries, 1899–1939: A Study of Output, Employment and Productivity*, New York (NBER), 1944, Table A-1.

For 1948 and 1953: *Minerals Yearbook*, Bureau of Mines, annual issues and preprints for 1953; data for 1953 are incomplete and are subject to revision.

[a] Ores containing less than 5 per cent of manganese are included in iron ore. Our primary sources also include, in early years, manganiferous ore (5 to 25–40 per cent manganese) with iron ore (see Spencer, *op. cit.*, Table B-6, note k). These quantities are shown separately in our table and have been deducted from iron ore. Manganiferous ore was negligible in 1880.

[b] The 1953 data for manganese and manganiferous ores are slightly defective because the *Minerals Yearbook* preprints make the distinction with reference to battery ores only between the ores containing less than 25 per cent and 25 per cent or more manganese. For all other varieties 35 per cent of manganese is the dividing point. However, the error involved is not very serious as the total of battery ore represents 1.3 per cent of the sum of manganese and manganiferous ores in 1953.

[c] Production of gold in Alaska is excluded throughout. Prior to 1906, gold, silver, copper, lead, and zinc are expressed in terms of product, rather than by industry breakdown (see discussion in text). Moreover, the early figures represent metal recovered, rather than recoverable metallic content, a distinction also discussed in the text.

[d] The fluorspar series begins in Barger and Schurr, *op. cit.*, in 1909. However, data are available for earlier years in *Minerals Yearbook, 1925*, Part II, p. 13; and they are included, since employment in fluorspar, reported on an industry basis, is part of lead and zinc employment.

[e] The 1889 data are from *Mineral Resources, 1918*, Part I, p. 516, the only issue where corrected figures were published.

[f] The flask as defined in early issues of *Mineral Resources* equals 76.5 pounds and was converted into 76-pound flasks, the basis for later data.

[g] Estimated on the basis of 1952 relationship of 60 per cent tungsten oxide short ton and 1,000 pound tungsten content.

was booming in the 1880's in California until restrictive legislation put a stop to it. The problem was solved here by including placer gold prior to 1899 and by linking in 1899 to the series excluding it.

The problem of consistency between output and employment figures arises in the nonferrous metal industries. The Bureau of Mines publishes its output data in *Minerals Yearbook* on a commodity basis, while its employment data, found in the accident bulletins, are presented on an industry basis. The difficulty looms large in the Barger and Schurr work; their solution is by way of adjusting the output data to make them correspond to the employment data.[12] However, it was possible to follow that procedure only beginning with 1906. Prior to that date, the data do not permit allocation of nonferrous metals to the several industries producing them and the data had to be used on a product basis for the output index of the total metal group. The link between the two sets of figures is easily obtained at the group level, and the problem of inconsistency with employment figures does not enter on this level. This obviates the need for elaborate adjustments of the kind to be found in Barger and Schurr in this volume, which is confined to the broader groupings of mineral industries. The Barger and Schurr procedure was, however, applied in 1948 and 1953 (see Table C-3).

A broader problem arises because metals can be measured in terms of quantities of ore or as the recovered or recoverable content of that ore. These measures would not yield the same picture of the movement of output, particularly in the nonferrous metal industries, because the qualities of ores change. Conceptually, the metallic content of ore is a more meaningful measure of output than the ore itself, since the derived productivity measure is influenced by the quality as well as the quantity of ore mined. The distinction between recoverable and recovered metallic content is of lesser significance; Barger and Schurr prefer the former because of the lag in time necessary for recoverable to become recovered metallic content and, also, because of considerations related to the separation of mining from manufacturing industries.[13] Our early figures are integrated with the Barger and Schurr pre-1906 data, and our later figures, with their post-1906 data. The link between the two is provided in their work.

As a final point of interest with reference to the output of metals, the index computed for the years prior to 1899 on the basis of data described above may be compared with some other published indexes. The comparison with the index implicit in Borenstein's output table[14] turns out

[12] For details see Barger and Schurr, *op. cit.*, notes to Table A–1 and Appendix B.

[13] Barger and Schurr, *op. cit.*, Appendixes B and D.

[14] *Op. cit.*, Table A–2. It may be noted that this index is derived by weighting output data throughout by 1929 prices.

TABLE C-4

Crude Petroleum and Natural Gas: Production and Unit Values, Key Years, 1880–1953

	Crude Petroleum		Natural Gas		Natural Gasoline		Well Drilling	
	(mil. bbl.)	($ per bbl.)	(bil. cu. ft.)	($ per th. cu. ft.)	(mil. gal.)	($ per gal.)	(mil. ft.)	($ per ft.)
1880	26	0.94	0	0	0	0	0	0
1889	35	0.77	250	0.0800	0	0	6.7	2.60
1899	57	1.13	223	0.0900	0	0	17.8	2.53
1909	183	0.70	481	0.1300	0	0	28.4	2.55
1919	378	2.01	746	0.2160[a] 0.0826[a]	352	0.1830	68.6	4.47
1929	1,007	1.27	1,918	0.0822	2,234	0.0709	88.1	4.76
1937	1,279	1.18	2,408	0.0513	2,065	0.0470	105.1	
1948	2,020	2.60	5,148	0.0647	6,162	0.0740	136.7	7.69
1953	2,360	2.68	8,397	0.0920	10,020	0.0600	198.4	8.36

SOURCE: For petroleum, natural gas, and natural gasoline, the data for 1880 and 1889 are from O. E. Kiessling *et al.*, *Technology, Employment, and Output per Man in the Petroleum and Natural-Gas Industries*, WPA–NRP Report E-10, Philadelphia, 1939, pp. 321 and 322 (value per unit of natural gas production in 1889 was derived from value data in *Mineral Resources, 1912*, p. 302); for 1899–1937 from Barger and Schurr, *The Mining Industries*, p. 285; for 1948 and 1953 from *Minerals Yearbook, 1948*, and 1953 preprints.

For well drilling, the series since 1929 is based on Department of Commerce data, extended to earlier years by using numbers of wells drilled as an extrapolator.

[a] In 1919, first figure, comparable with earlier years, refers to value at point of consumption; second figure, comparable with later years, refers to value at well.

favorably in the sense that the differences do not exceed one index point, and they are consistently in the same direction. The movement of our index in the early years is also almost perfectly parallel with that of the Leong index, despite somewhat different coverage and methods of weighting.[15] Finally, if an index for metal mining had been presented in the Spencer study, strong parallelism could have been expected because many of the underlying data and estimates are identical.

CRUDE PETROLEUM AND NATURAL GAS

The derivation of the quantities and the unit values used as weights in the output index for the oil and gas producing industry group can be seen in Table C-4. One point in the table deserves specific comment. The inclusion of well drilling in the composite output index of oil and gas wells is an innovation. The idea itself is not new; Barger and Schurr recognized that the peculiar importance of development activity in the oil and gas portion of the mining sector posed a conceptual problem with regard to the index of productivity, inasmuch as the labor input estimates include manhours spent in drilling. The inclusion of well drilling in the output index is justified as a means of improving consistency between the output and employment figures.[16] Table C-5 shows the extent to which inclusion of well drilling modifies the output index of the oil and gas group. The productivity indexes show a more regular movement when based on the output measure inclusive of drilling.

TABLE C-5

Crude Petroleum and Natural Gas: Alternative Indexes of Output, Key Years, 1880-1953
(1929 = 100)

	1880	1889	1899	1909	1919	1929	1937	1948	1953
Excluding drilling	2.8	6.1	8.1	18.3	34.7	100.0	123.8	207.2	254.6
Including drilling	2.2	6.2	10.2	20.7	41.7	100.0	122.8	196.6	248.3

NONMETALLIC MINING AND QUARRYING

In extending the Barger and Schurr indexes for the three components of this group—stone, gypsum, and phosphate rock—from 1909 back to 1880, the latter two minerals presented no special difficulties. Extrapolation

[15] Our modifications in classification have been already discussed. Moreover Leong's coverage is broader since he did not have to deal with employment data as well. Also, he weighted quantity data by the average 1935–39 unit values.

[16] For more detailed discussion, see Barger and Schurr, *op. cit.*, pp. 190 ff. It should also be noted that the figures of the Office of Business Economics, which we have used after 1929, take into account cost differences due to varying depths of wells. Numbers of wells, the unit used prior to 1929, is a less precise real-cost measure.

was by means of the Spencer indexes, which are based on physical units. In the case of stone, however, a major problem was encountered.

In the 1909 and subsequent censuses, production of the various types of stone was reported in terms of short tons, whereas in the 1890 Census different units were employed, varying with the categories of stone and the uses to which they were put. Spencer and Leong avoided the problem of converting units by deflating estimates of the value of stone production by the wholesale price index of building materials. This procedure is unsatisfactory, since the index is based on prices of materials other than stone. The more difficult alternative involved converting the units of measurement employed in the 1890 Census to short tons and thus obtaining quantity figures more or less consistent with the later data. Experimentation with this procedure, and computation of comparable unit values for the various categories, suggested that average unit values had increased significantly less than the wholesale price index for building materials and that the deflated value estimate for 1889 had an upward bias relative to 1909. When completed, our index number of output (1929 = 100) for the stone industry in 1889 was 31.0 compared with Spencer's 55.7 and Leong's 44.6 (for the construction group).

Interpolation between 1889 and 1909 and extrapolation to 1880 were done on the basis of deflated value,[17] but the establishment of a quite different 1889 benchmark from those previously available changes the trend of the series significantly. Some explanation of the 1889 estimate is therefore in order.

For about two-thirds of the categories of stone production, as indicated by the asterisks in Table C-6, relatively reliable conversion factors were available. These factors were derived from output figures for later years reported by the Bureau of Mines both in short tons and in the other physical units involved—cubic feet, square feet, linear feet, number of paving blocks, etc. We computed the conversion factors for each variety and use of stone given in the published figures for some six individual years covering a span of over twenty years. The conversion factors were found to be almost constant through time, a circumstance expected because the use of stone within each variety is determined by its qualities, among which the degree of porosity and specific gravity are important ones.

For the remaining items, other than limestone used for lime and cement, conversion factors were obtained by consulting the technical literature.[18]

[17] The 1880 value of output was deflated by an extension of the 1889 average unit value by the Warren and Pearson index of the prices of building materials, instead of the BLS index. G. F. Warren and F. A. Pearson, *Wholesale Prices for 213 Years, 1720 to 1932*, Ithaca, Cornell University Agricultural Experiment Station, Memoir 142, 1932.

[18] In particular, Oliver Bowles, *The Stone Industries*, New York, McGraw-Hill, 1939.

The factors ranged from 11 to 12 cubic feet per short ton for quality stone (used for construction, monuments, and decoration) to over 21 cubic feet per short ton for crushed stone (which was relatively unimportant in 1889). While the conversion factors were not wholly stable in some instances, they seemed to be firmly enough based to be used.

TABLE C-6

Varieties of Stone: Distribution of Value of Production by Use, 1889
(per cent)

	Type of Stone				*Total*
	Granite	Marble	Limestone	Sandstone	
Building	13.7[a]		12.0[a]	15.8[a]	41.5
Monumental and decorative	5.3[a]	7.8[a]			13.1
Paving	6.6[a]			5.1 0.7[a]	12.4
Other streetwork, bridges, dams, railways	6.1		8.2	2.3	16.6
Lime[b]			3.7		3.7
Cement[b]			4.5		4.5
Flux			3.5[a]		3.5
Abrasive				1.3	1.3
Miscellaneous	0.5		0.3[c]	2.6	3.4
Total	32.2	7.8	32.2	27.8	100.0
Items with reliable conversion factors[a]	25.6	7.8	15.5	16.5	65.4

SOURCE: The percentages are based on value figures given in *Report on Mineral Industries, 1890.*

[a] Conversion factors were derived from production data in alternative units, given in *Mineral Resources* and the *Minerals Yearbook* for a number of years and considered to be reliable. The estimate for monumental and decorative marble is based on statements of a general nature in *Report on Mineral Industries, 1890,* p. 618. The proportion in terms of value for all other uses does not exceed 2.3 per cent in later years.

[b] Derivation is discussed in the text.

[c] The figure consists of two parts: 0.1 per cent is the miscellaneous category gven by *Report on Mineral Industries, 1890*; 0.2 per cent is due to discrepancies in estimates made for the limestone used for making lime.

With respect to limestone used for making lime, Bowles estimated that 100 pounds of stone are required to produce 56 pounds of lime.[19] By means of this ratio, the quantity data on lime production in the 1890 Census were converted to quantities of limestone. The conversion was more difficult in the case of limestone used for making cement. A conversion factor could be found only for the relationship between limestone and Portland cement. By applying this factor to the output of Portland cement in 1909, the limestone used to produce natural cement could be derived as a residual. The 1909 ratio between estimated limestone consumption and natural cement production was used to derive the 1889 limestone output (see Table C-7).

TABLE C-7

Estimated Limestone Used in Cement Production, 1889 and 1909

	1889		*1909*	
	Output of Cement[a] (thousands of barrels)	Limestone Used (millions of short tons)	Output of Cement[a] (thousands of barrels)	Limestone Used (millions of short tons)
Natural cement	6,532	9.34[b]	1,538	2.2[c]
Portland cement	300	0.07[d]	64,991	14.6[d]
Total		9.41		16.8[e]

[a] Statistical Appendix to *Minerals Yearbook, 1935*, p. 178. Apart from natural and Portland cement, there is a third kind, pozzuolan, but only the first two are made of limestone.

[b] Estimated by applying the 1909 ratio of limestone used for natural cement to output of natural cement.

[c] By deduction of stone used for Portland cement from stone used for total cement.

[d] Estimated by using the relationship quoted in E. C. Eckel, *Cements, Limes and Plasters*, 2nd. ed., New York, Wiley, 1922, p. 275, of 225 tons of limestone per 1,000 barrels of Portland cement.

[e] Barger and Schurr, *The Mining Industries*, p. 289.

The result of the conversion of the various types of stone output to short tons in 1889, together with other nonmetallic mining output, is summarized in Table C-8. A final word should be said about slate, which is treated separately from stone in the censuses. The 1890 Census reported roofing slate in numbers of squares. The squares were converted to short tons by use of a three-to-one ratio.[20] The output of other slate was

[19] *Ibid.* pp. 387–88.

[20] Based on *Mineral Resources, 1925*, Part II, p. 66.

reported only in value terms. Here, the estimated 1909 price per short ton[21] was extrapolated to 1889 by means of the price index for building materials, and the physical volume was obtained by deflation of value. Use of the unsatisfactory deflation procedure in this minor instance could hardly affect the level of the 1889 index.

TABLE C-8

Nonmetallic Mining and Quarrying: Production and Unit Values, by Type of Stone, 1889

	Quantity (thousands of short tons)	Unit Value (dollars per short ton)
Granite	4,320	3.35
Marble	284	12.29
Limestone	28,713	0.50
Sandstone	6,227	2.01
Slate	295	11.80
Gypsum	268	1.13
Phosphate Rock	607	5.98

Extension to recent years. The 1948 and 1953 quantities and prices represent a simple continuation of the Barger and Schurr series for stone, gypsum, and phosphate rock, based on data from the *Minerals Yearbook.* The detail is presented in Table C-9.

Coverage adjustment. Once the Barger and Schurr figures were extended to 1880–1953, the question of serious undercoverage of the nonmetallic mining and quarrying industries called for a solution. To this end, an adjustment ratio was applied in each key year to the group output index derived on the basis of estimates described in the preceding pages.

The adjustment ratios for each key year were obtained from the value of product for Barger and Schurr coverage (i.e., stone, including slate, gypsum, and phosphate rock) and from the total value of product for full coverage. In addition to stone, gypsum, and phosphate, the latter includes asbestos, asphalt and bitumens, barite, borates, bromine, clay (including Fuller's earth), emery (including corundum), feldspar, gems and precious stones, graphite, magnesite, magnesium chloride and sulfate, marl, mica, millstones (and buhrstones), monazite and zircon, peat, potash, sand and gravel, silica and silicates, calcium chloride, sodium carbonates and sulfates, sulfur, and talc (and soapstone). Tests indicated that the difference between the true total and our "full coverage" was within 1 per cent.

[21] After conversion of the reported square feet to short tons using the ratio of 300:1 based on *Mineral Resources, 1925,* Part II, p. 66.

TABLE C-9

Nonmetallic Mining and Quarrying: Production and Unit Values, by Type of Stone, 1948 and 1953

	1948		*1953*	
	Quantity (thousands of short tons)	Unit Value (dollars per short ton)	Quantity (thousands of short tons)	Unit Value (dollars per short ton)
Dimension stone				
Granite	639	34.92	604	40.49
Marble	83	110.10	76	110.56
Nondimension marble	193	6.81	377	9.96
Limestone	607	17.43	799	19.40
Sandstone	204	20.41	354	24.43
Slate	141	48.90	153	43.72
Nondimension slate	659	9.13	546	10.91
Miscellaneous dimension stone	80	22.07	65	42.23
Nondimension stone				
Nondimension basalt	20,600	1.45	30,000	1.54
Dimension basalt	58	1.33	59	3.65
Granite	13,050	1.26	22,890	1.37
Limestone	180,700	1.23	243,260	1.35
Limestone used for cement	56,500	0.61	66,300	0.75
Sandstone	7,090	1.96	8,300	2.37
Miscellaneous nondimension	16,810	0.87	18,980	1.08
Gypsum	7,250	2.63	8,290	2.79
Phosphate rock	9,390	5.83	12,500	6.13

Table C-10 shows both the corrected and uncorrected indexes for nonmetallic mining and quarrying. The validity of the adjustment rests on the reasonableness of the underlying assumption that unit values of the covered and uncovered products showed parallel movement (see Appendix D for a general discussion of coverage adjustments).

TABLE C-10

Nonmetallic Mining and Quarrying: Output Indexes, Unadjusted and Adjusted for Coverage, Key Years, 1880–1953

	Unadjusted Index	*Coverage Adjustment*		*Adjusted Index*
		Per Cent	Index	
	(1929 = 100)		(1929 = 100)	
1880	12.0	0.9452	165.6	7.2
1889	28.1	0.9452	165.6	17.0
1899	36.9	0.8803	154.2	23.9
1909	66.6	0.7429	130.2	51.1
1919	50.6	0.5945	104.2	48.6
1929	100.0	0.5708	100.0	100.0
1937	68.3	0.5580	97.7	69.9
1948	117.5	0.5402	94.6	124.2
1953	151.6	0.5400	94.6	160.3

ANNUAL DATA

The annual indexes of output have been taken from primary sources wherever readily available; in other cases, they have been estimated by interpolation between the key years. Indexes of output for groups of mining industries, constructed by Leong and by the Board of Governors of the Federal Reserve System for the later period, and an index that we constructed on an annual basis using all available quantity data served as interpolators.

Labor Input

The backbone of the estimates of employment and manhours in the mining groups is the work of Barger and Schurr for 1899–1939. Their data required certain adjustments and supplementation to achieve full coverage of class of worker and industry for the key years used in this study. They were extrapolated back to 1880 largely by data in the censuses of 1880 and 1889, and forward to 1957 by the employment estimates of the Department of Commerce and the average hour estimates of the Department of Labor.

First, we shall describe briefly the sources and methods used by Barger and Schurr and point up some of the general conceptual and statistical problems. Then we shall describe, by industry, the sources and methods

used to supplement and extrapolate the Barger and Schurr estimates. The sources used for the recent estimates can be described in a single section, since they are uniform for all segments. Finally, the method of estimating proprietors throughout the entire period will be explained, and the weighting system by which total manhours in the various groups are combined into labor input for the segment as a whole will be described.

SOME GENERAL PROBLEMS

The estimates by Barger and Schurr of employment and mandays worked in the mining groups other than oil and gas were derived for the most part from the accident reports of the Bureau of Mines and the 1902 Census. Except for 1902, then, the output and employment estimates are based on two separate canvasses by the Bureau of Mines, but Barger and Schurr maintain that with a few exceptions, the industry coverage of the two sets of estimates is comparable. In the few cases of patent undercoverage of certain parts of the industry groups, they have made adjustments. The industry coverage in the quarrying and nonmetallic minerals groups, while the same for labor as for output, is admittedly partial for both, and we have applied coverage adjustments to manhours as well as to output.

The employment data of the Bureau of Mines relate to "active-period averages," that is, averages of monthly counts for only those months in which the reporting establishments were active; in some cases in the latter years of the period, the estimates represent the actual number of mandays worked, as tabulated for payroll purposes, divided by the number of days per year that the mines were operated. The active-period average employment series are not well suited for comparison with output since they do not reflect changes in the extent of mine operation from year to year and are closer to a labor force concept. Accordingly, Barger and Schurr compared output with mandays and manhours worked. The manday estimates usually represent the active-period average number of employees multiplied by the average number of days the mine was active (computed separately for each enterprise by the Bureau of Mines), but they may also represent actual payroll records of mandays worked. The manhours estimates represent mandays multiplied by nominal hours worked per day. For consistency with the other segments, our emphasis is on the manhour estimates, and we computed ratios of output to manhours rather than to mandays.

Although the relationship of average employment to output is less meaningful in mining than in other segments, we needed employment estimates to arrive at economy aggregates. For consistency of treatment with that of other segments, the Commerce employment estimates from 1929 forward were used and were extrapolated back by the Barger series as

extended to 1870 by data from the censuses. The Commerce estimates represent full-period averages and, thus, the extrapolation by active-period averages[22] represents a break in continuity. Active-period average employment shows less volatility over the cycle and, conversely, the implicit series on average hours worked per year are more volatile. However, the levels of the two types of employment estimates tend to be close together in years of sustained activity, and the employment trend in the spliced series should evidence continuity. In the petroleum and natural gas group, the estimates for the early period are on a full-period average basis consistent with the later estimates. Differences between estimates on the alternative bases in this group would be negligible anyway, since operations are generally continuous.

A further problem is introduced by the fact that the accident bulletins of the Bureau of Mines report only employees "in and about mines." Thus, proprietors and certain categories of salaried workers such as general officers and clerks are not covered. On the basis of detailed information presented in the censuses of 1889, 1902, and 1939, the percentages of total employment accounted for by these categories could be estimated. The proportions involved are small and have not changed drastically; but to approximate our ideal of full coverage of persons engaged, we applied the coverage adjustments in Table C-11 to the

TABLE C-11

Coal and Metal Mining: Adjustment Ratios for Coverage of Number Employed and Manhours, 1889, 1902, and 1939

	1889	1902	1939
Bituminous	0.980	0.980	0.971
Pennsylvania anthracite	0.980	0.980	0.962
Metals	0.980	0.952	0.952

Barger and Schurr estimates for three groups of mining industries, interpolating linearly between benchmarks. The adjustment for quarrying and nonmetallic mining was included in our over-all industry coverage adjustment, described later. The available employment estimates for the oil and gas group cover wage earners only; so total salaried employment was estimated as described in the section on that group.

[22] The 1902 Census employment estimates were on a 300-day basis, but were converted to active-period averages by the method used by Barger and Schurr in metal mining (*op. cit.*, p. 300). The 1889 Census definitely reverts to active-period averages, and whereas the 1880 Census is not explicit on this point, the indications are that the employment estimates are consistent with those for 1889.

SUPPLEMENTATION AND EXTENSION OF BARGER AND SCHURR ESTIMATES

Under this heading we present, by group, the basic data and estimates for key years for which no figures are available in the Barger and Schurr volume.

Coal. The figures in Table C-12 are consistent with the Barger and Schurr estimates. The estimates for 1899 were obtained by multiplying their estimates of mandays by estimated average hours worked per day.

TABLE C-12

Coal: Employment and Manhours, 1880, 1889, and 1902

	Number Employed		*Manhours*	
	Bituminous	Pennsylvania Anthracite	Bituminous	Pennsylvania Anthracite
	(thousands)		(millions)	
1880	100.0	70.7	215.7	145.0
1889	175.2	124.3	376.2	236.2
1902	370.1	148.1	749.0	163.2

SOURCE: 1880: Spencer, *Mineral Extractive Industries*, pp. 153–54; and W. E. Hotchkiss *et al.*, *Mechanization, Employment, and Output per Man in Bituminous-Coal Mining*, WPA–NRP Report E-9, Philadelphia, 1939, p. 358, adjusted to include salaried employees "in and about mines" on the basis of data in *Report on Mining, 1880* for the "administrative force."

1889: Employment data are from *Report on Mineral Industries, 1890*, p. 347; manhours was estimated by using data in *Mineral Resources, 1925*, Part II, p. 410, on average number of days per year and estimates by Spencer, *Mineral Extractive Industries*, on average number of hours per day.

1902: Barger and Schurr, *The Mining Industries*, Table A-3, p. 312.

Metals. The figures for employment and manhours in the metal mining industries have been derived for 1880 and 1889 by components (see Table C-13).

In metal mining, the key years of 1899 and 1909 were not covered by Barger and Schurr. We have made estimates separately for iron ore, copper, and the group of other nonferrous metals by making a linear interpolation of the ratio of output to mandays between 1889 and 1902 and between 1902 and 1911,[23] and then applying the interpolated ratio to the output index numbers for 1899 and 1909. Adjustments for the average number of active days per year and the average number of hours worked per day[24] yielded numbers employed and manhours, respectively. The results are presented in Table C-14.

[23] Data for 1902 and 1911 are to be found in the Barger and Schurr volume. However, for the 1899 interpolation, the 1902 figures had to be adjusted to include placer gold.

[24] Both have been estimated separately for iron ore, copper, and the group of other nonferrous metals.

TABLE C-13

Metal Mining: Employment and Manhours, by Type of Ore, 1880 and 1889

	1880		*1889*	
	Number Employed (thousands)	Manhours (millions)	Number Employed (thousands)	Manhours (millions)
Iron ore	31.67	72.4	38.23	93.5
Copper	6.26	16.8	9.82	26.4
Manganese	0.23	0.7	0.60	1.6
Gold and silver	30.00	91.2	56.92	117.4
Lead	7.48	20.2	9.00	15.6
Mercury	2.20	6.5	1.00	2.7
Total[a]	78	208	115	257

SOURCE: *Report on Mining, 1880; Report on Mineral Industries, 1890; Census of Mineral Industries, 1939;* Spencer, *Mineral Extractive Industries;* Y. S. Leong *et al.*, *Technology, Employment, and Output per Man in Copper Mining*, WPA–NRP Report E-12, Philadelphia, 1940; Yaworski *et al.*, *Iron Mining*. The figures include placer gold. Correction was made to make the employment data consistent with that for output with respect to manganiferous ore. On both points, see discussion in the text in section on output. Employment in bauxite mining was negligible.

[a] The totals are adjusted with respect to fluorspar in Illinois and Kentucky and to pyrites (see section in text on output).

Oil and gas wells. In terms of available information with respect to employment and manhours, this is the most difficult group of mining industries. Barger and Schurr put it this way:

> Prior to the Census of Mineral Industries for 1939 there was no comprehensive survey of employment in the petroleum and natural gas industry. Bureau of Mines statistics similar to those we have used for most other important mineral industries are not available except for a few recent years. For years prior to 1939, information from the decennial Censuses is either lacking altogether, or deficient. In 1929, for instance, no attempt whatever was made to cover the industry. In the reports on the industry in 1909 and 1919 a very important part of total operations—that conducted by contractors—remain untouched. Only in the Census of 1902 was information collected in anything approaching as comprehensive a fashion as that of the Census of 1939.[25]

For the period between 1902 and 1939 Barger and Schurr published estimates only for 1929 and 1935–38. However, the NRP offers estimates

[25] *Op. cit.*, p. 325.

TABLE C-14

Metal Mining: Employment and Manhours, by Type of Ore, 1899 and 1909

	Iron Ore		*Copper*		*Other Nonferrous Metals*		*Total*	
	Number Employed (thousands)	Manhours (millions)	Number Employed (thousands)	Manhours (millions)	Number Employed (thousands)	Manhours (millions)	Number Employed (thousands)	Manhours (millions)
1899	36.6	93.1	24.2	62.4	73.3	141.7	134.1	297.2
1909	62.9	156.7	62.1	140.6	77.6	155.2	202.6	452.5

TABLE C-15

Oil and Gas Group: Wage Earner Employment and Manhours, Key Years, 1880–1937

	Number Employed (thousands)	Manhours (millions)
1880	11.48	41.3
1889	18.50	67.3
1899	45.80	167.3
1909	46.75	140.9
1919	111.20	275.3
1929	179.00	413.3
1937	159.80	315.9

SOURCE: Kiessling *et al.*, *Natural-Gas Industries*, p. 327. The 1899 estimates were derived by interpolation between 1889 and 1902, following the same principle as in the case of metal mining.

TABLE C-16

Oil and Gas Group: Estimates of Salaried Employees, Key Years, 1889–1939

	Number Employed			*Estimated Annual Number of Hours per Employee*[a]	*Total Manhours of Salaried Employees (thousands)*
	Producing Operations[b]	Contractors[c]	Total		
1889	2,305	336	2,641	3,579	9,452
1902	4,596	645	5,241	3,558	18,647
1909	6,128	590	6,718	3,034	20,382
1919	24,400	1,289	25,689	2,470	63,452
1929	33,115	3,082	36,197	2,310	83,615
1937	25,888	2,406	28,294	1,977	55,937
1939	32,327	5,153	37,480	1,779	66,677

[a] Kiessling *et al.*, *Natural-Gas Industries*. The figures refer to wage earners, and the assumption is made that they apply also to salaried employees.

[b] The figures here refer to total salaried employees, not to salaried employees in and about mines. Sources of data are: 1889: *Report on Mineral Industries, 1890*; 1900, 1902, 1909, 1919, and 1939: *Census of Mineral Industries, 1939*; 1929 and 1937: estimated by interpolation of ratio of wage earners to salaried employees.

[c] Estimates are based on the assumption that the ratio of salaried employees to wage earners for contractors and for regular producers showed the same movement. Thus, two kinds of movements are taken into account: that of the ratio of wage earners to salaried employees in the oil industry, as represented by regular producers, and of employment in contracting services, as represented by number of wage earners. 1939 figure is from *Census of Mineral Industries, 1939*.

for many of the other key years within the 1880–1937 period. These estimates, in the words of Barger and Schurr, ". . . represent the abstract of an enormous amount of research . . ." and are the best available. Since the difference between full-period and active-period averages is of no practical significance for the group of oil and gas wells, it was easier for us to rely heavily on the NRP study. Moreover, this study takes into account workers employed by contractors. The series in Table C-15 represent only the wage earners, including those employed by contractors. Estimates of all salaried employees in the industry are contained in Table C-16; our sources and methods of derivation are explained in the footnotes.

Nonmetallic mining and quarrying. As in the case of output, the data on employment and manhours for this group of mining industries are poor. In consequence, our estimates are not entirely satisfactory, but they are sufficiently consistent with the output figures; so the productivity trends for the group, and especially for the mining segment, should not be distorted. Our basic estimates cover stone, gypsum, and phosphate rock. The estimates for this part of the group for the key years not covered in the Barger and Schurr study are given in Table C-17; the footnote describes the sources and methods used.

TABLE C-17

Nonmetallic Mining and Quarrying: Employment and Manhours, Key Years, 1880–1919

	Number Employed (thousands)	Manhours (millions)
1880	39.6	89.4
1889	80.8	182.5
1899	94.2	166.7
1909	127.2	259.2
1919	78.4	185.8

SOURCE: 1880: Number employed was estimated by using the figure on manhours and some evidence found in *Census of Mines and Quarries, 1902*, concerning average hours worked in 1880. Manhours was extrapolated by the Spencer estimates (*Mineral Extractive Industries*) on manhours.

1889: Data of *Report on Mineral Industries, 1890* on employment adjusted to exclude lime (see discussion in the section on output). Manhour figures were obtained with the help of census data on average number of days worked per year and an estimate of the average number of hours per day.

1899 and 1909: Estimated by interpolation between 1889 and 1902 and between 1902 and 1911 (figures for 1902 converted from 300-day workers to active-period averages). The method of interpolation was similar to that described in the section on metal mining above.

1919: Sum of Barger and Schurr figures (*The Mining Industries*) on gypsum and phosphate rock plus our estimate for stone. The latter was derived by applying to the Barger and Schurr estimate of mandays the figures from *Quarry Accidents*, Bureau of Mines, on average number of mandays per year and average number of hours per day.

Since a significant and increasing portion of the segment was not covered by the continuous industry estimates, adjustments for full coverage were worked out from census data for 1889, 1902, and 1939 (Table C-18). The adjustment ratios for employment and manhours were interpolated for key years between 1902 and 1939 by means of the adjustment ratios for output, described in a preceding section and presented in Table C-10.

TABLE C-18

Nonmetallic Mining and Quarrying: Adjustment Ratios for Full Coverage of Employment, Manhours, and Output, Key Years, 1889–1939

	Number Employed	Manhours	Output
1889	0.9346	0.9320	0.9452
1902	0.9050	0.8993	0.8881
1909	0.7536	0.7435	0.7429
1919	0.5988	0.5851	0.5945
1929	0.5708	0.5519	0.5708
1939	0.5476	0.5238	0.5513

RECENT-PERIOD ESTIMATES

Although the Commerce estimates of employment in the mining groups were generally used beginning 1929, for the petroleum and natural gas group the Commerce estimates have been used only since 1939. Careful examination of this series and the NRP series has convinced us that the latter is a more accurate representation of employment movements between 1929 and 1939. The Barger and Schurr estimates, as supplemented and extended, were linked to the Commerce estimates in the year indicated.

Estimates of average hours worked per week prepared by BLS are available since the mid-1930's for mineral industries. These are consistent with the OBE full-period employment estimates, and the two series have been used jointly to obtain estimates of manhours worked for 1939 and later years. The absolute levels of manhours so derived are quite close to the manhours estimates of Barger and Schurr after adjustment in the several instances already noted. This serves to confirm our impression that the two sets of estimates are reasonably consistent in industry and class-of-worker coverage. Unfortunately, it has not been possible to compare the current movement of the OBE-BLS-based manhour estimates with manhours prepared by the Barger method, since the Bureau of Mines has discontinued publishing some of the information needed.

PROPRIETORS

Proprietors represent a category that has been considered part of labor input throughout this volume. Therefore, although information is scanty, an effort has been made to include them in the mining sector as well.

Our procedure of estimating the number of proprietors in each group of mineral industries is based on the 1939 figures of the *Census of Mineral Industries*,[26] extrapolated forward, and back to 1929, by the OBE series. For 1909 and 1919 the figures given in the mining censuses for those years were adopted. The 1902 estimates were derived by extrapolation of the 1909 figures by data on the number of unincorporated firms. Finally, for all years previous to 1902, the estimates of total persons engaged were linked to the employee estimates, a procedure which is equivalent to extrapolation of 1902 proprietors by the sum of wage earners and salaried employees.

The oil and gas wells group again introduced special problems. In the first place, data on the contractors' portion of the industry were lacking, and our estimates had to be based on the same principles as those applied to salaried employees. Secondly, the 1902 estimates obtained in the fashion just described seemed improbably high; this forced another exception to the procedure followed elsewhere, and the link of 1902 was in this case moved to 1909.

Hours worked by proprietors have been derived by applying to the estimated number of proprietors either BLS average weekly hours for those years in which they are available or the average hours implicit in the Barger and Schurr study for the earlier period, multiplied by the estimated number of weeks worked per year and days worked per year respectively. In the case of oil and gas wells, since Barger and Schurr offer only a few figures on labor input, our estimates for the rest of the key years were based on NRP Report E-10.[27] The estimates of number of proprietors and manhours are given in Table C-19.

With the help of Borenstein's 1870 estimates of the number of wage earners and of the average number of hours worked per year,[28] the man-hour figures for 1870 can be derived by extrapolation for each of the five components of the mining segment. When compared with the output estimates, however, the computed productivity ratios seemed high relative to 1880; consequently, we do not publish the 1870 figures but use the manhour estimates in deriving economy totals.

WEIGHTING SYSTEM

In accordance with the basic procedures in this study, manhours in each of the five mineral groups were weighted by average hourly compensation in order to obtain labor input in the segment as a whole. The average

[26] This represents a modification of the methods applied in other sectors of the economy, where the OBE figures were used as given; but the 1939 Census data seemed, on several grounds, more reliable for our purposes and yielded more reasonable results when extrapolated backwards.

[27] O. E. Kiessling *et. al.*, *Technology, Employment, and Output per Man in the Petroleum and Natural-Gas Industries*, WPA–NRP Report E-10, Philadelphia, 1939.

[28] *Op. cit.*, Table 3.

TABLE C-19

Mining: Estimates of Proprietors, by Group, Key Years, 1902–53

	Number (Thousands)				*Manhours (Millions)*			
	Bituminous Coal	Metals	Oil and Gas Wells	Nonmetallic Mining and Quarrying[a]	Bituminous Coal	Metals	Oil and Gas Wells	Nonmetallic Mining and Quarrying[a]
1902	6.3	5.3	n.a.	6.3	8	13.9	n.a.	18.0
1909	3.7	4.2	26.7	3.5	8	11.1	80.9	10.0
1919	4.2	1.4	20.0	1.8	7	3.4	49.4	4.9
1929	3.0	0.4	7.0	1.6	10	0.9	16.2	4.3
1937	4.6	0.8	7.8	2.1	9	1.5	15.4	4.1
1939	4.6	0.8	7.8	2.1	16	1.5	14.2	3.9
1948	5.8	0.4	10.9	2.1	10	0.8	20.7	4.4
1953	5.2	0.2	10.9	2.5	8	0.4	20.5	5.3

NOTE: In the Pennsylvania anthracite coal industry numbers of proprietors and manhours worked were negligible.

n.a. = not available.

[a] After adjustment for coverage.

compensation estimates were based on the total compensation series of the Department of Commerce for 1929 and subsequent years, extrapolated to 1919 by Kuznets' estimates. The relative weights used to combine the five manhour indexes in each of the subperiods are shown in Table C-20.

TABLE C-20

Mining: Relative Weight of Manhours, by Group, Subperiods, 1919–53
(per cent)

	1919–29	1929–37	1937–48	1948–53
Bituminous	42.2	38.3	40.6	42.4
Pennsylvania anthracite	14.2	15.3	13.7	13.3
Metals	12.2	12.8	13.5	13.9
Oil and gas wells	24.9	26.0	25.7	24.5
Nonmetallic mining and quarrying	6.5	7.6	6.5	5.9

Capital

Our measures of capital are built upon those of Israel Borenstein.[29] Capital is defined by Borenstein as follows: "The depreciated net value of structures and equipment is designated as 'plant,' and the sum of inventories, cash, and receivables as 'working capital.' The net value of surface land and mineral resources owned by the mining establishment, excluding leased land, we designate 'land.' The sum of plant and working capital we call 'capital,' and the sum of capital and land, 'total capital.' "[30]

For our purposes, capital is defined as plant plus inventories. The cash and receivables are eliminated from working capital. Land is not included owing to the difficulties of deflating the book values into meaningful real terms, a fact that has been noted by Borenstein.[31] Consequently, our capital figures in Table C-21 are taken from the worksheets underlying Tables A-3 and A-4 in Borenstein's study. Generally speaking, Borenstein's figures up to 1919 are based on the censuses of mineral industries and on the data of the Internal Revenue Service, adjusted to Census coverage, for the years beginning with 1929. The value of reproducible capital was converted to constant 1929 prices.

In terms of the consistency in coverage with output and labor input, the capital figures are satisfactory for the study of trends. As a matter of fact, for a considerable number of the key years, Borenstein's coverage is identical to ours. The two exceptions, oil and gas wells and nonmetallic mining and quarrying, are noted in Table C-21.

[29] *Op. cit.* ,Tables A–3 and A–4.
[30] *Ibid.*, p. 16.
[31] *Ibid.*, pp. 42–43 and Appendix D.

TABLE C-21

Mining: Plant and Inventories, by Group, Key Years, 1870–1953
(millions of 1929 dollars)

	Bituminous		*Pennsylvania Anthracite*		*Metals*		*Oil and Gas Wells*	*Nonmetallic Mining and Quarrying*[b]		
	Plant	Inventories	Plant	Inventories	Plant	Inventories	Plant and Inventories[a]	Plant	Inventories	*Total*
1870	23.3	1.4	32.7	0.7	33.8	2.3	17.7	6.5	0.6	119.0
1880	40.2	2.2	80.8	1.6	160.0	7.6	92.8	15.8	2.1	403.1
1889	100.6	2.7	106.1	1.4	309.5	25.9	325.0	63.2	7.8	942.2
1909	605.9	16.7	180.2	4.1	802.6	158.3	1,505.0	154.7	15.6	3,443.1
1919	882.8	23.9	205.0	4.7	693.2	169.4	3,675.0	146.7	14.8	5,815.5
								218.4	22.0	5,894.4
1929	700.0	51.0	173.7	19.2	704.0	208.2	5,698.8	298.1	80.7	7,933.7
1937	483.3	43.0	111.9	10.5	434.1	133.8	3,289.1	181.9	54.3	4,741.9
1948	521.8	73.0	75.0	11.4	352.6	80.9	5,571.5	190.4	35.7	6,912.3
1953	596.2	74.3	52.5	17.3	561.6	145.5	5,309.2	262.4	52.6	7,071.6

SOURCE: Israel Borenstein, *Capital and Output Trends in Mining Industries, 1870–1948*, Occasional Paper 45, New York (NBER) 1954, worksheets underlying Tables A-3 and A-4.

[a] The sum of plants and inventories was adjusted to cover contracting operations (which are mostly in drilling; see section on oil and gas wells output). The ratio of the total number of employed in the oil industry to the number employed by regular producers served as the adjustment factor.

[b] The figures refer to what we have called "full coverage" (see discussion of this group in output and labor input sections). In 1919 the first figure is comparable with the earlier years, the second with the later years.

Table C-21 contains no data for 1899 because they were not available. The estimates of capital input we have used for that year were derived by interpolation. The variable we interpolated between 1889 and 1902 was the ratio of output to capital, from which the estimated value of capital was then derived from the available output estimates.

The composite index of capital input for the mining sector was obtained by combining the indexes for the five groups of mining industries. The weighting factors—unit capital compensation—are based on OBE data on national income originating, extrapolated by the Kuznets national income estimates, less labor compensation. The relative weights are shown in Table C-22. This method contains one imperfection, which, however,

TABLE C-22

Mining: Relative Weight of Capital Input, by Group, Subperiods, 1919–53
(per cent)

	1919–29	1929–37	1937–48	1948–53
Bituminous	3.8	3.0	13.2	10.7
Pennsylvania anthracite	2.6	0.7	2.5	2.4
Metals	41.1	34.4	23.6	15.7
Oil and gas wells	41.6	54.8	53.7	63.2
Nonmetallic mining and quarrying	10.9	7.1	7.0	8.0

does not substantially affect the results: Royalties, the compensation for land, could not be entirely eliminated from the capital compensation estimates underlying the computation of weights. The trend rate of growth of the unweighted composite capital index is, on the whole, somewhat greater than that of the weighted index.

Total Factor Input

The index of total input was constructed by weighting the indexes of labor and of capital inputs by the unit compensation of each in the mining segment as a whole, as shown in Table C-23. This procedure yields the

TABLE C-23

Mining: Relative Weights of Labor and Capital Inputs, Subperiods, 1919–53
(per cent)

	Labor	Capital
1919–29	70.0	30.0
1929–37	65.4	34.6
1937–48	58.1	41.9
1948–53	63.3	36.7

same result as that obtained by weighting the total factor input of each group by the corresponding unit factor compensation.

TABLE C-I

Mining: Output, Inputs, and Productivity Ratios, Key Years, 1879–1953
(1929 = 100)

	Output	Persons Engaged	Output per Person	Manhours	Output per Manhour	Labor Input	Output Per Unit of Labor Input	Capital Input	Output per Unit of Capital Input	Total Factor Input	Total Factor Productivity
1879	9.8	26.6	36.8	30.4	32.2	31.1	31.5	10.3	95.1	24.9	39.4
1889	18.7	48.0	39.0	51.8	36.1	50.2	37.3	22.5	83.1	41.9	44.6
1899	31.3	62.3	50.2	63.1	49.6	62.0	50.5	37.8	82.8	54.7	57.2
1909	55.3	102.1	54.2	101.3	54.6	99.0	55.9	67.2	82.3	89.5	61.8
1919	68.7	108.3	63.4	104.3	65.9	103.8	66.2	80.0	85.9	96.7	71.0
1929	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1937	95.7	91.1	105.0	73.1	130.9	72.5	132.0	60.0	159.5	68.2	140.3
1948	133.3	95.1	140.2	88.9	149.9	88.5	150.6	78.3	170.2	85.3	156.3
1953	138.4	82.6	167.6	74.2	186.5	72.6	190.6	82.5	167.8	76.6	180.7

TABLE C-II

Mining: Output, Labor Inputs, and Productivity Ratios, 1879–1957
(1929 = 100)

	Output	Persons Engaged	Output per Person	Manhours	Output per Manhour	Labor Input	Output per Unit of Labor Input
1879	9.8	26.6	36.8	30.4	32.2	31.1	31.5
1889	18.7	48.0	39.0	51.8	36.1	50.2	37.3
1890	20.5	50.7	40.4	55.0	37.3	53.3	38.5
1891	21.7	51.9	41.8	56.2	38.6	54.7	39.7
1892	22.9	53.4	42.9	56.7	40.4	55.1	41.6
1893	22.4	53.1	42.2	54.2	41.3	53.4	41.9
1894	21.6	53.2	40.6	50.6	42.7	49.8	43.4
1895	24.3	55.1	44.1	55.1	44.1	54.6	44.5
1896	25.0	57.2	43.7	55.6	45.0	55.1	45.4
1897	24.9	56.8	43.8	53.9	46.2	53.2	46.8
1898	27.6	59.1	46.7	56.3	49.0	55.4	49.8
1899	31.3	62.3	50.2	63.1	49.6	62.0	50.5
1900	33.1	67.4	49.1	68.0	48.7	67.1	49.3
1901	35.9	73.0	49.2	73.7	48.7	72.5	49.5
1902	36.2	78.6	46.1	75.5	47.9	73.3	49.4
1903	41.9	82.7	50.7	83.4	50.2	82.2	51.0
1904	42.6	86.3	49.4	82.7	51.5	80.9	52.6
1905	47.0	91.1	51.6	90.4	52.0	88.8	52.9
1906	48.4	92.9	52.1	91.1	53.1	89.1	54.3
1907	53.4	96.3	55.5	100.7	53.0	99.4	53.7
1908	49.3	95.0	51.9	90.3	54.6	88.8	55.5
1909	55.3	102.1	54.2	101.3	54.6	99.0	55.9
1910	58.9	103.5	56.9	106.4	55.4	104.4	56.4
1911	58.4	102.2	57.1	109.6	53.3	107.0	54.6
1912	62.4	103.9	60.1	113.1	55.2	109.9	56.8
1913	66.2	107.8	61.4	119.6	55.4	117.1	56.5
1914	61.7	104.9	58.8	104.8	58.9	103.6	59.6
1915	66.5	102.6	64.8	104.5	63.6	102.8	64.7
1916	75.3	107.0	70.4	116.6	64.6	114.9	65.5
1917	80.2	111.4	72.0	123.0	65.2	121.9	65.8
1918	80.5	109.0	73.9	120.5	66.8	120.7	66.7
1919	68.7	108.3	63.4	104.3	65.9	103.8	66.2
1920	77.8	110.2	70.6	114.0	68.2	112.7	69.0
1921	61.5	107.6	57.2	88.5	69.5	89.0	69.1
1922	65.9	112.1	58.8	86.8	75.9	85.4	77.2
1923	90.2	121.4	74.3	114.4	78.8	113.1	79.8
1924	84.4	113.3	74.5	106.3	79.4	104.4	80.8
1925	86.7	109.1	79.5	102.1	84.9	100.6	86.2
1926	93.8	109.0	86.1	109.2	85.9	108.9	86.1
1927	93.5	109.6	85.3	102.8	91.0	102.6	91.1
1928	92.7	98.9	93.7	94.6	98.0	94.0	98.6
1929	100.0	100.0	100.0	100.0	100.0	100.0	100.0

(continued)

TABLE C-II (concluded)

	Output	Persons Engaged	Output per Person	Manhours	Output per Manhour	Labor Input	Output per Unit of Labor Input
1930	87.3	92.5	94.4	84.8	102.9	84.8	102.9
1931	72.2	82.0	88.0	66.3	108.9	66.9	107.9
1932	57.8	68.1	84.9	51.2	112.9	52.0	111.1
1933	63.1	69.2	91.2	54.4	116.0	55.2	114.3
1934	68.3	77.4	88.2	57.4	119.0	58.2	117.4
1935	73.9	79.6	92.8	57.9	127.6	58.1	127.2
1936	95.2	85.2	111.7	68.7	138.6	68.5	139.0
1937	95.7	91.1	105.0	73.1	130.9	72.5	132.0
1938	80.5	81.3	99.0	58.0	138.8	57.9	139.0
1939	89.4	80.2	111.5	61.7	144.9	61.6	145.1
1940	100.5	89.2	112.7	69.0	145.6	68.5	146.7
1941	106.5	93.9	113.4	77.0	138.3	76.0	140.1
1942	109.8	94.9	115.7	82.4	133.2	80.8	135.9
1943	113.0	88.5	127.7	83.5	135.3	82.4	137.1
1944	120.1	84.6	142.0	88.2	136.2	88.3	136.0
1945	117.9	79.8	147.7	81.8	144.1	82.1	143.6
1946	115.9	84.0	138.0	82.2	141.0	81.7	141.8
1947	126.6	90.5	139.9	87.8	144.2	87.2	145.2
1948	133.3	95.1	140.2	88.9	149.9	88.5	150.6
1949	114.7	88.2	130.0	75.5	151.9	74.7	153.5
1950	129.6	88.4	146.6	79.0	164.0	78.2	165.7
1951	141.1	88.9	158.7	80.4	175.5	79.2	178.1
1952	137.2	86.4	158.8	77.6	176.8	76.1	180.3
1953	138.4	82.6	167.6	74.2	186.5	72.6	190.6
1954	130.6	75.3	173.4	66.3	197.0	64.5	202.5
1955	145.0	75.8	191.3	70.3	206.3	68.4	212.0
1956	153.1	79.6	192.3	74.3	206.1	72.2	212.0
1957	152.2	79.0	192.7	72.3	210.5	70.3	216.5

TABLE C-III

Mining: Output, Inputs, and Productivity Ratios, by Group, Key Years, 1879–1953
(1929 = 100)

	Output	Persons Engaged	Output per Person	Manhours	Output per Manhour	Capital Input	Output per Unit of Capital Input	Total Factor Input	Total Factor Productivity
				METAL MINING					
1879	12.9	65.3	19.8	69.7	18.5	18.4	70.1	39.4	32.7
1889	21.7	96.0	22.6	86.6	25.1	36.8	59.0	57.2	37.9
1899	39.1	111.3	35.1	100.3	39.0	64.0	61.1	78.8	49.6
1909	66.6	150.0	44.4	141.7	47.0	105.3	63.2	120.2	55.4
1919	72.7	124.2	58.5	121.7	59.7	94.6	76.8	105.7	68.8
1929	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1937	98.2	96.8	101.4	81.8	120.0	62.3	157.6	70.3	139.7
1948	99.6	81.5	122.2	66.6	149.5	47.5	209.7	55.4	179.8
1953	109.2	86.3	126.5	71.7	152.3	77.5	140.9	69.4	157.3
				PENNSYLVANIA ANTHRACITE MINING					
1879	38.8	45.7	84.9	52.5	73.9	42.7	90.9	51.8	74.9
1889	61.7	80.8	76.4	85.5	72.2	55.7	110.8	83.3	74.1
1899	81.8	90.7	90.2	83.0	98.6	72.5	112.8	82.2	99.5
1909	109.8	113.2	97.0	116.3	94.4	95.6	114.9	114.8	95.6
1919	119.3	101.0	118.1	120.0	99.4	108.7	109.8	119.2	100.1
1929	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1937	70.2	64.9	108.2	50.0	140.4	63.5	110.6	50.3	139.6
1948	77.4	53.6	144.4	54.3	142.5	44.8	172.8	52.0	148.8
1953	41.9	35.8	117.0	28.7	146.0	36.2	115.7	28.6	146.5

(continued)

TABLE C-III (continued)

Mining: Output, Inputs, and Productivity Ratios, by Group, Key Years, 1879–1953
(1929 = 100)

	Output	Persons Engaged	Output per Person	Manhours	Output per Manhour	Capital Input	Output per Unit of Capital Input	Total Factor Input	Total Factor Productivity
				BITUMINOUS MINING					
1879	7.9	20.0	39.5	24.2	32.6	5.6	141.1	23.5	33.6
1889	17.9	35.0	51.1	42.4	42.2	13.8	129.7	41.3	43.3
1899	36.1	54.0	66.9	62.8	57.5	33.5	107.8	61.7	58.5
1909	71.0	107.6	66.0	109.1	65.1	82.9	85.6	108.1	65.7
1919	87.1	123.6	70.5	110.1	79.1	120.7	72.2	110.5	78.8
1929	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1937	83.3	100.2	83.1	77.4	107.6	70.1	118.8	77.1	108.0
1948	112.1	96.6	116.0	103.8	108.0	79.2	141.5	100.5	111.5
1953	85.4	61.6	138.6	59.8	142.8	89.3	95.6	63.4	134.7
				CRUDE PETROLEUM AND NATURAL GAS					
1879	2.2	7.8	28.2	11.3	19.5	1.6	137.5	7.2	30.6
1889	6.2	14.7	42.2	21.2	29.2	5.7	108.8	14.7	42.2
1899	10.2	20.6	49.5	29.2	34.9	10.9	93.6	21.6	47.2
1909	20.7	36.2	57.2	47.2	43.9	26.4	78.4	38.5	53.8
1919	41.7	70.6	59.1	75.6	55.2	64.5	64.7	71.0	58.7
1929	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1937	122.8	88.1	139.4	75.4	162.9	57.7	212.8	66.1	185.8
1948	196.6	122.0	161.1	98.4	199.8	97.8	201.0	100.0	196.6
1953	248.3	142.2	174.6	117.2	211.9	93.2	266.4	104.9	236.7

(continued)

TABLE C-III (concluded)

Mining: Output, Inputs, and Productivity Ratios, by Group, Key Years, 1879–1953
(1929 = 100)

	Output	Persons Engaged	Output per Person	Manhours	Output per Manhour	Capital Input	Output per Unit of Capital Input	Total Factor Input	Total Factor Productivity
				NONMETALLIC MINING AND QUARRYING					
1879	7.2	36.7	19.6	32.3	22.2	7.0	102.9	21.7	33.2
1889	17.0	75.6	22.5	65.9	25.8	27.9	60.9	50.1	33.9
1899	23.9	92.2	25.9	64.2	37.2	34.8	68.7	51.9	46.1
1909	51.1	141.1	36.2	114.0	44.8	66.9	76.4	94.4	54.1
1919	48.6	108.9	44.6	102.5	47.4	63.5	76.5	86.2	56.4
1929	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1937	69.9	86.7	80.6	67.7	103.2	62.4	112.0	66.0	105.9
1948	124.2	110.0	112.9	82.1	151.3	59.7	208.0	73.1	169.9
1953	160.3	122.2	131.2	91.8	174.6	83.2	192.7	89.1	179.9

TABLE C-IV

Mining: Persons Engaged and Manhours, by Group, 1929

	Persons Engaged (thousands)	Manhours (millions)
Metals	124	314
Pennsylvania anthracite	151	282
Bituminous	474	925
Crude petroleum and natural gas	218	513
Nonmetallic mining and quarrying	90	279
Total	1,057	2,313