

This PDF is a selection from a published volume from the National Bureau of Economic Research

Volume Title: Capital in the Nineteenth Century

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Volume Publisher: University of Chicago Press

Volume ISBNs: 978-0-226-63311-4 (cloth); 978-0-226-63325-1 (electronic)

Volume URL:

<https://www.nber.org/books-and-chapters/capital-nineteenth-century>

Conference Date: n/a

Publication Date: February 2020

Chapter Title: Mining and Manufacturing

Chapter Author(s): Robert E. Gallman, Paul W. Rhode

Chapter URL:

<https://www.nber.org/books-and-chapters/capital-nineteenth-century/mining-and-manufacturing>

Chapter pages in book: (p. 203 – 218)

Mining and Manufacturing

8.1. Introduction

This chapter focuses on mining and manufacturing, detailing the estimation of the current-price and constant-price (1860) values of the capital stock on a decadal basis from 1840 to 1900.

8.2. Mining

8.2.1. Introduction

The estimates are based on modified US census data. They distinguish improvements, equipment, and land. “Improvements” are buildings and other immovables; “equipment” is tools, machinery, livestock, and other moveable durable assets. The concept of “value” adopted by the census is discussed below, in section 8.2.4.

8.2.2. Value of Capital and Land

1870–1890. We based our estimates on the work of Creamer, Dobrovolsky, and Borenstein (1960, 304–14), who used census data but modified it by excluding the value of leased land. Since we wished to include the value of leased land, we used the Creamer-Dobrovolsky-Borenstein series as an extrapolator, to which we applied estimating ratios designed both

The substance of this chapter was written by Gallman. “We” and “our” refers to Gallman and Howle.

to distinguish the values of improvements, equipment, and land, and to introduce the value of leased land into the final estimates.

1900. There are no census capital figures for 1900. We obtained estimates for that year by interpolating between 1890 and 1909 on output. Since mining industries operated at less than full capacity in some years, we computed each capital-to-output ratio from the output figure in the relevant year, or from the highest previous output where that was higher (see table 8.1).

1850–60. Mining and manufacturing industries were reported in the same tables in the censuses of 1850 and 1860. Most of the important mining industries could be distinguished, but industries accounting for roughly 5 percent of total mining capital (7 percent in 1870, 3.1 percent in 1840) could not. We increased our final estimates to account for this factor.

Mining statistics prior to 1880 are of poor quality (see section 8.2.3 below). In several instances we adjusted the 1850 and 1860 figures upward. For details, see the notes to table 8.3.

1840. The 1840 census combined some mining and manufacturing operations. For example, the smelting, casting, and forging of metals were apparently all included in the returns of the mining industries. In these instances, we used data from later censuses to distribute capital between mining and manufacturing (see table 8.2).

8.2.3. *Estimates of Improvements, Equipment, and Land*

The only year for which separate valuations of improvements, equipment, and land are available is 1890, a year in which land was the most important of the three assets (US Census Office 1892a). Creamer, Dobrovolsky, and Borenstein (1960, 285) cite evidence to indicate that the “ratio of land value (excluding leased land) to capital fell from 57.4 percent in 1890 to 48 percent in 1922.” However, they show that this overall decline can be explained by the relatively faster growth of those mining industries (e.g., petroleum) in which land value was less important. Had land value ratios for individual industries remained unchanged, shifts in the relative importance of mining industries would have produced a decline in the land-to-capital ratio from 57.4 percent in 1890 to 41.7 percent in 1922, a sharper drop than the true ratios show (Creamer, Dobrovolsky, and Borenstein 1960, 285–86). Relying on this evidence, we assumed that the ratios of the individual components of capital within industries did not change

TABLE 8.1 Capital-to-output ratios and the value of capital in mining, 1890, 1900, and 1909

	1890	1900	1909
A. Capital-to-output ratios			
Anthracite coal	$\frac{105}{46.6}$	$\frac{150}{60.4}$	$\frac{247}{85.6}$
Bituminous coal	$\frac{146}{111}$	$\frac{363}{212}$	$\frac{961}{395}$
Iron mining	$\frac{74.6}{160}$	$\frac{137}{273}$	$\frac{301}{517}$
Copper mining	$\frac{60.7}{130}$	$\frac{150}{303}$	$\frac{302}{563}$
Stone quarrying	$\frac{75}{50}$	$\frac{79}{52}$	$\frac{133}{77}$
Petroleum wells	$\frac{82.4}{45.8}$	$\frac{118}{63.6}$	$\frac{408}{183}$
Natural gas wells	$\frac{16.3}{-}$	$\frac{61}{128}$	$\frac{275}{481}$
B. Value of capital (in millions of dollars)			
Gold and silver	447	474	501
Industries listed in lines 1–7	560	1,058	2,627
Line 8 plus line 9	1,007	1,532	3,128
Value of total mining capital	1,035	1,589	3,280
Ratio of line 10 to line 11	0.973	0.964	0.954

Note: These figures are used as the basis for final capital estimates; see table 8.3. Top value is capital; bottom value is output.

Sources: Lines 1–8: Value of capital 1890 and 1909. Creamer, Dobrovolsky, and Borenstein 1960, 304–8), in millions of dollars. Creamer et al. give only the total capital in gas and petroleum. We divided it in proportion to the capital figures in US Bureau of the Census 1913, 265. The 1890 Creamer, Dobrovolsky, and Borenstein estimate for natural gas wells includes independently owned pipelines. We deducted \$31.6 million to remove this element (see chapter 10.7, below). The 1909 figure excludes independently owned pipelines; see US Bureau of the Census 1913, 264.

Lines 1–8, output: US Bureau of the Census 1960, 351–68). The output of stone quarries is expressed in dollar value (millions of dollars); all other outputs are in physical units, which vary from case to case. Each figure represents the output of the year indicated, or the highest previous annual output, where that is larger. Lines 1–6, value of capital, 1900: The ratios of 1890 and 1909 were interpolated on output to 1900 and multiplied by the output figures to produce estimates of the value of capital. (That is, the change in the capital-to-output ratio, 1890–1900, was taken to be the same proportion of the change, 1890–1909, as the change in output, 1890–1900, was of the change in output, 1890–1909.)

Line 7, Value of capital, 1900: Extrapolated from 1909 and subsequent years on output. Line 8, 1900: Straight-line interpolation. Line 9, 1890, 1900, 1909: Sum of capital values in lines 1–7. Line 10, 1890, 1900, 1909: line 8 + line 9. Line 11, 1890, 1909: Creamer, Dobrovolsky, and Borenstein 1960, 304–8.

Line 11, 1900: line 10 ÷ line 12. Line 12, 1890, 1909: Line 10 ÷ line 11. Line 12, 1900: Straight-line interpolation.

TABLE 8.2 Value of mining capital, measured in current prices, 1840, in millions of dollars

1	Iron	1.43
2	Gold	0.23
3	Anthracite coal	3.20
4	Bituminous coal	1.87
5	Stone	2.54
6	Lead	1.05
7	Other metals	0.18
8	Total	9.60

Note: These figures are used as the basis for final estimates; see table 8.3.

Sources: The data on the value of capital were taken from US Department of State 1841, 354, 355, 361; and Schaefer 1967, 69. In several cases it was necessary to estimate the division of the value of capital between mining and manufacturing. We based these estimates on data drawn from the census figures from 1850 through 1870. The estimating ratios are as follows: line 1, 0.07; line 2, 0.994 (the 1870 census data used refer to gold and silver); line 6, 0.113 (the 1870 census data used refer to lead mining plus the manufacture of lead bar, pig, pipe, and shot); line 7, 0.75 (predominantly copper and silver). Salt mining is included with manufacturing.

from 1840 to 1900. We adjusted for shifts among industries by applying the 1890 ratios of land, improvements, and equipment for each significant mining industry to the corresponding capital figures for each census year. Improvements, equipment, and land values were then totaled for each year, and the totals increased to account for minor industries for which we did not develop separate ratios. (The total valuation of the significant industries was divided by the ratio of their capital to the total capital of all mining industries.) In every year the capital of industries for which we did develop ratios accounted for at least 93 percent of the total mining capital.

The derivation of the mining estimates is shown in table 8.3. The final series was increased by 10 percent for the 1840 to 1870 period to compensate for the likely exclusion of borrowed capital from the total capital estimates of that period. (See the remarks in 8.3.2 below.)

8.2.4. Deflation

The capital estimates to which we applied our ratios do not represent precisely the same thing in all years. Prior to 1880, census marshals were instructed to determine the amount of capital used in the business, a

TABLE 8.3 Value of mining capital by asset type and industry, measured in current prices, 1840–1900, in millions of dollars

	1840	1850	1860	1870	1880	1890	1900
1 “Capital” in anthracite coal mining	3.2	5.1	13.9	50.9	100.4	105	150
2 (1) $\times$ 0.350 = Improvements	1.12	1.79	4.87	17.8	35.1	36.8	52.5
3 (1) $\times$ 0.135 = equipment	0.43	0.69	1.88	6.9	13.6	14.2	20.3
4 (1) $\times$ 0.995 = land	3.18	5.07	13.83	50.7	100	104.6	149.4
5 “Capital” in bituminous coal mining	1.87	3.2	15.5	59.1	78.6	145.9	363
6 (5) $\times$ 0.187 = Improvements	0.35	0.6	2.9	11.1	14.7	27.3	67.9
7 (5) $\times$ 0.144 = equipment	0.27	0.46	2.23	8.5	11.3	21	52.3
8 (5) $\times$ 0.837 = land	1.57	2.68	12.97	49.5	65.8	122.1	303.8
9 “Capital” in iron Mining	1.43	3.3	7.4	17.8	45.9	74.6	137
10 (9) $\times$ 0.103 = Improvements	0.15	0.34	0.76	1.8	4.7	7.7	14.1
11 (9) $\times$ 0.108 = equipment	0.15	0.36	0.8	1.9	5	8.1	14.8
12 (9) $\times$ 1.05 = land	1.5	3.47	7.77	18.7	48.2	78.3	143.9
13 “Capital” in gold and silver mining	0.23	1.8	12	50	225.8	447	474
14 (13) $\times$ 0.235 = Improvements	0.05	0.42	2.82	11.8	53.1	105	111.4
15 (13) $\times$ 0.020 = alternative Improvements	0	0.04	0.24	1	4.5	8.9	9.5
16 (13) $\times$ 0.034 = equipment	0.01	0.06	0.41	1.7	7.7	15.2	16.1
17 (13) $\times$ 0.249 = alternative equipment	0.06	0.46	2.99	12.5	56.2	111.3	118
18 (13) $\times$ 0.756 = land	0.17	1.36	9.07	37.8	170.7	337.9	358.3
19 “Capital” in copper mining		2.8	8.5	7.8	30.9	60.7	150
20 (19) $\times$ 0.096 = Improvements		0.27	0.82	0.7	3	5.8	14.4
21 (19) $\times$ 0.056 = equipment		0.16	0.48	0.4	1.7	3.4	8.4
22 (19) $\times$ 0.825 = land		2.31	7.01	6.4	25.5	50.1	123.8
23 “Capital” in petroleum and natural gas					43.1	98.7	179
24 (23) $\times$ 0.65 = improvements					28	64.2	116.4
25 (23) $\times$ 0.077 = equipment					3.3	7.6	13.8
26 (23) $\times$ 0.50 = land					21.6	49.4	89.5
27 “Capital” in stone quarrying	2.54	4	9.2	11.2	20.7	74.6	79
28 (27) $\times$ 0.145 = improvements	0.37	0.59	1.33	1.6	3	10.8	11.5
29 (27) $\times$ 0.195 = equipment	0.5	0.8	1.79	2.2	4	14.5	15.4
30 (27) $\times$ 0.721 = land	1.83	2.96	6.63	8.1	14.9	53.8	57
32 Total capital above	9.27	20.22	66.5	196.8	545	1,007	1,532
32 Total capital, all mining	9.6	21.15	70.51	211.7	558	1,035	1,589
33 Ratio line 31 to line 32	0.966	0.956	0.943	0.93	0.977	0.973	0.964
34 Improvements, above	2.04	4.01	13.5	44.8	141.6	257.6	388.2
35 Alternative improvements, above	1.99	3.63	10.92	34	93	161.5	286.9
36 Total improvements	2.11	4.19	14.32	48.2	144.9	264.7	402.7
37 Alternative total improvements	2.06	3.8	11.58	36.6	95.2	166	297.6
38 Equipment, above	1.36	2.53	7.59	21.6	46.6	84	141.1
39 Alternative equipment, above	1.41	2.92	10.17	32.4	95.1	181.1	243
40 Total equipment	1.41	2.65	8.05	23.2	47.7	86.3	146.4
41 Alternative total Equipment	1.46	3.05	10.79	34.8	97.3	186.1	252.1

continues

TABLE 8.3 (continued)

		1840	1850	1860	1870	1880	1890	1900
42	Land above (owned and leased)	8.25	17.85	7.28	171.2	446.7	796.2	1225.7
43	Total land (owned and leased)	8.54	18.67	60.74	184.1	457.2	818.3	1271.4
44	Total improvements, adjusted for borrowed Capital	2.32	4.61	15.75	53	144.9	264.7	402.7
45	Total equipment, adjusted for borrowed capital	1.55	2.92	8.86	25.5	47.7	86.3	146.4
46	Total land, adjusted for borrowed capital	9.39	20.54	66.83	202.5	457.2	818.3	1271.4

Sources:

Lines 1, 5, 9, 13, 19, 23 and 27: N.B. These series are extrapolators, not final estimates of capital.

1840, table 8.2, above.

1850–60: All except the iron figure (line 9) are from US Census Office 1872, 399, 408, which summarizes the 1850 and 1860 data. The introduction to the 1860 census points out that the census figures for iron mining include only independent mines. A product estimate for the other mines is given, and we have assumed the same capital/ton ratio as for the mines included in the census. We also assumed that the same ratio of reported to unreported iron mines applied to 1850. Thus we increased both the 1850 and 1860 census estimates to include “captive” mines. The anthracite estimate is from “A Quantitative Description and Analysis of the Growth of the Pennsylvania Anthracite Coal Industry, 1820 to 1865” (Schaefer 1967, 69), “owned land plus equipment and improvements.”

1870–90, Creamer, Dobrovolsky, and Borenstein 1960, 304–14 (except petroleum and natural gas, which is from table 8.1, above). Capital in stone quarrying in 1870 consists of Creamer’s “total stone,” plus “total misc.,” less “asphalt” and “other,” an aggregate roughly comparable to Creamer’s “total stone” in 1880 and 1890.

1900, table 8.1 above.

Lines 2, 3, 4, 6, 7, 8, 10, 11, 12, 14, 15, 16, 17, 18, 20, 21, 22, 28, 29, and 30: These ratios were derived from the valuation of assets in the 1890 Census of Mineral Industries and the total capital estimates from the same source, that have been adjusted by Creamer, Dobrovolsky, and Borenstein (1960, 304–14) to exclude leased land. Improvements include buildings and fixtures, while equipment includes tools, machinery, and livestock. For gold and silver mining, a separate category for “underground improvements” was listed. Kuznets’s estimates (1946, 202, 213) apparently include this category under equipment. We included it under improvements, but derived alternative estimates (lines 15, 17, 35, 37, 39, and 41), which treat gold and silver underground improvements as Kuznets does.

Lines 24, 25, 26: The 1890 census provides inadequate data to make these divisions. We therefore based them on data in the census of 1880 (US Census Office 1884b, 143–47, data for Bradford and Lowes Counties, Pennsylvania). We treated rigs, drive pipe, casing, tubing, and the cost of drilling as elements in the value of improvements; engines and boilers, as equipment. The distribution of the value of capital and land that we thereby obtained was: land, 38.1 percent; improvements, 55.4 percent; and equipment, 5.7 percent. We used these proportions to distribute the total census value of capital and land in 1890 among asset types. (We included in this total the value of oil and gas land, and the value of oil and gas rigs, etc.) We then computed the ratio of the value of each asset type in 1890 to the value contained in line 23, and rounded. The ratio relating to the value of improvements was also adjusted downward, and the ratio relating to the value of equipment was adjusted upward, to take into account the fact that the 1880 census data (which refer to current investment rather than to the stock of capital) almost certainly overstate the value of improvements and understate the value of equipment.

Lines 31, 34, 35, 38, 39, and 42: These lines are totals of the corresponding categories in the listed mining industries, above.

Line 32: 1840, table 8.2, above. 1850–1860, These estimates were obtained by dividing line 31 by line 33. See notes to line 33, 1850–60.

1870–90: Creamer, Dobrovolsky, and Borenstein 1960, 304. This total also excludes leased land. Note that they lowered the 1870 census total by \$10 million, to account for an error in the quicksilver returns. In 1890, 31.6 million is subtracted for gas pipelines.

1900, table 8.1.

Line 33: 1840, line 31 ÷ line 32.

1850–60, interpolated between 1840 and 1870. The omission of copper mining from the separately listed categories in 1840 evidently does not appreciably affect the interpolation.

1870–90, line 31 ÷ line 32.

1900, table 8.1, above.

Lines 36, 37, 40, 41, and 43: Lines 34, 35, 38, 39 and 42, respectively, were divided by line 33.

Lines 44, 45, and 46: For 1840–70, lines 36, 40, and 43 were adjusted upward by 10 percent to account for borrowed capital. For 1880–1900, these lines are identical to lines 36, 40, and 43.

question that—in the absence of further instructions—might have elicited answers about equity in the business; the market or par value of outstanding stocks and bonds; or the reproduction cost, market value, or book value of the firm's property:

If the question is simply, How much capital is employed in your business? it may be considered an inquiry into a strictly private matter; the answer may refer to what would remain after the debts were paid; or some such unsubstantial thing such as “the goodwill of the business” may be included. In case the producer is an incorporated company, the answer will be the amount of share capital at par (US Census Office 1886, xxvi–xxvii).

An effort was made at standardization in 1880. According to the introduction to the 1880 census, the following questions were asked:

What is the value of the mineral real estate attached to the mine? What is the value of the plant? and how much is usually employed as working capital (US Census Office 1886, xxvi–xxvii)?

Apparently, market values were being sought. Thus “plant” was defined as follows:

The “plant” means all machinery, improvements, personal property (not supplies), animals, fixtures, etc. An estimate of this should be based on actual values, not cost, and should exclude all antiquated and idle machinery (US Census Office 1886, 801).

The 1890 census is of particular interest, as the source of the asset ratios we used to distribute property among types in all other years. Inquiry forms specified that values should represent what the property was presently worth or what it would cost in 1890. The form used for gold and silver asked, among other things, for the present actual cash value of buildings. It thus appears that the census collected estimates of either market value or reproduction cost—depending in each case on whether the enumerator and the person being interviewed were more struck by the question that emphasized the former or by the question that emphasized the latter. Since Kuznets (1946, 192–93) and Creamer, Dobrovolsky, and Borenstein (1960, 204) tell us that the census figures contain little undeducted depreciation, we may assume that net reproduction cost was

TABLE 8.4 **Underground improvements deflators, 1840–1900**

	1840	1850	1860	1870	1880	1890	1900
1 Coal							
a Daily wage rate			1.00	1.66	1.66	1.87	1.93*
b Value of improvements (in millions of dollars)	—	—	7.77	28.90	49.80	64.10	120.40
c Ratio (1b ÷ 1a)			7.77	17.40	30.00	34.30	62.40
2 Iron							
a Daily wage rate			1.00	1.90	1.90	1.91	2.00*
b Value of improvements (in millions of dollars)	—	—	0.76	1.80	4.70	7.70	14.10
c Ratio (2b ÷ 2a)			0.76	0.90	2.50	4.00	7.10
3 Gold							
a Daily wage rate			3.10	3.00	2.70	3.00	3.10*
b Value of improvements (in millions of dollars)	—	—	2.82	11.80	53.10	105.00	111.40
c Ratio (3b ÷ 3a)			0.91	3.90	19.70	35.00	35.90
4 Sum of 1b + 2b + 3b			11.35	42.50	107.60	176.80	254.90
5 Sum of 1c + 2c + 3c			9.44	22.20	52.20	73.30	105.40
6 Weighted average wage rate Ratio of line 4 to line 5			1.2	1.91	2.06	2.41	2.42
7 Underground improvement deflator (base = 1860)	85	120	100	159	172	201	202

Note: *1902
Sources: Line 1a: The daily wage rate of Pennsylvania coal miners (Lebergott 1964, 529) was reduced to the US level according to the ratio for 1860 (Lebergott 1964, 318). Line 1b: Sum of lines 2 and 6, table 8.3. Lines 1c, 2c, 3c: These divisions convert the improvements estimates into their equivalents in labor time. Thus, the average wage rate (line 6) is a weighted average, in which the labor time equivalents of the underground improvements serve as weights. Line 2a: Lebergott 1964, pp. 319 (1860) and 529 (1880–1902). Information for 1870 was extrapolated from 1880 on line 1a. Line 2b: Line 10, table 8.3. Line 3a: The value for 1890 is the weighted average daily wage rate of below-ground miners, laborers, and boys in deep precious-metals mines (US Census Office 1892a, 34; \$3.04, rounded to \$3.00). This value was extrapolated to 1902 on the wage rates of coal and iron miners, lines 1a and 2a (\$3.12 rounded to \$3.10) and to 1880 on the average wage of all deep-mine precious metals workers (US Census Office 1892a, 34, \$2.97) and the 1880 census (US Census Office 1885, 157, \$2.67). The 1880 value, in turn, was extrapolated to 1870 on the average annual income of all deep-mine precious metals workers (US Census Office 1885, 157, \$766) and the 1870 census (US Census Office 1872, 760, \$838, “gold quartz” and “silver quartz”). The 1870 value was extrapolated to 1860 on the average annual income of all gold and silver mine workers (US Census Office 1872, 401, 404, 760, gold quartz, silver quartz, placer, hydraulic). Line 3b: Line 14, table 8.3. Line 7: 1840, 1850, 1860, Lebergott (1964, 317–18), converted to a set of index numbers on the base 1860. 1860, 1900: Line 6, converted to a set of index numbers on the base 1860.

reported more often than gross reproduction cost. Market and net reproduction cost figures—especially in an industry that is growing very rapidly, as mining was—are likely to be similar. The price deflators we used are reasonably apposite for both (Gallman 1987).

The estimates for the years before 1880 are a different matter. We have applied our 1890 ratios to capital figures that must have been at least partly

expressed in book values. There is no sure way to cope with this problem, though it is probably not serious in any case. This was a period of dynamic expansion of mining investment. In *each* ten-year period from 1840 to 1880, mining capital investment more than doubled (see table 8.3). Thus, even if book values made up a large portion of our conglomerated total capital estimates, the quantity of older capital was small enough to exert only a minor influence on the valuation of the total. To make a long story short, we deflated our 1840–70 estimates as though they were market (or net reproduction cost) values, not book values. This seems appropriate for 1880–1900. For the earlier period it may or may not be appropriate, but the quantitative significance of the matter is surely slight.

TABLE 8.5 Value of reproducible durable mining capital and land, current and 1860 prices, 1840–1900, in millions of dollars

	1840	1850	1860	1870	1880	1890	1900
1 Improvements (excl. pet. and gas), at current prices	2.82	4.61	15.75	53	116.9	200.5	286.3
2 Price index	95	113	100	127	143	146	146
3 Improvements (excluding petroleum and gas), at 1860 prices	2.44	4.08	15.75	41.7	81.7	137.3	196.1
4 Petroleum and gas improvements (e.g., wells), at current prices					28	64.2	116.4
5 Price index					83	75	54
6 Petroleum and gas improvements, at 1860 prices					33.7	85.6	215.6
7 Total improvement, at current prices	2.82	4.61	15.75	53	144.9	264.7	402.7
8 Total improvements, at 1860 prices	2.44	4.08	15.75	41.7	115.4	222.9	411.7
9 Equipment, at current prices	1.55	2.92	8.86	25.5	47.7	86.3	146.4
10 Price index	103	105	100	102	83	75	54
11 Equipment, at 1860 prices	1.5	2.78	8.86	25	57.5	115.1	271.1
12 Total reproducible durable capital, at 1860 prices	3.94	6.86	24.61	66.7	172.9	338	682.8
13 Land, at current prices	9.39	20.54	66.83	202.5	457.2	818.3	1,271.4

Sources: Line 1: line 44 – line 24, table 8.3. Line 2: The adjusted Brady index for factories and stores (see notes to table 8.9) and the underground improvement deflator (table 8.4) receive equal weights. Line 3: $100 \times \text{line 1} \div \text{line 2}$. Line 4: line 24, table 8.3. Line 5: The adjusted price index of machine shop products (table 8.9), the railroad equipment price index (table 10.9), and the price index of horses (derived from table 7.3, above), equally weighted. Line 6: $100 \times \text{line 4} \div \text{line 5}$, multiplied by 100. Line 7: line 1 + line 4. Line 8: line 3 + line 6. Line 9: line 45, table 8.3. Line 10: See Line 5. Line 11: $100 \times \text{line 8} \div \text{line 9}$. Line 12: line 7 + line 10. Line 13: line 46, table 8.3.

Table 8.5 shows the deflation of our estimates (accompanying notes give details). We made use of the Brady factory price index, but also developed a price index of underground improvements based on the cost of mining labor, their chief input (see table 8.4). The two indexes were combined to form a deflator for mining improvements. Petroleum and gas were exceptions; we decided that the improvements in these sectors were more appropriately deflated by an equipment index (see table 8.5).

8.2.5. Evaluation of Mining Estimates

Those who have worked with the censuses before 1880 agree that the mining data probably understate the true value of mining capital. Thereafter, census data are doubtless better, but a substantial margin for error must still be allowed. Creamer, Dobrovolsky, and Borenstein (1960) present an excellent critique of the census capital data in the years after 1860. Rather than repeat their remarks, we refer readers to them.

8.3. Manufacturing

8.3.1. Introduction

Our estimating procedure for manufacturing was simpler than that for mining. By modifying census data, we first obtained an estimate of total capital in all manufacturing. For 1890 and 1900 the land, buildings, and equipment breakdowns are from the censuses, with appropriate adjustments to include rented property. For earlier years, we extrapolated the ratio of each of these assets to total capital from later census figures. Applying the ratios to the total capital estimates gives the asset estimates for 1840 through 1880.

8.3.2. Total Capital in Manufacturing

For all years we used adjusted census data to obtain a capital estimate that includes borrowed capital but excludes rented property. (Rented property was added back in at a later stage in the estimating procedure.) Two initial adjustments of the census data were necessary:

(1) The 1840–60 censuses recorded mining and manufacturing together. Since we had already estimated mining capital, we simply deducted it from the total to obtain manufacturing capital.

TABLE 8.6 Value of manufacturing capital, measured in current prices, 1840–1900, in millions of dollars

	1840	1850	1860	1870	1880	1890	1900
1 Manufacturing and mining	305.7	533.2	1,009.9				
2 Less mining	9.6	21.2	70.5				
3 Manufacturing	296.1	512	939.4	2,118.2	2,790.3		
4 Borrowed capital	29.6	51.2	93.9	211.8	279.0		
5 Total manufacturing capital, census definition	325.7	563.2	1,033.3	2,330	3,069.3	6,525.2	9,817.4

Sources: Line 1: 1840, US Department of State 1841, 354–55, 361. 1850 and 1860, US Census Office 1872, 392–93. Line 2: Table 8.3, line 32, above. Line 3: For 1840–60, line 3 = line 1 - line 2; for 1870–80, the line 3 figures are from the respective censuses of manufacturing. Line 4: Ten percent of line 3; see text. Line 5: For 1840–80, line 5 = line 3 + line 4. The 1890 and 1900 estimates are taken directly from the census.

TABLE 8.7 Indexes (1890 = 100) of capital-to-output ratios in mining and manufacturing, 1870–90

	1870	1880	1890
1 Manufacturing: capital unadjusted	(74)	(81)	100
2 Mining: capital unadjusted	(54)	92	100
3 Manufacturing: adjusted for borrowed capital	81	89	100
4 Mining: adjusted for borrowed capital	66	92	100

Sources: Capital estimates are from table 8.3 (lines 31, 44, 45, and 46) and table 8.6, above. The mining output figures are taken from Creamer, Dobrovolsky, and Borenstein 1960, 304 (all mining value of output). The manufacturing output estimates are from Gallman's value added series (1960, 56).

(2) Before 1890, census officials asked for “total capital invested” by the firm. In 1890 and 1900, the censuses asked detailed questions regarding the value of each kind of asset. For the first time, the 1890 census specifically stated that borrowed capital should be included. It appears that, when the owner of an establishment was asked merely for “capital invested,” he usually excluded borrowed capital.¹ Since borrowed capital amounted to about 12.6 percent of owned capital in 1890, we increased the estimates for earlier years by 10 percent to compensate for the tendency on the part of the census to exclude this item (US Census Office 1892b). The capital figures resulting from these adjustments are shown in table 8.6.

We are now able to compare manufacturing and mining capital-to-output ratios (table 8.7). The comparison supports our adjustment of the earlier estimates to compensate for the exclusion of borrowed capital. The detailed questions concerning capital were first adopted by the mining

census in 1880, and by the manufacturing census in 1890. The ratios corresponding to the old form of questioning are enclosed in parentheses. To make a comparison of manufacturing and mining easier, the ratios have been put into index form, with 1890 = 100. There is a considerable jump in the unadjusted series when the method of questioning was changed (i.e., between 1880 and 1890 for manufacturing, and between 1870 and 1880 for mining), which confirms the notion that, prior to this, borrowed capital had been omitted, at least in part.

8.3.3. *Buildings, Equipment, and Land*

The censuses of 1890 and later reported the values of buildings, equipment, and land separately. Rented real estate was excluded. The value of the omitted real estate was estimated in the introduction to the Census of Manufactures in 1890 and again in 1900 (US Census Office 1892a, xcix, c). We divided rented real estate between land and improvements (see notes to table 8.8) and added the resulting estimates to the owned land and improvements figures. The ratios of buildings, land, and equipment to total capital were extrapolated to the period prior to 1890 and applied to our adjusted capital estimates. See table 8.8.

8.3.4. *Deflation*

Are our estimates expressed in book or current values? There is no simple answer, because the questions asked by census agents varied from time to time. Thus, in no year (except perhaps 1890) can the returns be considered precisely as either market, reproduction cost, or book values. The year 1890 is of particular interest; we use evidence from this year to extrapolate the asset ratios. The wording of the 1890 census questionnaire is quite clear. Enumerators were directed to collect net reproduction cost data:

The value should be estimated at what the works would cost in 1890, if then to be erected, with such an allowance for depreciation as may be suitable in the individual case (US Census Office 1892b, 10).

As to the years 1840 to 1880, the comments in section 8.2.4 on deflation with respect to mining capital apply as well to manufacturing. It is probable that the census figures reflect in part book values (most often for incorporated businesses) and in part estimated market values (for small

TABLE 8.8 Value of capital in manufacturing, current prices, 1840–1900, in millions of dollars

		1840	1850	1860	1870	1880	1890	1900
1	Census definition	325.6	563.2	1,033	2,330	3,069	6,525	9,817
2	Buildings	74.9	129.5	238	536	706	1,493	2,150
3	Equipment	70.0	123.9	232	536	737	1,584	2,543
4	Land	86.1	142.5	250	536	671	1,318	1,522

Sources: Line 1: table 8.6, line 5, above. Line 2: 1890–1900: The 1890 and 1900 censuses reported separate valuations of owned buildings and land (US Bureau of the Census 1902, xcvi). In addition, they estimated the value of rented real property (buildings and land together; US Bureau of the Census 1902, c). We divided the rented property between buildings and land by applying the owned property ratio of these two assets. 1840–80: The ratio of buildings (owned and rented) to total capital (excluding rented property) was taken from 1890 and 1900 and applied to the earlier years. The 1890 ratio was 0.224; in 1900 it was 0.235. We used 0.23 for the earlier periods. The small change in the ratio between 1890 and 1900 was not considered an adequate basis for an extrapolated trend. Information on total rented real estate was lacking in the 1909 and 1919 censuses. Line 3: 1890–1900: The equipment estimates were taken directly from the census. 1840–1880: Paul Douglas (1934, 116) developed ratios of equipment to total capital for the period 1879–1919, based on census asset data for 1890 and later (i.e., the asset data we used for 1890 and 1900, and data from the censuses of 1909 and 1919). We extrapolated the ratio of machinery and equipment to total capital to 1840:

Douglas estimates					Extrapolation			
1919	1909	1900	1890	1880	1870	1860	1850	1840
0.295	0.281	0.259	0.243	0.240	0.230	0.225	0.220	0.215

These ratios were applied to our total capital estimates (1840–80) to estimate machinery and equipment. Line 4: 1890–1900: See notes to line 2. 1840–80: The value of land is a rough estimate based on the extrapolation of the land to buildings ratio from 1890 and 1900.

Census data		Extrapolation						
1900	1890	1880	1870	1860	1850	1840		
70.8	88.3	95	100	105	110	115		

See notes to line 2 for details of the 1890 and 1900 asset figures.

firms with poor bookkeeping). Businesses were probably often forced to rely on tax appraisal data, which are closer to the market value concept than to the book value concept.

What the figures in the 1900 census represent is not clear. The asset ratios and the ratio of fixed to short-term assets do not change much from 1890 to 1900, which suggests that the census value concept may have been the same in these two years. The 1900 census says:

The value of capital represented by buildings and machinery (supposed to be returned as the valuation of the property upon the inventories of the census year) is too variable to permit statistical accuracy. The return is, strictly speaking, a return of estimated market value, rather than capital invested. The amount of the latter is affected by many causes—by depreciation requiring additional investment, by throwing out old machinery and substituting new, by business failures, and by other causes. So that in the case of most of the old and successful manufacturing concerns in the country the total investment in the plant has been much greater than the present market value, as estimated by assessors (US Census Office 1902, xcix).

Unfortunately, the case is not as clear-cut as the above quotations indicate. Creamer, Dobrovolsky, and Borenstein (1960, 12) conclude that the census figures in both 1890 and 1900 are book values, quoting from the 1900 census to support this conclusion:

Capital invested: The answer must show the total amount of capital both owned and borrowed. All the items of fixed and live capital may be taken at the amounts carried on the books. If land or buildings are rented, that fact should be stated and no value given . . . The value of all items of live capital, cash on hand, bills receivable, unsettled ledger accounts, value of raw materials on hand, materials in process of manufacture, and finished products on hand, etc., should be given as of the last day of the business year reported. (US Census Office 1902, xcvi).

The statistics of capital invested at the two censuses (1890 and 1900) show totals which are perfectly comparable (US Census Office 1902, xcvi). Creamer, Dobrovolsky, and Borenstein (1960, 13) then write, quoting the italicized part from the census, that for 1890, “the respondents were instructed to make *‘such allowance for depreciation as may be suitable in the individual case. . . .’*”

From these statements, Creamer and coauthors conclude that the returns in both 1890 and 1900 were of book values and that, at least in part, they referred to depreciated values. Yet their last quotation, placed in italics, is only the last part of the sentence appearing in this census. The first part of the sentence, which has already been quoted above, reads: “The value should be estimated at what the works would cost in 1890, if then to be erected” (US Census Office 1892b, 10). Creamer, Dobrovolsky, and Borenstein are clearly incorrect regarding the 1890 census, which expressly sought net reproduction cost, not net book value.

The quotations for the 1900 census are conflicting. The case of Creamer, Dobrovolsky, and Borenstein for 1900 stands chiefly on the statement in the questionnaire that the items of fixed and live capital may be taken at the amounts carried on the books. This statement is subject to a new interpretation, however, when our earlier quotation is taken into account: “The value of capital represented by buildings and machinery (supposed to be returned as the valuation of the property upon the inventories of the census year) is too variable to permit statistical accuracy” (US Census Office 1902, xcix). “Books” may refer to tax appraisal books.

Our asset ratios were extrapolated from 1890, when the valuations were clearly current values (depreciated replacement cost). The total cap-

TABLE 8.9 **Value of manufacturing equipment, buildings, and land, measured in current and 1860 prices, 1840–1900, in millions of dollars**

	1840	1850	1860	1870	1880	1890	1900
Equipment							
1 Value, at current prices	70	123.9	232	536	737	1,584	2,543
2 Price index	145	138	100	105	76	32	28
3 Value, at 1860 prices	48.3	89.8	232	510	970	4,950	9,082
Buildings							
4 Value, at current prices	74.9	129.5	238	536	706	1,493	2,150
5 Price index	107	108	100	90	114	91	89
6 Value, at 1860 prices	70	119.9	238	596	619	1,641	2,416
Land							
7 Value, at current prices	86.1	142.5	250	536	671	1,318	1,522

Sources: Line 1: table 8.8, line 3, above. Line 2: Dorothy Brady's price index numbers of machine shop products, adjusted to bring them into line with the correct calendar year (see section 8.2.4 above). The adjustments were based on data in US Senate, *Aldrich Report* (1893), 181–82, 184, 187–89, 195, 197, 209, 211–13, 217, for prices of anvils, augers, axes, chisels, files, hammers, meat cutters, planes, circular saws, six-foot crosscut saws, scythes, shovels, vises (unweighted means of percentage changes); and US Bureau of the Census 1949, series L-9 and L-10 (1839, 1840, 1899, 1900). The adjustments were made by multiplying the Brady index numbers by the following ratios: 1839 = 0.97; 1849 = 1.00; 1869 = 0.93; 1879 = 1.07; 1889 = 1.00; 1899 = 1.00. Line 3: $100 \times \text{line 1} \div \text{line 2}$. Line 4: table 8.8, line 2, above. Line 5: Brady's price index of new factory and store construction, 1850–1890, adjusted in the manner (and for the reasons) described in chapter 8.2.4 above (Brady 1966, 110–11). The 1840 and 1900 figures were obtained by extrapolation on the series in table 7.2. Line 6: $100 \times \text{line 4} \div \text{line 5}$. Line 7: table 8.8, line 4.

ital estimates for earlier years are at best a conglomeration. Either the 1900 data are net reproduction costs, or net reproduction costs and book values were virtually the same in that year, because of the similarity of the 1890 and 1900 asset ratios.

We treated all the capital estimates as though they were net reproduction costs—an assumption as nearly correct as any other, and one that considerably simplified the computation of our constant value series. In any case, the question is not as important as it may appear. As long as our asset ratios are for net reproduction cost, it makes surprisingly little difference whether total capital is in book or current terms. Several factors contribute to this result.

(1) Almost half of total capital is short-term capital. This is always in current values.

(2) The remaining half would have to be deflated by three price indexes: indexes for land, for equipment, and for buildings. Both the buildings and equipment price indexes generally declined over time (see table 8.9). No land index has been developed, but the value of land in the vicinity of a mill would generally rise as a result of the very fact that the mill has been constructed, and the current value for the land would generally be above the book or cost valuation. Thus there is probably a tendency for

these diverse influences to bring book values and current values of total capital closer together.

(3) The rapid rate of growth of manufacturing capital in the 1800s (often more than doubling in ten years) diminishes the influence of old assets in the total valuation.

If the census valuations are really net reproduction cost valuations, then Brady's price indexes are appropriate means for deflating our manufacturing capital stock estimates, and we therefore made use of them. Details are contained in table 8.9.

8.3.5. *Evaluations*

The census capital figures for manufacturing appear to be only slightly better than the mining data. It is quite possible that they are low, particularly prior to 1880. The reader is invited to read the discussion of the quality of the census data in Creamer, Dobrovolsky, and Borenstein (1960, 195–221). In general, we may say that our 1890 and 1900 estimates are reasonably accurate, the 1880 estimate is only slightly less so, but the 1840–1870 estimates are of considerably poorer quality, and are more likely to understate valuations than to overstate them.

8.4. Conclusion

This chapter discusses the estimates of the capital stock in mining and manufacturing. It addresses important debates over valuation.