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## CHAPTER TEN

## Transportation

## IO.I. Introduction

This chapter details the estimation of the current-price and constantprice (1860) capital stock on a decadal basis from I840 to 1900 for the transportation sector. It covers, in turn, shipping, canals and river improvements, steam railroads, street railroads, Pullman and express cars, and pipelines.

### 10.2. Shipping

### 10.2.I. Current Value of Vessels

The censuses of 1880 and 1890 include statements of the value of vessels that seem reliable. The 1880 value of sailing vessels was established by an insurance expert; steam valuations were apparently obtained from steamboat owners (US Census Office 1883b, 718-19). In i890 all valuations were "commercial valuations" estimated by owners (US Census Office 1895b, xii, 5). The fact that both steam and sailing values per ton show small increases between 1880 and 1890 is encouraging. All the appraisals appear to be in current market values.

We used the census data for 1880 and 1890 without modification. Our I900 estimate is from Kuznets, who interpolated between I890 and 1906 on the basis of tonnage figures (see table io.I and accompanying notes for details).

Gallman wrote the substance of this chapter. "We" and "our" refers to Gallman and Howle.

For 1870 and earlier, only official tonnage data are available. We first modified them to exclude ghost tonnage (US Bureau of the Census i960, series Q-ı55, Q-ı6ı, Q-i62, Q-ı78, Q-i79). Then we extrapolated the I880 valuations per ton, for each kind of vessel, back to 1840 on the basis of the adjusted Brady price index of ships and boats. Finally, we multiplied the tonnage figures by valuations per ton for each kind of vessel (steam, sail, and other) to yield total valuations (see table io.r and accompanying notes for details). ${ }^{1}$

Since the Brady index relates to the prices of vessels of constant size and quality, since price per ton was positively associated with size of vessel, and since the size of vessels was increasing, the current price series we computed is almost certainly biased upward, although probably only modestly - the bias being greater the earlier the date of the estimate.

### 10.2.2. Constant Value of Vessels

The current value of vessels was deflated by the Brady index.

### 10.2.3. Real Estate in Shipping

We were unable to develop an accurate estimate of the value of real estate in shipping. Rather than omit this component of capital entirely, we used a rough estimating procedure developed by Kuznets. We divided real estate between land and improvements according to our ratio for trade and nonfarm residential real estate. The improvement estimate was then deflated by Brady's adjusted price index for factories and stores (see table io. i for details).

### 10.3. Canals and River Improvements

## io.3.I. Coverage

All canals and all river improvements, whether part of a canal system or not, are included. For convenience, we will henceforth use the term "canals" to include river improvements.

### 10.3.2. Derivation of Cost Estimates

We first estimated the cost of canal construction by decades. For the period I8I5 through I860, the most reliable source is an annual construction
table io.i Value of vessels and real estate in shipping, measured in current and $\mathbf{1 8 6 0}$ prices, $1840-1900$

|  | 1840 | 1850 | 1860 | 1870 | 1880 | 1890 | 1900 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Ghost tonnage deduction | 12\% | 10\% | 2.50\% | - | - | - | - |
| Steam vessels |  |  |  |  |  |  |  |
| Tons (in thousands) | 202 | 526 | 868 | 1,075 | - | - | - |
| Adjusted tonnage | 178 | 473 | 846 | 1,075 | - | - | - |
| Value per ton (in dollars) | 148 | 109 | 87 | 73 | 66 | - | - |
| Value, at current prices (in millions of dollars) | 26.3 | 51.6 | 73.6 | 78.5 | - | - | - |
| Sailing vessels |  |  |  |  |  |  |  |
| Tons (in thousands) | 1,582 | 2,408 | 3,589 | 2,363 | - | - | - |
| Adjusted tonnage | 1,392 | 2,167 | 3,499 | 2,363 | - | - | - |
| Value per ton (in dollars) | 56 | 41 | 33 | 28 | 25 | - | - |
| Value, at current prices (in millions of dollars) | 78 | 88.8 | 115.5 | 66.2 | - | - | - |
| Other vessels |  |  |  |  |  |  |  |
| Tons (in thousands) | I,189 | 1,956 | 2,97I | 2,292 | - | - | - |
| Adjusted tonnage | 1,046 | 1,760 | 2,897 | 2,292 | - | - | - |
| Value per ton (in dollars) | 12.8 | 9.5 | 7.5 | 6.3 | 5.7 | - | - |
| Value, at current prices (in millions of dollars) | 13.4 | 16.7 | 21.7 | 14.4 | - | - | - |
| All vessels |  |  |  |  |  |  |  |
| Tons (in thousands) | 2,973 | 4,890 | 7,428 | 5,730 | - | - | - |
| Adjusted tonnage | 2,616 | 4,401 | 7,242 | 5,730 | - | - | - |
| Value per ton (in dollars) | 44.9 | 36 | 29 | 27.6 | - | - | - |
| Value, at current prices (in millions of dollars) | 117.5 | 158.4 | 210 | 158.1 | 156 | 221 | 343 |
| Price index | 170 | 126 | 100 | 84 | 76 | 57 | 51 |
| Value, at 1860 prices (in millions of dollars) | 69.1 | 125.7 | 210 | 188.2 | 205 | 388 | 673 |
| Real estate |  |  |  |  |  |  |  |
| Improvements, at current prices (in millions of dollars) | 20.4 | 27.6 | 36.5 | 27.5 | 27.1 | 38.5 | 59.7 |
| Price index | 107 | 108 | 100 | 90 | II4 | 91 | 89 |
| Real estate |  |  |  |  |  |  |  |
| Improvements, at 1860 prices (in millions of dollars) | 19.1 | 25.6 | 36.5 | 30.6 | 23.8 | 42.3 | 67.1 |
| Land, at current prices (in millions of dollars) | 26.6 | 35.8 | 47.5 | 35.7 | 35.3 | 49.9 | 77.5 |

Sources:
Line 1 : For all years, US Bureau of the Census 1960, 439, indicates that in 1841 official tonnage figures were reduced by about 12 percent to eliminate ghost tonnage. We accordingly reduced the 1840 unadjusted data by 12 percent. The next adjustment for ghost tonnage was made in $1855-58$ and resulted in an 18 percent reduction of official tonnage figures. We prorated this by years, deducting io percent necessary to adjust the tonnage figures for 1870 and later, since ghost tonnage represented a much smaller part of the total (I-3 percent).
Line 2: For all years, US Bureau of the Census 1960 , series Q-I 55 . Lines 3,7 , 11 , and 15 , for all years, ines $2,6,10$, and 14 respectively, 18 . $\qquad$ Lines 5, 9, I3: For all years, adjusted tonnage multiplied by value per ton.
Line 6: For 1870 , US Bureau of the Census 1960, series Q-161, hereafter Historical Statistics.
For $1840-60$, certain vessels were included in the data that were not included in our 1880 value-per-ton figure. We reduced the Historical Statistics figure by 20 percent to account for this. The 20 percent estimate is somewhat arbitrary, since we know the tonnage of these vessels only after they were excluded from the sailing category. In the years from 1868 to 1875 , the sailing category was smaller than it would have been if the pre-1869 classification had been used, by the following percentages:
$\begin{array}{llllllll}1868 & 1869 & 1870 & 1871 & 1872 & 1873 & 1874 & 1875\end{array}$
US Bureau of the Census 1960, series Q-I6I and Q-I62. After 1875 , the information for a comparison is not available. It can be seen that the data we have are insufficient to indicate a definite trend. Therefore, we reduced the 1840,1850 , and 1860 figures by 20 percent, the ratio computed from the 1868 data.
Line 1o: Unfortunately, the 1960 Historical Statistics figures included only documented vessels. Many internal, non-passenger-carrying vessels were excluded. The "other ships" (canal boats and barges, series QI62) category in the 1960 Historical Statistics is therefore not nearly so broad as the ones in the 1880 or 1890 census. This miscellaneous category in 1880 made up 44 percent of total tonnage, and in 1890 it made up 57 percent. We assumed that this category made up 40 percent of total tonnage prior to 1880 . Even though the tonnage is quite significant, the value is not, since this category has a low pre-ton value. See US Bureau of the Census 1960.
Line 14: For all years, line $2+$ line $6+$ line 10 .
Line 16 : For all years, line $17 \div$ line 15 (expressed in millions).
Line 17 : For $1840-70$, line $5+$ line $9+$ line 13 . For 1880 , US Census Office 1883 b, $718-19$. For 1890 , US Census Office $1895 b$ b, xii, 5 . For 1900 , we accepted Kuznets's interpolation between 1890 and 1906 ,
derived as follows: "The value of vessels is estimated as the product of the tonnage and the value per ton. Tonnage is interpolated between 1890 and 1906 (for 1890 given in [US Census Office 1897 ] and for 1906 in [US Bureau of the Census I908] by tonnage of the total merchant marine [US Bureau of Navigation 1923]. Value per ton, computed for 1890 and 1906, is interpolated along a straight line. Value figures for 1890 and 1906 are from the sources cited for tonnage" (Kuznets 1946, 215).
Line 18: Brady 1966, 1 IO-1I, adjusted as follows. The Brady index numbers refer to the wrong years (see chapter 7, above). However, the evidence on lumber prices and the wage rates paid by shipbuilding firms suggest that the Brady indexes require no adjustment on this account, except for 1880 ( 1879 ). The Brady index of 1879 had to be raised by 5 percent to approximate a vessel's price index for 1880 , an adjustment we made. See the Aldrich Report (US Senate 1893, 228 [white oak boards], 232 [yellow pine boards], 229 [white pine boards], and 238 [spruce boards]); Henry Hall I884, $245-46$;
 1886, 499), to obtain index numbers for 1840 and 1850 (calendar years).
Line 19 : $100 \times$ line $17 \div$ line 18 .
Line 20: For all years, very little information is available on which to construct an estimate of real estate in shipping. Kuznets ( 1946 , 21 I ), used 1880 steamship figures to compute a ratio of the value
of real estate to the value of vessels, a ratio he then used to estimate the value of real estate in shipping. We accepted Kuznets's ratio ( 0.40 ). We divided real estate between land ( 0.565 ) and improvements ( 0.435 ) according to ratios developed in Chapter 9.2, above.
Line 21: For all years, table 8.9, Line 5 .
Line 23: For all years, same method as for line 20.
cost series done by H. Jerome Cranmer (1960, 547-64) and modified by Harvey Segal (196I, I69-215). An alternate source for the period is US Census Office (i883b), where cost and dates of construction are given for each canal. The census estimates are slightly higher than the CranmerSegal series, apparently because they include some maintenance costs and noncanal assets. We therefore used the Cranmer-Segal estimates, with minor modifications (as indicated in table 10.2 and table ro.3) to include river improvements and pre-1815 canal construction.

All of our cost figures for the 1860-1900 period are from the US Census Office (1883b, 753) and US Bureau of the Census (1929, 72-73). The 1860-80 census data omitted river improvements that were not part of a canal system and canals constructed by the federal government. We modified the census data to include estimates of these items, as indicated in tables io.2 and io.3.

Having determined the cost of canal construction by decades, we then adjusted the data to exclude obsolete canals. When properly maintained, canals do not wear out, but the development of the railroads made obsolescence an important factor. We deducted the cost of abandoned canals from our decade cost totals from US Census Office i883b and US Bureau of the Census 1929. (The former source lists individual abandoned canals and dates of abandonment.) In addition, the value of an abandoned canal can be considered to have been greatly impaired for a number of years prior to abandonment, due to reduced traffic and inadequate maintenance. To compensate for this factor, we assumed that any canal abandoned during the ten years following a valuation date was of no value on that date. For example, our I870 canal estimate excludes the cost of all canals abandoned before $I 880$. This adjustment is the equivalent of our depreciation adjustments of other wealth categories.

### 10.3.3. Division of Cost into Improvements, Equipment, and Land

We assumed that all construction costs were for improvements; land could hardly have accounted for I percent of the total cost of canals. The principal component of equipment - and the only one we took into accountwas canal boats, which form part of our shipping series.

### 10.3.4. Derivation of Constant Cost Estimates

The cost basis estimates were deflated by decade of construction, as shown in table ro.4. To obtain the construction dates of canals in operation at

| Operating canals, 1840 | II2 |
| :---: | :---: |
| Less those abandoned, $1840-50^{\text {a }}$ | -2 |
| Value of canals, 1840 | I 10 |
| Add construction, 1840-50 | +44 |
| Operating canals, 1850 | 154 |
| Less those abandoned, 1850-60 | -3 |
| Value of canals, 1850 | 151 |
| Add construction, 1850-60 | +39 |
| Operating canals, 1860 | 190 |
| Less those abandoned, 1860-70 | -6 |
| Value of canals, 1860 | 184 |
| Add construction, 1860-70 | +9 |
| Operating canals, 1870 | 193 |
| Less those abandoned, 1870-80 | -25 |
| Value of canals, 1870 | 168 |
| Add construction, 1870-80 | $\underline{+12}$ |
| Operating canals, 1880 | 180 |
| Less those abandoned, 1880-90 | -7 |
| Value of canals, 1880 | 173 |
| Add construction, 1880-90 | $\underline{+1 \text { I }}$ |
| Operating canals, 1890 | 184 |
| Less those abandoned, 1890-1900 | -13 |
| Value of canals, 1890 | 171 |
| Add construction, 1890-1900 | +59 |
| Operating canals, 1900 | 230 |
| Less those abandoned, 1900-10 | -19 |
| Value of canals, 1900 | 211 |

## ${ }^{\text {a i.e. From June 30, }} 1840$ through June 30, I850 <br> Sources:

Line I: According to Cranmer's estimate, as modified by Segal (1961, 208-9), \$107 million was invested in canal construction between 1815 and 1840 . (We interpolated the June 3I, 1840 , figure from year-end figures for 1839 and 1840 .) We added $\$ 5$ million to this, as a rough allowance for canals constructed before 1815 . The abandonment of canals prior to 1840 was negligible, so no adjustment on this account was necessary. See Goodrich's introduction to Segal 196ı, 7, for a comment on abandonment. Lines 2, 6, 10, and i4: Estimated from data in US Census Office I883b, we adjusted the census data upward by 5 percent to account for those abandoned canals with no valuation listed. Lines 18, 22, and 26: US Bureau of the Census 1929, 72-73. The 1890-1900 and 1900-1910 estimates were interpolated between 1889 , 1906, and I916. Lines 4 and 8: Segal 196i, 209, interpolated between year-end figures. To the Segal estimate we added the estimated cost of river improvements. See notes to lines I2 and I4. Lines I2 and I6: US Census Office 1883b listed the cost of construction of operating canals, and the dates of construction. From these data we estimated the decade totals. We added the cost of construction of US government-built canals and of river improvements that were not a part of canal systems, since neither was included in the census estimate. The costs of these categories were extrapolated from 1880,1889 , and 1906 on data found in U.S. Bureau of the Census $1908,40$. See table 10.3. Lines 20 and 24: US Bureau of the Census 1929, 72-73. The census lists the total cost of operating canals in 1880, 1889, and 1906. The cost of abandoned canals was also given for $1880-89$, and $1889-1906$. By subtracting the cost of operating canals in 1880 from the cost in 1889 and adding to the difference the cost of canals abandoned, we obtained the cost of canals constructed between 1880 and 1889. The same procedure was used for 1889-1906. The 1900 estimate was then interpolated between 1889 and 1906 . We assumed that one-half of the total construction between 1889 and 1906 was carried out prior to 1900 . We used only the incremental changes given in the census, not the census total cost figures, because we believe that the earlier canal cost totals are not accurate; see text. Lines 3, 5, 7, 9, II, 13, 15, 17, 19, 21, 23, 25, and 27: Obtained from the other columns in this table by addition and subtraction as indicated.
table io. 3 Categories excluded from the Cranmer-Segal and tenth census estimates, 1840-1900, in millions of dollars

|  | $\mathbf{1 8 4 0}$ | $\mathbf{1 8 5 0}$ | $\mathbf{1 8 6 0}$ | $\mathbf{1 8 7 0}$ | $\mathbf{1 8 8 0}$ | $\mathbf{1 8 8 9}$ | $\mathbf{1 9 0 6}$ |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| US government canals | - | - | - | 4 | 8 | 2 I | 27 |
| River improvements | - | I | 2 | 4 | 9 | 17 | 43 |
| Total | - | I | 2 | 8 | 17 | 38 | 70 |

Source: US Bureau of the Census 1908, 40.
each valuation date, we assumed that the canals abandoned earliest were the first to be constructed. Common labor is the major portion of construction cost. We therefore used Lebergott's common labor wage index as our price index. Since the wage index extends back only to 1832 , we made a rough extrapolation to 1815, based on a comment by Segal regarding changes in canal construction costs during the 18I5-44 period; see notes to table 10.2 for details.

### 10.4. Steam Railroads

## IO.4.I. Introduction

Two methods were available to us to make railroads asset estimates. The first, used by Kuznets (i946, 201-19), was to develop total capital estimates, break them down into their components using asset ratios (available for 1858 and 1880), and then apply appropriate price indexes to convert them to constant dollars. Instead, we used a procedure developed by Albert Fishlow (1965). The procedure allowed us to exploit more reliable evidence: evidence of the count of physical components of the capital stock. Indexes were developed that were adjusted for changes in resource content per unit of component. For example, a mile of track in 1850 might be considered to be the equivalent of 0.9 miles of track in 1900. Fishlow followed this procedure for track, locomotives, freight cars, and passenger cars. He then combined the indexes into an index of improvements and one of equipment, and used ig09 prices to convert them to constant dollars. Because we wanted our series in 1860 prices, we applied 1860 valuations to Fishlow's improvement and equipment series. ${ }^{2}$ See table 10.5. The i860 valuations were based on census data, but were modified because the census valuations did not represent the true value of the assets.

### 10.4.2. Value of I860 Fixed Capital

The i860 census lists $\$ 1,15$ I. 6 million as the cumulative cost of construction of railroads to that date (US Census Office 1866, 33I). From what we know of railroad accounting methods of the period, we can be confident that no depreciation had been deducted. In addition, railroads typically paid for construction materials with stock; the result was that assets were set up on the books at valuations considerably above their cash prices. Fishlow's adjustment of the census cost of construction figure to exclude overvaluations, land purchases and non-railroad assets, and to include omitted railroads, reduced the census return from $\$_{\text {I }, 151.6}$ to $\$ 990.7$ million. ${ }^{3}$ This figure is net of retirements, but gross of depreciation. It is also on a cost basis, which may represent a deviation from i860 market prices. But before addressing these problems, we will show how we divided the total between improvements and equipment.

### 10.4.3. Value of Improvements and Equipment in 1860

Based on a sample of railroad balance sheets in 1858, we estimated that improvements made up 89.2 percent and equipment 10.8 percent of the total value of improvements and equipment. The sample from which we derived this estimate was weighted for size of railroad, to parallel the size distribution of the total population. ${ }^{4}$ On this basis we divided Fishlow's total between its two major components (see table io.6, panel A.)

Fishlow's (1965, 389) price indexes for railroad equipment and improvements indicate that there is no need to adjust the 1860 valuation from book to current value. Assuming a twenty-year life-span of equipment, and interpolating our equipment growth rate along the change in mileage (table 10.7), shows that the prices at which equipment was entered on the books averaged about 98 percent of average 1860 prices. The deviation of the book value of improvements from the 1860 price level was even smaller. We therefore used the estimates in table io.6, panel A, as if they were in 1860 dollars-that is, as if they represented gross reproduction cost estimates.

Next, our equipment and improvements estimates had to be depreciated. Fishlow's equipment series is already properly depreciated, using a twenty- to twenty-five-year life, but we had to depreciate our 1860 value of equipment before we applied it to his series. Conveniently, we could use the ratio of undepreciated values to depreciated values for 1860 that
table io. 4 Value of canals and river improvements, measured in current and $\mathbf{1 8 6 0}$ prices, $\mathbf{1 8 4 0 - 1 9 0 0}$, in millions of dollars

| Date of valuation | Date of construction ${ }^{\text {a }}$ |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
|  | Pre-1815 | 1815-35 | 1835-40 | 1840-50 | 1850-60 | 1860-70 | 1870-80 | 1880-90 | 1890-1900 | All |
| Price index $(\mathrm{I} 860=100)$ | 73 | 73 | 91 | 91 | 91 | I3I | I26 | I27 | I36 |  |
| 1840 |  |  |  |  |  |  |  |  |  |  |
| Cost valuation | 2 | 61 | 47 |  |  |  |  |  |  | IIO |
| Constant value | 3 | 84 | 52 |  |  |  |  |  |  | 139 |
| 1850 |  |  |  |  |  |  |  |  |  |  |
| Cost valuation |  | 60 | 47 | 44 |  |  |  |  |  | 151 |
| Constant value |  | 82 | 52 | 48 |  |  |  |  |  | 182 |
| 1860 |  |  |  |  |  |  |  |  |  |  |
| Cost valuation |  | 54 | 47 | 44 | 39 |  |  |  |  | 184 |
| Constant value |  | 74 | 52 | 48 | 43 |  |  |  |  | 217 |
| 1870 |  |  |  |  |  |  |  |  |  |  |
| Cost valuation |  | 29 | 47 | 44 | 39 | 9 |  |  |  | 168 |
| Constant value |  | 40 | 52 | 48 | 43 | 7 |  |  |  | 190 |



[^0]table io.5 Fishlow's railroad price indexes

|  | Equipment | Improvement |
| :--- | :---: | :---: |
| I840 | 79.3 | 99.8 |
| I84I | 78.9 | 92.3 |
| I842 | 76.2 | 90.2 |
| I843 | 73.8 | IOI.7 |
| I844 | 75.5 | 99.0 |
| I845 | 78.2 | 99.2 |
| I846 | 83.3 | 110.9 |
| I847 | 88.0 | 106.9 |
| I848 | 86.5 | 99.3 |
| I849 | 86.0 | 94.0 |
| I850 | 84.3 | 88.2 |
| I85I | $85 . \mathrm{I}$ | 88.3 |
| I852 | $87 . \mathrm{I}$ | 89.0 |
| I853 | 91.4 | 98.3 |
| I854 | 96.7 | 108.0 |
| I855 | I00.0 | 97.5 |
| I856 | I00.I | 106.5 |
| I857 | IO3.I | 109.0 |
| I858 | IO6.3 | 104.0 |
| I859 | IO2.7 | 100.4 |
| I860 | Ioo.0 | 100.0 |

Source: Correspondence with Albert Fishlow
is implicit in the Fishlow figures. We simply recomputed the 1860 value in Fishlow's series, but this time left out all adjustment for depreciation and retirements. In this way we determined that the depreciated value of equipment in 1858 was 65.3 percent of the new value, and we therefore multiplied the total cost of equipment, including retired equipment, by 0.653 to obtain the approximate depreciated value of equipment in 1860 (see table io.6, panel B).

We could not follow the same procedure for depreciating improvements, because a useable estimate of depreciation is not implied in Fishlow's improvements index. Fishlow (i966c, 600) depreciated the long-lived railroad improvements (road bed), but assumed that the ratio of depreciated value to new value would remain about the same throughout the period for rails and ties. This assumption is reasonable as far as the index is concerned, but to apply our 1860 values to the index we had to depreciate all assets. ${ }^{5}$ Fishlow (1966c, 596) estimated the accumulated depreciation on long-lived improvements at 8.9 percent of the value of all improvements in 1858 , and 13.8 percent in 1869 . An interpolation yields 9.8 for

TABLE IO. 6 Value of railroad assets, $\mathbf{I 8 6 0}$, in millions of dollars

| Panel A. Gross book value of railroad assets, $\mathbf{1 8 6 0}$ |  |  |
| :--- | :--- | :--- |
| I | Improvements | 883.70 |
| 2 | Equipment | 107 |
| 3 | Improvements and equipment | 990.70 |

Panel B. Depreciated value of railroad equipment (net reproduction cost), $\mathbf{1 8 6 0}$

| I | Book value of equipment, December 1860 | 107.00 |
| :--- | :--- | :---: |
| 2 | Retirements through I860 | 8.90 |
| 3 | Undepreciated value of equipment | 115.9 |
| 4 | Ratio of depreciated to undepreciated value | 0.653 |
| 5 | Depreciated value of equipment | 75.7 |
| 6 | Line 5 extrapolated from December to June | 73.7 |

Panel C. Depreciated value of railroad improvements (net reproduction cost), 1860

| I | Book value of improvements, December 1860 | 883.7 |
| :--- | :--- | :--- |
| 2 | Less depreciation | 199.7 |
| 3 | Depreciated value of improvements | 684 |
| 4 | Line 3 extrapolated from December to June | 666.2 |

Sources: Panel A. See text.
Panel B. Line 1: panel A, line 2. Line 2: communication from Albert Fishlow. Line 3: line $1+$ line 2 . Line 4 : See text. Line 5 : line $3 \times$ line 4 . Line 6 : Line 5 was extrapolated for six months according to the interpolated change in railroad mileage in US Bureau of the Census 1960, series Q-43.

Panel C. Line I: panel A, line I. Line 2: The depreciation adjustment of $0.226 \times$ line I; see text. Line 3: line I - line 2. Line 4: Line 3 was extrapolated for six months according to the interpolated change in railroad mileage in US Bureau of the Census 1960, series Q-43.
1860. For all practical purposes, retirements of these assets were nil as of that date. To the cumulated depreciation of long-lived improvements we added the depreciation of rails and ties to obtain an estimate of the total accumulated depreciation of improvements still in use in 1860. (Since this total excludes retired assets, there was no need to add retired improvements to our book value of improvements, as we did with equipment.)

If we assume a ten-year life of rails and ties and interpolate Fishlow's improvements index along the change in railroad mileage, we find the depreciated value of rails and ties in use in 1860 amounting to about 62 percent of their new value. ${ }^{6}$ This is probably too high, since rerolled rails were extensively used for replacement purposes (Fishlow 1965, I30). We have not been able to determine how much this affected the total value of all rails, but we lowered our estimate of the ratio of depreciated to
TABLE 10.7 Value of railroad equipment, measured in $\mathbf{1 8 6 0}$ prices, $\mathbf{1 8 4 0 - 1 9 0 0}$

|  | ( I ) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Value, at 1909 prices, in millions of dollars | Decade increase | Track mileage | Track mileage | Track mileage | Ratio of mileage increase | Equipment increases to census date | Value, at 1909 prices, in millions of dollars | Equipment index $(\mathbf{1 8 6 0}=\mathbf{1 0 0}) .$ | Value, at 1860 prices, in millions of dollars |
| Dec. 1838 | 2.9 |  | I,879 |  |  |  |  |  |  |  |
| June I840 |  |  | 2,510 |  | 63 I | 0.144 | I. 2 | 4. I | 0.062 | 4.57 |
| Dec. I848 | II. 4 | 8.5 | 6,262 |  | 4,383 |  |  |  |  |  |
| June i850 |  |  | 7,941 |  | I,679 | 0.0863 | 4. I | I5.5 | 0.233 | 17.2 |
| Dec. I858 | 59.2 | 47.8 | 25,713 |  | I9,45 |  |  |  |  |  |
| June I860 |  |  | 28,170 |  | 2,457 | 0.138 | 7.2 | 66.4 | 1.00 | 73.7 |
| Dec. I869 | III. 7 | 52.5 | 43,512 | 46,844 | 17,799 |  |  |  |  |  |
| June I870 |  |  | 49,883 |  | 3,039 | 0.0765 | 13.3 | I25 | I. 883 | I38.8 |
| Dec. I879 | 286.I | 174.4 | 86,556 |  | 39,712 |  |  |  |  |  |
| June i880 |  |  | 89,909 |  | 3,353 | 0.0449 | 14.4 | 300.5 | $4 \cdot 526$ | 333.6 |
| Dec. I889 | 606.8 | 320.7 | 160,884 | 161,276 | 74,720 |  |  |  |  |  |
| June I890 |  |  | 163,597 |  | 2,713 | 0.089 I | I2.7 | 619.5 | 9.33 | 687.6 |
| Dec. I899 | 749.6 | I 42.8 | 191,32 I |  | 30,437 |  |  |  |  |  |
| June I900 |  |  | 193,346 |  | 2,025 | 0.0429 | 39 | 788.6 | I I. 877 | 875.3 |
| Dec. 1909 | I658.2 | 908.6 | 238,564 |  | 47,243 |  |  |  |  |  |

Sources: Column I: Fishlow i966c, 606; see text. Column 2: column I less the column I estimate ten years earlier (i.e., the 1848 entry in column 2 is the 1848 entry in column 1 less the 1838 entry Sources: Column I: Fishlow 1966c, 606; see text. Column 2: column I less the column I estimate ten years earlier (i.e., the i 848 entry in column 2 is the i848 entry in column I less the i838 entry
in column I. Columns 3 and 4: Three different mileage series (miles built, miles operated, miles owned) were pieced together. See US Bureau of the Census ig6o, series Q-I5, Q-43, Q-47. The June estimates were obtained by interpolation, down to 1890 ; the December estimates were obtained thereafter. Column 5 : the increase in columns 3 or 4 between the index date and the census date, and between two index dates (i.e., the 1840 entry in column 5 is the increase in column 3 from 1838 to 1840 , while the 1848 entry in column 5 is the increase in column 3 from 1838 to 1848 ) Column 6: The increase in mileage from December 1838 to June 1840 is this portion of the increase from December 1838 to December 1840 . The same procedure was used for other years. Column 7: Column $6 \times$ column 2 entry for the corresponding period (i.e., the 1840 entry in column 6 was multiplied by the 1848 entry in column 2 to yield the 1840 column 7 figure). Column 8 : To the column I index was added the interpolated increase indicated in column 7 . Column 9: Column 8 was divided by its own 1860 entry so that $1860=100$. Column 10 : The 1860 figure is from table 10.6 in panel B above. For other years, the 1860 entry was multiplied by the column 9 entry for each respective year (i.e., for the 1870 estimate, $73.7 \times 1.883=125.4$ ).
undepreciated value from 62 to 60 percent, as a rough allowance. This meant lowering the value of rails and ties by 40 percent, or, since rails and ties made up about 32 percent of all improvements, lowering the value of the latter by 40 percent $\times 32$ percent $=12.8$ percent. Adding this to Fishlow's 9.8 percent depreciation of long-lived improvements gives a total depreciation allowance of 22.6 percent.

## Io.4.4. Equipment and Improvements: Constant Value Series

The Fishlow equipment and improvements indexes could now be used to determine the 1860 dollar value of these assets in all other years. As already mentioned, the indexes represent weighted physical counts of assets that have been adjusted for changes in resource content (over time) per unit of asset. The application of 1860 valuations to the Fishlow indexes is shown in table 10.7 for equipment, and in table 10.8 for improvements. (The indexes had first to be interpolated along rail mileage to coincide with census years.) Table io.9 summarizes the results.
table io. 8 Value of railroad improvements, measured in $\mathbf{1 8 6 0}$ prices, $\mathbf{1 8 4 0 - 1 9 0 0}$

|  | (1) | $(2)$ | $(3)$ | $(4)$ | $(5)$ | $(6)$ | (7) |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |

Sources: Column I: Fishlow 1966c, 596; see text. Column 2: See notes to table 10.7, column 2. Column 3: table io.7, column 6. Columns 4, 5, 6 and 7: derived in the same manner as columns 7, 8,9 and 10, respectively, in table 10.7. The 1860 figure in column 7 is from table io.6, panel C.
table ro.9 Value of railroad capital and land, measured in current and $\mathbf{1 8 6 0}$ prices, $\mathbf{1 8 4 0 - 1 9 0 0 ,}$, in millions of dollars

|  | 1840 | 1850 | 1860 | 1870 | 1880 | 1890 | 1900 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Equipment |  |  |  |  |  |  |  |
| I Value, at 1860 prices | 4.57 | 17.2 | 73.7 | 138.8 | 333.6 | 687.6 | 875.3 |
| 2 Price index | 79.3 | 84.3 | 100 | 62 | 6 I | 49 | 43 |
| 3 Value, at current prices | 3.62 | I4.5 | 73.7 | 86.I | 203.5 | 336.9 | 376.4 |
| Improvement |  |  |  |  |  |  |  |
| 4 Value, at I860 prices | 6 I .3 | I75.9 | 666.2 | I,063.9 | I,924.7 | 3,648.I | 4,227.0 |
| 5 Price index | 99.8 | 88.2 | 100 | 151.3 | I I7.I | 107.6 | 109 |
| 6 Value, at current prices | 6 I .2 | 155.I | 666.2 | I,609.7 | 2,253.8 | 3,925.4 | 4,607.4 |
| Land |  |  |  |  |  |  |  |
| 7 Value, at current prices | $4 \cdot 3$ | 10.9 | 46.6 | I 12.7 | I 57.8 | 274.8 | 322.5 |

Sources:
Line i: Table io.7, column io.
Lines 2 and 5: 1840-60: Fishlow 1965, 389. 1870-1900: The equipment index is from Brady 1966, 11 I , adjusted per the notes to table 8.9. The improvements index was constructed following the procedures of Fishlow 1965, 387-90. We used the same wage rate series (weight of 6) as Fishlow (Lebergott 1960, 462). Unfortunately, Lebergott has no wage data for 1890 and 1900 ; we were obliged to substitute data for 1889 and 1899 . For the building materials price index (weight I) Fishlow used US Senate 1893; we substituted the Warren-Pearson index, which seems to have a slightly better structure and also covers the full period we required, which the Aldrich Report index does not. (See Fishlow's discussion of the Aldrich Report index, p. 390.) For the weights of the Warren-Pearson index, see Warren and Pearson 1932, I28. We constructed a chained rail price index (weight 3) from data in American Iron and Steel Association I9I2, 86-89. The link between I860 and I870 was established on the basis of domestic iron rail prices (American Iron and Steel Association 1912, 87); the link between 1870 and subsequent years, on the basis of domestic steel rail prices (American Iron and Steel Association 1912, 89). Fishlow used imported rail prices in the antebellum period, since imports composed a large part of the rails used by American railroads. After the Civil War, domestic supply dominated the market.

Line 3 : line $1 \times$ line $2 \div$ 100. Line 5 : table 10.8 , column 7 . Line 6 : line $4 \times$ line $5 \div 100$. Line 7 : A sample of railroad balance sheets taken from US Census Office 1883b, 60-131, indicates that land values amounted to percent of the value of improvements. Fishlow's (i965, II9) study shows that the percentage was about the same in the prewar period. Line 7 is therefore 7 percent of line 6 .

### 10.5. Street Railways

### 10.5.I. Introduction

The value of street railways (gross book value) is listed in the censuses of 1860, I890, and 1900 (Ulmer 1960, I59, 163). In addition, some data are available for 1870 and 1880 from US and state sources. Using these sources we developed undepreciated book value estimates, then depreciated and deflated to obtain our current and constant price series.

### 10.5.2. Undepreciated Book Values

1880-90. We used Kuznets's (i946, 20I-2, 208-9, 213, 215) gross current price series, the estimates for 1890 and i900, taken from the census, and the estimate for 1880, extrapolated on miles of track.

1850-70. Ulmer computed the total value of street railways for 1870 , using the reports of the railroad commissions, but his sample covered only three states. He assumed that these three states contained the same portion of the total US street railways in 1870 as they did in i890 (Ulmer 1946, 403, 413). We accepted Ulmer's estimate for these three states, but followed a different procedure in the construction of a national estimate.

The 1860 census gives the major city passenger railways and lists the cost of "roads, equipment, etc." as \$14,862,840 (US Census Office 1866, 332). We do not know how reliable or complete the 1860 data are, how they were obtained, or even the concept of value involved, although we have assumed that it is gross book value. The implied growth rates of individual state roads after 1860 are plausible, however, and we therefore decided to accept the data in the absence of better evidence. Presumably the data were collected in the same way as other railroad data returned by the census.

The three states for which Ulmer has data (New York, Massachusetts, Pennsylvania) accounted for 93.2 percent of the total value of street railways in 1860, according to the census. Ulmer shows that in I890 they contributed 48.7 percent of the total. We interpolated between 1860 and 1890 , obtaining a value of 78.3 percent for 1870 . We then divided Ulmer's data for the three states by 0.783 to get a figure of $\$ 45.57$ million as the value of capital in 1870 .

No primary data are available on which to base an estimate for 1850 , but Willford King (1915, 257) published a figure of $\$ 4$ million for that year. How King arrived at this result is unclear, but an exponential
table io. io Gross book value of capital of street railways, $\mathbf{1 8 5 0} \mathbf{- 1 9 0 0}$, in millions of dollars

|  |  | $\mathbf{1 8 5 0}$ | $\mathbf{1 8 6 0}$ | $\mathbf{1 8 7 0}$ | $\mathbf{1 8 8 0}$ | $\mathbf{1 8 9 0}$ | $\mathbf{1 9 0 0}$ |
| :--- | :--- | :--- | ---: | ---: | ---: | ---: | ---: |
| I | Land | 0.5 | I .8 | 5.4 | I 5 | 4 I | I 57 |
| 2 | Improvements | 2.8 | 10.4 | 3 I .9 | IO 4 | 288 | $\mathrm{I}, \mathrm{I} 3 \mathrm{I}$ |
| 3 | Equipment and animals | 0.7 | 2.7 | 8.3 | I 9 | 60 | 288 |
| 4 | Total durable capital | 4 | 14.9 | 45.6 | I 38 | 389 | $\mathrm{I}, 576$ |

Sources:
1850: The total capital estimate is by Willford King (1915, 257). It agrees with the extrapolated growth rate indicated by our later figures. The total was divided among land, equipment, and improvements by the same procedure as that used for 1860 .
1860: Total durable capital is from US Census Office 1866,332 . The value of equipment was obtained by using an I890 ratio of equipment to total durable capital from US Census Office ( $1895 \mathrm{a}, 697$ ) data on animal-drawn street railways. The remaining fixed capital was divided between land and improvements in accordance with Ulmer's ( 1960,415 ) estimate that land made up iI. 9 percent of total durable capital for animal-drawn roads. 1870: Total durable capital was estimated as described in the text, above. The total was divided among land, improvements, and equipment by the same procedure as that used for 1860 . 1880, I890, I900: Kuznets's (I946) tables IV.I, line 9; IV.2, line 9; and IV.3, line 8.
table io. I i Net book values of street railway improvements, measured in current and $\mathbf{1 8 6 0}$ prices, $\mathbf{1 8 4 0 - 1 9 0 0 ,}$, in millions of dollars


[^1]TABLE IO. 12 Net book value of street railway equipment, measured in current and $\mathbf{1 8 6 0}$ prices, $\mathbf{1 8 4 0} \mathbf{- 1 9 0 0}$, in millions of dollars

|  |  |  | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | 1840-50 | 1850-60 | 1860-70 | 1870-80 | 1880-90 | 1890-1900 | Equipmen | reciated |
|  |  |  |  |  |  |  |  |  | Cost basis | 1860 prices |
| I | Book value of equip |  | 0.7 | 2.7 | 8.3 | 19 | 60 | 288 |  |  |
| 2 | incre |  | 0.7 | 2.0 | 5.6 | II | 41 | 228 |  |  |
| 3 | retir |  |  |  | 0.7 | 2 | 6.3 | 13 |  |  |
| 4 | Gross capital forma |  | 0.7 | 2.0 | 6.3 | 13 | 47 | 24 I |  |  |
| 5 | Depreciated value | 1850 | 0.6 |  |  |  |  |  | 0.6 | 0.7 |
| 6 | on evaluation date | 1860 | 0.5 | I. 6 |  |  |  |  | 0.8 | 2 |
| 7 |  | 1870 |  | 0.6 | 5.0 |  |  |  | 5.6 | 6.8 |
| 8 |  | 1880 |  |  | I. 9 | Io |  |  | 11.9 | 18.6 |
| 9 |  | 1890 |  |  |  | 4 | 38 |  | 42 | 76 |
| 10 |  | 1900 |  |  |  |  | 14 | 193 | 207 | 445 |
| II | Price index | Decade | 81. 8 | 92.2 | 8I | 61.5 | 55 | 46 |  |  |

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extrapolation of our later estimates yields a value of slightly less than $\$ 5$ million for 1850 , so we accepted the King estimate.

The total asset figures for 1850 , 1860, and 1870 were divided among land, improvements, and equipment according to 1870 and 1890 ratios. The notes to table io. 10 give further details.

### 10.5.3. Depreciation and Deflation

Depreciation and deflation of the book values are shown in tables io.II and Io.I2; their derivation is explained in the notes.

### 10.6. Pullman and Express Cars

The value of equipment in this category is available for 1900 and I904, but not for earlier years. We adjusted the igoo figure and extrapolated it according to our general railway equipment category. US Bureau of the Census (1907, 22) gives a value of $\$ 98.8$ million for Pullman and private cars in 1900 . We assumed that the 1900 value given by the census is similar to the railroad valuation, since "the value of Pullman and Private cars was ascertained in connection with the estimates of the value of railroads" (US Bureau of the Census 1907, 23). In order to obtain an approximation to net reproduction cost, we reduced the stated valuation by the same proportion that our railroad estimate lies below the census returns for railroads (US Bureau of the Census 1907, 36). The adjusted igoo Pullman and express valuation was then extrapolated along our current value general railroad equipment series. This seems to be appropriate because the ratio of Pullman
table io. i3 Value of Pullman and express cars, net reproduction cost, measured in current and $\mathbf{1 8 6 0}$ prices, $\mathbf{1 8 7 0 - 1 9 0 0 , ~ i n ~ m i l l i o n s ~ o f ~ d o l l a r s ~}$

|  |  | $\mathbf{1 8 7 0}$ | $\mathbf{1 8 8 0}$ | $\mathbf{1 8 9 0}$ | $\mathbf{1 9 0 0}$ |
| :--- | :--- | :--- | :---: | :---: | ---: |
| I | Value, at current prices | 13.3 | 3 I | 52 | 58 |
| 2 | Price index | 62 | 6 I | 49 | 43 |
| 3 | Value, at I860 prices | $2 I .5$ | 55 I | 106 | 135 |

Sources: Line I, 1870-90, extrapolated from I900 by the change in the current value of railroad equipment, table 10.9, line 4. 1900: The census estimate was $\$ 98.8$ million. We reduced this by the ratio of our railroad asset valuation to the census valuation. $98.8 \times 5307 \div 9036=58.0$. See text and lines 4,7 , and 8 of table 10.9 . Line 2: see line 3 of table 10.9 . Line $3: 100 \times$ line $1 \div$ line 2 .
table io. 14 Value of capital and land in pipelines, measured in current and $\mathbf{1 8 6 0}$ prices, 1880-1900, in millions of dollars

|  |  | Investment flows |  |  | Capital stocks |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | 1870-79 | I880-89 | 1890-99 | I880 | 1890 | 1900 |
| I | Net investment in improvements, book value | 10 | 32 | 99 | IO | 42 | I4I |
| 2 | Price index $(\mathrm{I} 860=100)$ | I26 | I27 | 136 |  |  |  |
| 3 | Net investment in improvements, 1860 prices | 7.9 | 25 | 73 | 7.9 | 33 | I06 |
| 4 | Net investment in equipment, book value | I | I | 7 | I | 2 | 8 |
| 5 | Price index $(1860=100)$ | 90.5 | 54 | 30 |  |  |  |
| 6 | Net investment in equipment, I860 prices | I.I | I. 9 | 23.3 | I.I | 3 | 25.2 |
| 7 | Value of land, at current prices |  |  |  | 0.5 | 2 | 8 |

Sources: Line I: Kuznets 1946, table IV, 2, line 17. We assumed that no improvements had been retired before 1900. Line 2: Table 10.3, line 1. Each index number represents an average price level for the indicated decade. Line 3: In columns I-3, $100 \times$ line $\mathrm{I} \div$ line 2 . In columns 4-6, these are stock estimates, derived by cumulating the flows in columns I-3. Line 4: Kuznets I946, table IV, 3, line 16 . We assumed that the equipment acquired in the period 1870 through 1879 was retired in the period 1890 through 1899. Line 5: Table 8.9, line 2 , the means of the indexes for 1870 and 1880,1880 and 1890,1890 and 1900 , respectively. These means were taken to represent the average price levels during the decades of the 1870 , 1880 s, and 1890 s respectively. Line 6 : In columns $1-3,100 \times$ line $4 \div$ line 5 . In columns 4-6, these are stock estimates, derived by cumulating the flows in columns $\mathrm{I}-3$. We assumed that the equipment acquired in the period 1870 through 1879 was retired in the period 1890 through 1899 . Line 7: Kuznets 1946, table IV, I, line 17.
and private car values to railroad asset values (census figures) remained constant from igoo to 1904. Table IO.I3 presents the summary estimates.

### 10.7. Pipelines

We adopted Kuznets's (i946) current price estimates (tables IV-I and IV-2), which are in book values, presumably net, and deflated them, using price indexes assembled for the deflation of manufacturing and canal aggregates (described above). See the notes to table io.I4 for details.

### 10.8. Conclusion

This chapter details the estimation of the capital stock in the transportation sector (exclusive of the value of roads).


[^0]:    ${ }^{\text {a }}$ The dates refer to intervals extending from June 30 of the first date to June 30 of the second. Sources:

    Line I: The price index is a common labor wage index for all years after 1834 . For $1834-90$, it is based on Lebergott's (1964, 298, 541 ) common labor daily earnings index. We shifted the Lebergott index to an 1860 base. The decade averages for $1850-60$ and $1880-90$ were obtained by averaging the wage index for the beginning and end of the decade, since annual data are not解

    For $1890-1900$, the Lebergott index was extrapolated on the index of lower skilled labor from US Bureau of the Census 1960 , series D-602. Annual data were averaged to produce the
    The pre-1835 index values are based on a statement by Segal (I96I, I86): "We believe . . that average construction cost rose sharply between the first (i815-34) and second (i834-44) canal cycles-perhaps by as much as thirty-three percent." David and Solar's ( 1977,59 ) data suggest that the figure may have been more like 17 or 18 percent. We assumed a 25 percent increase. 2 Lines $2,4,6,8$, 10,12 , and 14 : table 10.2 . The pre- 1840 values were broken down by construction cycle according to the Segal ( $\mathrm{I} 96 \mathrm{I}, 208-9$ ) annual construction index. Canals abandoned in
    the decade following each census date were treated as obsolete and of no value on the census date. See text.

    Lines $3,5,7,8$, 11 , 13 , and $I_{5}$ : Lines $2,4,6,8,10$, 12 , and 14 respectively, divided by the price index and multiplied by 100 .

[^1]:    Columns I-6. Line i: table forio, book value at the end of the decade designated. Line 2: line 1 , less line 1 entry for previous date. Line 3: A 30-year life span was assumed. Line 4: line $2+$ line 3 . Lines 5 -IO: The gross capital formation for each decade was depreciated 3.33 percent per year. We assumed that the average age of capital formed during each decade was four years at the end of the decade. This assumption is approximately correct for the growth rate indicated. Line ir: table 10.9 , column 6 , means of terminal-year values, approximating decade averages. Column 7: for all years, the totals of Cols. I-6.

    Column 8: Columns I-6 were each divided by the relevant price index (line II) and then multiplied by ioo; the lines were then totaled for each valuation date.

[^2]:    Sources: See notes to table io. i . Here the life of equipment was assumed to be twenty years, and the average age of capital formed during each decade was assumed as four years. The price index is from table 10.9, the means of terminal year values (column 3 ) approximating decade averages.

