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CHAPTER SIX

Investment Flows and Capital Stocks

6.1. Introduction

There are two ways to estimate the value of the capital stock: by cumulating investment flows, following the perpetual inventory procedures developed by Raymond Goldsmith (1955); or by taking a census of the existing stock, enumerating each element, and placing a value on it (as in the preceding chapters). With identical concepts in each case and perfectly accurate measurements, the two sets of results ought to be the same. In practice, measurements are never perfectly accurate, and historically the concepts embedded in perpetual inventory and census-style estimates have often differed, so that one or the other had to be adjusted to permit close comparisons. Given these incongruities, the degree of consistency observed between US capital stock estimates of the two types is encouraging. Census-style and perpetual inventory series have exhibited similar levels and trends, so that for many analytical purposes it matters little which type is used. Quite the contrary obtains, however, when the focus is on short periods; in such cases the two series often trace discrepant courses (Kendrick 1964, 24–25; Kuznets 1946, 1961a; Davis and Gallman 1973). In the study of business cycles or Kuznets cycles, it matters a great deal which form of evidence is adopted.

The two types of estimates differ in other respects. Censuses of wealth have been taken only intermittently, so that capital series assembled from them are discontinuous, whereas perpetual inventory series can be continuous, a great advantage for many purposes. Economists have worked

Gallman published the substance of this chapter as Gallman 1987. Rhode has revised it modestly for clarity and consistency with the rest of this volume.

out several useful concepts of value and systems of measuring capital consumption. Perpetual inventory procedures can be readily adapted to generate, from a given set of flow data and prices, a variety of capital stock estimates reflecting different systems of valuation, average service lives, distributions of service lives, and systems of capital consumption. It is much more difficult—virtually impossible in some cases—to manipulate census-style capital data to achieve similar ends.

Census-style estimates, however, are likely to be the more comprehensive than perpetual inventory estimates. Perpetual inventory estimates depend upon measurements of investment flows. Such measurements are almost bound to be more complete with respect to repetitive, market-bound events than with respect to their opposite. Should a farmer build a log cabin or a split-rail fence, his activity would probably not be captured in any official record of investment on which perpetual inventory estimates are based. But his log cabin and his fence would almost certainly turn up in a census of wealth, should one be taken. In modern economies, homemade cabins and fences are so few as to be negligible sources of discrepancy between aggregate stock and flow capital series. That would not have been the case in earlier days, when agriculture accounted for a larger fraction of activity, when the raw materials of construction lay within the reach of many farmers, when mechanization had not yet smoothed out the seasonal demand for farm labor, and when markets were so incompletely articulated that off-season work away from the farm was not widely available. In those days, farmers built many a fence and cabin in the off-season from the materials drawn from farm woodlots.

There is ample reason, then, to attempt to build two sets of capital stock estimates: one based on perpetual inventory and the other on census-style procedures. We can check one against the other and lay the basis for sensitivity testing with respect to analyses involving investment and the capital stock (e.g., analyses of the share of investment in income, the rate of growth of the capital stock, the sources of economic growth, or the structure of the capital stock). Furthermore, in view of the existing range of analytical requirements—for gross and net series, for acquisition-cost, reproduction-cost, and market-value series—and the degree of uncertainty as to appropriate capital service lives and the pattern by which capital loses value as it ages, there is reason to produce a wide array of perpetual inventory series, resting on a variety of assumptions with respect to these matters. Such considerations motivated the work of this chapter.

Chapter 3 detailed the estimates of capital stock figures at decade intervals from 1840 through 1900. But many of the details depend upon census-style evidence—evidence that leaves something to be desired, in part because the capital concepts involved are not always perfectly clear. A central part of this chapter is devoted to tests comparing the census-style estimates and perpetual inventory estimates assembled specifically for that purpose, and to a consideration of the implications of the results for the history of the US capital stock. The perpetual inventory series are also used to explore the effects of choices with respect to average service life, retirement schedule, and depreciation technique on the level and rate of change of the measured capital stock.

The perpetual inventory series encompass two elements: manufactured producers' durables (i.e., tools, equipment, machines) and "other construction" (i.e., construction other than railroads, canals, farmland clearing, and construction carried out with farm materials). They are important elements, accounting for 80 to 90 percent of the conventionally defined nineteenth-century US domestic capital stock (exclusive of inventories), and 50 to 70 percent of the same stock, including the value of farmland clearing and first ground breaking. Unfortunately, the ultimate source for these series is production data, which do not provide the sectoral evidence available in the census-style series.

The perpetual inventory series are imperfect in other respects, as well. The basic annual investment series from which they were derived were initially assembled chiefly to establish secular levels of investment. As noted in the previous chapter, their authors were doubtful that they could be depended upon to pick out year-to-year movements accurately (Gallman 1966, 39–41, 64–71).[1] For present purposes, however, that is not so serious a problem. Perpetual inventory capital stock series, after all, are cumulations of investment over several years. They are not likely to be unduly sensitive to spurious annual perturbations in the investment series, so long as errors more or less offset each other, and so long as the series are reliable indicators of, for instance, quinquennial or decennial levels. The basic annual investment series probably pass that test satisfactorily; at least their authors believed this to be so, because they published quinquennial and decennial averages.

A more serious problem is that the basic series cover only the years 1834 through 1859 and 1869 through 1909. To fill the gap of the Sixties, and to extend the evidence backward to the late eighteenth century (necessarily if estimates of the stock of "other construction" were to be produced for the mid-nineteenth century), the basic series (hereafter, the Gallman series) had to be pieced out with evidence from Berry's (1978) monograph. Because Berry's work consisted of carrying Kuznets's series backward from the late nineteenth century to 1790, and because the Gallman series are also linked to Kuznets's work (at 1909), this procedure seems reasonable enough. But the nature of the Berry series poses some problems. It was derived as the difference between national product and consumption (including government), and therefore has all the weaknesses of a series composed of residuals. Furthermore, components of investment are not distinguished, which means that the bases for carrying the two elements of the Gallman series, individually, across the 1860s and into the years before 1834 are by no means so strong as one could wish. Finally, the empirical bases for the Berry estimates become ever more frail as the series extends into the early nineteenth century and the late eighteenth.

These matters are important, but perhaps not quite so important as they seem at first. Presumably, the most doubtful elements of the pieced-together Berry-Gallman series are those that relate to the earliest period. But given the rapid rate at which the US economy was growing, these elements bear only very modest weights in the determination of the capital stock estimates discussed in this chapter—estimates beginning in 1840. So long as the remote Berry-Gallman figures pick up the trend level of investment at least roughly, there is no serious problem. Although it is true that one should cast a more distrustful eye on the perpetual inventory estimates for 1840 than on the rest. The rest also deserve their share of suspicion. None of the investment flow evidence underlying the perpetual inventory estimates—whether of Berry, Gallman, or Kuznets—can be regarded as being of exceptionally high quality.

The tests to be described here are thus tests of consistency between two series, both of which must be regarded with some suspicion. They are intended as checks on both series, rather than on just one. The required consistency tests are not easily made. As noted earlier, there are certain types of investment that appear in only one of the two series—either census-style or perpetual inventory. Thus, adjustments are called for before proper comparisons can be drawn. Furthermore, the conceptual content of the census-style estimates is not perfectly clear, and that must also be clarified before proper comparisons can be made.

The chapter proceeds by first considering the conceptual problem, in section 6.2. Section 6.3 then takes up the questions of the appropriate service life of capital, the retirement schedule, and the depreciation procedure. Section 6.4 considers elements of the capital stock omitted from the two series, proposes appropriate adjustments, and exhibits the final comparisons. The final section pulls things together.

6.2. The Conceptual Problem

Capital stocks can be valued at acquisition cost, reproduction cost, or market value. Each measure has its own special analytical uses. Acquisition cost is backward-looking. A capital stock estimate so valued might be used to study savings behavior, since in this view the stock can be regarded as accumulated savings. Reproduction cost concerns the present. It conceives of the capital stock as the value of inputs required to reproduce it, given current factor prices and production techniques.[2] Such measures are useful in the study of production relationships. Market value is forward-looking. It is the discounted stream of anticipated returns to capital, and it would serve well, for example, in the analysis of aggregate consumption. It would be good to have all three types of measure, but commonly it is necessary to make do with one or two.

Market value is a net concept, since it takes into account only the remaining earning life of existing capital. Acquisition cost and reproduction cost can be measured as both gross and net. The questions about whether net measures should be produced—and, if so, how—are vexing; neither would be appropriately addressed here. The subsequent sections rest on the assumption that both gross and net measures are legitimate, as are conventional methods of obtaining net measures.

If the economy were perpetually in equilibrium, if prices and productivity never changed, and if depreciation allowances accurately described the decline in the earning power of capital as time passed, then net acquisition cost would always equal net reproduction cost, which in turn would always equal market value. In fact, these conditions do not obtain, and therefore the three measures are not equal.

These matters would be of no present importance were it certain that the perpetual inventory and census-style estimates embraced the same valuation scheme. But that is not the case. The perpetual inventory series, which are expressed in constant (1860) prices, closely approximate reproduction cost, deviating from that standard only to the extent that the markets for new capital goods were out of equilibrium in 1860. The meaning of the census-style figures is less clear, and may in fact differ from one figure or one year to the next.

The principal but not exclusive source of these data is the federal census, which collected wealth data from individuals, business firms (including farms), and tax officials. From the latter, the census requested statements of "true value," a concept that is itself ambiguous. While it is often understood by outsiders to refer to market value, tax officials seem to have something else in mind: perhaps what market value would be, were it not subject to temporary fluctuations proceeding from transitory interest rate shifts or from cyclical booms and busts.

Businessmen might be thought to have provided the census takers with acquisition-cost values: book values, either gross or net. But one must remember that capital accounting was a new phenomenon in the nineteenth century. Most businessmen charged off capital as a current expense. For these people, tax records would have constituted the only "books" from which the answers to the census taker's questions could be drawn. The census instructions are not a great help in guiding one as to the meaning of value, and different modern analysts have interpreted them in different ways. There is strong support for the notion that the census was seeking acquisition cost—probably gross—when it approached businesses. However, the evidence indicates that net reproduction cost or market value was most often meant, at least in the latter part of the century. Consider the following definition of value, drawn from the 1890 manufacturing census questionnaire: value "should be estimated at what the works would cost in 1890, if then erected, with such an allowance for depreciation as may be suitable in the individual case (US Census Office 1892, 10)."[3]

But however the matter is judged, it must be regarded as being still in doubt. Thus, if consistency tests are to be run between the two sets of capital estimates, and if the conceptual content of one set is uncertain, it behooves the analyst to consider first—before comparisons are drawn—the forces at work during the century driving acquisition, reproduction, and market values apart, and the strength of these forces. Only with this information in hand can the comparison of the two series be properly interpreted.

The acquisition cost and reproduction cost of a capital stock will differ if capital goods prices have changed over time, and if the changes have not offset each other. For example, if capital goods prices persistently rise, a capital stock will be smaller if measured in acquisition costs than if measured in reproduction costs. If capital goods prices persistently fall, the reverse will be true.

What happened to capital goods prices across the nineteenth century? Interestingly enough, the prices of construction goods apparently rose and fell periodically, but exhibited no clear long-term trend (see table 6.1, columns 1 and 2). Thus one would suppose that acquisition costs and reproduction costs would differ little at the census dates, and that any differences that emerged would place acquisition costs sometimes above and sometimes below reproduction costs.

Experiments show that this is precisely what happened. In the experiments, the constant-price annual flow series was cumulated to produce constant-price reproduction-cost estimates of the "other construction" capital stock, at decade intervals, from 1839 through 1899. The series was then inflated using construction price index numbers relevant to the benchmark years 1839, 1849, and so on. To form acquisition-cost estimates of the same capital stock for the same years, the annual flow series was first inflated and then cumulated. The resulting ratios of the current-price acquisition-cost estimates to the current-price reproduction-cost estimates are given in column 3 of table 6.1.[4] It will be observed that the ratios are all close to a value of one. In every case but one, acquisition cost is within 6 percent of reproduction cost. That must be regarded as very close, particularly given the fairly wide margins for error that must be allowed for all capital stock estimates in the nineteenth century. In view of these considerations, it is a matter of small importance whether the census measured "other construction" capital projects at acquisition costs or at reproduction costs.

The situation with respect to manufactured producers' durables was very different, however. The prices were more variable, and they dropped throughout the century, but particularly sharply in the 1880s (see table 6.2). Consequently, in 1890, acquisition cost (gross and net) was well above reproduction cost—a quarter to a third higher in the net variants, and two-fifths to almost three-fifths in the gross variants. But by 1900 the two measures produced roughly the same values. No doubt acquisition cost was also slightly higher in 1850 and 1880 (but not in 1860), and perhaps more pronouncedly so in 1870, but not to the degree exhibited in 1890. It does matter, then, whether the census returns of the stock of manufactured producers' durables were measured in acquisition cost or reproduction cost. To interpret the census wealth estimates for 1890, one must know the concept that guided the collection of the evidence in that year. It is less important, but useful, to have this information for other years as well.

TABLE 6.1 **Construction price indexes, 1789–98 through 1889–98 (base: 1860), and estimates of the ratio of acquisition cost to reproduction cost for "other construction" capital stock, 1839–99**

	(1)	(2)	(3)
Dates	Index of residential bldg. costs in Philapdelphia	Index of total US construction costs	Ratio of acquisition cost to reproduction cost (gross)
1789–98	96		
1794–03	110		
1799–08	110		
1804–13	118		
1809–18	121		
1814–23	126		
1819–28	108		
1824–33	102		
1829–38	101		
1834–43	97		1.06 (1839)
1839–48		95	
1844–53		95	1.05 (1949)
1849–58		97	
1854–63		110	1.00 (1859)
1859–68		117	
1864–73		125	0.93 (1869)
1869–78		107	
1874–83		109	0.96 (1879)
1879–88		118	
1884–93		109	1.00 (1889)
1889–98		100	
1894–03		104	1.05 (1899)

Sources:

Column 1: Adams 1975. 813. Variant B, linked to Brady-Gallman index (implicit index of "new construction," able A-3 in Gallman 1966, 34) at census year 1839. The link was established in the following way. The Adams (calendar year) index numbers for 1839 and 1840 were averaged (1839, weight of 7; 1840, weight of 5) to approximate an index number for census year 1839 (86.3). This number was divided through the Brady-Gallman index number for census year 1839 (97.9), resulting in the ratio 1.134. The Adams index numbers. 1789–1839 (decade averages, unweighted), were multiplied by 1.134 and then rounded, to produce the values in column 1, which refer to calendar years. The Adams variant B series was accepted in preference to variant A, because the weighting scheme adopted by Adams in variant B is similar to the one underlying the Brady-Gallman series.

Column 2: Figures for 1839–48 through 1849–58 and 1869–78 through 1894–1903 are derived from Gallman 1966 (see notes to column 1) and refer to all new construction. Figures for 1839–48 through 1854–63 are three-item averages, referring to 1839, 1844, 1849 (1839–48), 1844, 1849, 1854 (1844–53), etc. The years are census years, except 1863, which is a calendar year. Figures for 1869–78 through 1894–1903 are weighted decade averages and refer to calendar years. Figures for 1859–68 (calendar years) are based on interpolations of the Brady-Gallman estimates of 1860 and 1869, carried out on a construction-cost series derived for the purpose. The construction-cost series was computed from the David-Solar (1977) index of the common wage and the Warren and Pearson price index of building materials. The weights used were the same as Adams's variant B weights.

Column 3: See text. The service life adopted was fifty years, except for 1839, in which case I used forty years. The price index numbers used to inflate the constant-price flow series are the index numbers contained in columns L and 2. (These inflators were required only for the years prior to 1869, since the Gallman flow series are available in both current and constant prices, 1869–1909.) Flows across each decade were inflated by decade average index numbers. The index numbers used to inflate the reproduction-cost stock series—1869, 1879, 1889, and 1899—refer expressly to "other construction" and were derived from data underlying the data in column 2. The figures for 1879, 1889, and 1899 are weighted averages of prices for calendar years 1878 and 1879, etc., to approximate the census year. Such an adjustment was impossible for 1869, which refers to the calendar year. The index numbers used to inflate the reproduction-cost series—1839, 1849, and 1859—are the appropriate figures underlying column 2.

TABLE 6.2 **Manufactured producers' durables price indexes, 1839–48 through 1899–1908 (base 1860), and estimates of the ratio of acquisition cost to reproduction cost, 1890, 1900, and 1908**

	(1)	(2)	(3)	(4)	(5)
		Ratios of acquisition cost to reproduction cost			
		Net valuation		**Gross valuation**	
Dates	**Price index**	13 years[a]	18 years[a]	13 years[a]	18 years[a]
1839–48	114				
1844–53	109				
1849–58	108				
1869–78	88				
1874–83	72				
1879–88	55				
1884–93	42	1.24 (1890)	1.31 (1890)	1.42 (1890)	1.56 (1890)
1889–98	35				
1894–1903	37	0.92 (1900)	0.96 (1900)	1.03 (1900)	1.09 (1900)
1899–1908	38	0.99 (1908)	0.99 (1908)	1.02 (1908)	1.02 (1908)

[a] Service lives.
Sources:
Column 1: See the source notes for column 2 of table 6.1.
Column 2: See the source notes for column 3 of table 6.1. The net valuations depend upon straight-line depreciation.

Market price might deviate from net reproduction cost for any cause or development that (1) could throw the new capital goods markets out of equilibrium, (2) alter the distribution of expected earnings among capital goods of differing age, or (3) alter the appraisal of a given income stream. The first type of development is not of great interest here, since the measures of net reproduction cost used here are probably affected by disequilibrium in new capital goods markets, and are thus a kind of mixture of reproduction cost and market value. The other two types of developments could be allowed for in forming net reproduction-cost estimates, with service lives and depreciation systems being adjusted to reflect the changing market reality. But insofar as these decisions were left unchanged over extended periods, market value and net reproduction cost could and would diverge.

The distribution of earnings among capital goods of differing vintage might presumably change in response to technical changes, but no account can be offered about precisely how earnings streams were altered and, thus, how the pattern of market capital values was affected in the nineteenth century. It is possible, however, to say something about the third and probably most powerful development listed above: changes in the appraisal of the income streams flowing from capital.

The market value of the capital stock represents the discounted anticipated income flowing from capital. A rise in the discount rate—the rate of interest—will tend to reduce the market value of capital, ceteris paribus, while a decline will tend to increase it. To judge the effect of changes in interest rates on the value of capital, one needs to know which interest rates are relevant, the extent to which they changed, and the age distribution of the capital stock beforehand. With this information and an annuity table, one can readily compute the change in the market value of capital.

The focus here is on the capital stock values derived from census wealth data. The question is this: If the census had appraised capital at market value, how far would the interest rate changes across the nineteenth century have altered census capital stock values, relative to what they would have been had capital been appraised at net reproduction cost with fixed estimating parameters from one census to the next? For example, assume that in 1840 the market value of the stock of manufactured producers' durables had been equal to the net reproduction cost of this capital, the latter computed on the assumption of a thirteen-year average service life and straight-line depreciation. How far would this equality have been disturbed by the observed interest rate changes of the nineteenth century?

To answer this question, one must imagine how census appraisers (officials or respondents) went about their task. It may be safely assumed that if they attempted to place market values on capital, they were well aware of the influence of interest rates on capital values and therefore took interest rates into account. Whether they would have looked to nominal or real interest rates is by no means certain, but both possibilities were considered. Surely they would have been concerned not with the interest rate on the morning of the day on which their appraisals were made, but rather with the general level of the interest rate in the census year, and perhaps even the year or two preceding it. That is, it may be assumed that they would have left out of account what they regarded as temporary, short-run movements.

With these considerations in mind, one can examine interest rate changes from one census year to the next, coming to the following conclusions concerning patterns of change summarized in table 6.3.[5] The table suggests that the period from 1870 onward is worthy of examination. From 1870 to 1880, the nominal rate fell pronouncedly, from roughly 7 percent to 5 percent. From 1880 to 1890, the real rate fell pronouncedly, from

TABLE 6.3 **Interest rate movements**

Intercensal periods	**Real**	**Nominal**
1840–50	Fell	No change
1850–60	Rose	Fell modestly
1860–70	Rose modestly	Fell modestly
1870–80	Fell	Fell pronouncedly
1880–90	Fell pronouncedly	Fell
1890–1900	Fell very pronouncedly	Fell

Sources: See text.

7 percent to 5 percent; and from 1890 to 1900, the real rate fell very pronouncedly, from 5 percent to 1 percent. In each episode the market price of the capital stock must have gone up. Assuming that the market price had been equal to net reproduction cost before each rise, how far would the former have increased above the latter as a result of the interest rate change? Answers to this question were worked out with an annuity table and the perpetual inventory estimates, using a service life of thirteen years (manufactured producers' durables) and straight-line depreciation. The ratio of market value to net reproduction cost emerging from a change from 7 percent to 5 percent is 1.10. The ratio for a change from 5 percent to 1 percent is 1.24.

One's first impression is that these differences are small. This is particularly the case if one is concerned chiefly with the probable differences between the perpetual inventory series and the measures taken from the wealth census. Some part of the effect of falling interest rates on the value of capital—the part that has to do with the pricing of new capital—is reflected in the perpetual inventory series. Thus, if the census wealth and perpetual inventory series were in all ways consistent, except in mode of valuation, and if the census-of-wealth data were expressed in market value and the perpetual inventory series in net reproduction cost of the form previously attributed to it, then the ratios in the tabulation would actually overstate the quantitative differences between the two series.

Second thoughts suggest the following qualifications. The service life selected above, thirteen years, may not be unrepresentative of manufactured producers' durables, but it is short for improvements. Changes in interest rates have greater effects on long-lived capital. Thus, for improvements (construction), computed changes in value would surely be greater than those recorded above. Furthermore, since the interest rate seems to have been falling from at least 1870 to 1900, it is possible that the deviation between reproduction cost and market value would continue to grow from one census date to the next, in which case the two might diverge in 1900 by as much as 50 percent ($1.10 \times 1.10 \times 1.24 = 1.50$). (This assumes that the experiences of the decades 1870–80 and 1880–90 were similar, and it ignores the qualification advanced in the previous paragraph.) Such a conclusion surely goes too far, however, since it rests on the implicit assumption that reproduction cost would remain unchanged. In fact, with the interest rate falling and investment being encouraged, one would expect some tendency for reproduction cost to rise (relative to market price) toward a new equilibrium. This would be a factor counteracting the widening of the gap between market price and reproduction cost. Furthermore, the calculations carried out above rest on the implicit assumption that the income-earning capacity of capital remained unchanged. But, ceteris paribus, one would expect that a flood of new investment would tend to lower income, and thus reduce the market value of capital.

Clearly, the calculations are less than conclusive, especially since they take into account only one element affecting market value. Nonetheless, the modest change in market value occasioned by a fall from a rate of 7 percent to one of 5 percent remains impressive and, despite all qualifications, even the effects of a change from 5 percent to 1 percent appear rather modest. In terms of the practical problems to be discussed in the next section, it seems possible to conclude that at the decennial census dates 1840–90, reproduction cost and the market price of capital were unlikely to have been very far apart—though at the last of these dates, and perhaps the one before as well, market price probably exceeded reproduction cost. This was also almost certainly true in 1900, and the margin between these two measures was the greater at that date.

In summary, the constant-price perpetual inventory series approximate the reproduction-cost series, while the series derived from the census wealth data may be valued at reproduction cost, at market value, or at acquisition cost. The possible conceptual differences are apparently empirically unimportant for the antebellum period. The question of whether construction is measured at acquisition cost or at reproduction costs is also unimportant for most of the postbellum period. Where conceptual differences *are* important, reproduction cost is a smaller value than acquisition cost (for example, for manufactured producers' durables in 1890) and market value (for example, for all capital in 1900). With this background, the relevant comparisons can be examined.

6.3. The Service Life of Capital

To compute perpetual inventory estimates, one must establish service lives for the relevant types of capital, the pace at which each type of capital lost value as time passed (the depreciation schedule), and the pattern in which capital retirements took place. Since the perpetual inventory estimates under discussion were assembled to test the census wealth data, it was necessary to make allowance for casualty losses and to keep in mind, while choosing among depreciation schedules, the manner in which the census wealth data were assembled. That is, census wealth data are net of casualty losses. Comparable perpetual inventory estimates must therefore also be net of casualty losses. Census wealth data represent appraisals by owners or officials. Thus, comparable perpetual inventory estimates must capture the mental processes of nineteenth-century appraisers.

The service lives have not been computed from nineteenth-century evidence, although there are surely data among census and business records by which such computations could be made. For example, the Tenth Census (1880) contains data from which the service lives of railroad rails and ties of various specifications have been computed (Fogel 1964, 172). Davis, Hutchins, and Gallman (1987) assembled a set of data concerning the New Bedford whaling fleet, from which service lives and the incidence of casualty losses have been calculated. There must be much more evidence of this type, particularly in business records. But I have not been able to assemble a full set of such data, and have therefore accepted guidance from the work of Simon Kuznets and Raymond Goldsmith—both of whom, however, have been concerned chiefly with twentieth-century experience, not nineteenth-century experience.

In his research on the late nineteenth century, Kuznets adopted a service life of thirteen years for manufactured producers' durables, and fifty years for improvements—figures that include an allowance for losses by fire, but not for other types of casualty losses.[6] Furthermore, the improvements include railways and waterways, unusually long-lived capital that is excluded from the perpetual inventory series discussed in this chapter. Thus, fifty years may be an excessive service life for this exercise. As a check, Goldsmith's service life data, drawn from IRS bulletin F, were weighted up, by sector and type of capital, with data from the census-style capital stock series (Goldsmith 1951, 14–17, 20–24).[7] These calculations yielded values of seventeen years for durables and fifty-two years for improvements (exclusive of railroads and canals); neither figure includes an allowance for casualty losses.

Perpetual inventory producers' durables series based on both thirteen- and seventeen-year service lives were computed, but while the latter presumably consists of upper-limit estimates in each year, the former may not constitute lower limits, in view of Kuznets's evidence. With respect to improvements, series using forty- and fifty-year service lives were computed. It is possible that these two values do describe limits within which the appropriate service life lies, although one can be more sure with respect to the upper bound than with respect to the lower.

It is possible that average service lives changed across the nineteenth century. Experiments with weighting up the bulletin F evidence revealed no shifts in average lives occasioned by changes in weights (i.e., changes in the structure of the stock of durables and improvements). But the information used for this purpose is not detailed as to types of capital. In any case, there may have been shifts in durability or in the rate of obsolescence which influenced average service life by type of capital. That must be borne in mind when the two sets of capital stock estimates are compared.

Estimates were made based on three systems of capital consumption: straight-line, declining-balances, and BLS concave. The first system would presumably come closest to replicating census values, if census enumerators or their respondents in fact estimated the cost of reconstructing each piece of capital, chose a service life, and then computed the depreciation to be deducted from the value of that piece of capital. But it is possible that estimators did not go through all of these steps, at least not consciously. It is also possible that they used rules of thumb that in fact reflected a different depreciation scheme. Certainly, it would not be surprising if they believed that capital lost value with particular rapidity—or, for that matter, with particular slowness—in the first years of life, thus adopting in this way attitudes that are embodied in declining-balances and BLS concave procedures. Therefore, while it was expected that the best results would come from the first technique, computations were carried out for all of them.

Two separate retirement schedules were made. The first rests on the assumption that all pieces of capital of a given type were retired at the same age. For example, in the case of the lower-bound durables estimates, it was assumed that all durables lasted exactly thirteen years. The second set of estimates makes provision for both early and late retirements.[8] While it is based on twentieth-century rather than nineteenth-century experience, it is more realistic than the assumption of a uniform retirement age. But it poses a problem: it is a formidable consumer of data. Thus, producing estimates of the value of improvements for years before 1889, on the basis of a fifty-year service life, requires data running deep into the eighteenth century—data that do not appear to exist. Estimates can be produced, of course, if zeroes are entered for missing values, and such computations were made. Given the rapid pace at which investment grew in the nineteenth century, and given the nature of the retirement distribution, these estimates are unlikely to deviate very far from true values in the years with which this chapter is concerned. But they are biased downward, and the bias is more serious the earlier the date to which the estimate refers. For this reason, one set of estimates was computed resting upon these procedures, and another was computed depending upon the assumption of a common retirement age. The two *sets* of estimates, in fact, differ little with respect to level, and even less with respect to trend. Consequently, it matters little, for present purposes, which set of estimates is employed.

Table 6.4 contains the results of a first effort to compare the perpetual inventory and census-style capital stock estimates. Each entry expresses one of the former estimates as a ratio of one of the latter. Both gross and net perpetual inventory estimates were prepared; the gross figures represent each of the four average service lives deemed relevant: forty years and fifty years, in the case of improvements; thirteen years and seventeen years, in the case of producers' durables (machinery and equipment). Only the net calculations that produced the closest fits to the census-style estimates figure in the ratios computed for the table. At least one estimate for each service life is included. A common age of retirement was assumed in the case of improvements, to avoid the computational problem discussed above. In the cases of the producers' durables, that assumption was unnecessary.

Even a casual study of the table reveals several important points. All of the ratios in the columns headed "gross" are greater than one—several substantially so—while this is not true of the ratios in the columns headed "net." *Gross* and *net* refer to the perpetual inventory estimates. Since the net values correspond more closely to the values derived from census data, the results are consistent with the notion that the census returns are expressed in net values. This does not preclude the idea that the census data are gross, and that they or the perpetual inventory data are subject to serious measurement errors leading either the former to be understated

TABLE 6.4 **Ratios of gross and net perpetual inventory capital stock estimates to census-style capital stock estimates, 1840–1900**

Panel A. Gross estimates

	Improvements service life		Producers' durables service life	
	40 yrs.	50 yrs.	13 yrs.	17 yrs.
1840	1.19	1.21	1.21	1.35
1850	1.45	1.48	1.31	1.54
1860	1.40	1.43	1.26	1.43
1870	1.67	1.73	1.89	2.17
1880	2.20	2.31	2.10	2.42
1890	1.89	1.99	1.51	1.73
1900	2.15	2.31	1.47	1.76
Mean	1.71	1.78	1.54	1.77

Panel B. Net estimates

	Improvements			
	Straight-line depreciation service life		Declining balance service life	Producers' durables, straight-line depreciation service life
	40 yrs.	50 yrs.	50 yrs.	13 yrs.
1840	0.90	0.96	1.79	0.77
1850	1.05	1.14	0.92	0.83
1860	1.02	1.1	0.89	0.77
1870	1.12	1.24	0.97	1.31
1880	1.49	1.65	1.29	1.22
1890	1.28	1.42	1.12	0.95
1900	1.46	1.61	1.25	0.86
Mean	1.19	1.3	1.03	0.96

Sources: See text.

or the latter overstated. These possibilities cannot be excluded, but they seem less probable. It is likely that the census data are truly net.

Assuming that this judgment is correct, what do the net ratios reveal about the degree of consistency between the two sets of series? Since the two sets of series do not contain precisely the same components (see above), the data underlying table 6.4 need to be adjusted before a final answer to this question can be given. A preliminary answer can be offered, however, if an appropriate standard of consistency can be established.

Suppose that the margin for measurement error in each series were as low as 10 percent—it may very well be higher—and that none of the series were biased, so that in any given year a positive error were as likely as a negative error. The maximum relative deviation between the two series in two successive years would then appear if a set of errors were as follows:

	Year 1	*Year 2*
Perpetual inventory	–10%	+10%
Census style	+10%	–10%

Now supposing that the two series were perfectly consistent, except for these random errors, the ratios for the two years—corresponding to those in table 6.4—would be 0.82 in the first year and 1.22 in the second. That is, 0.82 and 1.22 are values that can occur even if the two types of estimates are fundamentally consistent, but subject to independent measurement errors of as much as ±10 percent.

Now notice that of the thirty-five "net" ratios in table 6.4, twenty fall within this range and another five are within five percentage points of the limits of this range. Is that good or bad? It seems moderately good—that is, it suggests consistency—though the test is not very demanding.

There are also some details in table 6.4 that are worth noticing. Of the five ratios for 1900 that lie in the net columns, four exceed the value of 1, three exceed the values recorded for 1890, and the other two fall only moderately short of the 1890 values. Abstracting from the possible errors discussed in the preceding paragraph, the ratios for 1900 would have been lower than those for 1890, and it might also have been expected that they would fall well below a value of 1 *if census returns had been expressed in market values* (see section 6.2, above). One of the two producers' durables ratios for 1890 also exceeds a value of 1, while the other is very close to 1. Had the census valued capital at acquisition cost, both of these ratios would have been well below a value of 1. The ratios for 1890 and 1900, thus, are inconsistent with the idea that the census valued capital at acquisition cost or market value, and they are consistent with the idea that capital was valued at net reproduction cost. That suggests that no differences in valuation criteria stand in the way of the comparison of the perpetual inventory and census-style capital stock estimates. It also indicates that the census-style estimates can be treated, for analytical purposes, as net reproduction-cost estimates, though one should bear in mind that for the antebellum years, and in some measure for the postbellum years as well (see section 6.2), the three different systems of valuation are likely to have yielded very similar values.

Introducing the possibility of measurement error, of course, blurs the clear outlines of these conclusions. But the outlines are probably not completely erased. The results of the consistency tests square with what informed students might have supposed before the fact. It is therefore reasonable to accept the view that the census-style figures are truly net and are truly valued at reproduction cost (at those few dates where the valuation concept matters); at least these conclusions can be accepted in the preliminary way in which even the strongest research results should be accepted.

6.4. Omitted Components

The census-style data include all capital in each sector covered, regardless of where it was produced and regardless of the materials used. The perpetual inventory series are more narrowly conceived. They include, under the heading "producers' durables," only the products of census establishments, adjusted for foreign trade in durables. They exclude durables made by very small firms and implements produced at home or on the farm. These omissions are unimportant throughout, but they were more important at the beginning of the period under consideration than at the end. Thus, the perpetual inventory series should increase faster than the census-style series, as they do (see table 6.4). The upward bias imparted to the rate of change of the perpetual inventory improvements series is probably more serious. The estimates include all improvements, except railroads and canals, carried out with construction materials produced by census firms—again, adjusted for foreign trade flows. The census-style capital stock estimates, however, also include residences, sheds, barns, and the like produced from farm materials. For example, log cabins and barns are included in the census-style estimates, but not in the perpetual inventory estimates.[9] Since these types of capital were more important earlier in the period than later, one would expect the perpetual inventory series to exhibit higher rates of growth than the census-style series—as, in fact, they do (see table 6.4).

While the census-style data are comprehensive with respect to the industrial sectors covered, they do not cover all sectors. The principal omission consists of highways and highway bridges. Insofar as these projects were constructed from materials returned by the census, the value of such capital is included in the perpetual inventory improvements series. It seems likely that highways and bridges, so constructed, increased in relative importance over time, which is yet another reason why the perpetual inventory improvements series could be expected to exhibit higher rates of growth than the census-style series.

In summary, were it possible to remove these elements of incomparability lying between the perpetual inventory and census-style series, the ratios contained in the "net" columns of table 6.4 would probably be closer to values of 1, although they would certainly not all achieve a value of 1.

Finally, the two sets of series from which the ratios of table 6.4 were computed treat the losses of capital during the Civil War differently: the census-style estimates are net of such losses, while the perpetual inventory estimates are not. Removal of this inconsistency might further diminish the differences between the two sets of series.

The best estimate of Civil War destruction of capital is one prepared by Goldin and Lewis (1975, 308).[10] It covers only Southern losses—the implication is that Northern losses were negligible—and its authors regard it as an upper-bound estimate. However, if Northern losses were in fact more than negligible, the figure may not constitute an excessive appraisal of the losses of North and South combined. The North was not the theater of much of the war, although Southern raiders did do some damage. Greater losses were suffered at sea. Southern cruisers appear to have injured the US whaling fleet seriously, and to have induced the transfer of part of the merchant marine to foreign ownership, a transfer that was not immediately reversed with the end of the war. The real value of US shipping was only slightly greater in 1870 than in 1860. Presumably, the transfer of ownership of vessels simply changed the form in which US capital was held, thus diminishing the value of shipping and producing a compensatory change in net claims on foreigners. But because the latter claims are unrepresented in the series underlying table 6.4, and because the former value is reflected only in the postwar census-style estimates, the transfer is a source of difference between the two sets of estimates forming the numerators and denominators of the ratios. It does not stretch the meaning of words too far to attribute this element of the difference to northern wartime "losses" of capital.

If the Goldin and Lewis estimate exaggerates Southern losses—as they believe it does—it probably does not exaggerate Southern and Northern losses taken together, especially if the element of "loss" discussed immediately above is included. Indeed, it may even understate the true total. For present purposes, that is a matter of small importance, since this bias is offset by the fact that the Goldin and Lewis figure includes the value of certain types of destroyed capital (railroads, animal inventories) that have no bearing whatsoever on the ratios displayed in table 6.4. Whether the biases precisely offset each other cannot be established, but in what follows it is assumed that they do.

Table 6.5 contains ratios from table 6.4, recomputed to bring the numerators and denominators into closer conceptual conformity. Specifically, estimated Civil War losses, appropriately depreciated, were deducted from the numerators. To make the computations, it was assumed that total losses came to $1.5 billion (Goldin and Lewis's estimate of $1.487 billion, rounded up), and that four-fifths of the capital destroyed ($1.2 billion) consisted of improvements while one-fifth ($0.3 billion) consisted of manufactured producers' durables.

It was also assumed that the improvements destroyed were distributed among vintages in the same proportions as were improvements in general, that the average service life of all improvements was forty years, and that destruction was centered on the year 1864. In the case of producers' durables, it was assumed that while the average service life of the stock as a whole was thirteen years, the lost property—since it must have consisted disproportionately of shipping, farm vehicles, and other long-lived equipment—had an expected average service life of twenty years, perhaps an upper bound. It was assumed that the losses centered on the year 1863, a date lying between the time of the principal transfer of shipping to foreign ownership and the period of greatest military destruction in the South.[11]

The adjustments improve the results of table 6.4 by reducing the ratios for 1870 and 1880 and bringing the mean ratios closer to values of 1. That two of the ratios for improvements fall below 1 in 1870—well below, in one case—is a little bit troubling. The 1870 census is widely believed to have been short, particularly in the South (Ransom and Sutch 1975, 10). One would therefore expect to find the 1870 ratio to be larger than 1, even after adjustment of the perpetual inventory series for Civil War losses.

Nonetheless, given the nature of the data—and particularly given that the 1870 and 1840 perpetual inventory estimates are heavily dependent on disparate series patched together—the degree of consistency attained by the two sets of series is moderately reassuring. Notice that the declining-balances

TABLE 6.5 **Ratios of net perpetual inventory capital stock estimates (adjusted for Civil War losses) to census-style capital stock estimates, 1840–1900**

Panel A. Improvements

	Straight-line depreciation		Declining balance	Means of columns 1 and 2
	Service life			
	40 yrs.	50 yrs.	50 yrs.	
1840	0.90	0.96	0.79	0.93
1850	1.06	1.14	0.92	1.10
1860	1.02	1.10	0.89	1.06
1870	0.95	1.07	0.79	1.01
1880	1.42	1.57	1.22	1.50
1890	1.27	1.41	1.11	1.34
1900	1.46	1.61	1.25	1.54
Mean	1.15	1.27	1.00	1.21

Panel B. Producers' durables

	Straight-line depreciation		Means of columns 1 and 2
	Service life		
	13 yrs.	17 yrs.	
1840	0.77	0.89	0.83
1850	0.83	0.98	0.91
1860	0.77	0.91	0.84
1870	1.22	1.40	1.31
1880	1.22	1.48	1.35
1890	0.95	1.11	1.03
1900	0.86	1.05	0.96
Mean	0.95	1.12	1.00

Panel C. Improvements and producers' durables

	Weighted means of	
	panel A, column 4 and panel B, column 3	panel A, column 3 and panel B, column 3
1840	0.90	0.79
1850	1.05	0.92
1860	1.02	0.88
1870	1.08	0.91
1880	1.46	1.25
1890	1.23	1.08
1900	1.29	1.13
Mean	1.15	0.99

Sources: See text.

improvements series (panel A, column 3) and the mean of the two producers' durables series track the two census-style series reasonably well, particularly when one allows for the incompleteness of each set of series.

Happily, the degree of consistency improves when the level of aggregation is increased. That is as it should be, in view of the fact that several of the census-style estimates were made by distributing a total between its improvements and producers' durables components. Errors made at that level wash out with aggregation. Panel C of table 6.5 shows that the weighted average ratios are better than the component ratios from which they were assembled, and that the combination of the declining-balances improvements estimates and the straight-line producers' durables estimates yields a fairly plausible set of ratios; the one large outlier appears in 1880. Even that value lies only barely outside the boundaries established by assuming that each series is subject to errors as large as 10 percent, and that the errors are distributed among years randomly (see above).

The position of 1880 as outlier calls for a little further consideration. Are there peculiarities surrounding the evidence for that year that account for the differences between the two sets of series? So far as the producers' durables series are concerned, we know nothing. It is true that the prices of producers' durables fell very dramatically in the postwar years. If the weighting schemes underlying the deflation for the two series differed, that might produce contrasting results of the sort we observe. Given the nature of the series, this is a difficult possibility to check. Nonetheless, the patterns of change described by the implicit deflators of the census-style stock estimates and the flow data underlying the perpetual inventory series move nicely in parallel, picking out precisely the same periods of rapid and slow decline. The 1880 problem does not appear to be rooted in deflation.

The annual construction-flow data for the years 1869 to 1909 that underlie the perpetual inventory improvements estimates are based on a series prepared by Simon Kuznets for *Capital in the American Economy.* To calculate the estimates here, this series was reworked, distinguishing its components and altering the total construction flows, particularly for the earlier years (Gallman 1966, 37–39). Were these adjustments well advised? Did they influence importantly the "other" construction component relevant to the present discussion? There are two ways to approach these questions: by recomputing the perpetual inventory estimates on the basis of the Kuznets series, to see whether a better fit with the census-style estimates can be obtained; and by considering the rationale for the original adjustments to the Kuznets series.

In computing the census-style estimates, I have departed from the practice of Raymond Goldsmith. In his own work with the nineteenth-century capital stock, Goldsmith has assumed that nonfarm residences typically accounted for three-quarters of the value of nonfarm residential real estate. It has been assumed here that the figure was probably closer to 64 percent. Clearly, had Goldsmith's example been followed, the census-style capital stock estimate for 1880 would have been higher, and the ratios in columns 1 and 3 of table 6.5 for 1880 would have been lower. But presumably the ratios for all the other years would also be lower, which would not be an altogether desirable result.

Table 6.6 was assembled to test the proposition that shifting to the original Kuznets flow data and adjusting the census-style estimates to reflect Goldsmith's judgment as to the relative importance of structures in nonfarm residential real estate would markedly improve the quantitative fit of the perpetual inventory and census-style estimates. Panel A, which incorporates only the adjustment of the census-style estimates to bring them into closer conformity with Goldsmith's views, shows that the adjustment does not altogether solve the 1880 "problem." As to the ratios for the other years, some are improvements on those appearing in table 6.5, but others are not. The test does not provide a secure basis for choosing between the Goldsmith and Gallman judgments on this point. The differences between the Gallman estimates and the set that would be substituted for them in the event that we accepted Goldsmith's view are not very large, after all, and the test is by no means a refined one.

The ratios in panel B are only rough approximations of the ratios that would have emerged had the perpetual inventory estimates been reworked using Kuznets's data. To recompute the perpetual inventory series, it would be necessary to distribute the Kuznets flow estimates between the two components, "railroad construction" and "other construction," since Kuznets did not himself distinguish these components. For purposes of the computations underlying panel B, it was assumed that the ratio of this total construction-flow estimate to Kuznets's would be an appropriate basis for adjusting the "other construction" flow data to a basis consistent with the Kuznets's series (Gallman 1966, table A-6). That assumption almost certainly resulted in too large an adjustment (for reasons to be discussed below), so that the contrasts between the relevant table 6.5 and table 6.6 ratios are, in fact, too great.

With that qualification in mind, it can be said that the "Kuznets adjustment" does improve the fit between the perpetual inventory and census-

TABLE 6.6 **Ratios of net perpetual inventory capital stock estimates (adjusted for Civil War losses) to census-style capital stock estimates, 1840–1900**

	Straight-line depreciation		Declining balance	Mean of columns 1 and 2
	40 yrs.	50 yrs.	50 yrs.	
Panel A. Goldsmith adjustment to census-style estimates				
1840	0.85	0.91	0.75	0.88
1850	0.99	1.05	0.86	1.02
1860	0.95	1.02	0.82	0.99
1870	0.89	1.00	0.74	0.95
1880	1.32	1.46	1.13	1.39
1890	1.18	1.31	1.02	1.25
1900	1.37	1.5	1.16	1.44
Mean	1.08	1.18	0.93	1.13
Panel B. Kuznets adjustment to perpetual inventory series				
1840	0.90	0.96	0.79	0.93
1850	1.06	1.14	0.92	1.10
1860	1.02	1.10	0.89	1.07
1870	0.88	1.00	0.72	0.95
1880	1.18	1.33	0.98	1.26
1890	1.11	1.22	0.94	1.17
1900	1.37	1.49	1.08	1.44
Mean	1.07	1.18	0.90	1.13
Panel C. Goldsmith and Kuznets adjustments				
1840	0.85	0.91	0.75	0.88
1850	0.99	1.05	0.86	1.02
1860	0.95	1.02	0.82	0.99
1870	0.82	0.93	0.68	0.88
1880	1.10	1.23	0.91	1.17
1890	1.02	1.13	1.15	1.08
1900	1.28	1.39	1.08	1.34
Mean	1.00	1.09	0.89	1.05

Sources: See text.

style series in the 1880–1900 period, but in two of the variants it produces a much poorer fit in 1870.

Despite the seeming overall improvement occasioned by the adjustments underlying panel B, there are good reasons why they should be rejected. There are three differences between the annual construction-flow estimates of Kuznets and Gallman. In each of these cases, Gallman benefited from the work done by other scholars after the publication of the Kuznets estimates. Harold Barger worked out margin estimates for wholesale and retail trade, Dorothy Brady assembled final price index estimates, and Melville Ulmer and Albert Fishlow estimated railroad construction series. Kuznets had generated his nineteenth-century construction-flow series by extrapolating his twentieth-century series backward to 1869 on constant-price materials flows and then inflating the series. There is the implicit assumption here that trade margins and value added by construction constituted a constant fraction of final product, at least in constant prices.

The assumption was clearly the best one available when the estimates were made, particularly in view of the deflators available to Kuznets. But given the data of Barger (1955), Brady (1966), Fishlow (1966c), and Ulmer (1960)—and particularly Brady's true price indexes—this assumption no longer has to be made. Following the work of Barger, the materials flows for trade margins were marked up. Distinctions were made between flows into railroad construction and all others, because value added by construction is much more important in heavy construction—for example, in railroads—than elsewhere in the sector. The materials for construction were marked up using census current-price ratios and the Fishlow work on railroads, and they were deflated using the final price indexes developed by Brady and Ulmer. The series thus rests on improved evidence and procedures. It does yield much larger estimates of construction flows, especially in the 1870s. But the main explanation for this is not that my "other" construction series deviated far from what Kuznets's procedures would have yielded, but that the estimates distinguish railroad construction, where the ratio between final product flows and materials inputs is very large. The great margin of my total construction series in the 1870s over Kuznets's reflects, chiefly, the fact that railroad construction was very important in that decade.

The conclusions are that the data underlying table 6.5 are the best series feasible given currently available evidence, and that they are reasonably consistent. But clearly, the two sets of series are far from identical. How far would the historical narrative of US economic growth in the nineteenth century be affected by the choice, on the part of the narrator, of one of these sets of series over the other? The question is a large one, and a detailed answer is best left to another occasion. However, table 6.7 gathers together a few data that bear on the question. The estimates from which they were drawn refer to the national capital stock-land improvements and producers' durables of all kinds, as well as inventories and net claims on

TABLE 6.7 **Rates of growth, structure of the capital stock, and capital-to-output ratios: Two versions measured in 1860 prices, 1840–1900**

Panel A. Rates of growth

	Census-style	Perpetual inventory
1840–50	4.2	4.6
1850–60	5.8	5.5
1860–70	1.6	1.8
1870–80	4.2	6.0
1880–90	6.3	5.5
1890–1900	3.8	4.2
1840–60	5.0	5.1
1860–80	4.0	3.9
1880–1900	4.8	4.8
1840–1900	4.3	4.6

Panel B. Shares of "other" improvements and producers' durables

	Improvements		Durables		Improvements and durables	
	Census-style	Perpetual inventory	Census-style	Perpetual inventory	Census-style	Perpetual inventory
1840	0.24	0.21	0.05	0.05	0.29	0.26
1850	0.27	0.25	0.06	0.06	0.33	0.31
1860	0.34	0.32	0.09	0.08	0.43	0.40
1870	0.37	0.31	0.11	0.15	0.49	0.46
1880	0.34	0.37	0.13	0.15	0.47	0.52
1890	0.37	0.40	0.22	0.22	0.60	0.62
1900	0.37	0.43	0.27	0.24	0.64	0.66

Panel C. Capital-to-output ratios

	Census-style	Perpetual inventory
1840	2.8	2.6
1850	2.7	2.7
1860	2.9	2.8
1870	2.8	2.9
1880	2.6	2.9
1890	3.2	3.3
1900	3.4	3.7

Sources: See text. For methods by which panel C was computed, see Gallman 1987.

foreigners. One set of estimates is based chiefly on census-style data. In the other set, the perpetual inventory data underlying table 6.5, panel A, column 3, and panel B, column 3 have been substituted for the census-style "other" improvements and producers' durables. Remember, both sets of total capital stock estimates include all the conventional components of the capital stock, as well as the value of land clearing, breaking, and fencing.

The two sets of estimates tell essentially the same story of the long-term growth of the capital stock, of shifts in its structure, and of the level and direction of change of the capital-to-output ratio. The capital stock grew rapidly—except over the decade of the 1860s—and the pace was particularly pronounced in the 1850s, 1870s, and 1880s. According to the census-style series, the rate of growth was higher in the 1880s than in the 1870s, while according to the other series the reverse was true. The differences are not great, but they are great enough to affect the analysis of the business cycle and the Kuznets cycle over this period.

The structural findings drawn from the two series (panel B) are also similar. The shares in total capital of "other" improvements and durables increase in both series, the change being particularly pronounced in the case of durables. Once again, the timing of the changes in shares is a little different from one series to the next—particularly with respect to improvements across the1860s—but not much different.

The same kinds of results emerge from panel C. The levels of the capital-to-output ratios and their broad trends are similar in the two cases, the two being distinguished only by very modest differences in the timing of the changes—this time across the 1870s.

Clearly, much more needs to be done along these lines. But the data in table 6.7 suggest that the most consistent sets of census-style and perpetual inventory estimates—estimates plausible on other grounds (e.g., average service life, system of depreciation) as well—do tell roughly the same story about the nineteenth-century capital stock.

What happens, however, when less consistent perpetual inventory estimates are selected? Table 6.8 was put together as a first step toward answering this question. Panels A and C compare levels of gross and net estimates computed following a variety of plausible procedures, while panels B and D compare rates of growth. (None of these series, incidentally, has been corrected for Civil War losses, since the adjustment is not required for present purposes.)

The table shows that while the levels of the series differ from one case to the next—declining-balances series are always very much lower than

TABLE 6.8 **Levels and decennial rates of change of stocks of "other" improvements and producers' durables, measured in 1860 prices, perpetual inventory estimates, various versions, 1840–1900**

Panel A. Producers' durables estimates expressed as ratios of net estimates, seventeen-year service life, straight-line depreciation

	17-year service life			13-year life
	Declining-balance	Bureau of Labor Statstics	Gross	Straight-line
1840	0.74	1.15	1.51	0.86
1850	0.75	1.16	1.57	0.85
1860	0.73	1.16	1.57	0.85
1870	0.78	1.13	1.46	0.88
1880	0.73	1.18	1.64	0.83
1890	0.75	1.16	1.55	0.85
1900	0.73	1.18	1.69	0.82

Panel B. Producers' durables, decennial rates of growth (%)

	17-year service life				13-year life
	Straight-line	Declining-balance	Bureau of Labor Statstics	Gross	Straight-line
1840–50	96%	99%	96%	103%	93%
1850–60	130	124	132	129	129
1860–70	132	147	124	116	141
1870–80	83	71	91	105	72
1880–90	138	143	134	126	145
1890–1900	64	59	68	78	58

Panel C. Other improvements estimates expressed as ratios of net estimates, fifty-year service life, straight-line depreciation

	Declining-balance	Bureau of Labor Statistics	Gross
1840	0.82	1.16	1.27
1850	0.81	1.18	1.30
1860	0.81	1.18	1.30
1870	0.78	1.23	1.40
1880	0.79	1.23	1.40
1890	0.79	1.22	1.40
1900	0.78	1.24	1.43

continues

TABLE 6.8 **(*continued*)**

Panel D. "Other" improvements, decennial rates of growth (%)

	Straight-line	Declining-balance	Bureau of Labor Statstics	Gross
1840–50	101%	97%	104%	106%
1850–60	116	116	116	116
1860–70	45	40	51	55
1870–80	83	84	82	83
1880–90	74	76	74	74
1890–1900	64	60	65	67

Sources: See text.

BLS concave series, for example—the various durables series move in parallel, as do the various improvements series. There are differences, of course, and they emerge where one would expect to find them. Thus, the durables declining-balances series shows an unusually large increase across the 1860s, as compared with the other series, because the postwar investment boom receives a much larger weight in the 1870 value in this series than in the others. Similarly, the gross series and the BLS concave series exhibit especially small rates of growth across the same decade, because the poor wartime investment experience figures importantly in the 1870 value in these series.

These expected contrasts aside, the ratios in panels A and C are quite stable, and the rates of change in panels B and D—particularly D, which has to do with longer-lived property—are quite similar. These are fortunate findings, since they suggest that analytical results depending upon rates of change of the capital stock are unlikely to be very sensitive to the choice of service life and depreciation scheme, the exceptions to the rule being quite obvious.

6.5. Conclusion

What has been learned from all of these data and calculations? The statistical tests suggest that nineteenth-century census-style capital stock estimates reflect net values—a useful result in view of the previous disagreements in the literature about this matter.

In most of the census years, net acquisition cost, net reproduction cost, and market value are unlikely to have differed much; in those few years in which they did, the statistical tests show that the census-style data are probably expressed in reproduction cost. The statistical finding, in this case, has support in literary evidence. Once again, this result bears on a subject on which scholars have previously disagreed. The results of the consistency tests could reflect no more than compensatory errors. Nonetheless, the evidence suggests that the tests do have merit, that both sets of estimates are in fact net, and that where the valuation scheme matters, both are valued in reproduction costs.

When plausible assumptions are made with respect to service lives and depreciation schedules, and when appropriate allowances are made for differences in coverage, the levels of the perpetual inventory series and census-style series appear roughly similar. There are some suspicious results: the ratios of perpetual inventory to census-style estimates seem always rather low in 1840 and high in 1880, the latter being the more important deviation. The ratio for durables also seems high in 1870, and the ratio for improvements seems high in 1890 and especially 1900. The 1840 results should not be surprising, since both sets of estimates are relatively weak at that date, while the deviations in 1870, 1890, and 1900 disappear when durables and improvements are aggregated, leaving 1880 as the one remaining major puzzle.

Combined with other elements of the capital stock, the census-style and perpetual inventory series imply essentially the same pattern of long-term evolution of the US capital stock, although moderate differences as to timing and short-period developments also emerge. The student of economic fluctuations who plans to introduce capital into his or her analysis would be well advised to examine both the perpetual inventory and the census-style series.

Finally, experiments with the perpetual inventory series show that decisions concerning whether capital should be measured gross or net, as well as decisions regarding the appropriate service life and system of capital consumption, affect the level of the measured capital stock much more than they do the rates of change. This is particularly true with long-lived capital, but it also holds, to a lesser degree, with respect to the relatively short-lived manufactured producers' durables. The greatest deviations occur across periods in which the flow of investment varied very widely—such as the decade of the 1860s, during the beginning of which capital formation was unusually low, and at the end of which it was unusually high. Under these circumstances, the differences in the weighting schemes between a declining-balance series and a BLS concave series will give rise to fairly marked differences in computed rates of change between the two series. But, such unusual circumstances aside, the rates of change traced by the various types of series are remarkably similar—a fortunate result, since it means that more conclusive findings with respect to the evolution of the capital stock can be obtained than would otherwise be possible.

Appendix to Chapter Six

The Gallman annual estimates of the flows of producers' durables and "other construction" into the US economy (1834–59, 1869–1909), in constant prices, were interpolated and extrapolated to the missing years 1860–68 and 1791–1833 on Berry's annual estimates of gross private domestic investment, also in constant prices. All calendar-year estimates (Berry, throughout; Gallman, 1869–1909) were first converted to an approximation of census-year values by computing two-year moving averages. Each series was then decomposed into a time trend and a cyclical component. Through least-squares analysis, the Gallman trends and cyclical movements were associated with the like characteristics of the Berry series. The predicted values of the cyclical part of the Gallman series were then combined with the predicted values of the trend relationship to produce estimates for the years missing in the original Gallman series. All these calculations were carried out in logarithms. The last step consisted of taking the antilogarithms.

The new series were then used to generate perpetual inventory capital stock estimates in the manner described in the text. The panels of table 6.app 1 that follow exhibit the various annual cumulations produced. The net series are intended to be net of capital consumption, including all casualty losses, *except for war losses.* The only important losses of this type during the period considered were Civil War losses. Capital was also destroyed during the war by neglect and lack of maintenance, especially in the South. This type of loss was also left out of account in the assembly of the tables.

Thus, all the values in the tables are gross of important elements of capital consumption that took place during the Civil War. The values computed on the assumption that average service lives of seventeen years

TABLE 6.APP1 **Annual perpetual inventory cumulations, at midyear points of years indicated, in millions of 1860 dollars**

Panel A. Manufactured producers' durables, service life of 13 years, retirement age of 13

	Gross	Net straight-line	Net BLS concave	Net declining balance
1840	305.8	193.3	225.8	138.2
1841	319.5	195.3	230.9	136.4
1842	338.2	201.9	240.2	140.5
1843	357.6	208.3	249.1	145.1
1844	376.6	215.0	257.8	150.4
1845	403.1	230.4	274.8	164.7
1846	433.4	250.4	296.2	182.7
1847	470.3	277.0	324.4	206.0
1848	513.8	316.3	365.6	239.8
1849	548.7	345.4	398.0	260.1
1850	583.5	369.7	426.7	274.6
1851	625.9	400.5	462.7	295.3
1852	678.9	439.2	507.8	323.3
1853	754.4	489.6	565.7	361.9
1854	841.2	543.9	628.5	403.0
1855	934.1	603.3	697.2	447.5
1856	1,044.8	674.5	778.7	502.4
1857	1,165.3	748.8	864.4	558.2
1858	1,259.2	797.5	925.0	586.2
1859	1,332.3	824.7	964.3	594.3
1860	1,405.5	855.4	1,006.1	609.2
1861	1,462.0	879.2	1,040.5	619.2
1862	1,447.6	821.0	992.9	549.9
1863	1,408.1	736.7	915.2	466.9
1864	1,379.4	675.4	854.7	419.2
1865	1,421.2	697.9	873.4	461.8
1866	1,687.7	957.7	1,127.7	735.5
1867	2,075.4	1,327.9	1,500.6	1,087.0
1868	2,438.4	1,655.3	1,843.0	1,357.0
1869	2,703.7	1,876.2	2,090.3	1,495.1
1870	2,916.5	2,035.7	2,285.0	1,565.0
1871	3,153.2	2,186.4	2,478.0	1,630.0
1872	3,485.1	2,399.8	2,739.3	1,764.6
1873	3,902.5	2,682.2	3,075.8	1,967.3
1874	4,268.1	2,879.5	3,335.5	2,077.7
1875	4,621.3	2,958.7	3,481.3	2,081.5
1876	4,999.8	3,008.7	3,589.3	2,084.2
1877	5,386.8	3,058.1	3,680.8	2,113.6
1878	5,737.1	3,122.7	3,767.6	2,177.6
1879	5,918.1	3,231.4	3,880.1	2,285.4
1880	6,144.0	3,502.2	4,153.1	2,540.3
1881	6,617.5	3,990.1	4,657.3	2,981.2
1882	7,318.0	4,590.0	5,295.8	3,490.7
1883	8,087.5	5,164.1	5,928.2	3,932.5
1884	8,711.0	5,540.5	6,377.2	4,150.3
1885	9,122.0	5,737.4	6,651.8	4,189.7
1886	9,621.0	6,085.2	7,079.6	4,398.2
1887	10,528.0	6,749.7	7,838.0	4,925.0

Panel A. Manufactured producers' durables, service life of 13 years, retirement age of 13

	Gross	Net straight-line	Net BLS concave	Net declining balance
1888	11,622.0	7,441.3	8,643.9	5,452.9
1889	12,726.0	8,056.8	9,384.9	5,887.0
1890	13,899.0	8,684.9	10,141.5	6,332.9
1891	15,148.0	9,343.7	10,927.9	6,811.1
1892	16,468.5	10,049.0	11,756.7	7,335.5
1893	17,654.0	10,693.7	12,519.3	7,789.4
1894	18,378.0	11,020.2	12,961.2	7,914.2
1895	18,928.0	11,265.5	13,319.9	7,980.1
1896	19,794.0	11,812.5	13,983.8	8,375.6
1897	20,755.5	12,249.9	14,551.7	8,660.4
1898	21,683.5	12,448.3	14,874.7	8,733.5
1899	22,698.5	12,844.8	15,362.9	9,050.7
1900	23,790.5	13,595.3	16,182.7	9,716.6
1901	25,033.5	14,509.8	17,176.8	10,496.4
1902	26,515.5	15,575.6	18,341.6	11,372.8
1903	28,316.5	16,944.0	19,829.2	12,490.6
1904	29,943.0	18,120.3	21,158.2	13,332.0
1905	31,432.5	19,177.0	22,398.7	14,008.5
1906	33,619.0	20,857.1	24,296.1	15,289.9
1907	36,619.0	22,955.5	26,668.1	16,925.2
1908	39,029.0	24,207.7	28,241.5	17,631.9
1909	40,579.0	24,758.4	29,116.5	17,664.8

Panel B. Manufactured producers' durables, average service life of 13 years, diverse retirement ages (Winfrey distribution)

	Gross	Net straight-line	Net BLS concave	Net declining balance
1840	300.2	190.2	222.0	136.2
1841	313.5	191.9	226.6	134.5
1842	330.9	198.2	235.3	138.7
1843	347.6	204.5	243.6	143.3
1844	364.2	211.3	252.2	148.7
1845	388.8	227.2	269.5	163.1
1846	417.8	247.8	291.8	181.1
1847	453.6	275.0	321.1	204.3
1848	503.3	315.1	363.9	238.3
1849	544.2	344.2	397.1	258.4
1850	581.9	368.0	425.7	272.5
1851	627.6	397.9	461.0	293.1
1852	683.6	435.4	504.3	320.8
1853	753.9	483.9	559.4	358.6
1854	832.2	536.5	619.6	398.6
1855	919.8	594.6	686.2	442.3
1856	1,023.6	664.8	765.8	496.3
1857	1,135.4	738.3	850.2	551.0
1858	1,226.2	786.5	910.2	578.3

continues

TABLE 6.APP1 *(continued)*

Panel B. Manufactured producers' durables, average service life of 13 years, diverse retirement ages (Winfrey distribution)

	Gross	Net straight-line	Net BLS concave	Net declining balance
1859	1,297.9	813.4	949.7	586.1
1860	1,372.7	843.7	991.5	601.5
1861	1,440.5	867.3	1,025.6	612.6
1862	1,423.6	807.9	975.6	543.7
1863	1,372.2	723.3	895.8	461.6
1864	1,332.7	663.5	835.4	415.9
1865	1,367.0	689.3	856.6	460.6
1866	1,634.0	953.1	1,115.9	735.7
1867	2,024.1	1,326.7	1,494.4	1,084.5
1868	2,395.2	1,655.6	1,842.6	1,349.0
1869	2,684.7	1,875.6	2,094.9	1,482.1
1870	2,933.5	2,030.9	2,290.4	1,548.9
1871	3,189.9	2,172.9	2,476.7	1,611.4
1872	3,528.4	2,374.5	2,724.4	1,743.9
1873	3,955.0	2,642.6	3,040.4	1,944.9
1874	4,319.0	2,823.0	3,271.7	2,052.7
1875	4,577.7	2,884.6	3,382.8	2,049.6
1876	4,811.8	2,925.0	3,465.4	2,045.9
1877	5,146.2	2,977.3	3,551.5	2,071.2
1878	5,288.0	3,058.0	3,658.6	2,135.3
1879	5,562.5	3,192.9	3,814.2	2,255.8
1880	5,969.3	3,484.1	4,123.9	2,525.8
1881	6,577.0	3,978.8	4,643.1	2,973.7
1882	7,303.1	4,574.3	5,277.6	3,477.7
1883	8,034.8	5,139.7	5,900.8	3,907.2
1884	8,609.4	5,507.4	6,344.0	4,112.2
1885	9,039.0	5,696.9	6,617.4	4,146.7
1886	9,637.8	6,034.1	7,037.7	4,359.6
1887	10,575.3	6,677.6	7,766.6	4,885.6
1888	11,585.6	7,342.3	8,527.9	5,402.4
1889	12,569.7	7,934.3	9,226.3	5,822.6
1890	13,606.3	8,546.4	9,950.6	6,256.5
1891	14,711.7	9,198.6	10,720.4	6,724.3
1892	15,899.0	9,907.0	11,552.5	7,240.1
1893	17,056.3	10,564.0	12,339.3	7,692.1
1894	17,908.9	10,903.9	12,812.6	7,825.4
1895	18,658.2	11,153.2	13,186.8	7,907.1
1896	19,675.1	11,690.5	13,836	8,316.2
1897	20,568.0	12,106.8	14,361.2	8,597.2
1898	21,215.1	12,290.2	14,646.3	8,655.1
1899	22,043.9	12,696.3	15,138.1	8,969.6
1900	23,219.1	13,473.0	15,995.2	9,649.5
1901	24,557.9	14,406.7	17,021.0	10,436
1902	26,064.0	15,483.1	18,207.8	11,307.6
1903	27,903.6	16,858.4	19,716.6	12,417.7
1904	29,621.6	18,033.6	21,062.6	13,249.0
1905	31,286.7	19,076.3	22,304.3	13,920.3
1906	33,626.6	20,724.0	24,168	15,197.2
1907	36,489.3	22,769.4	26,466.4	16,803.5

TABLE 6.APP1 (*continued*)

Panel B. Manufactured producers' durables, average service life of 13 years, diverse retirement ages (Winfrey distribution)

	Gross	Net straight-line	Net BLS concave	Net declining balance
1908	38,665.7	23,967.4	27,964.6	17,471.2
1909	40,243.9	24,475.9	28,780.2	17,495.0

Panel C. Manufactured producers' durables, service life of 17 years, retirement age of 17

	Gross	Net straight-line	Net BLS concave	Net declining balance
1840	341.6	225.3	259.9	166.7
1841	359.4	230.7	268.9	167.2
1842	382.3	240.8	282.3	173.2
1843	405.4	250.7	295.4	179.5
1844	429.1	261.1	308.9	186.6
1845	461.7	280.2	331.1	202.8
1846	500.2	304.1	358.0	223.1
1847	547.1	334.5	391.7	249.3
1848	607.4	377.8	438.6	287.1
1849	658.1	410.7	475.6	312.3
1850	703.9	438.5	507.8	331.5
1851	756.6	472.8	546.7	356.9
1852	811.5	515.2	594.2	389.1
1853	880.4	570.1	655.2	432.2
1854	961.0	630.6	723.2	478.8
1855	1,051.8	698.1	799.8	530.3
1856	1,161.0	779.4	891.6	593.1
1857	1,288.6	865.8	990.6	658.7
1858	1,401.4	928.3	1,067.1	698.4
1859	1,494.3	969.9	1,123.2	717.7
1860	1,595.0	1,015.1	1,182.7	743.1
1861	1,692.8	1,053.3	1,234.7	763.4
1862	1,702.6	1,007.9	1,202.4	702.4
1863	1,678.6	934.8	1,139.2	622.7
1864	1,665.7	883.1	1,093.4	574.1
1865	1,718.9	913.8	1,127.0	613.3
1866	2,019.4	1,181.7	1,397.6	887.5
1867	2,452.9	1,563.0	1,787.5	1,252.6
1868	2,864.3	1,905.7	2,147.8	1,550.3
1869	3,185.8	2,145.7	2,412.9	1,724.9
1870	3,450.7	2,325.8	2,623.0	1,831.8
1871	3,713.4	2,497.8	2,828.5	1,929.8
1872	4,045.3	2,735.4	3,102.9	2,093.6
1873	4,452.7	3,047.9	3,457.4	2,326 .6
1874	4,795.5	3,283.5	3,743.2	2,471.5
1875	5,064.7	3,408.9	3,925.3	2,506.2
1876	5,346.1	3,516.5	4,091.5	2,534.7
1877	5,647.0	3,636.0	4,269.5	2,586.9
1878	5,994.1	3,782.8	4,474.8	2,676.5
1879	6,489.8	3,980.2	4,730.0	2,829.2

continues

TABLE 6.APP1 (*continued*)

Panel C. Manufactured producers' durables, service life of 17 years, retirement age of 17

	Gross	Net straight-line	Net BLS concave	Net declining balance
1880	7,188.8	4,324.5	5,126.3	3,137.2
1881	8,102.3	4,862.1	5,710.2	3,633.1
1882	9,082.6	5,494.5	6,386.3	4,199.0
1883	9,850.6	6,097.2	7,034.0	4,693.7
1884	1,0349.0	6,516.3	7,510.4	4,968.3
1885	10,729.0	6,774.5	7,840.3	5,071.8
1886	11,370.0	7,192.9	8,339.1	5,347.9
1887	12,407.0	7,928.6	9,163.1	5,941.1
1888	13,533.5	8,700.3	10,036.3	6,543.6
1889	14,587.0	9,413.7	10,863.8	7,060.0
1890	15,643.5	10,162.6	11,740.2	7,591.6
1891	16,874.0	10,970.4	12,694.2	8,169.6
1892	18,337.0	11,848.3	13,734.2	8,811.0
1893	19,843.0	12,681.2	14,738.2	9,399.3
1894	21,093.5	13,198.4	15,430.0	9,672.1
1895	22,273.5	13,616.6	16,013.7	9,876.2
1896	23,726.5	14,309.4	16,856.7	10,389.6
1897	24,960.5	14,873.8	17,562.0	10,772.7
1898	25,795.0	15,200.5	18,022.0	10,918.7
1899	26,750.5	15,747.6	18,696.6	11,302.9
1900	28,110.0	16,670.6	19,753.3	12,060.6
1901	29,856.0	17,761.6	20,995.1	12,964.2
1902	31,980.5	18,996.8	22,390.9	13,990.7
1903	34,339.0	20,523.6	24,077.4	15,270.4
1904	36,289.0	21,858.2	25,582.7	16,284.6
1905	38,147.5	23,083.5	27,000.1	17,148.7
1906	40,736.0	24,937.6	29,065.1	18,623.1
1907	43,813.5	27,225.8	31,597.3	20,460.5
1908	46,154.5	28,717.6	33,379.7	21,404.2
1909	47,837.0	29,555.6	34,534.2	21,683.4

Panel D. Manufactured producers' durables, average service life of 17 years, diverse retirement ages (Winfrey distribution)

	Gross	Net straight-line	Net BLS concave	Net declining balance
1840	335.7	221.6	255.4	163.9
1841	352.6	226.6	263.7	164.2
1842	374.3	236.2	276.5	170.2
1843	396.1	245.8	289.0	176.5
1844	418.6	255.9	301.9	183.6
1845	450.0	274.8	323.5	199.8
1846	486.4	298.5	350.0	220.0
1847	530.0	329.0	383.4	245.9
1848	587.6	372.4	430.3	283.3
1849	636.2	405.5	467.7	307.9
1850	680.9	433.5	500.6	326.7
1851	733.2	468.0	540.4	351.7

Panel D. Manufactured producers' durables, average service life of 17 years, diverse retirement ages (Winfrey distribution)

	Gross	Net straight-line	Net BLS concave	Net declining balance
1852	795.0	510.6	588 .8	384.1
1853	870.7	565.0	649.8	427.2
1854	955.0	624.5	716.9	473.3
1855	1,049.1	690.6	791.8	524.0
1856	1,160.0	769.8	880.9	586.0
1857	1,281.0	853.9	976.4	650.1
1858	1,383.6	914.0	1,049.4	688.0
1859	1,469.0	953.7	1,102.6	706.0
1860	1,560.6	997.2	1,159.4	730.5
1861	1,647.1	1,034.1	1,209.3	750.2
1862	1,650.7	988.2	1,175.8	688.9
1863	1,623.1	915.1	1,112.1	610.3
1864	1,610.5	864.2	1,066.5	563.8
1865	1,672.9	896.3	1,100.5	605.8
1866	1,969.2	1,165.3	1,370.7	881.0
1867	2,389.4	1,547.1	1,760.5	1,243.4
1868	2,788.9	1,890.0	2,121.7	1,535.6
1869	3,103.5	2,129.6	2,389.l	1,704.3
1870	3,371.9	2,309	2,602.2	1,806.5
1871	3,642.6	2,479.3	2,810.0	1,901.2
1872	3,991.2	2,713.8	3,084.9	2,063.0
1873	4,430.6	3,020.9	3,436.7	2,294.8
1874	4,808.4	3,247.4	3,713.6	2,438.1
1875	5,088.8	3,360.3	3,879.5	2,469.8
1876	5,362.3	3,454.0	4,025.1	2,495.8
1877	5,658.8	3,560.0	4,179.4	2,547.3
1878	5,990.4	3,693.5	4,357.2	2,636.7
1879	6,375.2	3,878.5	4,582.9	2,783.0
1880	6,901.2	4,216.8	4,959.4	3,080.9
1881	7,629.0	4,758.3	5,542.2	3,565.6
1882	8,485.6	5,404.6	6,239.9	4,124.2
1883	9,351.8	6,027.5	6,927.1	4,623.2
1884	10,055.4	6,460.0	7,435.6	4,905.6
1885	10,597.0	6,718.9	7,776.1	5,012.3
1886	11,277.7	7,127.7	8,266.6	5,282.1
1887	12,278.3	7,850.0	9,075.0	5,866.0
1888	13,359.5	8,607.4	9,932.3	6,458.7
1889	14,435.6	9,306.1	10,744.5	6,969.8
1890	15,586.4	10,036.4	11,598.4	7,499.9
1891	16,828.6	10,817.3	12,512.2	8,069.2
1892	18,177.3	11,665.0	13,502.0	8,692.3
1893	19,529.6	12,471.5	14,460.2	9,260.2
1894	20,612.4	12,968.8	15,116.0	9,516.3
1895	21,614.0	13,376.0	15,677.5	9,709.2
1896	22,897.9	14,068.2	16,516.9	10,215.4
1897	24,078.2	14,641.4	17,237.8	10,598.9
1898	25,037.0	14,980.6	17,721.0	10,757.5
1899	26,204.8	15,534.7	18,407.5	11,160.6

continues

Panel D. Manufactured producers' durables, average service life of 17 years, diverse retirement ages (Winfrey distribution)

	Gross	Net straight-line	Net BLS concave	Net declining balance
1900	27,716.2	16,452.8	19,451.9	11,928.5
1901	29,370.8	17,529.4	20,660.2	12,819.2
1902	31,191.5	18,754.4	22,030.1	13,817.0
1903	33,359.4	20,287.0	23,725.2	15,076.7
1904	35,401.8	21,635.4	25,261.7	16,089.0
1905	37,380.4	22,866.7	26,701.2	16,950.8
1906	40,010.2	24,716.6	28,776.0	18,412.5
1907	43,132.7	26,992.4	31,309.4	20,229.0
1908	45,580.9	28,460.6	33,079.7	21,153.0
1909	47,450.9	29,263.1	34,202.1	21,424.0

Panel E. Improvements (other than canals, railroads, farmland clearing, and improvements constructed with farm materials), service life of 50 years, retirement age of 50

	Gross	Net straight-line	Net BLS concave	Net declining balance
1840	1,354.8*	1,070.3*	1,246.0*	878.71*
1841	1,465.8*	1,154.2*	1,345.6*	945.75*
1842	1,576.8	1,235.9	1,444.2	1,009.46
1843	1,679.4	1,308.7	1,534.9	1,063.16
1844	1,784.8	1,382.2	1,627.3	1,116.95
1845	1,919.3	1,482.9	1,747.9	1,197.3
1846	2,081.3	1,608.5	1,894.9	1,301.3
1847	2,265.9	1,754.3	2,063.7	1,423.4
1848	2,447.2	1,893.5	2,228.1	1,536.5
1849	2,621.1	2,021.6	2,383.3	1,636.5
1850	2,794.9	2,146.5	2,537.1	1,731.7
1851	3,002.9	2,302.3	2,723.5	1,856.5
1852	3,250.9	2,494.3	2,948.2	2,015.3
1853	3,538.6	2,721.4	3,210.7	2,206.4
1854	3,860.1	2,977.1	3,504.9	2,422.0
1855	4,201.2	3,246.8	3,816.8	2,647.3
1856	4,569.7	3,538.1	4,154.1	2,889.8
1857	4,975.6	3,860.7	4,526.7	3,158.7
1858	5,361.0	4,155.7	4,876.3	3,394.5
1859	5,698.1	4,394.6	5,174.1	3,570.2
1860	6,035.0	4,626.6	5,468.3	3,736.8
1861	6,360.5	4,840.2	5,747.3	3,883.6
1862	6,579.5	4,941.7	5,916.9	3,917.3
1863	6,722.7	4,963.5	6,007.9	3,874.0
1864	6,847.6	4,965.4	6,078.7	3,815.7
1865	6,977.5	4,972.1	6,153.6	3,767.4
1866	7,203.6	5,075.0	6,324.2	3,820.2
1867	7,550.9	5,298.1	6,615.6	3,994.7
1868	8,036.4	5,654.9	7,043.5	4,301.1

Panel E. Improvements (other than canals, railroads, farmland clearing, and improvements constructed with farm materials), service life of 50 years, retirement age of 50

	Gross	Net straight-line	Net BLS concave	Net declining balance
1869	8,636.1	6,117.7	7,581.9	4,707.6
1870	9,365.6	6,698.0	8,243.9	5,223.4
1871	10,040.8	7,209.3	8,844.8	5,659.1
1872	10,826.4	7,818.7	9,550.4	6,184.4
1873	11,736.7	8,538.2	10,374.1	6,809.2
1874	12,586.1	9,180.2	11,129.7	7,343.3
1875	13,402.9	9,775.2	11,846.6	7,820.4
1876	14,202.9	10,339.3	12,540.0	8,258.8
1877	14,964.3	10,851.3	13,188.3	8,639.2
1878	15,699.6	11,326.0	13,805.2	8,978.3
1879	16,433.0	11,787.1	14,413.7	9,301.1
1880	17,185.2	12,254.9	15,034.0	9,629.1
1881	18,066.6	12,842.5	15,778.7	10,074.9
1882	19,064.6	13,533.8	16,633.9	10,619.6
1883	20,093.2	14,243.0	17,514.7	11,174.4
1884	21,232.1	15,050.7	18,502.2	11,819.7
1885	22,435.1	15,895.8	19,536.9	12,493.1
1886	23,726.8	16,819.7	20,660.0	13,234.8
1887	25,200.5	17,893.9	21,944.5	14,115.8
1888	26,680.2	18,971.1	23,244.5	14,983.1
1889	28,128.3	20,003.7	24,513.8	15,790.8
1890	29,946.0	21,367.0	26,127.1	16,918.4
1891	32,017.4	22,950.4	27,978.1	18,246.1
1892	34,299.6	24,703.3	30,018.9	19,718.3
1893	36,633.1	26,455.1	32,081.0	21,161.4
1894	38,684.2	27,880.6	33,838.1	22,253.1
1895	40,739.4	29,298.5	35,603.2	23,321.4
1896	42,638.1	30,546.4	37,214.8	24,205.4
1897	44,473.4	31,716.4	38,763.1	25,003.3
1898	46,368.4	32,906.4	40,345.5	25,818.0
1899	48,133.4	33,921.1	41,766.1	26,455.0
1900	49,967.6	34,970.0	43,230.0	27,129.7
1901	52,010.2	36,224.9	44,908.6	28,011.1
1902	54,255.2	37,681.7	46,801.4	29,088.0
1903	56,509.1	39,142.8	48,715.0	30,156.8
1904	58,639.9	40,469.8	50,512.7	31,080.6
1905	60,786.3	41,790.3	52,321.2	31,992.7
1906	63,057.8	43,221.5	54,258.5	33,010.9
1907	65,457.4	44,773.9	56,337.7	34,141.7
1908	67,826.6	46,228.4	58,343.5	35,167.3
1909	70,287.5	47,678.9	60,367.0	36,188.9

continues

TABLE 6.APP1 **(*continued*)**

Panel F. Improvements (other than canals, railroads, farmland clearing, and improvements constructed with farm materials), average service life of 50 years, diverse retirement ages (Winfrey distribution)

	Gross	Net straight- line	Net BLS concave	Net declining balance
1890	29,219.0	20,943.9	25,534.1	16,614.7
1891	31,248.0	22,505.0	27,356.0	17,923.8
1892	33,480.4	24,233.6	29,366.4	19,374.0
1893	35,750.0	25,958.8	31,396.8	20,791.4
1894	37,729. 1	27,355.4	33,122.7	21,855.1
1895	39,730.4	28,743.4	34,857.2	22,897.5
1896	41,589.0	29,960.1	36,437.1	23,757.2
1897	43,398.2	31,097.8	37,952.3	24,533.6
1888	45,254.1	32,254.9	39,499.3	25,327.8
1889	46,960.2	33,235.8	40,882.3	25,944.3
1900	48,720.2	34,251.0	42,307.7	26,599.5
1901	50,707.0	35,473.3	43,948.5	27,464.3
1902	52,925.1	36,896.6	45,802.6	28,526.9
1903	55,177.5	38,322.8	47,674.2	29,582.6
1904	57,327.8	39,612.8	49,424.2	30,494.6
1905	59,493.1	40,893.7	51,177.0	31,395.2
1906	61,792.1	42,283.7	53,049.4	32,402.6
1907	64,243.2	43,792.2	55,054.6	33,524.6
1908	66,623.7	45,199.8	56,971.4	34,538.0
1909	69,033.5	46,601.3	58,893.8	35,542.8

*Assuming no investment in the years 1791 (1 July 1790–30 June 1791) and 1792 (1 July 1791–30 June 1792)—years for which data are not available.
Sources: See text.

and fifty years respectively characterized producers' durables and improvements are also almost certainly too large (see the text). The other estimates, associated with average service lives of thirteen and forty years, may or may not be too low. Only the thirteen-, seventeen-, and fifty-year estimates are shown here.