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Volume Authors/Editors: Robert E. Gallman and Paul W. Rhode

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CHAPTER THREE

The United States Capital Stock, 1840–1900

3.1. Introduction

There are at least four scholarly uses for aggregate capital stock series. First, they can be used in place of national product series—or in addition to national product series—to describe the scale, structure, and growth of the economy. There is no reason why, over short or even intermediate periods, the capital stock should grow at exactly the pace of the national product, but over the long run there should be a considerable degree of similarity. For this reason, capital stock series have sometimes been used as proxies for national product series in the measurement of long-term growth (Jones 1980). But one could easily make a case for the use of such series as independent indexes of growth, not simply as proxies for national product. Looked at and measured in one way, the capital stock of a given year describes the accumulated savings of the past; looked at and measured in a different way, it is a vision of future production. Either way, we have a picture of the economy that is different from the one provided by the national product, and one that is analytically useful.

Second, capital stock series have appeared as arguments in consumption functions and, thereby, in the analysis of the level of economic activity, cyclical variations, and economic growth. Land and consumers' durables are helpful additions to capital in these uses, as are paper claims.

Gallman published the substance of this chapter as Gallman 1986; Rhode reordered and revised the text to enhance its fit and flow in this volume. Rhode recalculated the growth rates on a continuously compounded basis, creating slight differences from the numbers appearing in Gallman 1986.

Third, the capital stock is a consequence of savings and investment decisions, with which are tied up choices of technique. The level and structure of the capital stock emerge out of these decisions, and capital stock series are used in studying them.

Fourth and finally, capital stock series are used in the analysis of production relationships and the sources of economic growth. In this chapter, the capital stock series are put chiefly to the first use and, to a limited extent, to the third and fourth.

This chapter describes and analyzes the estimates of the value of the US fixed capital stock, in current prices and in 1860 prices, at decade intervals from 1840 to 1900. The series contain estimates of the value of land, except agricultural land in 1840. The chapter will use the term "national wealth" to refer to the value of reproducible capital, land, stocks of monetary metals, and net claims on foreigners. "Domestic wealth" will mean the value of reproducible capital and land. Notice that paper claims are excluded from both of these aggregates, as are consumers' durables and human capital. The terms "national capital" and "domestic capital" refer to national wealth and domestic wealth respectively, minus the value of land. The concepts referred to here as "wealth" and "capital" are sometimes called by others "capital" and "reproducible capital" respectively.

Section 3.2 details the types of estimating procedures and tests adopted and their general results, the identity and character of the principal sources used, and the theoretical concepts that guided the work. Section 3.3 is concerned with the theoretical and quantitative relationships between the refined Gallman estimates and those already in the field: the Goldsmith and Kuznets series, as well as the original Gallman-Howle figures (Kuznets 1946; Goldsmith 1952; Gallman and Howle 1965; Gallman 1965). Section 3.4 considers the ways in which the refined Gallman series illuminate the nature of the nineteenth-century US economy and the course of US economic development.

3.2. Methods of Estimating the Capital Stock

Capital stock estimates can be made in two ways: they can be cumulated from annual investment flow data (Raymond Goldsmith's [1956] perpetual inventory method) or they can be assembled from censuses of the capital stock. If census and annual flow data were perfectly accurate, if the identical concepts were embodied in each, and if appropriate estimating

procedures were used, then perpetual inventory and census procedures would yield the same results. In fact, they rarely do, though given the rich opportunities for discrepancies to arise, it is surprising how narrow the margins of difference often are.

The choice between the two techniques turns on the types and quality of data available. From 1850 through 1900 there were six reasonably comprehensive federal censuses of wealth, while for 1805 and 1840 we have census-style estimates constructed by able and informed contemporaries—Samuel Blodget (1806) and Ezra Seaman (1852)—chiefly from federal census, taxation, and trade data. Investment flow data, from which perpetual inventory estimates might be made, are less generally available. But researchers have subsequently produced additional data that offer opportunities for estimates superior to those derivable from nineteenth-century census-style data. The best were assembled in the extraordinarily well conceived and careful work of Albert Fishlow (1965, 1966) on the railroads. The estimates use Fishlow as the bases for the railroad series; Cranmer (1960) and Segal (1961) for canals; North (1960) and Simon (1960) for the international sector; and Ulmer (1960) for telephones and for electric light and power. Perpetual inventory methods were used to create figures for the telegraph industry and for consumers' durables. No doubt other sectoral estimates could be constructed, with profit, from flow data, although one doubts that the remaining opportunities are quantitatively important. The estimates described in this chapter are chiefly (and by necessity) drawn from census-style data (see table 3.1).

There are also some aggregate flow data which, while not very helpful in the derivation of sectoral estimates, proved useful in the construction of aggregate perpetual inventory estimates of manufactured producers' durables and structures—estimates that we have used for checking the census-style figures and for constructing annual capital stock series.

3.2.1. Valuation of Capital

In principle, capital stocks might be valued in any number of ways.[1] In practice, there are only three ways of any importance, two of which exist in two variants. (This refers to current price estimates; constant price estimates are discussed below.) Capital can be valued at acquisition cost (which is also referred to as "book value"), at reproduction cost, and at market value.[2]

Acquisition cost corresponds to the notion, expressed above, of the capital stock as piled-up savings. The great difficulty posed by such

TABLE 3.1 **Estimation methods, valuation bases, and principal sources of national capital stock estimates, measured in current prices, 1840–1900**

	Estimation methods[a]		Valuation bases[b]			Principal sources[cd]	
	Perpetual inventory	Census	Book value	Reproduction cost	Market price	Census	Other
A. By sectors							
Agriculture		x			x	x	x
Mining		x			x	x	
Manufacturing		x			x	x	
Nonfarm residences		x					
Shipping		x			x	x	x
Canals and river improvements	x		x			x	x
Railroads	x			x			x
Street railroads		x	x			x	
Pullman and express cars		x		x		x	
Telephone	x			x			x
Telegraph	x			x			x
Electric light and power	x			x			x
Pipelines		x	x				x
Churches		x			x	x	x
Government buildings	x	x	x				x
Schools		x			x		x
Inventories (excluding animals)	x				x	x	x
International sector	x	x	x[e]				x
B. Percentages							
1840	19	81	3	38	59	20	80
1850	23	77	2	34	64	50	50
1860	23	77	2	33	65	50	50
1870	27	73	1	27	72	50	50
1880	29	71	1	30	69	55	45
1890	26	74	1	26	73	60	40
1900	27	73	3	26	72	60	40

Notes:
[a] "Perpetual inventory" is used here to refer to any and all cases in which estimates were derived from flow data; "census" means any and all cases in which estimates were derived from stock data.
[b] There remain some doubts concerning valuation bases (see text). In particular, a number of the estimates identified as expressed in market prices may in fact refer to net reproduction cost.
[c] Both columns are checked (panel A) in cases in which the census was the principal source in certain years but not in others, and in those cases in which the census and some other source were about equally important in all years.
[d] The percentages in panel B are rough estimates of the relative importance of census and noncensus sources.
[e] Less bad debts.
Sources: See text.

estimates is that the capital stock of each year is valued in the prices of many different years, so that no meaningful comparisons (at least none that comes to mind) can be made. This difficulty can be overcome by adjusting the data by means of a general price index—a consumer price index would be best—so that all elements of the capital stock of a given year are expressed in the prices of that year. A capital stock so valued retains the sense of acquisition cost: the valuation expresses the capital stock in terms of forgone consumption. The forgone consumption consists of the consumption goods given up in the year of investment, expressed in the prices of the year to which the capital stock estimate refers. Unambiguous comparisons can thus be drawn—with the national product of the same year, for example.

The capital stock may also be valued at reproduction cost. Each item is valued at the cost of the resources that would be required to replicate it in the year to which the capital stock estimate refers, given the factor prices and techniques of production of that year. The capital stock thus has the sense of congealed productive resources, valued consistently, so that a summation has a precise meaning. Such estimates are well adapted to the study of production relationships. They avoid, in some measure, the circularity problem implicit in market value estimates. Compared to acquisition cost estimates, they express the capital stock in terms of current productive resources rather than historical forgone consumption.

The third system values the capital stock in market prices; that is, each item of capital is appraised at the price it would bring in the current market. The market value of a piece of capital is presumably a function of its productivity, its expected life, and the going rate of interest. The capital stock, so valued, expresses the income that capital is expected to earn, discounted back to the year to which the estimate refers. Such a measure would be useful in consumption function applications, as well as in describing the scale and structure of the economy.

Book and reproduction cost measures differ, theoretically, in that the former measures the capital stock in terms of what was given up to obtain it, while the latter measures the capital stock in terms of what would have to be given up in the current year to reproduce it. In an unchanging economy in equilibrium, these measures would be identical. In an economy in which there were no changes except in the price level, they could be made identical by means of the deflation adjustment described above. In the absence of this adjustment, book value would exceed reproduction cost whenever the price level was falling, and vice versa. Changes

in relative prices could lead to the divergence of the two measures, even after adjustment. Thus, if the prices of capital goods fell relative to the prices of consumption goods, adjusted book value measures would exceed reproduction cost, and vice versa. (All of the above analysis rests on the assumption that the market price of new capital goods equals the reproduction cost of these goods. If that is not the case, matters become more complicated, as will appear.)

In fact, we know that neither the price indexes of consumption goods nor those of capital goods exhibited a very pronounced trend between 1820 and 1860, though the latter fell slightly as compared with the former (see Brady 1964; US Bureau of the Census 1960, series E-1, E-7, E-8). Between 1859 and 1869–78, the price index of consumption goods rose dramatically while the price index of capital goods did not (Gallman 1966). The two indexes then fell pronouncedly until nearly the end of the nineteenth century, the latter declining the more markedly. Thus, for the dates of concern here, book value (adjusted and unadjusted) probably exceeded reproduction cost modestly, in 1840–60 and, more markedly, in 1880–1900, adjusted book value also probably exceeded reproduction cost in 1870.

Book value measures look to the past (what was given up to obtain capital) while market values look to the future (earnings potential). In an unchanging economy in equilibrium, and with perfect knowledge, book value and market value would differ only in that the former treats each piece of capital as though it were new, while the latter does not. Even in an unchanging economy, fixed capital would gradually wear out. Therefore, old fixed capital would sell for less than new fixed capital, and a capital stock expressed in market values would be smaller than one expressed in book values. The disparity could easily be removed by deducting capital consumption from the book value measures, producing estimates of net book value.

The effects of changing prices (levels and relative prices) on the relative magnitudes of net book and market values are presumably much the same as the effects of changing prices on the relative magnitudes of book and reproduction cost values (see above). Once we drop the assumption of perfect knowledge, other opportunities for divergence between capital stock estimates based on these two concepts emerge. Specifically, deviations between the expected life of individual pieces of fixed capital (on which capital consumption allowances rest) and their actual life may arise. These deviations may prove in practice not to be serious, in view of the opportunity for errors of opposite direction to offset in the aggregate, though a general change in the rate of innovation could produce an uncompensated

deviation.[3] Changes in the interest rate produce systematic shifts in the relative values of assets of differing life expectation in the market, but they do not influence aggregate net book values. Actual changes in the interest rate over the last sixty years of the nineteenth century seem likely to have raised market values above net book values from 1870 onward; but not by much, except perhaps for the year 1900 (Gallman 1987).

Once allowance is made for capital consumption, reproduction cost (that is, net reproduction cost) ought to be similar to market value. Indeed, if the economy were in equilibrium—such that the market price of new capital equaled its reproduction cost[4]—and if capital consumption allowances followed the pattern implicit in the structure of the sales prices of capital goods of differing vintage, then market value and net reproduction cost would be identical. In fact, however, these conditions are not met. Market prices deviate from the value of resources used up in production (there are profits or losses), and capital consumption allowances fail to reflect precisely the structure of prices of capital of differing age. Thus, divergences arise between market value and net reproduction cost—divergences of a type discussed previously in connection with book and market values.

Finally, it should be said that the deviations among net book value, net reproduction cost, and market value are least marked for items recently produced; in equilibrium, there is no deviation at all for new goods. The faster a capital stock grows, ceteris paribus, the lower the average age of capital and the narrower the differences among book value, reproduction cost, and market value. As will appear, the US capital stock grew at an extraordinarily rapid pace in the nineteenth century. Thus, the application of the three concepts might produce net valuations that differed little from one concept to the next. The market value and reproduction cost of inventories also will normally differ little. Thus, the more important inventories are in the total capital stock, the smaller the disparity between aggregate reproduction cost and aggregate market value, ceteris paribus. Inventories were in fact an important element of the nineteenth-century capital stock, partly because agriculture bulked large in the economy and agriculture held large inventories (e.g., of animals).

If data were readily available and estimates costlessly made, it would be desirable to have sets of capital stock estimates based on acquisition costs, reproduction costs, and market values. Comparisons among the estimates would have interesting analytical uses (e.g., Tobin's q). Unfortunately, these conditions do not obtain. Data are less than abundant and less than perfect; the assembly of estimates is not costless.

The data that have been most abundant have been acquisition cost data, since firms maintain records of sales and purchases and keep books on their capital stock. Given good price data, evidence on purchases and sales can also be converted into perpetual inventory reproduction cost estimates, although the procedure is not problem-free. Market values and census-type figures on reproduction cost are much harder to obtain. Few elements of the capital stock (apart from goods held in inventory) are sold in any given year. If the capital stock is to be valued at market prices, imputations must be drawn from recorded prices in markets that may be very thin (see also Kuznets 1938).

Estimating reproduction cost is even more difficult, since it sometimes requires that one work out the cost, in a given year, of producing a good that in fact was not produced in that year. These are familiar points. But we should not lose sight of the fact that market and reproduction costs are constantly being estimated, and that there are experts who spend their lives at these tasks—experts hired by insurance companies, the loan departments of banks, and various tax offices. Indeed, anyone who owns a home has a fair idea of what it would bring on the market, or what it would take to rebuild it, despite the gyrations of the real estate market.

In the nineteenth century, book value data were much less common than they are today. Until late in the century, most firms charged off capital purchases on current accounts. Thus, there were few books to refer to when the census taker came around. Perhaps equally important, businessmen did not think in terms of book value. It was more natural for them to appraise plant and equipment in terms of what it would take to replace it should it all burn down, or what it might sell for. This was even more clearly the case for farmers and householders viewing their property. These notions of value seem to have influenced the designers of census questions. While the questions are by no means always crystal clear, they seem to refer most often to market value or net reproduction cost. (The two concepts are not always clearly distinguished.) There is little doubt—especially for the first three or four census dates—that book value was only rarely sought by census takers, though how rarely is a matter on which there is not full agreement. Gallman and Howle (1965) concluded that most of the census returns they used were expressed in market values or net reproduction costs (see table 3.1). But this position stands in opposition to very good authority; Kuznets (1946) and Creamer, Dobrovolsky, and Borenstein (1960), for example, believe that the manufacturing censuses for 1880, 1890, and 1900 returned book value.

The distinctions among book value, market value, and reproduction cost may not have great practical significance in any case, so far as the nineteenth-century capital stock is concerned.[5] This is especially true in view of the wide margins for error that must be assigned to the estimates. More important is whether the census measurements of fixed capital are net or gross. There exists a test that does not rely on the interpretation of nineteenth-century language. One can check the census data (land improvements and manufactured producers' durables, separately) against perpetual inventory estimates based on reproduction cost.

As the story of these tests has been told elsewhere (Davis and Gallman 1973; Gallman 1987; and chapter 6 in this volume), only a brief summary is offered here. The net reproduction cost estimates check quite closely with the census aggregates before the Civil War, suggesting that the latter are indeed net valuations. There is also some support for the notion that the census valuations refer to reproduction cost and that they are accurate. The postbellum fit is poorer, but the evidence for the belief that the census figures are net is strong: the perpetual inventory figures typically exceed the census figures.

Our estimates of agricultural land improvements (clearing, breaking, fencing, draining, irrigating) depend chiefly on census physical stock data (e.g., acres of improved land) and various coefficients developed from the work of Martin Primack (1962). Given the form of the data, we were restricted to the construction of reproduction cost figures. Fishlow's (1965, 1966) estimates of railroad investment also rest on physical data, as do our estimates for the telegraph industry. In these cases, however, the form of the data left open the possibility of constructing book value series. In order to maintain consistency with most of the rest of the work—and because we believed they would prove more useful—we chose to produce reproduction cost estimates instead.

The capital stock figures, thus, consist chiefly of net reproduction cost or market value estimates, as table 3.1 indicates. The assignment of items to the reproduction cost category in table 3.1 is sure, but the same cannot be said of the estimates referred to as "market value." For a number of these, the valuation may in fact refer to net reproduction cost. The practical distinctions between these two types of measures on the dates to which the capital stock estimates refer, however, are unlikely to be very important, for the reasons given earlier in this section.

All of the data—including the federal census data—underwent considerable processing and testing during the construction of the estimates.

The estimating and testing notes are included in chapters 7–12 in this volume. Some general statements of appraisal can be ventured, however.

The evidence is considerably weaker for 1840 and 1870 than for the other census dates. The 1840 census provided much less information on wealth than did the censuses in subsequent years (though with respect to the trade sector, it was unusually helpful). Also, prices fell dramatically across that census year, which means that it is very important to date the available evidence correctly. We cannot be absolutely sure that we have done so. The census dragged on for an inordinate length of time, so that the dating of census magnitudes is problematic. We also were obliged to depend heavily on the work of Ezra Seaman (1852), who was not always entirely clear about his valuation base. The 1870 census came at a difficult time, and it is widely believed that Southern wealth was badly returned (Ransom and Sutch 1975). Nonetheless, it must be said that the results of the perpetual inventory tests for these two dates do not impugn the stock estimates. The test is particularly difficult to run for 1840 and 1870, and the results must be regarded as particularly chancy. Still, it is moderately reassuring that the stock and flow estimates are about as consistent at these dates as at any others in our series.[6]

The test for 1880 is less successful. It suggests that our stock estimates at that date—for both equipment and improvements—may be too low. These are matters to which we will return below. It is perhaps sufficient to say here that the capital stock figures are much more likely to tell an accurate story of the long-term rate of growth and structural changes of the capital stock than of the decade-to-decade changes, and this is particularly true after 1860.

3.2.2. Constant Price Series

The best capital stock deflators available are to be found among the price index numbers assembled by Dorothy Brady (1966) to deflate components of the GNP. The Brady indexes are the best for several reasons: they are true price index numbers of capital goods (including structures), they are available in considerable detail, they were constructed with careful regard to their theoretical meaning, and their theoretical meaning makes them reasonably apt deflators for capital stock series valued in terms of reproduction cost or market value (see also Brady 1964). They are not perfect, but, in the absence of price data for old capital, they are as close to perfection as can be had. They are linked price indexes describing, in principle, the movement of the prices of capital goods of unchanging

quality. If the economy were in equilibrium in all the relevant years, such that market prices and reproduction costs of new goods were identical, and if the prices of new and old goods moved closely together over time (i.e., if the interest rate was the same at each relevant date and the rate of obsolescence was unchanging), then deflation of capital stock estimates valued in market prices or net reproduction costs would yield a constant price series expressed in net reproduction costs. That is, it would produce a series in which each element measured the net reproduction cost of the capital stock, given the factor prices and techniques of producing capital goods of the base year. These conditions were surely not met: the interest rate changed, affecting the relative magnitudes of market value and reproduction cost. Nonetheless, the constant price capital stock series approximates more nearly to a reproduction cost series than it does to any other coherent concept.

While the Brady indexes were the chief deflators we used, other price data figure in important ways in the construction of the constant price capital stock series. Some important components of the capital stock were built up by placing values on counts of capital goods, described in physical terms. In these cases—improvements to agricultural land (structures apart), railroads, the telegraph, farm animal inventories, crop inventories—constant price estimates could be made directly from the evidence on physical counts and base year prices, and we could be sure that the series so constructed were true reproduction cost series, or very close thereto. Inventories of manufactured goods and imports were deflated with price indexes germane to the types of products incorporated in these inventories, drawn from sources other than the Brady papers (Gallman 1960; US Bureau of the Census 1960, series U-34, E-1, E-70).

The Brady indexes refer to the census years (beginning on 1 June of the years ending in nine and ending on 31 May of the years ending in zero) before the Civil War, and to calendar years ending in nine after the Civil War. The current-year capital stock valuations to which the Brady indexes apply refer to 1 June of the years ending in zero. The Brady indexes are adjusted on the basis of other available price data to make them conform to the appropriate dates. Gaps in the coverage of the Brady indexes were filled similarly.

3.2.3. Original and Refined Capital Stock Series Compared

The series presented here are refinements completed by Gallman to estimates made in collaboration with Edward Howle in the mid-1960s. The

original Gallman-Howle estimates of the value of property employed in agriculture extract from the value of agricultural land and list separately the value of agricultural structures. These estimates treat all other agricultural improvements as part of the value of land. This accounting approach brought the estimates into conceptual alignment with the twentieth-century estimates.[7]

The refined Gallman figures include two sets of estimates, variants A and B. Variant A treats all improvements to farmland as capital. Variant B excludes land improvement other than structures. Variant B captures a conventional definition of reproducible capital, and is conceptually close to the original Gallman-Howle series. The two capital stock variants correspond to two variants of the GNP series appearing in Gallman (1966). The variant A capital stock estimates correspond conceptually, with the GNP II series that includes investment flows devoted to land clearing. The variant B capital stock estimates corresponds conceptually, with the GNP I series that excludes investment flows devoted to land clearing. For purposes of analyzing nineteenth-century developments (when land clearing was important), the GNP II series is certainly more appropriate than the GNP I series; similarly, the broader capital stock series (variant A) would be superior for these purposes to the narrower series (variant B), which reflects twentieth-century conventions.

The difference between variants A and B is the reproduction cost of clearing and breaking farmland, fencing it, and draining and irrigating it. The estimates of the value of land improvement are based on the work of Martin Primack (1962). The value of fences was taken net of capital consumption. Capital retirements were deducted from the other items, but no allowance was made for capital consumption, on the ground that normal maintenance would prevent physical deterioration of these improvements. Clearly some deduction in value should have been made to account for the deterioration of improvements on land withdrawn from production but not yet returned, for census purposes, as unimproved (i.e., land retired from cultivation), but no system for making this type of adjustment could be devised. The improvements estimates are therefore almost certainly overstated, as compared with the values recorded for other elements of the capital stock.

Farm improvements (exclusive of structures) constituted a very large part of the capital stock, but a part that declined in relative importance as time passed. Thus roughly 60 percent of the agricultural capital stock consisted of these improvements in the years 1840 and 1850—a fraction

TABLE 3.2 **Ratios of the value of farm improvements (exclusive of structures) to the value of US farm capital and the value of US domestic capital, measured in current and constant prices, 1840–1900**

		1840	1850	1860	1870	1880	1890	1900
Relative to farm capital	Current prices	0.58	0.59	0.56	0.51	0.51	0.48	0.49
	1860 prices	0.61	0.61	0.56	0.55	0.58	0.55	0.54
Relative to domestic capital	Current prices	0.34	0.3	0.27	0.22	0.18	0.14	0.13
	1860 prices	0.38	0.34	0.27	0.24	0.22	0.14	0.12

Note: The denominators include farm improvements.
Source: See text.

that fell to less than 50 percent, in current prices, in 1900, and something over 50 percent, in constant prices. The fraction of total domestic capital accounted for by these improvements fell from between 35 and 40 percent in 1840 to just over 10 percent in 1900 (see table 3.2). It should be clear, then, that the refined Gallman variant A series, which is inclusive of improvements, is substantially larger than the original Gallman-Howle capital stock series, and exhibits a substantially lower rate of growth.

On balance, the other revisions made in the constant price series are not of overwhelming quantitative significance. In no year do they amount to more than 10 percent of the value of the domestic capital stock, but they are far from negligible. The adjustment for 1840 is in an upward direction, and those for the 1870–1900 period in a downward direction.

The original Gallman-Howle series, expressed in constant prices, was never published, but a set of index numbers based on it appeared in *American Economic Growth: An Economist's History of the United States* (Davis et al. 1972, 34). These index numbers provide the best bases for comparing the original Gallman-Howle series with the refined Gallman series.[8]

The comparisons can be made with data in table 3.3, which show that both variants of refined series describe lower long-term rates of growth than do the original (panels A and C). The disparities are wider when the refined series, inclusive of all farmland improvements (variant A in table 3.3), is compared with the original series. That is reasonable enough, in view of the conceptual difference between the two series and the well-known fact that the agricultural sector grew at a slower pace over the last six decades of the century than did the rest of the economy.

TABLE 3.3 **Comparisons of the refined Gallman and original Gallman-Howle national capital stock series, measured in 1860 prices, 1840–1900**

A. Index numbers on the base 1860 = 100

		1840	1850	1860	1870	1880	1890	1900
1	Refined series, variant A[a]	38	57	100	118	178	328	475
2	Refined series, variant B[b]	31	51	100	121	189	385	570
3	Original series	28	51	100	143	220	437	656

B. Annual rates of growth, short intervals (%)

		1840–50	1850–60	1860–70	1870–80	1880–90	1890–1900
1	Refined series, variant A[a]	4.12	5.61	1.66	4.11	6.12	3.69
2	Refined series, variant B[b]	5.01	6.61	1.96	4.40	7.12	3.92
3	Original series	5.93	6.79	3.61	4.27	6.86	4.07

C. Annual rates of growth, long intervals (%)

		1840–1900	1850–1900	1860–1900	1870–1900	1880–1900
1	Refined series, variant A[a]	4.22	4.24	3.89	4.64	4.90
2	Refined series, variant B[b]	4.84	4.81	4.35	5.15	5.52
3	Original series	5.26	5.12	4.70	5.07	5.47

Notes: [a]Includes all improvements to farmland. [b]Excludes all improvements to farmland except structures.
Sources: Refined series, see text. Original series derived from data in Davis et al. 1972, 34.

But even when the conceptual difference is removed—when the variant B series is substituted for the variant A series—the refined estimates exhibit somewhat lower long-term rates of growth than do the original estimates. The margins are not great, however: less than one-half of a percentage point in every case. The data on the decadal rates of growth show, moreover, that in only two decades, 1840–50 and 1860–70, are the disparities in growth rates at all wide (panel B). These are the decadal growth rates that are affected by the major estimating changes described at the top of this section. It should also be pointed out that the refined and original series exhibit the same patterns of change over time, the rate of growth rising from 1840–50 to 1850–60, falling to 1860–70, rising again to 1870–80 and 1880–90, and finally falling to 1890–1900.

On the whole, the refined series differ from the original in important respects, but once allowance is made for differences in concept and coverage, they appear to tell roughly the same story with respect to the rate of growth of the capital stock.

Two preexisting sets of comprehensive capital stock estimates cover a substantial part of the nineteenth century: Simon Kuznets's (1946) series, reported in *National Product since 1869*, which cover the years 1880, 1890, and 1900; and Raymond Goldsmith's (1952) revisions to the Kuznets figures and extension of them to 1850. There were also many sectoral estimates, deriving from a major program at the NBER in which Creamer, Dobrovolsky, and Borenstein (1960); Ulmer (1960); Grebler, et al. (1956); and Tostlebe (1957) participated (see also Kuznets 1961 and Kendrick 1961).

Kuznets's (1946) *National Product since 1869* provided the framework for this analysis. The volume contains very detailed estimates, together with full descriptions of estimating procedures. The idea was to modify Kuznets's estimates in light of the work that had come forward since *National Product since 1869* was published, and to extend the estimates to the years 1840, 1850, 1860, and 1870. The Goldsmith (1952) estimates for 1850, while available in less detail, were to serve as an antebellum benchmark.

Table 3.4 compares the refined Gallman series with the Kuznets and Goldsmith estimates. It will be seen that in the cases of fixed reproducible capital in farming, street railroads, shipping, canals, river improvements, and pipelines and in the cases of inventories of farm livestock and monetary metals, the differences are slight. (In the cases of street railroads and pipelines, there are no differences at all.) For the rest, there are substantial differences. As they relate to the Kuznets and Gallman estimates,

TABLE 3.4 **Ratios of the Goldsmith (1850, and elsewhere where indicated) and Kuznets (1880–1900) capital stock estimates, measured in current prices, to the refined Gallman estimates**

		1850	1880	1890	1900
A. Fixed reproducible capital					
1	Agriculture, variant B[a]	1.07	0.97	0.97	1.00
2	Mining		1.21	1.15	1.32
3	Manufacturing		0.72	0.8	0.85
4	Other industrial (trade)		1.56	1.27	1.28
5	Nonfarm residences				
	Goldsmith	1.10	1.20	1.15	1.28
	Kuznets		0.83	0.72	0.81
6	Steam railroads		1.54	1.56	1.71
7	Street railroads		1.37	1.38	1.32
8	Pullman cars		1.32	1.37	1.57
9	Telephones		2.81	1.98	1.95
10	Shipping, canals, and river improvements		0.85	0.92	0.95
11	Electric light and power			1.63	1.42
12	Waterworks[b]				
13	Irrigation		1	1	0.78
14	Pipelines		1	1	1
B. Inventories (Goldsmith)					
1	Farm livestock	0.92	1.05	0.96	1.06
2	Monetary metals	1	1.2	1	1
3	Net international debits	1.36	0.69	0.97	1.12
4	Other inventories	0.52	0.96	1.06	0.94
C. Totals					
1	Fixed reproducible capital (Kuznets)[a]		1.10	1.04	1.11
2	National capital (Goldsmith)	0.89	1.17	1.16	1.2

Notes:
[a] Excluding farmland improvements, other than structures.
[b] Not estimated by Gallman.
Sources: Goldsmith 1952; Kuznets 1946.

they tend to cancel out, so that the values of aggregate fixed reproducible capital fall within 11 percent of each other in each year, the Kuznets figures being the higher. The net gaps between the Goldsmith and the Gallman estimates are wider, and they also run in opposite directions in 1850 and the later years. Thus, the Goldsmith series describes a substantially higher rate of growth across the nineteenth century than does the

refined Gallman series, even when differences of concept and coverage are eliminated.[9]

The differences between the refined Gallman estimates and those of Goldsmith and Kuznets were due in part to newly available evidence, to different interpretations of the evidence, and to the use here and there of different concepts. Examples of new data based on later research by other scholars include the estimates relating to agriculture, the "other industrial" (or "trade") sector, nonfarm residences, steam railroads, telephones, canals and river improvements, electric power and light, irrigation, tax-exempt property, and international claims. Examples of new data based on research by Gallman and Howle include the estimates for inventories and the telegraph. Examples of different interpretations of existing evidence include the estimates for mining and manufacturing. (It appears that rented real estate was inadvertently left out of Kuznets's manufacturing estimates.) Examples of the use of different concepts include steam railroads and the telegraph, where estimates of net reproduction cost were substituted for book value.

In summary, then, the refined Gallman capital stock estimates are net of capital retirements and net of capital consumption. While a few of the components (current prices) are expressed in book values, most are in market prices or in net reproduction costs. Conceptually, the refined series differ importantly from the original; substantively, somewhat less. The substantive differences between the refined Gallman series and the Goldsmith and Kuznets nineteenth-century series are wide enough that one might anticipate that accounts of economic structure and change based on the refined series would offer an element of novelty.

3.4. Capital and Economic Growth

3.4.1. Rates of Growth

How did the growth experience of the US economy between 1840 and 1900 compare with growth at other times or in other places? It is difficult to make meaningful direct comparisons of this type, but a fairly obvious indirect one can be made. We know that the US real national product increased between the 1830s and 1900 at an exceptionally high rate (Gallman 1966; Davis et al. 1972, ch. 2). Unless the rates of change of capital stocks and national products diverged widely—which is highly improbable—the US capital stock must also have grown rapidly. That

means that the US capital stock was probably relatively young, with a high proportion of the stock embodying best-practice techniques (Gallman 1978).

In fact, the data in table 3.5 show that the capital stock actually grew faster than the national product, in both current and constant prices, in both variants, over long periods and over most of the short periods identified in the table. That fact has a rather important set of implications. But before considering them, it will pay us to look at other aspects of the evidence in the table.

Rates of change of both variants A and B of the capital stock are contained in table 3.5. It will be observed that the rates of change of the variant B series are always at least as large as the rates of change of the variant A series, and usually larger. One should recall that the variant A series includes investment in agricultural land clearing, fencing, and the construction of drainage and irrigation ditches, while the variant B series does not. The variant A series grew more slowly because this component of the capital stock increased at a below average pace. This in turn was a consequence both of the fact that the value of improvements of this type (measured in reproduction costs) constituted a declining fraction of the value of the agricultural capital stock (in both current and constant prices) and of the fact that the agricultural sector—including the capital stock thereof—grew more slowly than the rest of the economy. The former development reflected both a slowing in the rate (percentage) at which agricultural land was being added to the stock, and in the continued high rates of increase of the stocks of agricultural structures and equipment, particularly the latter. Agriculture was becoming more highly mechanized.

A second feature of table 3.5 worth remarking is that the rates of growth recorded therein exhibit, on the whole, a downward long-term movement. This is true of both of the GNP series, in current and constant prices; both of the capital series, in current prices; and the variant B series, in constant prices. The variant A series, in constant prices, is only a moderate exception. It exhibits lower rates of growth for the periods 1860–1900 and 1870–1900 than for 1840–60, which makes it consistent with the variant B and GNP series. But if the period is broken into three equal lengths, the variant A series shows equal rates of growth for 1840–60 and 1880–1900, the rate for the period 1860–80 being considerably lower. This is the one bit of evidence running against a conclusion of general retardation in rates of growth across the latter part of the nineteenth century. The exception is

not a very important one, however, in view of the reservations expressed above concerning the 1880 capital stock figure. If the estimate for that date is indeed biased downward, then an appropriate adjustment would remove this one exception to the general finding of retardation in the rates of growth of the GNP and the capital stock, a development begun in the nineteenth century and continued in the twentieth.

A third piece of information emerging from table 3.5 is that the decade-to-decade variations in the rates of growth of the GNP and the capital stock are reasonably consistent. Thus, the long-swing boom of the 1850s

TABLE 3.5 **Annual rates of growth of the national capital stock and GNP, 1840–1900**

	Variant A[a]		Variant B[a]	
	Capital stock	GNP[b]	Capital stock	GNP
A. Measured in current prices				
Long-term				
1840–1900	4.35%	3.86%	4.84%	3.96%
Intermediate				
1840–60	5.74	4.81	6.33	4.98
1860–1900	3.66	3.38	4.10	3.44
1870–1900	3.64	(2.09)[c]	4.04	(2.12)[c]
1860–80	3.31	4.16	3.79	4.24
1880–1900	4.00	2.61	4.40	2.64
Short-term				
1840–50	4.77	3.73	5.46	4.10
1850–60	6.71	5.89	7.20	5.86
1860–70	3.72	(4.39)[d]	4.28	(4.38)[d]
1870–80	2.90	(3.67)[c]	3.31	(3.98)[e]
1880–90	4.94	2.49	5.59	2.54
1890–1900	3.07	2.74	3.21	2.75
B. Measured in 1860 prices				
Long-term				
1840–1900	4.22%	3.86%	4.84%	3.98%
Intermediate				
1840–60	4.86	4.39	5.82	4.64
1860–1900	3.89	3.59	4.35	3.64
1870–1900	4.64	(2.85)[c]	5.52	(2.89)[c]
1860–80	2.88	3.61	3.1	3.68
1880–1900	4.86	3.57	5.52	3.61
Short-term				
1840–50	4.12	3.56	5.01	4.04
1850–60	5.61	5.22	6.63	5.20
1860–70	1.66	(3.03)[d]	1.96	(3.07)[d]
1870–80	4.11	(5.28)[c]	4.40	(5.44)[e]

continues

TABLE 3.5 (*continued*)

	Variant A[a]		Variant B[a]	
	Capital stock	GNP[b]	Capital stock	GNP
1880–90	6.12	4.05	7.12	4.13
1890–1900	3.69	3.07	3.92	3.09
C. Implicit price index				
1840	84	97(94)[g]	90	99(94)[g]
1850	89	91(95)[g]	94	91(96)[g]
1860	100	100	100	100
1870	123	(123)[h]	126	(123)[h]
1880	108	113	113	115
1890	97	97	97	97
1900	91	94	90	94

Notes:

[a] The variant A measures include improvements to agricultural land; the variant B measures exclude all such improvements other than structures.

[b] The dates to which the GNP estimates refer differ slightly from the dates in the stub:

Stub	*GNP estimates*
1840	1839
1850	1849
1860	1859
1870	Mean of 1869–78
1880	Mean of 1874–83
1890	Mean of 1884–93
1900	Mean of 1894–1903

[c] These rates of growth were computed from data for 1869–78 and 1894–1903 (means of annual data), and thus refer to the period 1873.5–1898.5.

[d] These rates of growth were computed from data for 1859 and 1869–79 (mean of annual data), and thus refer to the period 1859–73.5.

[e] These rates of growth were computed from data for 1869–78 and 1874–83 (means of annual data), and thus refer to the period 1873.5–78.5.

[f] The dates to which the GNP estimates refer differ slightly from the dates in the stub:

Stub	GNP Estimates
1840	Mean of 1834–43
1850	Mean of 1844–53
1860	1859

For the rest, see note b above.

[g] The implicit price indexes were computed from annual current price data (1839, 1849) and decade average constant price data (1834–43, 1844–53); see notes b and f above. The index numbers in parentheses were computed from annual data above (1839, 1849).

[h] Refers to the period 1869–78.

Sources:

(1) See text.

(2) GNP estimates: Variant B, Gallman 1966, 26, table A-1 (See note b below). Variant A computed from Gallman 1966, pp. 26 and 35, tables A-1 and A-4, variant I, and the implicit price index of improvements to farmland (exclusive of structures) computed from data underlying the appendix. GNP A is defined as conventional GNP plus the value of improvements to farmland (table A4 in Gallman 1966). The numbers in the table assume that average annual improvements, 1849–58, were equal to improvements in 1859. Constant price improvements (table A4 in Gallman 1966) were converted to current prices by means of the price index of agricultural land improvements, exclusive of structures, implicit in the data underlying the appendix. The numbers in the table assumed that the value of improvements (current and constant prices) in 1839 and 1849 were equal to the mean values in 1834–43 and 1844–54 respectively.

clearly emerges from the record provided by table 3.5, rates of growth rising above the levels attained in the 1840s (with the exception of the current price GNP variant B series), while the rates of change of all series drop sharply in the Civil War decade, 1860–70.[10] Between 1870 and 1880 the rates of change of the current price series continue to fall, reflecting the price deflation of the period, while the rates of change of the real series all rise. All of these variations are reassuring. They correspond to what one might have expected, from a knowledge of the qualitative history of the period and of quantitative studies of a micro variety. It is also reasonable to expect the rates of change of the GNP and capital stock series to move together as they do. These features of table 3.5 thus enhance one's confidence in the capital stock series, but necessarily offer no new insights into the period.

The consistency in the movements of the rates of change of the two sets of series ends with 1880. Thereafter, the rate of growth of the GNP series, expressed in constant prices, falls persistently, while the rate of growth of the current price series falls and then rises. The rates of change of the current and constant price stock series follow neither of these patterns, rising between 1880 and 1890 and falling between 1890 and 1900. Thus, the variations in the rates of growth of the GNP and capital stock series diverge across the last two decades of the century. Once again, if the capital stock estimate for 1880 is indeed too low, adjusting it might bring the patterns of change of the two series more nearly into line.

3.4.2. Sources of Growth

How do the revised Gallman capital stock series (in table 3.5) affect our understanding of the sources of economic growth? Davis et al. (1972) and Gallman (1980) had performed standard growth accounting analysis on the basis of the original Gallman-Howle capital series. Table 3.6 compares the results from reworking the analysis using the refined series, together with the original figures. The revisions leave everything unchanged from the earlier set of calculations, with the following exceptions: in the new calculations based on the variant B series, the contributions of the capital stock and productivity are recomputed; in the new calculations based on the variant A series, the contributions of capital, productivity, and land are recomputed. The variant B series is conceptually identical to the original Gallman-Howle series. It was therefore possible to substitute it into the calculations without changing anything else, except for the

contribution of productivity change to economic growth. Because productivity change is taken as a residual, the introduction of a new capital stock series necessarily produces changes in the productivity figures. The variant A series differs conceptually from the original Gallman-Howle series, incorporating elements of value attributed to land in the Gallman-Howle framework. Substituting variant A into the calculations therefore required reestimating the land supply and the system of weights to be attached to the rates of change of capital and land. The details of these calculations are given in the notes to table 3.6. Note that the labor input is the size of labor force, without accounting for human capital or hours worked. The land input is restricted to agricultural land.

Table 3.6 is organized as a set of "sources of growth" calculations of the type made popular by Edward Denison. Panel A shows the contribution of each factor of production and productivity change to the rate of growth of real net national product and real net national product per capita. Panel B displays these figures in the form of percentile distributions.

The calculations based on the original series invited the conclusion that nineteenth-century growth could be attributed chiefly to increases in the supply of factors of production, in contradistinction to that of the twentieth century, in which productivity change was the leading source of growth. The refined capital stock series do not oblige us to change this view dramatically. But they do argue for the assignment of a somewhat larger importance to nineteenth-century productivity change than recent custom has accorded it. In particular, use of the variant A series leads to the conclusion that productivity change accounted for almost six-tenths of the growth of per capita NNP in the nineteenth century. This is lower than the figure recorded for the twentieth century (almost eight-tenths), but is by no means low. The term "productivity" covers the influences of a multitude of forces operating on output. Perhaps a more meaningful way to put the conclusion is to say that the calculations in table 3.6 (variant A) assign to the factor inputs, narrowly defined, responsibility for only a little more than two-fifths of the increase in per capita real national product across the last six decades of the nineteenth century. The role of other forces, therefore, cannot be regarded as small.

3.4.3. Capital-to-Output Ratios

The capital stock increased faster than the national product, according to the data in table 3.5. This means that the capital-to-output ratio was rising; the economy was engaged in capital deepening. Table 3.7 is organized

TABLE 3.6 **Contributions of factor inputs and productivity to the growth of net national product, total and per capita, 1840–1960**

		1840–1900			1900–60
		Original	Refined		
			Variant A	Variant B	Original
A. Average annual rates of growth					
I. Net national product, total					
1	Labor force	1.88%	1.88%	1.88%	1.09%
2	Land supply	0.38	0.13	0.38	0.08
3	Capital stock	1.03	1.12	0.94	0.58
4	Productivity	0.69	0.85	0.78	1.38
5	Totals	3.98	3.98	3.98	3.12
II. Net national product per capita					
1	Labor force	0.17%	0.17%	0.17%	0.11%
2	Land supply	0.05	0.02	0.05	-0.01
3	Capital stock	0.55	0.42	0.46	0.28
4	Productivity	0.69	0.85	0.78	1.31
5	Totals	1.46	1.46	1.46	1.69
B. Percentage distributions					
I. Net national product, total					
1	Labor force	47.2%	47.2%	47.2%	34.8%
2	Land supply	9.6	3.3	9.6	2.5
3	Capital stock	25.9	28.1	23.6	18.6
4	Productivity	17.3	21.4	19.6	44.1
5	Totals	100	100	100	100
II. Net national product per capita					
1	Labor force	11.6%	11.6%	11.6%	6.7%
2	Land supply	3.6	1.6	3.6	-0.6
3	Capital stock	37.5	28.6	31.5	16.4
4	Productivity	47.3	58.2	53.3	77.5
5	Totals	100	100	100	100

Sources: All of these figures, except the ones labeled "Land supply, variant A," "Capital stock, variants A and B," and "Productivity, variants A and B" were taken from Davis et al. 1972, table 2.12, and Gallman 1980, tables 1 and 2, or were computed from these tables or their underlying data. The productivity figures in panel A were taken as residuals. The data in panel A labeled "Capital stock, variants A and B" were derived by weighting rates of change with appropriate income share weights. The rates of change were taken from table 3.5, above (in the case of panel A, part D) or were computed by subtracting the rate of change of population from the rate of change in table 3.5 (in the case of panel A, part II). The income share weight for the variant B series (0.19) was taken from the notes to table 2.12 of Davis et al. 1972. The income share weight for the variant A capital series (0.26) was computed by raising the variant B weight in the same proportion as the variant A capital stock figure (current prices) exceeds the variant B figure, in 1860. The average annual rate of change of the variant A land supply figure was computed from US Bureau of the Census 1960, series K-2, 1850–1900. The income share weight (0.06) was computed by subtracting the capital stock weight (0.26) from the sum of the land and capital stock weights (0.32) employed for the variant B calculations.

to describe this process. The data leave something to be desired because, for the period before the Civil War, some of the ratios depend upon data referring to individual years. The ratios, therefore, are influenced by events peculiar to these years and may not be fully representative of the period 1840–60. The postbellum estimates are less susceptible to this

TABLE 3.7 **Capital-to-output ratios, measured in current and 1860 prices, 1840–1900**

			Numerators[a]			
Year	Variant A	Variant B	Inventories	Farm improvements[b]	Other improvements	Equipment
A. Measured in current prices						
1840	2.37	1.63	0.67	0.84	0.74	0.23
1850	2.64	1.87	0.73	0.81	0.88	0.24
1860	2.86	2.14	0.72	0.78	1.14	0.25
1875	2.58	2.08	0.74	0.54	1.19	0.24
1880	2.45	2.00	0.69	0.48	1.16	0.24
1890	3.14	2.71	0.75	0.45	1.72	0.36
1900	3.25	2.84	0.74	0.43	1.73	0.40
B. Measured in 1860 prices						
1840	2.75	1.79	0.85	1.10	0.76	0.15
1850	2.69	1.82	0.79	0.92	0.84	0.17
1860	2.92	2.19	0.73	0.79	1.17	0.26
1875	2.78	2.17	0.75	0.65	1.18	0.34
1880	2.57	2.02	0.71	0.58	1.06	0.33
1890	3.16	2.72	0.75	0.46	1.40	0.70
1900	3.36	2.95	0.70	0.42	1.38	0.91

Notes: [a]All the denominators, except for those for column 2, are GNP, variant A (see table 3.5); the denominators for column 2 are GNP, variant B. [b]Exclusive of structures.
Sources: See the source notes to table 3.5.

criticism because the national product data are decade averages, centered roughly on the years to which the capital stock figures refer (see the notes to table 3.7). One should remember also that the estimates are not equally reliable; those for 1840, 1870, and 1880 rest on capital stock data that are probably less strong than the data for the other years. Differences in ratios between one year and the next should not be given undue importance. It is the general drift of the ratios that should be the focus of our interest.

The aggregate capital-to-output ratios (first two columns of table 3.7) do in fact rise over time, and this is true of both the variant A and the variant B series in current and constant prices. The variant A ratios are much larger than the variant B ratios, indicating the great quantitative significance of the component of capital consisting of farmland clearing, fencing, and so on (see also the fourth column), components included in variant A but not variant B. The variant A ratios also rise less rapidly than the variant B ratios, reflecting the declining relative importance of these forms of agricultural land improvement. But both series, in current and constant prices, exhibit a fairly marked increase; or perhaps it would be best to speak of two increases. All of the series show some rise before the

Civil War, a decline to the first two postbellum dates for which we have ratios, and then a more pronounced increase to the end of the nineteenth century.

The last four columns of table 3.7 show that the increase of the aggregate capital-to-output ratio reflects exclusively developments with respect to equipment and improvements, other than agricultural land improvements. In current prices, inventories increased about as fast as did the national product, the inventory-to-output ratio changing little. In constant prices it actually declined moderately. The ratio of farm improvements to national product fell quite dramatically, especially in constant prices. On the other hand, the ratios of "other improvements" and of machinery and equipment to output rose vigorously, the latter particularly in the constant price variant; the relative prices of machinery and equipment were falling dramatically. By the end of the nineteenth century, the structure of the capital stock had changed strikingly. Whereas in 1840 farm improvements were the most important components of capital, accounting for over two-thirds of the value of the stock in constant prices, by 1900 their share had fallen to about a third. Machinery and equipment, composing barely 5 percent of the stock (constant prices) in 1840, were over 25 percent of the stock in 1900. Accompanying the capital deepening there was, then, a substantial reshaping of the stock, with new forms of capital rising to prominence.

The last four columns of table 3.7 also throw some light on the nature of the decline in the capital-to-output ratio between 1860 and 1875. Changes in the ratios of inventories, equipment, and "other improvements" to output clearly are not responsible. The first rose moderately, in both current and constant prices, whereas the other two either changed very little (equipment, in current prices), or rose vigorously (equipment, in constant prices; "other improvements," in current prices). But the ratio of "farm improvements" to GNP declined very sharply (especially in current prices) and played a major role in the observed capital shallowing for the economy as a whole. This development may reflect the effects of the Civil War. In the South, some improved land was allowed to return to nature during the war, while in the North the pace at which land was improved slackened for lack of labor. One would think that the effects of the Civil War on improved land would have been largely removed by 1875, but it may be that the value of improvements had not yet attained the level it would have reached had there been no war.

A second factor also bears on the change in the aggregate capital-to-output ratio between 1860 and 1875. Bear in mind that the numerator of

TABLE 3.8 **Capital-to-output ratios, 1860 and 1875**

	1860	1875
Measured in current prices		
Sum	2.86	2.71
Column 1	2.86	2.59
Measured in 1860 prices		
Sum	2.95	2.92
Column 1	2.92	2.78

Source: See text.

the ratio is the national capital stock, an aggregate (variant A) composed of the four components discussed above—inventories, equipment, farm improvements, and other improvements—plus net claims on foreigners. The latter is represented only indirectly in table 3.7; that is, there is no column containing estimates of "net claims"-to-output ratios, paralleling the last four columns. The reason is that net claims represented a negative value in all the years of table 3.7, a relatively small one in most of them. Between 1860 and 1875, however, the size of this variable increased, going from a small negative value in 1860 to a very large one in 1875. This was also probably a consequence of the Civil War, which increased the volume of negotiable American debt, altered the disposition of American savings, and changed the American balance of trade. In any case, this phenomenon also played a role in the decline of the capital-to-output ratio between 1860 and 1875 (Williamson 1974).

An indication of the importance of the impacts of the Civil War is easily obtained. The sum of the ratios in the last four columns of table 3.7 in each year approximates the variant A ratio of domestic capital to GNP. The difference between this sum and the value in the first column measures the effect of net claims on foreigners on the national capital-to-output ratio. The sums and the entries from column 1 for 1860 and 1875 are as shown in table 3.8. The sums are almost identical with the first column values in 1860, but larger than the first column values in 1875. More to the point, the sums drop slightly between the two years in constant prices, while they fall more dramatically in current prices. The decline in the aggregate national capital-to-output ratio, then, reflects both changes in the international circumstances of the United States and changes in the agricultural sector, both sets of changes probably being legacies of the Civil War.

3.4.4. Capital-to-Output Ratios by Industry

Table 3.9 gathers together data at the industrial sectoral level, with the object of seeing how pervasive the trend toward higher capital-to-output ratios was. The evidence in Table 3.9 should be approached with great caution. All of the sectoral output data (value added) are discrete, being distributed at ten-year intervals from 1840 to 1900. Ratios measured from such data are likely to be unstable, particularly when computed for narrow industrial sectors. Furthermore, since it is not possible to distribute all inventories accurately among industrial sectors, they are left out of account here. The ratios measure only fixed capital. The variations among these sectoral ratios in table 3.9 may not accurately represent sectoral variations in more comprehensively defined capital-to-output ratios. In particular, the ratios in table 3.9 probably understate the relative degree to which the "commerce" sector held capital. Additionally, the agricultural value-added data underlying lines 1(a and b) and 8(a and b) should have been adjusted to conform precisely to the variant A and B concepts.

TABLE 3.9 **Sectoral depreciable capital-to-value-added ratios, measured in current and 1860 prices, 1840–1900**

Panel A. Depreciable capital-to-value-added Ratios

		1840	1850	1860	1870	1880	1890	1900
	Measured in current prices							
1	Agriculture							
a	Variant A	3.23	3.25	2.51	2.73	3.21	3.31	3.31
b	Variant B	0.75	0.91	1.02	0.90	0.97	1.18	1.27
2	Mining, manufacturing, and hand trades	0.53	0.52	0.53	0.61	0.72	0.80	0.88
3	All other private business (excl. residences)	0.90	1.08	1.31	1.21	1.29	1.45	1.46
a	Transportation and public utilities	2.85	4.95	4.57	4.27	4.27	3.99	4.15
b	Commerce and all other private business	0.35	0.42	0.57	0.45	0.53	0.73	0.68
4	Government and education	1.36	1.76	1.32	1.27	1.70	1.45	1.82
5	Farm and nonfarm residences	4.75	5.33	7.87	6.28	8.86	11.3	10.99
6	Weighted averages, lines 1–4							

continues

TABLE 3.9 (*continued*)

Panel A. Depreciable capital-to-value-added Ratios

		1840	1850	1860	1870	1880	1890	1900
a	Fixed (1860) v.a. weights, variant A	1.47	1.86	1.87	1.56	1.70	1.93	1.99
b	Fixed (1860) v.a. weights, variant B	0.74	0.97	1.03	0.94	1.03	1.16	1.22
c	Fixed K/O weights, variant A	2.10	1.82	1.87	1.82	1.77	1.54	1.52
d	Fixed K/O weights, variant B	1.10	0.95	1.03	1.02	1.07	1.07	1.07
7	Weighted averages, lines 1–5							
a	Fixed (1860) v.a. weights, variant A	1.77	2.17	2.41	1.98	2.34	2.77	2.80
b	Fixed (1860) v.a. weights, variant B	1.10	1.35	1.63	1.42	1.72	2.06	2.09
c	Fixed K/O weights, variant A	2.69	2.48	2.41	2.36	2.23	1.96	1.93
d	Fixed K/O weights, variant B	1.77	1.70	1.63	1.62	1.61	1.54	1.53
	Measured in 1860 prices							
8	Agriculture							
a	Variant A	3.01	3.19	3.27	3.18	2.76	2.72	2.90
b	Variant B	0.65	0.75	1.02	1.05	0.81	0.87	1.04
9	Mining and manufacturing	0.63	0.43	0.55	0.99	0.83	1.54	1.79

Panel B. Weights

	Lines 6a + 6b	Lines 7a + 7b
Agriculture	0.38	0.35
Mining, etc.	0.24	0.22
Transportation, etc.	0.07	0.06
Commerce, etc.	0.29	0.26
Government, etc.	0.02	0.02
Residences		0.09

Panel C. Shares

	1840	1850	1860	1870	1880	1890	1900
Lines 6c and 6d							
Agriculture	0.45	0.39	0.38	0.36	0.31	0.21	0.20
Manufacturing, etc.	0.19	0.25	0.24	0.24	0.27	0.32	0.33
Transportation, etc.	0.08	0.05	0.07	0.07	0.09	0.10	0.10
Commerce, etc.	0.26	0.29	0.29	0.31	0.31	0.34	0.34
Government, etc.	0.02	0.02	0.02	0.02	0.02	0.03	0.03

TABLE 3.9 (*continued*)

Panel C. Shares

	1840	1850	1860	1870	1880	1890	1900
Lines 7c and 7d							
Agriculture	0.41	0.35	0.35	0.33	0.28	0.19	0.18
Manufacturing, etc.	0.17	0.22	0.22	0.24	0.25	0.30	0.31
Transportation, etc.	0.07	0.04	0.06	0.06	0.08	0.09	0.09
Commerce, etc.	0.23	0.26	0.26	0.26	0.29	0.32	0.32
Government, etc.	0.02	0.02	0.02	0.02	0.02	0.03	0.03
Residences	0.10	0.11	0.09	0.09	0.08	0.07	0.07

Notes: v.a. = value added; K/O = capital-to-output ratio.
Sources:
Panel A. The value-added data are from Gallman 1960 and Gallman and Weiss 1969. The same agricultural value-added series were used to compute the ratios in lines la and lb. (That is, no adjustments were made to bring them into closer conformity with the variant A and B concepts.) The same is true of lines 8a and 8b. Value added by construction (variant A) was included in the data from which lines 3a and 3b were computed. The numerators of the ratios of line 5 include the value of all farm buildings. The mining and manufacturing ratios, in current prices, are as follows: 1840, 0.60; 1850, 0.56; 1860, 0.58; 1870, 0.66; 1880, 0.77; 1890, 0.85; 1900, 0.95. Lines 6a, 6b, 7a, and 7b were computed by weighting the capital-to-output ratios in the body of the table by the shares of the sectors in the total value added of all sectors taken together. The weights are from panel B.

Lines 6c, 6d, 7c, and 7d were computed by multiplying the 1860 capital-to-output ratios in the body of the table by annual sectoral shares in total value added. The shares are from panel C.

The ratios of the sum of the value-added measures to GNP, variant A, are as follows: 1839, 1.03; 1849, 1.03; 1859, 0.98; 1869, 1.03; 1879, 104; 1889, 1.17; 1899, 1.16. Correcting the value-added and GNP estimates to put them both on the same basis, with respect to the treatment of farm improvements (variant A concept) and the international sector (i.e., leaving changes in claims against foreigners out of both sets of measures), and deducting from the value-added series those elements that are most likely to involve double counting (value added by steam railroads, public utilities, banks, fire and marine insurance, lawyers and engineers, "all other" professionals, and the independent hand trades), the ratios become thus: 1839, 1.05; 1849, 0.94; 1859, 0.96; 1869, 0.92; 1879, 0.93; 1889, 1.00; 1899, 1.00. The reconciliation between the two series is by no means perfect; the upward movement of the ratio from 1879 to 1889 is more than negligible. Nonetheless, the long-term trend is much reduced in the second tabulation, as compared with the first, and the variations from one year to the next are not large, in the context of the observed annual changes in GNP.

But these and other readily imagined adjustments were not made, as they are quite unlikely to alter the general results emerging from table 3.9 in any case.

Finally, it should be said that the sectoral value-added data have never been fully reconciled with the GNP data forming the bases of tables 3.5 and 3.7. When obvious conceptual or measurement differences between the two are eliminated (differences pertaining to the handling of the international sector and farm improvements), the sum of the value-added series exceeds the value of the GNP series in all years but one, the margin between the two widening over time. That is a reasonable result, in a general way. The aggregated value-added series are less net than the GNP series, the value of intermediate services being double-counted in

the former but not in the latter. One would suppose that such duplication probably increased in relative importance as time passed. The value-added and GNP series, then, may be fully reconcilable. But since the former exhibits a higher rate of growth than the latter (due to the double-counting of intermediate services in the former), it follows that capital-to-output ratios computed from the former will show less tendency to rise over time than will capital-to-output ratios computed from the latter. That must be borne in mind when tables 3.7 and 3.9 are compared.

The analysis begins with three sectors: agriculture; mining, manufacturing, and hand trades; all other private business. The estimates for these sectors are relatively strong (that is, compared with the estimates on which the other ratios in table 3.9 depend), the capital and value-added estimates are independent in each case, and the sectors are sufficiently broad so that one can hope for a modicum of stability in the ratios.

All of the series, except for agriculture, variant A, show quite pronounced upward movements over time. The variant A series shows no very clear trend, in either current or constant prices. The variant B series and the ratios for the "all other private business" sector rise strongly before the Civil War, flatten out between 1860 and 1880, and then rise again strongly, while the "mining, manufacturing, and hand trades" sector exhibits a ratio that neither rises nor falls before the Civil War, but increases strongly from 1860 to 1900 in both current and constant prices. It would be fair to say, then, that the upward movement of the national capital-to-output ratio (table 3.7) represents a fairly pervasive movement, affecting the chief industrial sectors.

These conclusions are moderated only slightly if we look within the "all other private business" sector and observe the ratios for its two dissimilar components, "transportation and public utilities" and "commerce and all other private business." The ratios for the former are fairly volatile but show no long-term trend. That is not the case for the latter, the ratios for which move strongly upward to 1860, show no trend for the next twenty years, but rise pronouncedly again across the last twenty years.

The ratios for the remaining two sectors, government and education, and farm and nonfarm residences, also rise strongly and quite persistently, but there are reasons to place less emphasis on these data. The first sector is a very small one, and the capital stock data, with respect to government, refer only to buildings, while the education capital data include land as well as capital. Thus the evidence is not entirely apposite.

There are even more serious problems with respect to the residential

sector. The denominator of the ratio includes the shelter value of all residences, farm and nonfarm. Since the capital stock series do not distinguish farm residences, all farm buildings are included in the numerator, which means that all of the ratios for this sector are biased upward. Furthermore, the denominator was initially estimated on the basis of capital stock data (see Gallman and Weiss 1969), although not the capital stock data appearing in the numerators of these ratios. Thus, the ratios cannot be taken very seriously. They are included for the sake of completeness and because the data do figure, in another form, in table 3.7, and the reader is therefore entitled to know something about them.

Whether or not the estimating procedures were proper (for the purpose of measuring the capital-to-output ratio), the relationships obtained between value added and the capital stock of the "residences" sector are plausible. Reversing the ratios and adding land to residential capital, we have estimates of the rate of return (gross) to residential property. The computed rate follows fairly closely the pattern of the interest rate (at least from 1860 onward), a result which might have been anticipated on theoretical grounds. Thus, at least the value-added and capital stock data for this sector seem consistent.

The point draws attention to a factor that figured in the upward drift of all the capital-to-output ratios. The interest rate was falling through most of the postbellum period. This was certainly true of the nominal rate, and probably true of the real rate as well (see Davis and Gallman 1978). This development affected the capital-to-output ratio, as measured here, in two ways. First, a declining interest rate, ceteris paribus, leads to a rise in the market value of the existing capital stock. (Bear in mind that many of the capital values underlying table 3.9 are market values.) The increase in market value, ceteris paribus, induces investment, since market price exceeds reproduction cost. A falling interest rate, then, produces a temporary rise in the capital-to-output ratio, reflecting nominal changes only; but in the long run it produces an increase based on real phenomena: capital deepening. The actual interest rate reductions of the postbellum period were sufficiently gradual that we may suppose that the increases in the ratios described in tables 3.7 and 3.9 rest chiefly on real, not nominal, developments.

The capital-to-output ratios in table 3.9 differ widely from one sector to the next. In some measure this reflects no more than the fact that the data exclude certain types of capital. But that is certainly not all there is to it. The residential and transportation and public utilities sectors were, in

fact, more capital intensive than were the secondary sectors, for example. Since the structure of the economy was changing in important ways, the level of the aggregate capital-to-output ratio may have been influenced by the shifting relative importance of the various sectors. Lines 6(a–d) and 7(a–d) were computed to help settle that issue. The lines contain various weighted average capital-to-output ratios, sets of calculations appearing for variant A and B estimates, and for both all sectors except the questionable "residences" sector. In one set of calculations, 6(a and b) and 7(a and b), sectoral valueadded weights were held constant and sectoral capital-to-output ratios were allowed to vary over time. In the other, 6(c and d) and 7(c and d), capital-to-output ratios were held constant while value-added weights were allowed to change over time. The first set of calculations shows the effects of rising sectoral ratios on the aggregate ratio, no allowance being made for the effects of structural changes. In the second set, only structural changes influence the weighted averages.

The calculations show that the structural changes of the economy either produced no direct net long-term effect on the aggregate ratio, as in line 6d, or else reduced the ratio. The entire increase in the aggregate ratio was occasioned by developments within sectors. The explanation lies in the nature of the structural change that took place. The two sectors that exhibited the most pronounced alterations in their relative importance were agriculture and industry (mining, manufacturing, and hand trades), the former experiencing a pronounced loss in its share in aggregate value added, the latter a pronounced gain. The former had a high depreciable capital-to-output ratio (especially in the variant A form), the latter a very low one. The clear tendency of the exchange in degrees of relative importance of the two sectors was to force down the overall capital-to-output ratio. Two less pronounced compositional shifts in aggregate value added had the same effect. The "residences" sector, with a very high capital-to-output ratio, experienced a moderate loss in relative importance, while the "commerce, etc." sector, with a low ratio, gained in relative importance.[11] The one structural change that worked against the downward movement of the overall ratio was the growing relative size of the transportation and public utilities sector, with its exceptionally large capital-to-output ratio. All of these structural developments were interrelated: all were part of the general process of modernization, which consisted of the transfer of economic activities into the orbit of the market, increasing specialization and trade, and the movement of information and goods over longer distances and at faster rates.

While these structural changes had no pronounced direct effect on the depreciable capital-to-output ratio, they did influence the means by which the capital stock was assembled.[12] In the antebellum years, almost half of the depreciable capital stock (constant prices) consisted of agricultural land improvements, many created by family labor, by labor attached to the plantation on which they were constructed, or by other local sources of labor. These works were typically carried out in the off-season—the spaces in the agricultural year when there were no pressing tasks, such as planting or harvesting, associated with the growing crops. Little external finance was required to carry them out. But the structural changes of modernization brought to the fore industries, forms of capital, and organizational scales of operation that enhanced the roles of markets and of external finance in the provision of capital. Thus, the relative stability in the weighted averages of lines 6c, 6d, 7c, and 7d mask important developments with respect to American capital formation and finance.

The capital-to-output ratio can rise if the rate of growth of output falls without a compensating fall in the net investment proportion, if the net investment proportion (net investment to output) rises without a compensating increase in the rate of growth of output, or if some combination of these developments occurs.[13] The data of table 3.5 show that the rate of growth of output—GNP—did, in fact, decline during the nineteenth century. But what happened to the net investment proportion? Table 3.10 is organized to answer this question.

There are two ways of measuring the US investment proportion during the last six decades of the nineteenth century. Net investment can be measured across each decade after 1840 as the increment in the capital stock between the terminal dates of the decade. It can then be combined with estimates of the value of flows of commodities and services to consumers (1839–48, 1849–58, etc., in Gallman 1960, 27) to form estimates of net product (table 3.10, cols. 1, 2, and 4). This procedure does not result in useful estimates if current price stock data are employed; thus the estimates in table 3.10 all rest on constant price data. It should be said, however, that even the constant price estimates leave something to be desired, in view of the moderately ambiguous conceptual character of the stock estimates.

In the second procedure, net investment flows are estimated by subtracting from gross investment flows (Gallman 1960, 34) the value of capital consumption (table 3.10, col. 5). The latter can be estimated from the capital stock data, given estimates of the average age and useful life of the

TABLE 3.10 **Capital formation proportions, measured in 1860 prices, 1839–48 through 1889–98**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	National Capital			**Depreciable Capital**			
	Variant A	Variant B		Variant B			
Percentage	Net	Net	Gross	Net I	Net II	Gross I	Gross II
1839–48	12.1	9.6	14.3	6.0	5.6	11.1	10.6
1849–58	15.7	13.3	18.8	10.7	8.8	16.5	14.8
1869–78	12.8	10.7	18.4	7.3	15.4	15.5	22.3
1879–88	18.3	17.5	25.9	15.4	13.4	24.1	22.6
1889–98	14.8	13.8	26.4	11.1	15.7	24.5	27.9
1839–58	14.4	12.0	17.4	9.0	7.3	14.8	13.1
1869–98	15.6	14.5	25.1	11.9	14.3	23.0	25.0

Notes and sources:
The entries are a ratio × 100 where the denominator of each ratio is the sum of the numerator plus the value of flows to consumers, prices of 1860 from Gallman 1960, p. 27, column 5. The numerators are as follows:
Column 1: Increment to the national capital stock, variant A, 1860 prices, 1840–50, 1850–60, etc.
Column 2: Increment to the national capital stock, variant B, 1860 prices, 1840–50, 1850–60, etc.
Column 3: The numerators from column 2 plus capital consumption, the latter estimated at 10 percent of the value of machinery and equipment and 4 percent of the value of improvements (exclusive of farmland clearing, etc.). These estimates approximate straight-line capital consumption on the assumptions that machinery and equipment had a useful life of fifteen years and that the stock was on average five years old, and that improvements had a useful life of forty years and that the stock was on average fifteen years old.
Column 4: Increment to the depreciable capital stock (machinery, equipment, and improvements), exclusive of farmland clearing, etc.
Column 5: The numerators of column 7 minus the capital consumption allowances underlying column 3.
Column 6: The numerators of column 4 plus the capital consumption allowances underlying column 3.
Column 7: Gallman 1960, p. 34, column 1 plus column 2.

various components of the depreciable capital stock. The flow data are of such a character that investment proportions can be estimated for depreciable capital. Given estimates of capital consumption, it is also possible to generate gross investment shares, in which the measurement of gross investment depends exclusively on stock data (table 3.10, col. 3, 6). Of course, gross share estimates can also be made directly from the flow data (table 3.10, col. 7). Since the stock and flow data are not fully consistent, we have chosen to make estimates of investment proportions based on both sets of data, so that the fuller range of results obtainable from the data is exhibited.

All of the columns of table 3.10 devoted to the net proportion show it drifting upward over time. The movement is not uniformly persistent: the ratio actually falls between 1849–58 and 1869–78, as well as between 1879–88 and 1889–98, in the series depending exclusively on the stock

estimates. This is not, however, altogether unexpected. As previously indicated, the 1880 stock estimate may be too low. Adjusting it upward appropriately might eliminate the first decline, although not the second. In any case, it would be expecting too much to hope to establish the timing of the upward movement of the proportion exactly with data of this type. More important is the fact of the long-term upward movement, a fact that emerges clearly in the data in the last two lines of table 3.10—more clearly from the flow data (col. 5) than from the stock data (cols. 1, 2, 4), however, and from the measures incorporating a narrow definition of capital (cols. 2 and particularly 4) more than from the ones based on a broad definition (col. 1).[14]

The increase in the net investment proportion required an even more pronounced increase in the gross investment proportion (cols. 3, 6, and 7). We do not need to go far to seek the explanation: the rising depreciable capital-to-output ratio meant that, ceteris paribus, the share of capital consumption in national product was rising. But in fact, other things were not equal: the structure of the depreciable capital stock was changing, the shorter-lived machinery and equipment increasing in importance relative to the longer-lived improvements. This structural change increased the share of national product accounted for by capital consumption.

These two developments meant that the share of GNP (based on the concept adopted in Gallman 1960) accounted for by gross investment more than doubled between the 1840s and the 1890s. One must further remember that the forms of investment and their relationships with the market were changing. The requirements for a rich and well-articulated system of intermediation were expanding (Davis and Gallman 1973, 2001).

3.4. Concluding Comparisons

To say that US capital stock increased rapidly or slowly between 1840 and 1900 is to make a comparative statement. It is to say that the stock increased rapidly or slowly compared to other times—earlier or later—or to other places. So far as earlier times are concerned, Alice Jones's (1980) wealth data for 1774 and the Gallman figures for the early part of the nineteenth century would provide bases for a relevant comparison. The exercise is done in chapter 4.

Here we make comparisons with subsequent times. Raymond Goldsmith's (1982) extension of his estimates to 1980 provides us with data

covering virtually the entire twentieth century. In concept, the refined Gallman variant B estimates are virtually identical to Goldsmith's twentieth-century series.[15] Where the two overlap—at 1900—they are also substantively quite similar. Where differences of detail appear, aggregating up to the next relevant level virtually removes them. For example, the estimates of agricultural structures and equipment differ, in the two series, in 1900, but the sums of the two—agricultural fixed capital—are virtually identical. The same is true with respect to nonfarm residential land and nonfarm residential structures.[16] Thus the two series link together reasonably well, providing coverage for a period of 140 years, the link being particularly good for "domestic wealth." Here, however, Goldsmith's domestic capital series will be compared with the Gallman national capital series. For present purposes, the consequences of the conceptual and substantive differences between the series are trivial.

According to Goldsmith, domestic capital (reproducible tangible assets, narrow definition), in current prices, increased at an average annual rate of 5.79 percent between 1901 and 1929, 5.00 percent between 1930 and 1953, and 8.20 percent between 1954 and 1980. These are, on the whole, higher rates of change than are exhibited by the refined Gallman series over similarly extended periods (see table 3.5). This is true whether one looks at the variant A (which, recall, includes the value of improvements to farmland) or the variant B series (which excludes them). The explanation lies in the price history of the two centuries. While prices rose and fell dramatically in both the nineteenth and twentieth centuries, the longterm drift in the former period was neither powerfully upward nor powerfully downward. That is not true of the twentieth century, however. Prices moved strongly upward, on average, between 1901 and 1929, 1930 and 1953, and 1953 and 1980.

The more relevant comparison uses the constant price series. Thus, deflating on the base 1929, Goldsmith's real capital stock increased at rates of only 3.60 percent between 1901 and 1929, 1.68 percent between 1930 and 1953 and 3.60 percent between 1954 and 1980. Thus, in each of the three periods, growth was lower than most of the rates exhibited in table 3.5.[17] Over the full sweep of the years 1900 through 1980, the current price series rose 6.36 percent per year, on average, while the constant price series increased only 2.80 percent, the former substantially higher and the latter substantially lower than the long-term nineteenth-century rates (see table 3.5). Comparing the experiences of the two centuries, then, we find marked retardation of the rate of growth of the real magnitudes, just as had

been previously discovered with respect to the real national product (Gallman 1966).

By the standard of twentieth-century experience, the capital stock grew rapidly between 1840 and 1900. The evidence in the next chapter will show that it also grew rapidly by the standard of what had gone before.