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# 2 American Economic Growth before the Civil War: The Testimony of the Capital Stock Estimates

Robert E. Gallman

## 2.1 Introduction

Robert Giffen, of paradox fame, thought estimates of aggregate wealth have eight uses; the following have immediate relevance:

1. To measure the accumulation of capital in communities at intervals of some length . . .
2. To compare the income of a community, where estimates of income exist, with its property . . .
4. To measure, in conjunction with other factors, such as aggregate income, revenue, and population, the relative strength and resources of different communities.
5. To indicate generally the proportions of the different descriptions of property in a country to the total—how the wealth of a community is composed.
6. To measure the progress of a community from period to period, or the relative progress of two or more communities, in conjunction with the facts as to progress in income, population, and the like; to apply, in fact, historically and in conjunction with No. 1, the measures used under the above heads 2, 3, 4 and 5 for a comparison at a given moment. (1889, 136–37)

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The research underlying this paper was funded by the National Bureau of Economic Research, during my tenure as an Olin Fellow, and by the National Science Foundation, to which organizations I express my gratitude. In another form the paper was given to seminars at the California Institute of Technology, the University of Chicago, the University of California at Davis and Los Angeles, and Northwestern University. At all of these seminars I received useful suggestions, especially from Lance Davis, David Galenson, Morgan Kousser, Kenneth Sokoloff, and Sokoloff's graduate class in economic history. The discussant of the paper, Stanley Engerman, was, as always, most helpful.

Simon Kuznets, who made use of the list, said that the distributions alluded to in item 5 should include the size distribution of wealth (Giffen 1889; Kuznets 1958; see Engerman and Gallman 1983 for more on these issues).

The remarks of Giffen and Kuznets provide a justification for this paper, a list of things to include in it, and a set of suggestions as to how it should be related to the other papers prepared for this conference. Particularly attractive is Giffen's notion that many different types of aggregate series, as well as compositional indexes, should figure in the measurement of growth. He would have felt comfortable at the conference at which this paper was given, as the participants approached the questions of economic development and standards of living from various directions, using data on labor force, income, wealth, consumption, wages and prices, productivity, and heights.

Kuznets believed that a perfectly realized index of development would trace out shifts in human material welfare. Such an index could be employed to measure changes in the standard of living—so long as we understand that term to refer to the material aspects of life—without the need to introduce other measurements. But Kuznets was well aware that the indexes of development with which scholars must work are far from ideal and that, therefore, a variety of them may be required. In the spirit of Giffen and Kuznets, then, this paper treats the capital stock series as one that bears on the standard of living, rather than as one that measures it.[1]

Capital stock series have two possible conceptual relationships to economic growth (Gallman 1986). First, such a series may be used to measure the wealth accumulated by a society. The accumulation will be influenced by the economic performance of the economy in the past, by the degree of frugality displayed by its people individually, by the success the society had in its military activities, and by communal saving and investment decisions. The measure is clearly different from income, in that it relates to a stock collected over a period of years, not a flow during one year. Income and capital series are likely to change at different rates, then, at least in the short run. But the two types of series do both bear on the material well-being of the people of the society.[2] In the very long run they are also likely to exhibit roughly the same

1. This is not the first attempt to study the American economy before the Civil War by examining capital stock data. See, for example, Jones (1980); Goldsmith (1952, 1985); Davis, Easterlin, Parker et al. (1972). I think, however, that it is the most serious effort to assure that the various estimates are consistent from one date to the next.

2. One virtue of a capital stock series as an indicator of growth is that the short-term movements of such a series are likely to be much less violent than, for example, the short-term movements of a true income series. If estimates are available only at intermittent years, the rates of growth computed from the former are much less likely to be influenced by transient phenomena than are the rates of growth of the latter. It should be said, however, that this distinction probably does not apply to the income estimates for the years before 1840 that were put together by Thomas Weiss for this volume, since his estimating procedure does not pick up the effects of short-term influences on income, nor is it intended to. Weiss's estimates come close to describing the output capacity of the economy, rather than actual output.

growth rates, so that a capital series can serve in some instances as a proxy for income.

The second approach is to view capital in its capacity as an input into the production process. Whereas the first approach looks chiefly to the past and sees capital as the accumulation created by society, the second looks to the present and the future. It sees the capital stock as one factor influencing current production, as well as production to be expected of the economy in future. Clearly, such a series is particularly useful when combined with estimates of the other inputs.

If the direct relationship between real capital and material well-being is to be examined, the capital stock series should be deflated by a consumers' price index. That is, the stock should be appraised in terms of its equivalent in consumer goods. If, on the other hand, one is concerned with productive potential, proper deflation is in terms of the prices of the components of the capital stock. Both forms of deflation are employed in this paper. That is, the capital stock is treated as an index of both the material well-being of the society and its productive power.

The concept of capital is elastic. Some analysts have included land and investment in humans as elements of the stock. For most purposes, it is best to treat land as land and human capital as a characteristic of labor. In the present instance, the second preference makes a virtue of a necessity: there are no comprehensive estimates of human capital covering the full period of interest here. This paper introduces a set of estimates of the land stock, but they are not treated as part of the supply of capital.[3]

Although land is not included in the capital stock series of this paper, improvements to land are. In this respect the series is unconventional. Most capital estimates include structures but omit other important improvements, such as the clearing and first breaking of land. In this paper a conventional series is presented and is linked with estimates extending well into the twentieth century, for comparative purposes. But the series that is subjected to the most intense examination is one that includes the value of land clearing and breaking. These activities took up a substantial part of the work time of agricultural workers and made an immensely important contribution to the capital stock before the Civil War. They cannot properly be ignored.

3. Should the value of slaves be counted as part of the value of the capital stock? If we are interested, say, in the savings and investment behavior of planters, then the answer is surely yes. This paper is not concerned with that topic. It is concerned with the measurement of long-term economic growth. Slaves are regarded as part of the labor force. They are also treated as part of population, for purposes of computing per capita levels of the capital stock.

While I will present no estimates of the value of human capital, the general pattern of change in this variable across the period under review here is quite clear. Both the fraction of the population of children attending school and the length of the school year increased as time passed, as did the fraction of the work force holding semiskilled and skilled jobs. The rate of increase of human capital is therefore almost certain to have risen as time passed. See Fishlow (1966a, 1966b) and Uselding (1971).

The value of consumer durables is also sometimes incorporated in capital stock estimates, but appears in only one table in this paper, because appropriate figures are only intermittently available. The loss is not great. The value of consumer durables was small, compared with the rest of the capital stock, through most of the period considered in this paper, and the rate of change of the capital stock is approximately the same, regardless of whether or not durables are treated as capital (see table 2.2).

The United States (for convenience, the term will be applied to the colonies of 1774) began life as a debtor nation and gradually shifted to the position of a creditor nation. Ignoring recent experience, the national capital stock—which measures the net capital holdings of Americans—grew very much more rapidly over time than did the domestic capital stock, defined as capital physically located in the United States, regardless of who owned it. Through the rest of the paper, both series will be examined, although most attention will be devoted to the domestic capital stock.

The title refers to the period before the Civil War, but the series introduced will typically cover a much longer stretch of time. The fundamental questions at issue have to do with persistent changes, and these questions can be properly addressed only if data bearing on long periods are available. Some rates

**Table 2.1** **Capital and Wealth, 1774 and 1805, Estimates of Jones, Goldsmith, and Gallman (millions of current dollars)**

| | 1774 | | 1805 | |
|---|---|---|---|---|
| | Jones | Gallman | Goldsmith | Gallman |
| All structures | | | 370 | 352 |
| All land improvements | | 180 | | 732 |
| All privately owned real estate | 250 | | | |
| Shipping | | 8 | 40 | 80 |
| Other producers' durables | 13[a] | 15 | 32 | 65 |
| Inventories | 20 | 39 | 100 | 336 |
| Animals | 42 | 42 | 60 | 160 |
| Total domestic capital | | | 602 | 993 |
| International claims | | | −80 | −57 |
| Total national capital | | | 522 | 936 |
| Total domestic capital, including the value of clearing and first breaking of farmland | | 284 | | |
| Total private domestic capital, plus land | 327 | | | |

*Sources:* Jones (1980, 90, converted to dollars by means of the exchange rate on page 10); Gallman, see text; Goldsmith (1952, 315).

[a]Includes household equipment.

of growth covering relatively short intervals—such as the two decades 1840–60, which have been the focus of much scholarly interest—will be exhibited, but the reader should bear in mind that such rates are influenced by short-term phenomena. They cannot be used as the exclusive means of identifying shifts in trend rates of growth.

Section 2.2 deals briefly with the nature of the data underlying the estimates and the broad rules guiding the estimating procedure. Section 2.3 treats the rates of growth of the real capital stock and the real capital stock per capita, with the purpose of putting growth before the Civil War into historical perspective. Giffen's suggestion that the rates of change of capital and income be compared is taken up.

Economic development involves structural shifts as well as growth in the aggregates. Section 2.4 treats the changing composition of the capital stock and shows its connection to the nature of American economic development. Section 2.5 brings together estimates of all three factor inputs and combines them into several series describing the growth of total factor inputs. Estimates of changes in total factor productivity are presented. Section 2.6 is a summary of conclusions.

The data on which the estimates rest pose many problems. Appendix A takes up several important features of the series and considers a few tests of the most affected components.

## 2.2 The Estimating Procedures

Estimates were made for the years 1774, 1799, 1805, 1815, and 1840–1900 (at decade intervals) and for various dates in the twentieth century. As Giffen points out, capital series can be used to study economic growth, "regard being always had to the fact that the data and methods employed are sufficiently alike for the special purpose in hand" (1889, 136). The object of this section is to consider whether "the data and methods employed are sufficiently alike for the special purpose at hand." The subject is treated further in appendix A.

The current price capital stock estimates for 1850 and 1860 are based chiefly on census materials, which have been tested in a variety of ways and adjusted to make them consistent from one date to the next and to make them conform to an appropriate concept. The best overall tests that have been conducted so far are checks against perpetual inventory estimates derived from measurements of investment flows. The results of the checks are excellent (Gallman 1986, 1987).

The 1840 figures were similarly derived from census data, augmented in various ways, chiefly by contemporary estimates produced by Ezra Seaman. The census in 1840 was quite different from the ones that followed. It was administered under a different law and asked different questions. For some purposes it is quite good, but it is clearly weaker than the later censuses as a

source of material for the estimation of the capital stock, although it has survived testing quite well.

The estimates for these three years and some of the tests that have been run are described in Gallman (1986, 1987). These sources also contain the estimates for the years 1870–1900, which will be used in the present paper to put the experience of the years 1774–1860 in context. Tests of the post–Civil War data by means of perpetual inventory estimates suggest that the 1870, 1880, and 1890 aggregate capital stock figures are unlikely to be perfectly consistent. It appears probable that the 1880 figure is too low. Calculations of the rates of change of the capital stock from this series are therefore likely to understate the true rate of growth for the period 1870 to 1880 and overstate it in the years 1880 to 1890, matters of no great importance for present purposes.

The twentieth-century figures were assembled by splicing the nineteenth-century estimates to Raymond Goldsmith's series, which are based on perpetual inventory procedures (Goldsmith 1982). As indicated above, census-style and perpetual inventory estimates appear to be roughly comparable.

The estimates for the years before 1840 come from a variety of sources quite different from the censuses, which increases the risk that the capital stock estimates based on them may not be consistent, one with the other, and all with the figures for the years 1840 onward. The data that are farthest removed in type from census data are the ones underlying the capital stock figure for 1774. These data were taken chiefly from Alice Jones's (1980) work with probate records. The figures for 1799, 1805, and 1815 rest principally on sources that are more likely to be consistent with census records: the direct taxes of 1799, 1813, and 1815. (I used the data in Blodget [1806] 1964, Pitkin 1835, and Soltow 1984.) The 1805 estimate is based on the work of Samuel Blodget ([1806] 1964) and Raymond Goldsmith's (1952) adjustments of Blodget's work. The principal underlying source is the direct tax of 1799. Blodget apparently carried the 1799 data forward to 1805 at a rate of growth he believed most probable. The 1805 estimate falls out of line with those of 1799 and 1815 and is probably too high. The history of the period leads one to expect a higher rate of growth between 1799 and 1805 than between 1805 and 1815, of course, but not quite so high as the Blodget data suggest. Of course it is possible that the 1805 figure is close to the truth and that the other two are too low, but I do not think that is the case. It is also possible that the bias was introduced by my adjustment of the Blodget data (see table 2.1), but I doubt that is so.

The 1774 through 1815 estimates depend on the sources listed above, augmented and adjusted so that the same concept of capital underlies each final aggregate figure, and so that the same estimating principles are applied in each case. The last point is an important one. While accurate estimates were sought in each instance, it seemed clear that it would be better to have a series for

which the general level might be wrong, but which describes the rate of growth in a reasonably accurate way, than to have one for which the individual estimates might be closer to the truth, but which gives a more strongly biased account of the rate of growth. The choice made was always for consistency rather than for perfect accuracy.[4]

Table 2.1 compares some of the details of the new estimates with those provided by Jones and Goldsmith. As will be evident, the adjustments made to the Jones figures were relatively unimportant, so that the new estimates tell very much the same story as do the data taken from Jones. The differences between my estimates and Goldsmith's are greater, and are particularly pronounced with respect to inventories of all kinds. Goldsmith's estimates seem too low to me; for example, imports in 1805 ran around $150 million, and imports represented a relatively small part of total economic activity, even in 1805. Even a very modest estimate of the fraction of imports held, on average, in inventory across the year would leave very little for inventories of domestic goods, were we to accept Goldsmith's figure for total inventories. But the question of the appropriate *level* of inventories in 1805 is perhaps not the important issue. The important point is the one made in the previous paragraph. In building the inventory estimates for all of the years, 1774–1900, I have tried to follow consistent methods and have paid more attention to consistency than to the specific level of any one estimate. Consistency permits appropriate comparisons to be made across time, an important desideratum. Users of capital stock series for the nineteenth century, then, would be well advised to use either Goldsmith's estimates or mine, but not some combination of the two.

All of the capital figures are expressed in market prices or in net reproduc-

4. For example, imagine a series that has true values of 100 and 200 in two widely separated years. If the estimates produced for these years are each too large by 10 percent, then the estimated series and the true series will describe the same rate of growth. That would not be the case if the estimates were closer to the truth in each year, but deviated from it by different percentages—say the first estimate amounted to 95 and the second to 210. Obviously, one cannot know with certainty that the first circumstance or the second holds in any given instance. But there are cases in which one has the choice of following a consistent procedure and using consistent data from one date to the next, in full knowledge that the results are unlikely to be exactly correct, or employing different methods and bodies of data, in an effort to come as close as possible in each year to the true value. Where I was presented with these options, I chose consistency. (Emerson, after all, only deplored a foolish consistency.) But consistency at the component level does not guarantee unbiased rates of growth at the aggregate level. Suppose that the level of each component series is biased by a given percentage in each year, but the given percentage varies from one component to the next, by amount, sign, or both. For example, suppose that the figures composing the slow-growing components are biased in an upward direction, while the figures representing the fast-growing components are biased in a downward direction. The rate of growth of the aggregate composed of these elements will be biased in a downward direction. All that can be done in this case is to attempt to judge and to describe the direction and probable importance of the bias in the rate of growth.

The details of the construction of the capital stock estimates for the years 1774–1815 will be provided in a monograph currently under way.

tion costs. The two are virtually identical, where it has been possible to run a test. They are net of retirements and of capital consumption, with one exception, to be discussed further below.

The cost-of-living deflator is the one assembled by Paul David and Peter Solar (1977), the only series that covers the full period. According to Claudia Goldin and Robert Margo (1989), the index rises too little or falls too much in the nineteenth century before the mid-1840s. If they are correct, the rate of growth of the capital stock deflated by this series is too high in the period before the mid-1840s, a point to which we will return. Dorothy Brady's investment goods price indexes from volume 30 of *Studies in Income and Wealth* (1966), extended to the years before 1840 in a variety of ways, were the chief bases for the deflation of the capital stock, viewed as an input. The Brady index numbers refer to census years. They had to be adjusted modestly to make them relevant to the dates to which the capital stock estimates refer (the last day of the census year). Conceptually, these index numbers are exactly what are required. They were augmented in various ways to permit the deflation of inventories and certain types of farm improvements, for which Brady supplied no indexes. The problems of assembling appropriate deflators for the years before 1840 require a paper of their own. They are treated further in appendix A.

## 2.3 Rates of Growth in Historical Perspective

The concern of this paper is with American economic growth before the Civil War, which means that the measures of central concern to it are real measures, particularly real measures deflated by population. The current price estimates are worth at least a brief inspection, however. On the whole, they are less processed than the real figures and may therefore be a little more reliable. Table 2.2 contains current price estimates of the capital stock, conventionally defined.[5] Three points come through very clearly. The rates of growth are all very high; the capital stock in 1980 was apparently about 40,000 times as large as the stock of 1774, an extraordinary figure. Although most of the rates were computed over considerable stretches of time, and therefore should not be unduly influenced by transient phenomena, they vary quite widely from one period to another. Finally, it is clear that the experience before the Civil War was by no means uniform. In particular, the rates of growth are especially low in the years between the turn of the century and 1840, and especially high from 1840 to 1860. The second period is short, and

5. The conventional concepts are the domestic capital stock and the national capital stock. The former includes the value of structures, equipment, and inventories physically located in the country at issue; the latter includes all of these items, but also adjusts for net international claims, so that the measure includes the value of capital owned by nationals of the country at issue. Unconventional estimates may include, additionally, the value of the clearing and first breaking of land, the value of human capital, the value of consumer durables, etc.

**Table 2.2** **Indexes and Average Annual Rates of Change of the U.S. Capital Stock, Current Prices, 1774–1980**

| | Domestic Capital | Domestic Capital & Consumer Durables | National Capital |
|---|---|---|---|
| Panel A: Indexes | | | |
| 1774 | 100 | 100 | 100 |
| 1799 | 399 | | 415 |
| 1805 | 581 | | 628 |
| 1815 | 999 | | 1,110 |
| 1840 | 1,573 | 1,503 | 1,691 |
| 1850 | 2,579 | 2,538 | 2,919 |
| 1860 | 5,298 | 5,274 | 6,000 |
| 1870 | 8,620 | 8,751 | 9,201 |
| 1880 | 11,795 | 11,761 | 12,805 |
| 1890 | 20,526 | 20,198 | 22,396 |
| 1900 | 27,386 | 26,457 | 30,886 |
| 1929 | 138,592 | 135,343 | 170,360 |
| 1953 | 444,239 | 436,493 | 541,061 |
| 1980 | 3,761,382 | 3,665,337 | 4,560,608 |
| Panel B: Average Annual Rates of Change (%) | | | |
| 1774–1840 | 4.3 | 4.2 | 4.4 |
| 1774–99 | 5.7 | | 5.9 |
| 1799–1840 | 3.4 | | 3.5 |
| 1840–1900 | 4.9 | 4.9 | 5.0 |
| 1840–60 | 6.3 | 6.5 | 6.5 |
| 1860–1900 | 4.2 | 4.1 | 4.2 |
| 1900–1929 | 5.8 | 5.8 | 6.1 |
| 1929–53 | 5.0 | 5.0 | 4.9 |
| 1953–80 | 8.2 | 8.2 | 8.2 |
| 1774–1980 | 5.2 | 5.2 | 5.3 |

*Sources:* See text.

the rates of growth computed across it could be influenced by business cycles or long swings. But Abramovitz's (1989) chronology of long swings and protracted depressions suggests that this is probably not a problem.

The record described by table 2.2 is influenced both by real phenomena and price level changes. The price index numbers in table 2.3 allow one to judge how important the latter developments were. Between 1774 and 1900 the long-term trend of the two price indexes appears to be close to zero, but in the short term prices were quite unstable. In the twentieth century there is additionally a pronounced upward trend. Notice, finally, that while the two indexes tend to move together, the consumer index is the more volatile. The plan to deflate by two separate price indexes, then, seems to have substantive, as well as theoretical, merit.

Table 2.3 **Capital Stock Deflators, Base 1860, 1774–1900**

| | Domestic Capital Price Index | Consumer Price Index |
|---|---|---|
| 1774 | 81 | 97 |
| 1799 | 111 | 148 |
| 1805 | 115 | 141 |
| 1815 | 157 | 185 |
| 1840 | 91 | 104 |
| 1850 | 94 | 94 |
| 1860 | 100 | 100 |
| 1870 | 127 | 157 |
| 1880 | 112 | 123 |
| 1890 | 96 | 109 |
| 1900 | 90 | 101 |
| 1929 | 165 | 205 |
| 1953 | 357 | 320 |
| 1974 | | 589 |
| 1980 | 1,193 | |

*Sources:* See text.

The deflated series appear in table 2.4. Four matters of interest strike one immediately: First, deflation does reduce the volatility of the series somewhat; part of the short-term movement observed in table 2.2 is due to price fluctuations. Second, it is clear that the real capital stock has grown more slowly in the present century than it had previously. Third, it is also clear that the rate of growth accelerated between the years before 1840 and the years thereafter. The broad pattern, then, is of an early acceleration, followed by a subsequent retardation. Finally, notice that these findings emerge from all four series, the national and domestic capital stocks, deflated by the consumer price index and by the capital price index. But the detailed pattern of change differs from one series to the other. For example, compare the results obtained for the period 1929–53. The real capital stock, viewed as accumulated consuming power, grew much faster than did the real capital stock, viewed as an input to production: the prices of capital goods increased faster than consumer prices, between these two dates.

More interesting for present purposes is the pattern across the years 1774–1840. Notice (table 2.3) that consumer prices advanced much farther than capital goods prices between 1774 and the turn of the century, and fell much farther between then and 1840. Across the full span, 1774–1840, the two index numbers show roughly similar changes, so that the two capital stock series yield about the same results. But the interpretation of the subperiods before 1840 depends entirely on the system of deflation one chooses to use. And the systems of deflation, recall, view the capital stock in two quite different ways: as the value of the accumulations of the years, expressed in consumer goods, as against the productive power of the capital stock.

**Table 2.4** **Indexes and Average Annual Rates of Change of the U.S. Capital Stock, 1860 Prices, 1774–1980**

| | Domestic Capital Deflator | | National Capital Deflator | |
|---|---|---|---|---|
| | Capital Price Index | Consumer Price Index | Capital Price Index | Consumer Price Index |
| Panel A: Indexes | | | | |
| 1774 | 100 | 100 | 100 | 100 |
| 1799 | 289 | 262 | 306 | 271 |
| 1805 | 409 | 400 | 449 | 431 |
| 1815 | 513 | 525 | 571 | 581 |
| 1840 | 1,401 | 1,472 | 1,514 | 1,571 |
| 1850 | 2,212 | 2,665 | 2,497 | 3,007 |
| 1860 | 4,292 | 5,148 | 4,849 | 5,805 |
| 1870 | 5,486 | 5,335 | 5,897 | 5,669 |
| 1880 | 8,462 | 9,318 | 9,157 | 10,071 |
| 1890 | 17,217 | 18,295 | 18,665 | 19,877 |
| 1900 | 24,552 | 26,347 | 27,632 | 29,584 |
| 1929 | 68,472 | 66,398 | 77,681 | 80,390 |
| 1953 | 102,132 | 137,182 | 114,109 | 163,571 |
| 1980 | 223,632 | | 297,638 | |
| Panel B: Average Annual Rates of Change (%) | | | | |
| 1774–1840 | 4.1 | 4.2 | 4.2 | 4.3 |
| 1774–99 | 4.3 | 3.9 | 4.6 | 4.1 |
| 1799–1840 | 3.9 | 4.3 | 4.0 | 4.4 |
| 1840–1900 | 4.9 | 4.9 | 5.0 | 5.0 |
| 1840–60 | 5.8 | 6.5 | 6.0 | 6.8 |
| 1860–1900 | 4.5 | 4.2 | 4.4 | 4.2 |
| 1900–1980 | 2.8 | | 3.0 | |
| 1900–1929 | 3.6 | 3.2 | 3.6 | 3.5 |
| 1929–53 | 1.7 | 3.1 | 1.6 | 3.0 |
| 1953–80 | 3.5 | | 3.6 | |
| 1774–1980 | 3.9 | | 4.0 | |

*Sources:* See text.

No doubt the contrast is in some measure spurious, however. Items of construction compose an important part of the capital stock throughout (see table 2.8). The deflators for this component in the years before 1840 were constructed in part from data on wage rates. Wage rates tend to be less volatile than prices (see Robert A. Margo's paper in this volume). The capital stock price index numbers for the period before 1840 may therefore understate the fluctuations experienced by the prices of capital goods. It is thus possible that the measured rate of growth of the real capital stock, viewed as an input, is too high across the years 1774–99 and too low between 1799 and 1840. The matter is unlikely to be important with respect to the main point of present

concern, however. It seems clear that the rate of growth of the capital stock did accelerate between 1774–1840 and the subsequent years.

The capital stock treated so far ignores a component of investment that was important, particularly in the years before 1840: the activities of land clearing and first breaking which engaged so large a part of the working lives of American farmers (Primack 1962). Table 2.5 contains index numbers describing the change over time in the real value of the domestic capital stock, inclusive of the value of these farm-making activities. The overall rate of growth of this aggregate—3.9 percent, 1774–1900—is very much lower than the one recorded for the less comprehensive capital stock treated in table 2.4—4.5 percent (capital stock deflator in each case). These findings reflect the fact, of course, that farm formation was a very important part of capital, but one that increased over time much more slowly than the other components of the stock, a point to which we will return.

The acceleration picked out by the data of table 2.4 reappears in table 2.5 and in a more marked form. But notice that the pattern is somewhat different. The series deflated by the prices of capital now shows a higher rate of growth across the period 1799–1840 than across the period 1774–1799, in contrast to the results shown by table 2.4. The explanation is that introduction of the farm-making elements of the capital stock necessarily altered the capital price index numbers. Farm making was carried out by farm laborers, and the value of farm making is the value of the time of farm workers. Farm wage rates thus figure in the estimation of the value of land clearing and breaking, as well as in the deflation of these components of the stock. Farm wage rates rose quite pronouncedly between 1774 and 1840, which gives the deflator an upward tilt.

All of the series discussed above refer to the aggregate capital stock. A more interesting variable, however, is the per capita capital stock. Estimates appear in table 2.6. Deflating by population produces two important, if easily anticipated, results. First, the retardation of growth in the twentieth century disappears, while the acceleration between 1774–1840 and 1840–1900 becomes very much more pronounced. The acceleration appears in every variant but is particularly evident in the series describing the most comprehensive measure, deflated by capital stock prices.

The acceleration in the rate of growth of the capital stock reflects in part the increase in the investment rate and the rise in the capital/output ratio, which seems to have begun as early as the turn of the century, at least in the case of the conventional measurements, but which was particularly pronounced from 1840 until 1900 (Davis and Gallman 1978; table 2.7). That does not appear to be the only source, however. The rates of growth of real national product per capita from 1840 onward were higher than the rates of growth of real capital per capita in the period before 1840, regardless of the capital concept adopted and the deflator employed (Davis and Gallman 1978; Gallman 1966). Accepting the rate of change of the capital stock series before 1840 as an upper-

**Table 2.5** **Indexes and Average Annual Rates of Change of the U.S. Domestic Capital Stock, Including the Value of Clearing and Breaking Farmland, 1860 Prices, 1774–1900**

| | Deflator | |
|---|---|---|
| | Capital Price Index | Consumer Price Index |
| Panel A: Indexes | | |
| 1774 | 100 | 100 |
| 1799 | 227 | 245 |
| 1805 | 290 | 332 |
| 1815 | 353 | 379 |
| 1840 | 913 | 1,229 |
| 1850 | 1,362 | 2,140 |
| 1860 | 2,432 | 3,980 |
| 1870 | 3,004 | 3,884 |
| 1880 | 4,520 | 6,543 |
| 1890 | 8,491 | 12,229 |
| 1900 | 11,807 | 17,253 |
| Panel B: Average Annual Rates of Change (%) | | |
| 1774–1840 | 3.4 | 3.9 |
| 1774–99 | 3.3 | 3.7 |
| 1799–1840 | 3.5 | 4.0 |
| 1840–1900 | 4.4 | 4.5 |
| 1840–60 | 5.0 | 6.1 |
| 1860–1900 | 4.0 | 3.7 |

*Sources:* See text.

bound estimate of the rate of change of real national product, the evidence suggests quite clearly that the rate of growth of real national product per capita accelerated in the years before the Civil War.

These results are generally consistent with Thomas Weiss's inferences concerning income, which he derived from his labor force series (see table 2.7 and Weiss's paper in this volume). Both Weiss's figures and the capital stock data were assembled from fragmentary evidence and are subject to substantial margins for error. But both series seem to tell about the same story, and that affords greater confidence that the story is a true one.[6]

6. The capital and income (Weiss) data permit a check on an inference advanced by Davis and Gallman, who guessed that the net investment rate averaged between 6.2% and 7.0% in the period 1805–40 (Davis and Gallman 1978, 2). The rates of growth and capital/output ratios in or underlying table 2.7 are consistent with net investment rates, computed against GDP, of between 5 percent and 6.5 percent. The Davis and Gallman figures were computed against NNP, however. If the data in and underlying table 2.7 are adjusted to make them conform more nearly to the concepts Davis and Gallman were employing, the implied investment rates become roughly 5.9 percent and 7.2 percent, reasonably close to the Davis-Gallman figures.

Table 2.6 **Indexes and Average Annual Rates of Change of the U.S. Domestic Capital Stock and Structures, Per Capita, Conventional and Unconventional Concepts, 1860 Prices, 1774–1980**

| | Conventional Concept, Deflated by | | Including Clearing & Breaking, Deflated by | |
|---|---|---|---|---|
| | Capital Price Index | Consumer Price Index | Capital Price Index | Consumer Price Index |
| Panel A: Indexes | | | | |
| 1774 | 100 | 100 | 100 | 100 |
| 1799 | 132 | 120 | 104 | 112 |
| 1805 | 154 | 150 | 109 | 125 |
| 1815 | 143 | 147 | 99 | 106 |
| 1840 | 193 | 202 | 126 | 169 |
| 1850 | 224 | 270 | 138 | 217 |
| 1860 | 321 | 384 | 182 | 297 |
| 1870 | 323 | 315 | 177 | 229 |
| 1880 | 396 | 436 | 212 | 306 |
| 1890 | 643 | 683 | 317 | 456 |
| 1900 | 759 | 815 | 365 | 534 |
| 1929 | 1,348 | 1,461 | | |
| 1953 | 1,520 | 2,294 | | |
| 1980 | 2,735 | | | |
| Panel B: Average Annual Rates of Change (%) | | | | |
| 1774–1840 | 1.0 | 1.1 | 0.4 | 0.8 |
| 1774–99 | 1.1 | 0.7 | 0.1 | 0.4 |
| 1799–1840 | 0.9 | 1.3 | 0.5 | 1.0 |
| 1840–1900 | 2.3 | 2.3 | 1.8 | 1.9 |
| 1840–60 | 2.6 | 3.3 | 1.9 | 2.9 |
| 1860–1900 | 2.2 | 1.9 | 1.8 | 1.5 |
| 1900–1929 | 2.0 | 1.6 | | |
| 1929–53 | 0.5 | 1.9 | | |
| 1953–80 | 2.2 | | | |
| 1774–1900 | 1.6 | 1.7 | | |
| 1900–1980 | 1.6 | | | |
| 1774–1980 | 1.6 | | | |

*Sources:* See text.

## 2.4 Changing Composition of Capital Stock

Rates of change say something about the process of growth and development; data on the structure of the economy tell more. Development consists of structural change.

The conventional measure of domestic capital, in current prices, exhibits two pronounced compositional shifts: the fraction of the capital stock accounted for by animals drops very far, indeed, while the share attributable to

**Table 2.7** **Real GDP and Real Domestic Capital per Capita, Conventional and Unconventional Concepts, 1840 Prices, 1800–1860**

| | 1800 | 1840 | 1860 |
|---|---|---|---|
| Real GDP per capita ($) | | | |
| Conventional, variant A | 73 | 91 | 125 |
| Conventional, variant B | 66 | 91 | 125 |
| Unconventional, variant C | 78 | 101 | 135 |
| Real domestic capital per capita ($) | | | |
| Conventional | 104 | 157 | 262 |
| Unconventional | 175 | 219 | 316 |
| Capital/output ratios | | | |
| Conventional, variant A | 1.42 | 1.73 | 2.09 |
| Conventional, variant B | 1.57 | 1.73 | 2.09 |
| Unconventional, variant C | 2.24 | 2.16 | 2.34 |

*Sources:* The real GDP per capita estimates are from Weiss's paper in this volume. For the remaining estimates, see the text.

structures rises, both of these developments occurring chiefly after 1815 (see table 2.8). But current price data are not so useful, in this context, as constant price data, which tell a very interesting story. They show that the structure of the capital stock changed very little, down to 1840. Thereafter, there were accelerating shifts. The share of animals in the total dropped precipitately and inventories dropped mildly, while the share of structures rose a little and the share of equipment rose very much. There is the strong suggestion of an economy shifting in the direction of industrial activity and modern economic growth: away from agriculture and animal power, and toward manufacturing and mechanical power. There is no question that stirrings can be identified well before 1840—Kenneth Sokoloff's work shows clearly that important industrial change can be dated to 1820, at least. (See Sokoloff's paper in this volume.) But these activities could not have carried a very heavy weight in the economy much before 1840, and that is probably what the data in table 2.8 are showing us. Bias in the estimates may overstate the decline in the relative importance of animals after 1870, and may contribute to the finding of stability in the share of structures in the capital stock before 1840 (see appendix A), but these matters are probably not of much importance.

The introduction of the value of farm making into the capital stock produces some expected shifts. Concentrating on the constant price data, the value of land clearing and breaking accounted for over half of the capital stock in 1774 and something under half in 1799. This figure dropped modestly to 1840—when it was a little less than a third—and more dramatically thereafter, reflecting the relative decline of the agricultural sector. In this variant, inventories retained roughly the same share of the capital stock after 1799, while the share of structures experienced a strong upward movement from the same date.

**Table 2.8** **Constituents of the Domestic Capital Stock, Expressed as Shares in the Domestic Capital Stock, 1774–1900**

| | 1774 | 1799 | 1805 | 1815 | 1840 | 1850 | 1860 | 1870 | 1880 | 1890 | 1900 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Panel A: Excluding the Value of Farmland Clearing and Breaking | | | | | | | | | | | |
| | | | | | | *Current Prices* | | | | | |
| Structures | .39 | .33 | .35 | .41 | .45 | .47 | .54 | .54 | .55 | .61 | .60 |
| Equipment | .13 | .14 | .15 | .13 | .14 | .13 | .12 | .11 | .11 | .13 | .14 |
| Inventories[a] | .23 | .35 | .34 | .26 | .24 | .26 | .22 | .24 | .24 | .19 | .19 |
| Animals | .25 | .18 | .16 | .21 | .17 | .13 | .12 | .11 | .09 | .08 | .07 |
| | | | | | | *Constant (1860) Prices* | | | | | |
| Structures | .40 | .34 | .40 | .41 | .43 | .46 | .54 | .55 | .50 | .49 | .46 |
| Equipment | .08 | .09 | .09 | .07 | .08 | .09 | .12 | .13 | .16 | .25 | .30 |
| Inventories[a] | .28 | .35 | .32 | .29 | .26 | .27 | .22 | .22 | .25 | .21 | .19 |
| Animals | .25 | .23 | .19 | .22 | .23 | .17 | .12 | .10 | .09 | .06 | .04 |
| Panel B: Including the Value of Farmland Clearing and Breaking | | | | | | | | | | | |
| | | | | | | *Current Prices* | | | | | |
| Structures | .24 | .21 | .26 | .33 | .33 | .35 | .42 | .44 | .47 | .55 | .55 |
| Equipment | .08 | .09 | .11 | .10 | .10 | .10 | .09 | .09 | .10 | .11 | .13 |
| Inventories[a] | .14 | .23 | .24 | .21 | .18 | .20 | .17 | .20 | .21 | .17 | .18 |
| Animals | .15 | .11 | .12 | .17 | .12 | .10 | .09 | .09 | .08 | .07 | .06 |
| Land clearing & breaking | .40 | .36 | .28 | .19 | .28 | .25 | .22 | .17 | .14 | .10 | .08 |
| | | | | | | *Constant (1860) Prices* | | | | | |
| Structures | .17 | .19 | .25 | .27 | .29 | .33 | .42 | .44 | .41 | .44 | .42 |
| Equipment | .04 | .05 | .05 | .05 | .06 | .07 | .09 | .11 | .13 | .22 | .28 |
| Inventories[a] | .12 | .20 | .20 | .19 | .17 | .19 | .17 | .18 | .21 | .19 | .18 |
| Animals | .11 | .13 | .12 | .14 | .15 | .12 | .09 | .08 | .07 | .05 | .04 |
| Land clearing & breaking | .56 | .44 | .39 | .36 | .32 | .28 | .22 | .19 | .17 | .11 | .08 |

*Sources:* See text.

[a]Excluding animals.

Table 2.9 is another way of considering the same phenomena. It shows indexes of the per capita supply of each of the components of the capital stock. The growing importance of structures and, particularly, equipment comes through powerfully, while the value of the stock of land clearing and first breaking is shown to have fallen well behind the growth of population. There were two elements involved in the production of this result. First, the volume of farmland per capita declined over time, as the population became less and less rural and farm-centered. Since American agriculture was able to feed a growing population and expand its overseas sales, the decline in the value of farm improvements per capita went hand in hand with the growing

**Table 2.9** **Indexes of Per Capita Real Magnitudes, 1860 Prices, 1774–1900**

| | 1774 | 1799 | 1805 | 1815 | 1840 | 1850 | 1860 | 1870 | 1880 | 1890 | 1900 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Structures | 100 | 112 | 156 | 150 | 211 | 263 | 438 | 449 | 503 | 793 | 886 |
| Equipment | 100 | 142 | 166 | 133 | 202 | 262 | 479 | 538 | 785 | 1,981 | 2,867 |
| Inventories[a] | 100 | 166 | 176 | 149 | 178 | 218 | 253 | 258 | 360 | 479 | 526 |
| Animals | 100 | 122 | 121 | 130 | 179 | 154 | 154 | 126 | 139 | 148 | 132 |
| Land clearing & breaking | 100 | 81 | 74 | 64 | 73 | 70 | 72 | 62 | 66 | 60 | 55 |

*Sources:* See text.

[a]Excluding animals.

productivity of agricultural land. Second, as population moved westward, out of the wooded areas, the cost of preparing land for cultivation fell. Toward the end of the nineteenth century, then, the real value of farm improvements (exclusive of structures) per acre was smaller than it had been in the eighteenth century. The meaning of this change is taken up further in appendix A.

On the whole, the structural evidence supports the conclusions that one might tentatively draw from the aggregate series: the American economy began to experience the process of modern economic growth in the years after the War of 1812; by the 1840s the modern components of the economy were large enough and growing rapidly enough to have an observable impact on the rate of growth and the structure of the economy.

## 2.5 The Growth of Total Factor Inputs

The measurements of the capital stock, viewed as an input to the productive process, yield information that clearly bears on the speed and nature of American economic growth. Measurements of total factor inputs would be even more useful. The assembly of the additional required inputs is not very difficult. Estimates of the volume of agricultural land (the only land input that could be taken into account) already exist. (Gallman 1972, 201, 202, extended to 1774 in the same manner as the extension to 1800.) Weiss has generated new labor force figures for the years 1800–1900, at ten-year intervals, and they were readily extended to 1774.[7]

7. The estimate is based on Jones (1980, 30) and Weiss's chapter in this volume. According to Jones there were 53,056 indentured servants in 1774 and 480,932 slaves. All indentured servants were in the work force; following Weiss's judgment for 1800, slaves ten and older probably amounted to 65 percent of the population of slaves, and nine-tenths of these people were in the work force. According to Jones, there were 396,158 free adult males, of whom, if we follow Weiss's treatment for the nineteenth century, 87.2 percent were in the work force. The rest of the population—1,034,456—consisted of youths and children, by Jones's account. Assuming half were males (a safe guess) and that they were distributed among the age groups as the white population of 1800 was, then there were about 55,000 males, ten to fourteen years old, of whom 22.1

Table 2.10, panel A, contains statements of the rates of growth of each input and each input per member of the population for various periods between 1774 and 1900. Notice that the labor force grew slightly more slowly than population between 1774 and 1800 and a little faster between 1800 and 1840. Thereafter, with the expansion of immigration, and its effect on the structure of population, the labor force participation rate rose faster than before. On the whole, the patterns of change of the other inputs are similar. The volume of agricultural land per capita actually declined throughout, but the rate of decline was less after 1800 than before, while the quantity of capital increased faster than population, the rate rising persistently over time. The strong suggestion of these data is that the per capita supply of all inputs, taken together, must have grown very slowly, if at all, down to 1800, when it began to increase, the increase becoming more marked as time passed.

This, in fact, is what is shown by panel B of the table, which sets out the rates of change of all three factors combined. The rates of growth of total inputs and inputs per capita accelerated over time, the change in the per capita rates being particularly striking.

There are three series describing rates of change of aggregate inputs. In the first, the underlying labor input is measured by the numbers of workers, without regard to the length of the work year or the differential quality of the workers. In the second and third, very crude efforts have been made to adjust the labor supply for sectoral differences in the work year, trends over time in the work year, and differences among sectors in the "quality" of workers. In series LFQV, the weights by which the rates of change of the three input series are combined (estimated factor income shares) vary from one year to the next; in series LFQF, the weights are fixed at the 1880 levels. The techniques employed to make the estimates are described in appendix B; the adjustments are almost certainly too large. That is, the rates of change represented by LFQV—and possibly LFQF, as well—are probably too large. The three sets of figures, however, may very well establish boundaries within which the rates of change of a properly adjusted labor input series would lie.

In any case, the rates of change of the combined input series do describe the same general pattern: an acceleration in the supply of inputs and, especially, inputs per capita. For the period following 1800, these findings once again parallel Weiss's (table 2.7). Furthermore, there was not only an acceleration in the rate of change of aggregate inputs, but also in total factor productivity: the long-term rate of gain was substantially higher after 1840 than before (table 2.10, panel C).

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percent were in the work force (following Weiss's judgment for 1800), and there were 53,815 who were fifteen to twenty years old, of whom (again following Weiss) 87.2 percent worked. Adding free females, ten years old and older (497,973, with a participation rate of 7.5 percent, per Weiss), brings the total labor force to 776,241. A check on the total: assuming an overall participation rate of 32.5 percent (typical of the early decades of the nineteenth century, according to Weiss) yields a figure of 765,039, close enough.

**Table 2.10** **Rates of Growth of Factor Supplies, Factor Supplies per Capita, and Total Factor Productivity, 1774–1900**

| | 1774–1800 | 1800–1840 | 1840–1900 | 1840–60 |
|---|---|---|---|---|
| Panel A | | | | |
| Labor force (LF) | 3.09 | 3.09 | 2.72 | 3.41 |
| LF/population | −0.08 | 0.11 | 0.20 | 0.31 |
| Land | 2.26 | 2.80 | 2.17 | 2.87 |
| Land/population | −0.91 | −0.18 | −0.35 | −0.23 |
| Capital (K) | 3.39 | 3.45 | 4.40 | 5.17 |
| K/population | 0.22 | 0.48 | 1.88 | 2.07 |
| Panel B | | | | |
| Total factor inputs, LF | 3.10 | 3.18 | 3.20 | 3.91 |
| Total factor inputs/population, LF | −0.07 | 0.20 | 0.68 | 0.81 |
| Total factors, inputs, LFQV | 3.21 | 3.44 | 3.75 | 4.78 |
| Total factor inputs/population, LFQV | 0.04 | 0.46 | 1.23 | 1.69 |
| Total factor inputs, LFQF | 3.25 | 3.47 | 3.57 | 4.41 |
| Total factor inputs/population, LFQF | 0.08 | 0.49 | 1.05 | 1.31 |
| Panel C | | | | |
| Total Factor Productivity | | | | |
| GDP, LF | | .46 | | .82 |
| GNP, LF | | | .80 | .70 |
| GDP, LFQV | | | .25 | −.17 |
| GDP, LFQF | | | .43 | .20 |

*Sources:* The real GDP estimates underlying the first set of total factor productivity estimates (panel C) are Weiss's, chapter 1 in this volume (broad concept, variant C). They are expressed in 1840 prices, as are the capital stock estimates (domestic capital) used with them to estimate total factor productivity.

The real GNP estimates (panel C) were derived from those underlying Gallman (1966). They are expressed in 1860 prices and include the value of all land improvements made in the given year and the value of home manufactures. The capital stock estimates used in the analysis involving the GNP refer to the national capital stock.

The labor input series is based on Weiss's labor force figures. *LF* refers to this series in unadjusted form. *LFQV* means that the labor force has been adjusted to take into account differences in work time and labor quality, both among sectors and over time (1840 onward); that is, the sectoral "weights" are variable. *LFQF* means that the labor force figures have been adjusted to take into account differences in time and quality among sectors, but not across time; that is, the sectoral "weights" are fixed. (In fact, the weights employed are those of 1880; only two sectors are distinguished in the fixed weight variant: "agriculture" and "all other.")

The rates of growth of the capital stock, 1840–1900, were computed from the series that incorporates the value of fencing.

The weights assigned to the rates of growth of the individual factors of production are labor, .68; land, .03; and capital, .29. These weights are intended to reflect income shares. (Land improvements, of course, are treated as capital.)

For estimating details, see the text, especially appendix B.

These results are surely not amazing. The years from 1774 through 1815 were years in which the young country engaged twice in major wars; when peace was achieved, American products were frequently prevented from entering their natural markets under reasonably free conditions. There was one period of booming trade, when the Napoleonic Wars created great opportunities for American merchants, opportunities ended by the Embargo of 1807 and then the War of 1812. With the return of peace, the factory system began to spread in earnest, and by 1840 the production of textiles had been virtually completely transferred out of the home and the shop and into the factory. The variety of American manufacturing activities increased markedly in the 1840s and 1850s, and machine building began to assume the central position it was to occupy in American industrialization for the rest of the century. The aggregate statistics are simply the embodiment of these well-known developments. The degree to which the benefits of economic growth were offset by costs unrecorded here and the extent to which the benefits were shared among Americans are matters of considerable importance. But since they are taken up by John Wallis and me in the Introduction and by other authors contributing to this volume, it is reasonable to pass them by here.

## 2.6 Conclusions

The conclusions of this paper are readily summarized. The capital stock series suggest that the pace of American economic growth accelerated in the decades before the Civil War. The evidence for this statement is to be found in the real per capita capital stock figures, the various estimates of aggregate real inputs per capita, and the changing structure of the capital stock, which describe a process of industrialization. The components that make up the series have their weaknesses, but the review of these components conducted above, and also in appendix A, turned up no compelling reasons to believe that the computed rates of growth and structural changes are importantly biased.

The acceleration of the rate of growth should not be allowed to obscure the progress made before 1840. The series assembled in this paper support Thomas Weiss's finding that per capita GDP increased in the decades between 1800 and 1840. Furthermore, the per capita supply of capital seems to have been increasing since 1774, and the supply of all factors of production, combined, seems to have increased at least as fast as population between the beginning of the Revolution and the turn of the century. There were bad times as well as good ones, and the standard of life surely sometimes declined, perhaps for extended periods. But the trend was mildly favorable between 1774 and 1799/1800, if these series are to be believed, more clearly favorable from the turn of the century until 1840, and even more pronouncedly favorable thereafter. The capital stock figures, however, bear only on the side of life that has to do with the provision of commodities and services. Industrialization may

have brought a deterioration of the quality of life for some and may have for a time overwhelmed the capacity of society to deal with problems of public health. Other indexes of the standard of life, stressing health, for example, may yield results at odds with those reported in this paper—certainly this is the suggestion of the work described by Richard H. Steckel in his essay for this volume. The important point to be taken from the results described herein, however, is that the performance of the economy, narrowly conceived, was improving, and at an accelerating pace. The means for dealing with the problems created by the reorganization of society were therefore increasing. Solutions awaited the accumulation of the necessary knowledge and the emergence of a will to act.

# Appendix A
## *Estimating Problems and Tests of Estimates*

This appendix takes up a few of the chief problems encountered during the construction of the capital stock estimates, and describes some of the tests that were run to check the estimating decisions that were made.

### Land Clearing and Breaking

The largest item in the more unconventional—but more meaningful—of the capital concepts employed in this paper is the value imparted to land by the processes of clearing and first breaking. The estimating procedure was simple. The following variables were established for each year: the number of acres of improved farmland of each relevant type (land originally under forest, land originally under grass) in each state or region; the number of labor hours per acre required to improve land of each type; the cost of farm labor in each state or region (Primack 1962; Lebergott 1964). Simple multiplication and addition produced the final figures. Constant price estimates were obtained by substituting technical coefficients and wage rates relevant to 1860 for those relevant to the current year. For the years 1840–1900—but not earlier—estimates of the value of fencing, drainage, and irrigation works were also made.

Certain characteristics of the series that may be associated with biased rates of change are immediately evident. The weight attributed to the clearing and breaking series is incorrect; it is probably too low, especially for the years before 1840. Since the clearing and breaking series exhibits relatively low rates of change over time, giving it a heavier weight would tend to reduce the rates of growth of the aggregate capital stock series, particularly before 1840. Thus the acceleration of the rate of change described previously in this paper would be enhanced.

The weight attached to the series is too low because the estimates ignore all elements of clearing and breaking cost except labor. Labor was, no doubt, the principal cost, but it was not the only one. Second, the only improved land treated is agricultural land; no account is taken of land under houses, factories, shops, and so forth. Third, for the years before 1840, important elements of improvement—particularly fencing—had to be ignored. If it had been possible to treat all of these phenomena, the improvement series would have had a larger weight.

There are, however, certain offsets. First, the value of fencing may very well have increased faster than the value of clearing, before 1840; it is almost certainly true that the volume of land under houses and so forth increased faster than the volume of improved land in agriculture, at least after 1840. Introducing these elements into the analysis might raise the rate of change of the improvements series, although probably not by much.

Another factor may appear, at first blush, to be more important than any so far discussed: the estimates make allowance for land retirements (land allowed to go back to nature), but not depreciation. The reason depreciation has been ignored is that land improvements, if properly maintained, do not depreciate. Bad farming practices may erode the fertility of the land, and the opening of western farms may reduce the value of eastern farms, but these changes have to do mainly with the value of land, rather than with the value of improvements. Now in a sense this characteristic of improvements is shared with other elements of the capital stock. Properly maintained, houses and ships and even machines can last very long, indeed. The difference is that most of the houses, ships, and machines that existed in, for example, eastern Pennsylvania in 1774 are gone today, while much of the improved land of that period is still improved. A substantial part of it is now under houses and shopping malls and highways, rather than under Indian corn, but it is still improved. Furthermore, in the cases of buildings, machines, and so forth, one can devise reasonable depreciation rates that properly describe the average lifetime experiences of these elements of capital and that are roughly relevant to long reaches of history. That is not possible for land improvements.

The discussion above implicitly introduces another issue. The improvements series consists of reproduction cost estimates. Various tests have shown (see Gallman 1987) that the reproduction cost and the market value of structures and manufactured producers' durables were, on average, about the same in the nineteenth century. Is this also true of land improvements? If not, then how is the analysis affected? The few simple tests that have been run seem to suggest that they are alike. At least two efforts have been made to estimate the market value of clearing and breaking at midcentury: one by Stanley Lebergott for the Midwest, the other by Stanley Engerman and Robert Fogel for the South (Lebergott 1985; Fogel and Engerman 1977). Comparisons are not easily made, and the efforts reported here may be polluted by wishful thinking,

but I do not believe that is the case. The results suggest that estimates computed along the lines laid out above are very similar to the ones obtained by Lebergott and Engerman and Fogel. The suggestion then is that the market price and the reproduction cost of land improvements were about the same, on average, at midcentury.

The same may also hold for 1774. At least it is true that when one subtracts from Alice Jones's estimate of the value of real estate, my estimates of the value of land clearing and structures plus a rough allowance for other elements of land improvement (a relatively small part of the total), the remaining value, divided by the number of acres of land privately held (derived from Blodget [1806] 1964), yields an average price of land per acre—exclusive of improvements—that is almost identical with Blodget's estimate of the average value of unimproved land in 1774. The test is very roundabout and places much weight on a residual. Nonetheless, it encourages one to think that market price and reproduction cost may have been about the same, on average, at that date.

There is some evidence to the contrary, however. Specifically, Blodget's estimates of the average value of improved land per acre in 1774, 1799, and 1805 are substantially smaller than my estimates of the cost of improving land per acre. Bear in mind that Blodget's figures include the value of the land itself, while mine do not. The margin is so great that one has the impression that if Blodget's figures are truly market-price figures, and mine truly reproduction cost figures, then farmers of the late eighteenth century and the early nineteenth century were behaving irrationally, improving much more land than could be justified by the market. I do not believe that and therefore think that either Blodget is wrong or I am.

In making my estimates I assumed that all of the land improved at each of these dates had originally been forest land. That is probably not correct, and since forest land cost more to improve than grass land, this assumption probably leads to an overstatement of the value of cleared land at these dates. But the overstatement is tiny and is surely more than offset by the fact that the cost of factors other than labor was left out of account.

I also assumed that the labor hours per acre required for clearing were the same at these early dates as at midcentury. Primack (1962) believed that there were no important improvements in clearing techniques until after the Civil War, and while his interests were confined to the last half of the century, his remark is probably relevant to the early dates treated in this paper as well. In any case, if I am wrong about this matter, I have *understated* the value of improvements at these dates, not *overstated* them.

I also assumed that the treatment of stumps was the same at all dates: specifically, that one-third of the stumps were removed immediately and that the rest were left in the land to rot away on their own. It may be that an even smaller share of the stumps was taken out in the earlier years, but allowing for

the removal of no stumps would not bring my estimates and Blodget's very much closer together.[8]

A more promising source of disparity lies in the way in which labor time was valued. I assumed that the opportunity cost of the labor employed in clearing and first breaking could be approximated by the agricultural wage rate. In fact, however, one would suppose that clearing and first breaking would have been conducted by farmers in the off season, when real opportunities may have been restricted to maintenance tasks around the farm, hunting, fishing, and so forth. The wage rate, then, may overstate the opportunity cost of labor. That seems not to have been the case at midcentury, when, as indicated above, reproduction cost and market value of improvements were very similar. It may be that by midcentury clearing and breaking were more commonly hired out (e.g., to prairie sodbusters) than previously and that farmers themselves had better opportunities for off-season work. If that were the case, the estimating technique might work better for the mid-nineteenth century than for the earlier dates. But that would be a relatively unimportant matter. Our concerns are chiefly with the constant price series, which are properly a function of the techniques and wage rates of 1860. The contrast with Blodget refers exclusively to the current price estimates.

In any case, my by no means unbiased guess is that Blodget is simply wrong on the matter of the value of improved land. The check of my work against Jones's estimate of the value of real estate and Blodget's estimate of the value of unimproved land seems reasonably strong. Furthermore, in comparison with Jones's estimate, Blodget's figures on the values of improved land seem very much too low. I therefore incline toward the view that the improvements series—particularly in constant prices—gives a reasonable view of what it purports to describe. At least I cannot make a case for viewing the series as strongly biased in one direction or the other or as generating strongly biased rates of growth.[9]

## Structures

The estimates for 1850–1900 rest chiefly on census data; for 1840 on the work of Seaman (1852); for 1815 on the direct tax of 1813–15 and the work

8. The matter of stumps is tricky. What is the reproduction labor cost of ten acres of stumpless cleared land that was formerly under trees? Is it the full labor cost of clearing the land and removing all the stumps? Or is it the labor cost of cutting down the trees, removing the one-third of the stumps that were originally removed, and plowing the land? I decided that the second choice was the correct one, but clearly one could make a case for the first, or perhaps even a third or fourth option.

9. A word should be said about the land series, although there is inadequate space to go through the estimating procedures and tests. The 1850–1900 data come from the census, with some adjustments. The adjustments depend in part on the work of Primack (1962). The 1840 figures are weaker. They come from Seaman (1852) again adjusted and distributed, partly on the basis of the work of Primack. The figures for 1774 through 1805 are from Blodget ([1806] 1964), adjusted in various ways. The 1815 figure is a rough extrapolation from 1805. For a discussion of these matters, see Gallman (1972).

of Pitkin (1835); for 1805 on the work of Blodget ([1806] 1964) and Goldsmith (1952); for 1799 on the direct tax of 1798 and the work of Soltow (1984); and for 1774 on the work of Jones (1980). All of these data have been very heavily processed, frequently with the object of extracting one element from a larger aggregate, or dividing the aggregate among its components. In each case but two, however, there is a quite substantial component of real data that bears directly on the estimating problem. The weakest links are the ones for 1805 and 1840; there are no data expressly relevant to these dates. The underlying sources of evidence are the works of Seaman and Blodget. The latter extrapolated his estimate from an earlier date, for which real evidence *is* available, while the former both extrapolated from an earlier date and blew up partial estimates to encompass the universe. These figures have been tested, of course, but they are less trustworthy than are the rest.

There is not space to deal with all the estimating problems and with all the tests run with respect to the estimates relating to structures. In what follows, the most serious problem, which has to do with deflation for the years before 1850, will be treated.

For the years 1850–1900 there is no serious problem relating to deflation; indeed, the price index number situation is unusually good. For most of these years Dorothy Brady's two sets of deflators—for houses and churches, on the one hand, and factories and office buildings, on the other—are available. These are true price indexes, which makes them quite unusual among construction deflators. Usually it is necessary to make do with cost indexes. Brady's data need modest adjustment to make them expressly apposite to the task of deflating the capital stock, but no heroic efforts are needed to put them in proper condition for this purpose.

The problem appears in the years before 1850, for which Brady's indexes are not available. One possibility for this period is to follow the lead of David and Solar (1977), who linked Brady's housing price index to a construction cost index and then carried it back to the late eighteenth century. Since the relative importance of factories and office buildings before the 1840s was probably slight and since construction techniques in this period may not have varied much between residential construction and commercial buildings (except at the cutting edge of factory design and construction), an extension of the housing price index would be an entirely adequate way to deal with the deflation problem for all kinds of structures. David and Solar, however, did not use Brady's published series; they used the unrevised figures that Brady prepared for the Income and Wealth Conference. It turns out that in most instances the differences between the published and unpublished series are slight—matters of a point or two. There is one exception. In the published conference volume, Brady (1966) dropped her estimate of the price index of housing in 1839.

The Brady unpublished index falls from a level of 128 in 1839, to 94 in 1849, and then rises to 100 in 1859. Available construction cost indexes fall

much more modestly and rise more sharply over these two decades, implying that, if the unpublished Brady index is correct, productivity in construction must have been rising quite dramatically. David and Solar believe that the experience reflects chiefly the diffusion of the balloon frame, which was invented in 1833. They therefore suppose that the annual rate of productivity improvement realized in the 1840s was also achieved in the period 1834–39. They construct a building cost index and employ it with the Brady price index to estimate productivity gains, 1839–59, and they then use it, together with their estimate of the rate of productivity improvement, 1839–49, to extrapolate the Brady price index number for 1839 back to 1834. They assume that there were no important productivity improvements before 1833 and extrapolate the 1834 price index number to earlier years in the century on their construction cost index. The productivity improvement for the period 1834 through 1859 implied by their calculations is a little more than 36 percent.

The procedure is ingenious and surely adequate to the purposes of David and Solar. It is not so clear that it is adequate to the purpose of creating a deflator for the most important component of the conventional capital stock series. First there is the matter of Brady's decision to suppress her 1839 estimate. Does this mean that she had had second thoughts about the strength of that estimate? Presumably. Nonetheless there remains evidence that Brady believed that construction prices did fall in the late 1830s and early 1840s. Her price index for factories drops very sharply between 1836 and 1844, for example. But of course this index refers to factories, not residences.[10]

Is it reasonable to suppose that the balloon frame led to a rise in productivity of 36 percent in the first twenty-five years of its existence? Probably not. The balloon frame saved on framing. Framing accounted for about 25 percent of the cost of a building. Consequently, even if the balloon frame eliminated the expense of framing and even if the balloon frame was adopted throughout the industry within this period, the rise in productivity could not have come close to reaching 36 percent. Neither condition was met, of course.[11]

10. One should not infer much about productivity changes from the relative movements of price and cost indexes between 1836 and 1844, however. Between these two dates lay a very sharp contraction. At least part of the decline in prices reflected falling profits, not rising productivity. It is also likely that workers discounted standard wage rates in order to hold their jobs.

11. For example, "although many authorities assert that balloon frame construction had 'almost completely replaced the hewn frame for domestic construction by the time of the Civil War' . . . in North Carolina field surveys demonstrate the prevalence of heavy mortised-and-tenoned house frames until the Civil War" (Bishir, Brown, Lounsbury, and Wood 1990, 457). An architect whose book was published in 1855 writes: "There is no doubt that if the subject received closer attention, a better mode of framing than that generally employed, could be suggested. Timbers are often unnecessarily heavy, but are afterwards so weakened by the mode of framing which is in vogue, and which compels the cutting of mortices and tenons and insertion of one timber into another, that the frame is less substantial than if constructed of lighter stuff differently put together. It is difficult to persuade carpenters of this" (Wheeler 1855, 407). The implication of the last statement is important. The building industry was a conservative, locally organized industry. The architect goes on: "The *New York Tribune* of January 18th, 1855, reported a meeting of the American Institute Farmers' Club, and contained amongst other items some remarks from one of the mem-

The framing of a building called for many workers. Barn-raising parties were organized expressly for this purpose. The balloon frame eventually changed all that. With the new system a man and a boy could frame a house by themselves. Thus the innovation became immensely important to the farming community, particularly for people on the frontier, for reasons that transcended normal cost considerations. It also diffused quickly in new western cities, places under intense demand pressure and without established artisanal power groups. (Chicago and San Francisco were both balloon frame cities.) But it did not immediately spread to the East.

There were, of course, other innovations during this period, so that the rise in productivity that David and Solar identify need not be the result exclusively of the balloon frame. The principal changes that seem to have been taking place involved the transfer of some activities from the building site to mills. For example, it is said that it became more common to use manufactured nails, as well as manufactured windows and doors, which presumably lowered costs. But the census returns of 1810, 1850, and 1860 suggest that manufactured nails were already widely used before the 1830s. Mill-made sash, doors, and blinds do not appear in the census returns—separately, at least—before 1860, when their output amounted to a value of about $9.5 million, in a year in which the total value of conventional construction (exclusive of railroads and canals) ran to about $345 million. Mill-made windows and so forth were therefore by no means negligible by this date, but they did not bulk large enough to suggest that their introduction led to a major improvement in productivity. Furthermore, it may well be that their contribution to productivity actually came after 1849, rather than before. At least the treatment of these lines of production by the census suggests that this was so. David and Solar find most of the productivity change (almost three-quarters of it) occurring before 1849.

The general idea lying behind the David and Solar treatment of construction prices is clearly reasonable, and their execution of it may have solved their problem satisfactorily. The technique is less likely to solve my problem satisfactorily, however. Unfortunately, there is no option that is clearly superior.

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bers upon a novel mode of constructing cheap wooden dwellings" (408). The "novel method" was the balloon frame.

The extent to which innovations had diffused is relevant because it would have determined the degree to which prices responded to innovations. Prices would have been potentially affected only in localities in which the new framing system had begun to diffuse, and even there, prices need not have fallen immediately, if competition among builders was not severe. If builders commonly used cost plus pricing, of course, prices would have fallen immediately in areas where the balloon frame was put in use.

There is a question as to whether Brady's prices refer to average practice or best practice. I have assumed they refer to average practice. If I am not correct in this assumption, and if builders followed cost plus pricing practices, then the Brady price index numbers exaggerate the true decline in average prices. The course of average relative prices of residences after 1849 suggests that the ambiguity with respect to the meaning of the price indexes is unimportant for these years.

Nonetheless, I decided to accept the Brady indexes for the years 1849 onward. I then adjusted them to fit my needs, and extrapolated the adjusted 1849 (1850) index number to 1840, 1815, 1805, 1799, and 1785 on the Adams (1975) variant B (allowing for input substitutions) construction cost series. The index was extended to 1774 on a construction cost series based on the David and Solar common wage index, a Maryland farm wage rate, taken from Adams (1986, 629–30), and the Bezanson-Gray-Hussey arithmetic average price index for Philadelphia (U.S. Bureau of the Census 1975, ser. E-111). The last two steps need further discussion.

The Adams construction cost index was exceptionally carefully made from good basic data. It is an excellent construction cost index, and the version used allows for factor substitutions due to shifts in relative input prices. For present purposes, however, it has certain potential shortcomings. The ideal index, for present purposes, is a true price index, an index that allows for changes in productivity. The Adams index does not do that, except insofar as productivity changes are associated with shifts in factor proportions. As proxy for a true price index it will exaggerate any long-term price increases and understate any long-term price decreases, so long as productivity improvements are taking place. The capital stock series that it is used to deflate will then exhibit a rate of change that is biased in a downward direction. In the present instance, the bias would exaggerate the observed acceleration in the rate of growth of the capital stock. If the bias were serious enough, it would account fully for the acceleration. That seems highly unlikely, however. The sources of productivity improvement in construction do not appear to have been important before the mid-1830s, and, as I have tried to show, even in the period between the mid-1830s and the beginning of the true price indexes in 1849, the amount of productivity improvement is unlikely to have been very great. In any case, the Adams index has other shortcomings for present purposes, and it turns out that at least one of these may introduce a compensating bias, in direction at least, and perhaps in amount as well.

The Adams index refers exclusively to Philadelphia. How successfully does it represent the United States? Two questions immediately arise. First, housing price levels varied by region, and as time passed, the relative importance of the various regions changed. Did the shifts in regional weights affect the trend in the national average of housing prices? Probably not, and if they did, they tended to *raise* average prices a little. By ignoring the effects of the regional shift I can perhaps compensate slightly for whatever bias is present from the use of a cost index in place of a true price index. These conclusions are based on the results of a test of the following form.

The census of 1840 requested information on the numbers of two types of houses constructed in the census year, those built of brick and stone and those built of wood, as well as the value of both types of houses taken together. I used the state data in a regression analysis to obtain an intercept value and coefficients for each of the two types of houses. These data were then em-

ployed to value the houses constructed in each state, and the figures thus obtained were divided through the census returns of the value of houses built to get an index number for each state. The index number compares the value of the houses constructed in the state with the value that would have obtained if prices had been at the level of the national average. Clearly, the index numbers reflect not only variations in building prices—which are required for the proposed analysis—but also differences in average size and quality of new houses, from state to state. Since cost, size, and quality were likely to have varied together—frontier areas having lower building costs, smaller houses, and houses of lower quality than the well-settled areas—the index numbers almost certainly exaggerate the regional variations in building costs, a point to be borne in mind as the analysis unfolds.

The individual state index numbers were then used to deflate the state returns of the value of real estate in 1799, according to the direct tax. The sum of the deflated returns was then divided through the aggregate current price value of real estate in 1799, according to the direct tax. The result was an index number of 0.932, which compares with the 1840 index number of 1.000; that is, according to these calculations, the shifting weights among states tended to raise, very slightly, the true price index of structures between 1799 and 1840.[12] The index numbers almost certainly overstate the true impact of the redistribution of the value of structures among states in this period, because the state index numbers probably overstate (for reasons previously given) the true variation in building costs among states. It appears unnecessary, then, to adjust the Adams cost index to take into account the effects of the shifting real-value-of-structures weights among states. This is particularly the case in view of the fact that the Adams index is a cost index and is likely, therefore, to exaggerate the extent to which the prices of buildings rose or to understate the extent to which they fell during this period. Finally, if the bias is slight between 1799 and 1840, it is almost certainly negligible between 1774 and 1799.

There is another aspect of the regional specificity of the Adams index that must be considered. Do changes in Philadelphia costs properly represent changes in costs in other regions? The strong suggestion that one gets from looking at price and wage indexes from New England and New York (Rothenberg 1988; David and Solar 1977; Warren and Pearson 1933) is that they do not: Adams's cost index moves in step with the Bezanson-Gray-Hussey general price index (Philadelphia—U.S. Bureau of the Census 1975, ser. E-97), while the Rothenberg, David-Solar, and Warren-Pearson indexes also move more or less together, but quite differently from the Philadelphia indexes. (At least these statements apply to the benchmark dates relevant here.) David and

12. The two indexes should ideally be weighted by the state distribution of the real value of houses in the capital stock. These, in fact, are the weights utilized for 1799, but the weights for 1840 are the real values of houses built in the census year.

Solar report that a construction cost index they assembled from materials prices from New York (Warren and Pearson 1933) and common wage rates from Philadelphia (Adams 1975) and the Erie Canal (Smith 1963) exhibits a less pronounced decline between 1809 and 1834 than does the Adams index. I constructed an index from Warren and Pearson materials prices and David-Solar common wages (using Adams's weights and his procedure for allowing for factor substitutions) for all the relevant dates. The Adams index shows a much more pronounced drop over time than does the WP-DS index. There is the strong suggestion that a properly derived national construction cost index would exhibit more pronounced price increases and less pronounced price declines, over the long run, than would a Philadelphia index. The bias imparted to the real capital stock series from using a cost index to proxy a price index is, then, compensated for—in part? in whole? more than compensated for?—by the fact that Philadelphia prices moved differently from national average prices, at least after 1799, and probably from 1774 as well.

There is one final problem with the deflator: it represents the costs of commercial construction in a city. A substantial fraction of the stock of structures in the years 1799 through 1840 must have been built in the countryside by unprofessional labor. The matter may not be very important, however. According to Adams, Philadelphia construction and Maryland farm wage rates moved in roughly similar ways among the dates 1785, 1799, 1805, 1815, and 1840.

One cannot claim great accuracy for the deflator, but on the whole it seems satisfactory.

### Animal Inventories

There are at least two problems with the animal inventory estimates. First, they include only farm animals from 1840 onward (animals used in the mines are part of the "equipment" estimates in mining) and probably only farm animals at earlier dates as well, whereas ideally one would like to have all domestic animals throughout. The omissions are not trivial, but neither are they of overwhelming importance. In 1860, just over 12 percent of domestic animals, by value, were located off farms (U.S. Bureau of the Census 1860, cviii, cxxvi, 192); in 1900, the fraction was just under 7 percent (U.S. Bureau of the Census 1900, cxliv). The suggestion is that the total stock of animals increased a little more slowly than did the stock of farm animals, but correcting for this shortcoming would probably not affect very substantially the conclusions previously reached.

The second problem has to do with deflation. The constant price series was made by applying base-year prices (1860) to estimates of the numbers of animals in each year. The assumption is that a pig is a pig. In fact, pigs in 1890 were, without much doubt, superior animals to pigs of 1830. The deflator, then, is biased, and deflation tends to understate the importance of the growth of the stock of animals. Furthermore, the effect is also likely to be to under-

play the acceleration in the rate of growth of the per capita capital stock. The reason is that most of the gains in the quality of animals were realized after midcentury. In earlier decades there were probably periods when, on balance, the quality of animal stocks actually deteriorated. Nonetheless, numbers can reasonably proxy real values before 1840 or 1850, whereas they are less able to perform this function thereafter. There are, of course, problems with the evidence on numbers as well, but they seem less pressing and do not deserve a place in this brief treatment of the subject. On the whole, the series, despite these qualifications, is acceptable for the uses to which it has been put.

### Other Inventories

The procedure followed is one employed by Kuznets (1946, 228). Inventories were taken as a fixed fraction of the value of imports and the value of outputs of the agricultural, manufacturing, and mining sectors. No allowance was made for changes in the efficiency with which inventories were used, a matter of limited importance, especially before the Civil War. If there were improvements in efficiency, then the estimating procedure tends to exaggerate the acceleration in the rate of change of the real per capita capital stock. The details of how the value of imports and outputs were obtained are best left to another occasion.

### Equipment

The data for the years 1840 onward were derived chiefly from the census, were deflated by Dorothy Brady's true price indexes, and were tested—with considerable success—against perpetual inventory estimates (Gallman 1987). For the earlier years, the chief sources were Jones (1980), Blodget ([1806] 1964), Goldsmith (1952), and U.S. Bureau of the Census (1975, for Treasury data on shipping). The series seems adequate for present purposes, but should not be trusted for much more.

### Conclusions

It should be obvious that a substantial margin for error must be allowed for all of the estimates discussed in this paper, especially those dated before 1850, and particularly for those at the turn of the century. On the other hand, it is not obvious that the rates of change computed from the series are subject to important biases. The conclusions reached in sections 2.3–2.5 need not be altered—at least not on the basis of the results of the review conducted in this appendix.

# Appendix B
## *Time-Quality Adjustments to the Labor Force Estimates*

This appendix describes the time-quality adjustments that were made to the labor force estimates, for purposes of the measurement and analysis of changes in total factor inputs and changes in total factor productivity (table 2.10). The last paragraph takes up the estimation of the elasticities of output with respect to factor inputs that are necessary to make estimates of total factor productivity changes.

The estimates were made in two steps. First, the farm labor force figures were adjusted to take into account changes in the farm work year.[13] Then quality-time weights were devised for the two remaining sectors that could be readily distinguished: mining, manufacturing, and hand trades, and all others. The weights consisted of the ratio of labor income per worker in the relevant sector to labor income per worker in agriculture. Since two of the important factors accounting for sectoral differences in labor income per worker are the relative duration of the labor year in each sector and the relative quality of workers in each sector, one is perhaps justified in referring to these ratios as time-quality weights. Unfortunately, however, other factors—factors irrelevant to the time-quality adjustment—also affect intersectoral differences in labor income per worker. Sectoral labor income deviations arose out of short-term disequilibria in labor markets, as well as from enduring quality differences among workers. Furthermore, some part of the variations in labor income surely reflected regional and urban-rural price differences, rather than real income disparities. It is likely that both of these factors typically operated to widen the gaps between labor incomes in agriculture and the other two sectors identified, each of which enjoyed higher labor incomes per worker than did the agricultural sector. Since the labor forces attached to these two sectors were growing faster than the agricultural labor force, the excessive time-quality weights given these sectors mean that the rates of change of the time-quality adjusted labor series are biased upward. The present status of regional and urban-rural price series does not permit an appropriate deflating of the labor income series, and there is no way of knowing how serious the bias arising out of disequilibria in labor markets is.

There are other difficulties with these measurements.

1. It would be helpful to have detailed breakdowns of the labor force and labor earnings, so that a more fully articulated weighting scheme might be developed, but adequate data simply are not available.

2. Sectoral labor income estimates were developed from value-added data. Value-added estimates involve some double-counting. If the extent of double-counting varied from one sector to another, the labor income estimates would

13. First in principle, but not in fact. The quality adjustments were worked out first.

not be good indexes of the true relative sectoral labor incomes. It is quite unlikely, however, that this problem is, in fact, at all serious.

3. The labor income estimates were taken as residuals, the difference between total sectoral income and sectoral property income. Property income was estimated as the product of the value of capital and land and estimated rates of return. Since the estimates of inventories could not be distributed among sectors, property income was computed against the value of land and fixed capital only. If the relative importance of inventories varied by sector, the sectoral property estimates are biased. Unfortunately, there is no way to be sure that this was not the case, although it is unlikely that we have here a major source of bias.

4. More important, the system of estimating property incomes involved the assumption that the rate of return on property *of a given type* was the same in all sectors. In fact, this is unlikely to have been the case. The work of Bateman and Weiss shows that the returns to property in the antebellum South were much higher in manufacturing than in agriculture (1981, 107, 108, 114).[14] Unfortunately, there is no good basis for producing different sectoral rates of return for all types of property for all sectors in all years. We can be quite sure, however, that the procedure followed to produce labor income estimates has led to an exaggeration of the relative levels of labor income in the "mining, manufacturing, and hand trades" sector, and probably in the "all other" sector as well. This in turn means that the time-quality weights attached to the nonfarm sector labor forces are too high and that, therefore, the rates of change of the adjusted labor series are biased upward.

The sectoral value-added series (current prices) were taken from volumes 24 and 34 of Studies in Income and Wealth (Gallman 1960, 47, 54, 56, 63; Gallman and Weiss 1969, 305), and were adjusted in the following ways. The estimates of farmland improvements were dropped from farm value-added, and new estimates, derived from data in volume 30 of Studies in Income and Wealth (Brady 1966) were substituted for them.[15] Value added by the "all

14. The rates of return I have used do vary from one sector to another, as the structure of the capital stock varies; only the rates for individual types of property are constant. But the differences in the average rates that have emerged are small, compared with the ones observed by Bateman and Weiss. For example, the average rates I have obtained in four of the years are

| | *1840* | *1860* | *1880* | *1900* |
|---|---|---|---|---|
| Agriculture | 11.6% | 11.0% | 9.4% | 7.6% |
| Manufacturing, mining, and hand trades | 13.0 | 12.6 | 10.9 | 9.4 |
| All other | 13.2 | 12.5 | 10.7 | 8.9 |

Bateman and Weiss (1981, 116) report rates of return for large manufacturing firms of 17% in 1850, and 21% in 1860.

15. Gallman 1966, 35, variant I. The estimates are available in constant prices only. Current price estimates were made by assuming that the ratio of improvements to farm value added was the same in current and constant prices. The average value of improvements for 1834–43 was taken to correspond to the value of improvements in census year 1839, and so forth. The ratio of the value of improvements to the value of farm value added in 1859 was estimated on the basis of

other" sector was formed by adding to total value added by services (taken from volume 34 of Studies in Income and Wealth), value added by construction (drawn from volume 24 of Studies in Income and Wealth, construction variant A), and then subtracting the value of shelter and value added by the hand trades. The value of shelter was dropped because the production of shelter involves the use of practically no labor and therefore the value of shelter should not figure in the estimation of sectoral labor quality weights. Value added by the hand trades was added to value added by manufacturing and mining, taken from volume 24.

The gross rate of return for each type of property is composed of the net rate plus depreciation (if any). The following depreciation rates were assumed: Land, 0; animals, 0; buildings, fences, irrigation, and drainage works, 2 percent; land clearing and breaking, 0; tools and equipment, 6.67 percent. The net rate of return was taken to be 10 percent in 1860 and was adjusted in the other years on the basis of an index number of the rate of return on New England municipal bonds (Homer 1963, 287–288, linked at 1857–59 to Boston City 5s, 305).

The labor force data were drawn from Weiss's paper in this volume. The division of the nonfarm labor force between the two nonfarm sectors was based on Lebergott (1964).

The adjustment for changes in agricultural work hours was based on data in Gallman (1975, 73), and the David, Lebergott, and Weiss series. From Gallman (1975, 73, inclusive of improvements, variant B), and the David and Lebergott farm labor force series, it was possible to compute an index of the hours worked by farm laborers in 1800, 1850, and 1900. With this index and the Weiss farm labor force in each of these three years, an index of the number of hours worked per worker was computed. Index numbers for the missing intermediate years were interpolated on a straight line. The index for 1774 was assumed to be the same as the index for 1800. The aggregate quality-adjusted labor force series were then adjusted for changes in the number of hours worked by multiplying them by the index of hours worked per worker.

The procedure adopted to make estimates of the elasticities of output with respect to inputs was similar to the one by which labor and property incomes were computed for the three sectors (see above). The only difference was that the calculations were made at the national, not the sectoral, level and that components of capital left out of the sectoral calculations—inventories, the international sector—were here added back in.

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the ratio of improvements, 1849–58, and farm value added 1854. A similar procedure was followed to obtain the ratio for census year 1869.

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## Comment

Stanley L. Engerman

Robert Gallman here uses measures of the capital stock to estimate and describe the pattern of economic growth in the United States from the Revolutionary period to the end of the nineteenth century. The measures represent a continuation of his ongoing work, previously published in several places.[1] In these earlier publications he has presented many of the details of calculation for the 1840 to 1900 estimates, as well as described the various concepts and tests going into their preparation. In general, most of these problems are well-known and ably discussed, so there can be little new to say here in regard to the major issues. Following another remark of Giffen's, we can only compliment Gallman for doing the best that can be done with the limited data available, and though the "figures are necessarily rough," they make "a little clear what would otherwise be most dark, and they suggest problems for inquiry which would not otherwise be thought of." For "the figures, though rough, can be reasoned on safely with care."[2]

There is one initial point about the basic concept of capital that Gallman uses that is worth noting. His measures are restricted to variants of physical capital. There are no estimates of human capital, even of the slave population for which market values do exist. But, compared to the familiar constructs of Goldsmith, Gallman's measure is not of all tangible wealth, since he does not

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1. Robert E. Gallman, "The United States capital stock in the nineteenth century," in *Long-term factors in American economic growth,* ed. Stanley L. Engerman and Robert E. Gallman, NBER Studies in Income and Wealth, 51 (Chicago: University of Chicago Press, 1986), 165–206; and "Investment flows and capital stocks: U.S. experience in the nineteenth century," in *Quantity and quiddity: Essays in U.S. economic history in honor of Stanley L. Lebergott,* ed. Peter Kilby (Middletown, Conn.: Wesleyan University Press, 1987), 214–54.

2. Robert Giffen, *Growth of capital* (London: George Bell and Sons, 1889), 157.

include all of the value of land, nor is it all reproducible tangible wealth, since he does include some of the value of land.[3] Rather, Gallman's estimates include the value of improvements made to land, approximately equal in some years, it turns out, to the market value of improved land. Although Gallman's measure does omit the value of privately owned unimproved land and the "pure rent" on the acres improved, in most years the value of improved land represents the largest part of the total value of land. Thus the distinction between the Goldsmith and the Gallman treatments of land, while interesting and important, will not seriously distort most long-term comparisons.

Gallman uses the capital stock both as a means of measuring economic growth, for a period of time for which the basis of income measurement is not readily available, and as part of the explanation of the nature of economic growth, using capital stock measures with related input data to describe the patterns of change. There are some points to consider in the use of changes in the capital stock to measure changes in income level, as well as some differences between measures of potential income (which is perhaps the most desired measure of economic growth), observed (measured) income, and capital. There are choices made out of potential income that influence observed income and the observed capital stock. The choices between goods and leisure, and decisions in regard to fertility, clearly influence measured output per capita, as do the effects of intensity avoidance, risk avoidance, and market avoidance upon the product mix and thus potential income forgone. Capital, being based upon the amounts of income not consumed in the past, will have a different growth rate than income if there are changes in the savings rate over time. In addition, in considering the effects of savings upon the capital stock and its measured potential for future growth, it is also necessary to consider the form that these savings and investments take, and the related differences in types of assets and in their longevity. Savings can be used to provide either producer durables or consumer durables (the latter are omitted by Gallman, except for dwellings). It has, for example, been argued that in English history the level of savings was long sufficient to have financed the industrial revolution, but that a change in its structure and composition was needed for long-term growth.[4] Further, as Gallman points out, the longevity of capital will influence the breakdown between gross and net investment, and of the available capital stock. Estimates of asset durability and obsolescence are not, as Gallman notes, independent of the performance of the economy and its rate

3. See, for example, Raymond W. Goldsmith, "The growth of the reproducible wealth of the United States of America, 1805 to 1905," in *Income and wealth of the United States: Trends and structure*, ed. Simon Kuznets, Income and Wealth Series, 2 (Cambridge: Bowes and Bowes, 1952), 247–328; and *The national balance sheet of the United States, 1953–1980* (Chicago: University of Chicago Press, 1982).

4. M. M. Postan, "Recent trends in the accumulation of capital," *Economic History Review* 6 (1935): 1–12.

of technical change. Kuznets suggests that one of the basic shifts from the premodern to the modern era was not in the gross investment rate, but rather reflected an increase in asset longevity, lowering capital consumption, and leading to a larger capital stock from the gross investment.[5]

How good a proxy for the rate of growth of income is the rate of growth of the capital stock? In the long-run, increases in both are part of modern economic growth, and high growth (relative to preindustrial times) of both will come together. In the United States, the capital stock generally grew more rapidly than did GNP throughout the nineteenth century (and, depending on which of the several variants used from table 2.4, possibly after 1774), accounting for the rising capital-output ratio over that period. For shorter intervals, however, there are also differences not only in magnitudes, but even in the comparative ranking of rates of change, and the periods of acceleration or deceleration can differ. Thus the choice between income and capital as a measure of growth can influence examinations of the turning points in the growth process. Nevertheless, since for the period before 1840 it seems more possible to build up capital estimates from probate inventories and tax reports than to generate income data when no census production (or labor force) data are available, clearly these capital stock estimates for the early period must provide an essential set of measurements to be used by economic historians in the quantitative study of economic growth.

Gallman's estimates indicate that the post-1840 years of the nineteenth century had rates of growth of the capital stock per capita more rapid than those in preceding years.[6] In particular, the 1840 to 1860 growth rate exceeded that of the pre-1840 years and, indeed, almost all twenty-year periods since. This is not the same as dating the acceleration of growth in 1840, since the most analyzed data are for 1774, 1805, and 1840 (with 1815 given less attention). Thus it is hard to pinpoint from the data exactly when after 1805 (or 1815) the growth spurt began, but clearly some increase in capital's growth rate occurred in the first half of the nineteenth century (for at least three of the four series shown in table 2.6). For the last quarter of the eighteenth century the capital stock probably also grew at higher rates than did income, particularly for the concept of capital that excludes land clearing. Note, also, that the 1774–1840 rate of increase of the U.S. capital stock was considerably above that for Great Britain in this period.[7]

5. Simon Kuznets, "Capital formation in modern economic growth (and some implications for the past)," in *Third International Conference of Economic History* (Paris: Mouton, 1968).

6. In general, unless otherwise stated, the comparisons will be based on the Gallman capital stock series including land clearing and breaking, with the consumer price index as a deflator. While most comparisons would not differ if any of the other series were used, some would require minor alteration.

7. C. H. Feinstein, "Capital formation in Great Britain," in *The Cambridge economic history of Europe* (Cambridge: Cambridge University Press, 1978), vol. 7, pt. 1.

The growth pattern of the U.S. capital stock was consistent with the general pattern of growth in income, which also had an acceleration in the interval between 1800 and 1840. Compared to Thomas Weiss's (chap. 1 in this volume) newest estimates of national income, and using the estimated capital stock including land clearing, capital grew at a more rapid rate than did income between 1800 and 1840, while both had considerably higher rates of growth after 1840 than before, with the shift upward in the growth of capital being sharper than that in income. Weiss has some acceleration in the growth of per capita income after 1820, consistent with Gallman's post-1815 acceleration in capital stock growth.[8]

Significant structural shifts in the composition of the capital stock occurred, particularly when looking at the measure of capital stock including the value of land improvements. The relative shares of the other four major components of capital changed relatively little prior to 1840, particularly in constant dollar measures. The share of land improvements declined sharply starting with the 1774 estimates, while a quite dramatic decline in the share of animal inventories began in 1840. (There was possibly a smaller reduction in the food obtained from these inventories.) Both declines reflect the relative reduction in the role of the agricultural sector in the economy. There was a sharp rise in the share of equipment in constant dollar estimates (influenced by the fall in the relative price of equipment compared to construction), which starts around 1840 and accelerates after 1870.

As noted, one cause of the shift in the structure of capital was the decline in the share of the agricultural sector in the nineteenth century, a decline that in the Weiss labor force estimates was particularly sharp in the period from 1840 to 1860. There was a considerably greater decline in the capital share in agriculture than in Weiss's labor force estimates for 1800 to 1860, and overall a larger, but smoother, decline after 1840 than that in the Lebergott labor force series. And, if we use equipment as a rough measure of modernization, the fact that in 1840 it accounted for only 6 or 8 percent of the constant dollar capital stock suggests that up to that time increased investment in this component had only a limited potential for influencing the overall measured rate of growth of the economy, a point also indicated by the estimates of the share of the labor force in manufacturing.

It will be useful to place some of the issues raised by Gallman's capital stock estimates in a broader international and intertemporal perspective, particularly in comparisons with the other major developing economy of the late eighteenth and early nineteenth century, Great Britain.

First, the United States had high growth rates in total and per capita capital stock from quite early years, rates of growth not achieved by many other countries until the period after World War II, a finding rather similar to that

8. Note that Margo (chap. 4 in this volume), whose series for real wages begins in 1820, finds a shift upward in real wages in the 1830s or (in his preferred series) the 1840s.

for the growth of income.[9] Indeed, U.S. capital stock, total and per capita, grew much more rapidly than did that for the "first industrial nation," Great Britain, between the late eighteenth century and the end of the nineteenth.

Second, the high U.S. capital stock growth was accomplished with, before 1840, a savings ratio rather low by later standards.[10] The U.S. ratio of savings to income was probably lower than that of the British in the years between 1760 and 1840, the British ratio rising somewhat earlier (between 1760 and 1800) than that of the United States. After 1840 the U.S. ratio rises, sharply after the Civil War, and remains high through the remainder of the nineteenth century. Unlike the United States savings ratio the British ratio remained basically unchanged throughout the nineteenth century. The United States had, by the late nineteenth century, the highest savings rate among developed countries, rates not reached by many countries until after World War II.

Third, while the United States had a slightly higher share of land in total tangible wealth at the start of the nineteenth century than did Great Britain, in subsequent years of the nineteenth century both countries had roughly similar declines in the land share, although there was significant decade-to-decade variability. What might seem noteworthy, given the major differences in geographic expanse, industrial structure, and so forth, is the relative smallness of the intercountry differences in the shares of land in total wealth.

Fourth, the United States had a considerably lower capital-output ratio than did Great Britain (and the rest of the world) in the nineteenth century. Of the twenty countries for which Goldsmith provides data on capital-output ratios for net tangible assets, no country before 1939 had a capital-output ratio as low as that of the United States in 1850, with the exception of India.[11] The United States had, at the onset of growth, probably the lowest average ratio of capital to output of all developing countries; the British ratio of tangible wealth to income in 1800 was several times that of the United States. Post-1840, however, there were sharp rises in the United States in both the rate of savings out of current income and the ratio of capital to output. By the end of the century the U.S. capital-output ratio was among the lower, but was by no means the lowest, among developed countries. For the British, the capital-output ratio fell sharply throughout the century. The relative differences in the movement of output growth per unit of capital growth pose some interesting comparative questions for studies of the sources of growth.

Gallman's basic findings regarding the growth of the capital stock and its acceleration in the first part of the nineteenth century present a pattern similar to that of the growth of income, and all of this seems quite plausible given

9. See Raymond W. Goldsmith, *Comparative national balance sheets: A study of twenty countries, 1688–1978* (Chicago: University of Chicago Press, 1985).

10. See Lance E. Davis and Robert E. Gallman, "Capital formation in the United States during the nineteenth century," in *The Cambridge economic history of Europe* (Cambridge: Cambridge University Press, 1978), vol. 7, pt. 2. Gallman, "United States capital stock."

11. Goldsmith, *Comparative national balance sheets.*

other sources and the present state of knowledge. Thus the consistency is somewhat reassuring.

These capital stock estimates for the early national period pose many familiar historical questions, which Gallman has discussed here and elsewhere.[12] How were they financed? What individual behavior led to this new level of savings and investment? Did this require the formation of new institutions and legal provisions? And, given the role of land clearing and its importance, how much did it cost in terms of forgone output or was it, for the most part, forgone leisure? And, if the latter, was this increase in investment in improvements undertaken due to a taste change in favor of goods or was it due to a shift in the opportunity cost of time? Thus, as Gallman suggests, what seem for some purposes to be interesting questions for measurement are also significant issues for the broad understanding of the historical process.

12. As have Davis and Gallman in "Capital formation in the United States."