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CHAPTER SEVEN

Agriculture

7.1. Introduction

This chapter focuses on agriculture, detailing the estimation of the current-price and constant-price (1860) values of the capital stock on a decadal basis from 1840 to 1900. It includes buildings, equipment, animal inventories, and land improvements.

7.2. Buildings

7.2.1. Coverage

Barns, sheds, residences, and all other farm structures are included in the estimates of the capital stock. Capital formed by other types of improvements to the land—initial clearing and breaking, draining, irrigating, and fencing—is discussed in the section below headed "Other Improvements to Farmland."

7.2.2. Sources of Evidence

From 1850 through 1900, census enumerators were to ask farmers to estimate the value of the farms they worked. In 1850 and 1860 the "cash value" of the farm was to be returned; in 1870 the "present cash value"; in 1880 and 1890 the value ("fair market value," according to the 1890 instructions to enumerators) "including land, fences, and buildings"; and

Gallman wrote this chapter. "We" and "our" refers to Gallman and Howle. Rhode made minor revisions and contributed the epilogue.

in 1900 the "value . . . of the entire farm (including all owned or leased land contained therein, together with the value of buildings and other permanent improvements)." While the wording of the questions and the instructions to enumerators changed somewhat, it appears that the underlying concept—market value of farmland and permanent improvements thereto—did not change over the years (Wright 1900, 235–38, 278, 293; US Bureau of the Census 1902, 758–59; Kuznets 1946, 213). Furthermore, the question was asked of the person most likely to know the answer, and the concept of value selected made the answer easier to come by, in most cases, than alternative concepts would have made it. We believe that these are among the more reliable of the census wealth returns.

In 1900, for the first time, the census asked for a separate statement of the value of farm buildings. Our main problem of estimation was therefore to devise a way to extract the value of buildings from the larger aggregate, "the value of farms," for 1850 through 1890. We faced a similar—but somewhat less severe—problem with respect to 1840. The 1840 census did not return the value of farms. However, a reliable, well-informed contemporary student of that census, Ezra Seaman, prepared a plausible estimate of the value of farm and nonfarm residences and outbuildings (presumably including barns). We used his estimate, but again had to extract the value of farm buildings from a larger aggregate (Seaman 1852, 282).

7.2.3. Estimating Procedures

Three scholars have previously attempted estimates of the value of farm buildings in the nineteenth century. Simon Kuznets (1946, 202) extrapolated the ratio of the value of farm buildings to the value of farm real estate from the twentieth century back to 1880, and then used the extrapolated ratio to estimate the value of farm buildings in 1880 and 1900. Martin Primack (1962) followed a similar procedure, but improved it by employing nineteenth-century data (from a number of states) on the ratio of farm building value to farm real estate value. Alvin Tostlebe (1957, 54–57, 66–69) estimated the values of farm buildings (1870 onward) based on the assumption that the real value of buildings per farm remained constant prior to 1900.[1] The Kuznets and Primack estimates are very close. The Primack and Tostlebe figures, though at different levels, describe similar trends. This consistency is reassuring. We chose to use Primack's figures because they cover the full period, 1850–1900, and because they rely much more on nineteenth-century evidence than do the Kuznets and Tostlebe estimates.

The procedure we adopted to separate farm from nonfarm buildings in 1840 is described in chapter 9 (especially table 9.9).

7.2.4. Deflation

The best available deflator is Dorothy Brady's (1966, 110–11) index of the prices of houses, churches, and schools, which is a true price index, a rarity among construction indexes. It presents several problems, however.

First, it is an index of the prices of new structures, whereas the stock of farm buildings, the value of which we wished to deflate, consisted of both new and old structures. Of course, one would expect the prices of new and old structures to move roughly together, but not precisely so. In particular, changes in the rate of interest lead to changes in the age structure of the prices of capital goods. But we know of no index of prices of old and new structures, let alone one properly weighted for our present purposes, and we were therefore obliged to make do with an index of the prices of new structures.

Second, Brady's index numbers before 1860 refer to census years, which run from 1 June in a year ending in nine to 31 May in a year ending in zero; after 1860, they refer to the calendar years ending in nine. Census capital valuations, however, refer to 1 June in years ending in zero. Thus, the Brady index numbers are centered on dates either six months or eleven months prior to the census valuation dates. We dealt with this problem by building up, at each relevant calendar and census year, a construction cost index number (1860 = 100) based on input prices, and by adjusting Brady's price index on the basis of this series. For example, according to this series, construction prices were 0.9 percent higher in calendar year 1850 than in census year 1849. We therefore raised Brady's census year 1849 price index number by 0.9 percent, to convert it to a price index for calendar year 1850, and we accepted the calendar indexes as adequate proxies for the required 1 June indexes. All of the required adjustments are modest.[2]

A third problem is that Brady's index numbers refer to a group of structures ("houses, churches, and schools") that differs from the group of structures ("farm houses, barns, and sheds") whose value is to be deflated. Presumably "farm houses, barns, and sheds"—particularly in the early years of the period—would often have been built by farm labor, unlike the nonfarm houses, churches, and schools represented in the price

TABLE 7.1 **Building price and cost indexes, measured in 1860 prices, 1840–1900**

		Calendar year						
		1840	**1850**	**1860**	**1870**	**1880**	**1890**	**1900**
1	Adjusted Brady price index		96	100	128	130	135	
Building costs indexes								
2	Artisan labor	81	89	100	172	135	152	162
3	Farm wage	81	85	100	133	98	111	112*
4	Weighted average	81	86	100	146	117	132	137

Note: *1899
Sources: Lines 1, 2, and 4, see text. Line 3, the Warren-Pearson building materials index (see text) and the Lebergott (1964, 539) farm wage index were used; the weighting scheme is described in the text for the "artisan labor" index. Lebergott has no farm wage rate for 1840. We estimated an 1840 value by averaging the 1830 and 1850 figures.

index. In order to test the proposition that this would be important if true, we assembled two construction cost indexes: one depending on artisan labor, the other on farm labor. The two tell somewhat different stories of the evolution of construction costs (table 7.1). However, the adjusted Brady index does not track the "artisan labor" index much better than it does the "farm labor" index; in two of the four nonbase years, the adjusted Brady index lies between the "artisan labor" and "farm labor" indexes. We experimented and found that weights shifting from 3 to 1 in 1850 ("farm labor" to "artisan labor"), to 2 to 1 in 1860 and 1870, and to 1 to 1 in 1880 through 1900 produced a set of averages that parallel the Brady index numbers better than does either cost index by itself. The direction in which these weights shift—away from "farm labor" and toward "artisan labor"—is certainly appropriate, given the history of farm construction. The test, therefore, although not powerful, does tend to support our using the Brady index as a deflator for the farm building series.

The final problem posed by the Brady series is that it contains no index numbers for the years 1840 and 1900. We chose to estimate these values by extrapolation on the weighted average construction cost index discussed in table 7.1. We used the following regression:

$$Y = 40.8 + 0.663X$$

where the Y's are the Brady index numbers and the X's are from the weighted index in table 7.1. The results are plausible: The index numbers for 1880, 1890, and 1900 are very close, a result also obtained by Kuznets

(1946, 216); the deflated value for 1840 implies a ratio of the real value of structures to the volume of improved farm land only modestly below the 1850 figure.

7.3. Agricultural Equipment

7.3.1. Coverage

This category includes all machinery, tools, and other equipment used in agriculture. See table 7.2.

7.3.2. Derivation of Estimates

1850–1900. The current value estimates were taken directly from the censuses of agriculture. We believe that they represent market value, and therefore we have deducted no depreciation.

1840. The constant price estimate for 1840 was obtained by extrapolation, and then inflated to yield a current price estimate. The value of agricultural buildings (1860 prices) increased 104.6 percent from 1850 to 1860, while our constant value equipment estimate rose by 115.8 percent. Assuming the same relationship between the two rates of change between 1840 and 1850, our building rate of increase of 42.8 percent for that period indicates an equipment rate of increase of 47.4 percent. These data and

TABLE 7.2 **Value of agricultural buildings and equipment, measured in current and 1860 prices, 1840–1900, in millions of dollars**

		1840	1850	1860	1870	1880	1890	1900
Agricultural buildings								
1	Value, at current prices	415	599	1,277	1,949	2,115	2,760	3,560
2	Price index (1860 = 100)	95	96	100	128	130	135	132
3	Value, at 1860 prices	437	624	1,277	1,523	1,627	2,044	2,697
Agricultural equipment								
4	Value, at current prices	119	152	246	337	407	494	750
5	Price index (1860 = 100)	152	132	100	117	84	64	55
6	Value, at 1860 prices	78	115	246	288	485	772	1,364

Sources: Lines 1–4, see text. Line 5, see text; the Brady index numbers were adjusted on the basis of data in US Senate 1893, 21112 (hereafter the *Aldrich Report*) (scythes, shovels) and US Bureau of the Census 1949, series L-9 and L-10. The adjustments were made multiplying the Brady price index numbers by the following ratios: 1839, 0.97; 1849, 1.00; 1869, 0.90; 1879, 1.10; 1889, 1.00; and 1899, 1.00. Line 6: 1840, see text. 1850–1900: 100 × line 4 ÷ line 5.

the 1850 equipment estimate of $115 million imply an equipment valuation of $78 million in 1840, expressed in 1860 dollars.

7.3.3. Deflation

The estimates were deflated (1840 inflated) by averages of Brady's (1966, 110–11) price indexes of "agricultural machines" and "agricultural implements" (equal weights). Since Brady has no "implements" index number for either 1839 or 1849, we interpolated between 1834 and 1844 and between 1844 and 1854 on the "machines" index to obtain the combined "implements" and "machines" index number for these dates. As indicated in section 7.2.4 above, the dates of the Brady index numbers are not entirely apposite for our purposes. We adjusted them according to a method described in the notes to table 7.2.

7.4. Animal Inventories

7.4.1. Coverage

This category includes all cattle, horses, mules, sheep, and swine on farms and ranges. See table 7.3.

7.4.2. Estimating Procedures

1870–1900. For the period 1870 through 1900, the most consistent and satisfactory source of evidence is the US Department of Agriculture, which provides information on the number of animals of each type in stock and the average value per head.[3] We preferred these figures to those provided by the census, which are less consistent from one decade to the next. Unfortunately, the USDA data refer to 1 January, whereas we require 1 June data. With respect to cattle and swine, there is a satisfactory method for translating 1 January numbers into 1 June numbers, and we have made use of it (US Department of Agriculture 1925, 838, 899).[4] However, there is no adequate way to convert the average value data or the numbers of horses, mules, and sheep into 1 June equivalents. Consequently, we left them unadjusted. Thus, our post–Civil War animal inventory estimates are not entirely consistent with either our estimates of other components of the capital stock or our figures on pre–Civil War animal inventories. These inconsistencies are not important, however. Sheep accounted for

TABLE 7.3 **Value of animal inventories, measured in current and 1860 prices, 1840–1900**

		1840	1850	1860	1870	1880	1890	1900
Cattle[a]								
1	Number, in millions[c]	20.0	24.5	34.1	32.8	45.7	63.4	63.3
2	Price, in dollars per head	8.03	10.00	13.78	22.84	17.80	16.95	26.5
3	Value at current prices, in millions of dollars	160.6	245	469.9	749.2	813.5	1,074.6	1,669.5
4	Value at 1860 prices, in millions of dollars	275.6	337.6	469.9	452.0	629.7	873.6	868.1
Swine[b]								
5	Number, in millions[c]	26.3	30.4	33.5	40.1	52.5	57.0	60.6
6	Price in dollars per head	1.49	1.29	2.92	5.64	4.40	4.80	5.36
7	Value at current prices, in millions of dollars	39.2	39.2	97.8	226.2	231.0	273.6	324.8
8	Value at 1860 prices, in millions of dollars	76.8	88.8	97.8	117.1	153.3	166.4	177.0
Sheep								
9	Number, in millions[c]	32.0	36.0	36.0	36.4	44.9	42.7	45.1
10	Price in dollars per head	1.40	1.55	2.70	1.87	2.18	2.29	2.97
11	Value at current prices, in millions of dollars	44.8	55.8	97.2	68.1	97.9	97.8	133.9
12	Value at 1860 prices, in millions of dollars	86.4	97.2	97.2	98.3	121.2	115.3	121.8
Horses								
13	Number, in millions[c]	4.24	4.77	6.87	7.63	10.90	15.73	17.86
14	Price in dollars per head	40.62	44.37	48.12	66.99	53.74	69.27	43.56

continues

TABLE 7.3 **(*continued*)**

		1840	**1850**	**1860**	**1870**	**1880**	**1890**	**1900**
Horses								
15	Value at current prices, in millions of dollars	172.2	211.6	330.6	511.3	585.8	1089.6	778.0
16	Value at 1860 prices, in millions of dollars	204	229.5	330.6	367.2	524.5	756.9	859.4
Mules								
17	Number in millions[c]	0.539	0.615	1.266	1.245	1.878	2.322	3.139
18	Price in dollars per head	52.07	56.87	61.68	89.71	61.74	77.61	51.46
19	Value at current prices, in millions of dollars	28.1	35.0	78.1	111.7	115.9	180.2	161.4
20	Value at 1860 prices, in millions of dollars	33.2	37.9	78.1	76.8	115.8	143.2	193.6
Total								
21	Value in millions of current dollars	444.9	586.6	1,073.6	1,666.3	1,844.1	2,715.8	3,067.7
22	Value, in millions of 1860 dollars	676	791	1,073.6	1,111.4	1,544.5	2,055.4	2,219.9
23	Implicit price index	65.8	74.2	100	149.9	119.4	132.1	138.2

Notes: Estimated from January 1 numbers, 31.1 million, 43.3 million, 60.0 million, and 59.7 million respectively. See text. Ratio of June 1 to January 1 values = 1.056. [b]Estimated from January 1 numbers, 33.8 million, 44.3 million, 48.1 million, and 51.1 million respectively. See text. Ratio of June 1 to January 1 values = 1.186. [c]As of June 1, except number of sheep, horses and mules, 1870–1900; prices, 1870–1900.
Sources: See text.

only a small part of the value of animal inventories, and the 1 June and 1 January values for horses and mules are unlikely to have differed by much.

1840–60. The census data on the numbers of each type of animal on farms and ranges in 1840, 1850, and 1860 have been tested by Gallman (1956), who concluded that the numbers of swine returned approximated 1 June inventories, while the numbers of cattle, horses, and mules returned were less than 1 June inventories by about 25 percent, 10 percent, and 10 percent respectively. We accepted the judgments of Gallman (1956, 114–15, 130–31); adjusted the cattle, sheep, horse, and mule inventories accordingly; and used his prices for each type of animal.

7.4.3. Constant Price Series

The constant price series were constructed by multiplying the number of each type of animal in each year by the 1860 average value of that type of animal. No allowance was made for changes in the quality of animals from one census date to the next. It is probable that the average quality of animals improved over time, except perhaps between 1860 and 1870. Thus, the constant price series probably understates the true long-term increase in the animal stock, but may overstate the increase between 1860 and 1870.

7.5. Other Improvements to Farmland

7.5.1. Coverage

Farmers improved land for agricultural purposes by clearing trees; breaking virgin land with the plow; and fencing, draining, irrigating, and constructing farm buildings. Buildings have been treated in section 7.2 above. The other elements of improvements are taken up in this section. The irrigation of rice land and other types of land are distinguished, since they called for quite different types of works in the nineteenth century.

7.5.2. Sources of Evidence and General Procedures

The censuses of 1850 through 1900 contain estimates of the value of farms, made by those who farmed them. We extracted the value of farm buildings from these figures, following a procedure developed by Primack (see section 7.2). Although in principle we might have estimated the value of other improvements in the same way, we chose instead to work out detailed estimates of the cost of these improvements, based on the value of physical inputs (current year and base year techniques).

Again we made use of methods devised by Primack, modified in two respects (Gallman 1956, ch. 2 and 4–6, appendix, 152–61, 196–98, 202–8, 214–18, 224–28, 231–32). Primack was concerned with investment flows, rather than with stocks. However, he provided enough evidence so that stock estimates could be worked out, and we did so. Also, Primack concerned himself exclusively with labor inputs to land improvement. Labor contributed the lion's share to the value of land clearing and breaking, draining, irrigating, and even fencing with farm materials, and in each of these instances we followed Primack and ignored nonlabor inputs.[5] Our estimates should therefore be slightly too low. In the case of fences made with nonfarm materials (e.g., boards, wire), ignoring nonlabor inputs would have produced important errors. We therefore estimated the volume and value of the principal materials used in these fences.

The procedures described above give reproduction cost estimates. That is, the current price figures show the cost of reproducing the existing stock of capital, given current-year techniques of production and input prices; the constant price figures show the cost of reproducing the existing stock, given 1860 techniques of production and prices. Thus, these estimates differ conceptually from all our other estimates of the value of agricultural capital and land, which are market-value estimates. In order to diminish the degree of conceptual heterogeneity, it was necessary for us to translate our gross reproduction cost estimates into net reproduction cost estimates; i.e., it was necessary for us to consider the matter of depreciation.

The improvements composed of land clearing and breaking do not physically deteriorate, so long as the land is properly maintained. The fertility of the soil may be depleted; but, strictly speaking, this process affects the land itself, not the improvements to it. Changes in markets may drive some land out of production so that, e.g., trees once again grow up on it. But this does not necessarily happen to any given piece of land, and most of the improved land in production today was probably first improved more than a century ago. One cannot, then, work out reasonable depreciation schedules for these improvements, and we therefore left them undepreciated. Our estimating procedure removed retirements (land allowed to go back to nature) from the stock, however.

With perhaps less warrant, we also left stone fences, hedges, and draining and irrigation works undepreciated. In each case it seemed reasonable to suppose that proper maintenance and repair would make good all physical deterioration of nineteenth-century improvements of these types. Obsolescence is unlikely to have affected them in a sufficiently systematic way to warrant applying a depreciation schedule. Retirements were excluded from the stock by our procedures.

Worm, post and rail, board, and wire fences were all subject to depreciation. We assumed a twenty-year service life (see below).

7.5.3. Detailed Estimating Procedures: Clearing and Breaking

(a) Introduction. The inputs required to clear and break land depend on its vegetation and on the techniques used to clear and break it. Primack points out that different types of forests posed different kinds of problems, that prairies and plains were unequally receptive to the plow, and that techniques varied across regions. But the data are inadequate to permit all of these distinctions to be made in an empirically meaningful way. Thus, Primack distinguished only among three types of improved land: land formerly forested, land formerly grassland or desert, and land cleared a second time from abandoned land grown up in forest (Gallman 1956, ch. 2). He measured the effect of changes in techniques of clearing and breaking, but did not deal with geographic variation in technique at a given moment. We generally followed Primack, but did not distinguish between land cleared of original forest, and land abandoned to forest and then subsequently cleared again—a distinction relevant if one is interested in investment flows (as Primack was), but not if one is interested in capital stock.

(b) Acres of forested and nonforested land cleared, 1850–1900. Primack established the number of improved farm acres at each census date, 1850–1900, from the reports of the Census of Agriculture. We also adopted these totals, except for the year 1880, at which census some meadowland (improved) was double-counted in the Middle Atlantic states (Gallman 1972a, 201).[6] We removed the duplication. We accepted Seaman's estimate of improved land for 1840 (Gallman 1972a, 201–2).[7]

Primack used a map in the *Atlas of American Agriculture*, together with census county data, to establish the original ground cover of land cleared in the period 1850–1900 (US Department of Agriculture 1924, 4–5). We used the same sources, but chose to work at regional and state levels rather than at the county level.

Some states were originally covered entirely in forest or grass, or at least virtually so. In these instances, assigning improved land to one of our two categories of original ground cover posed no problem. It was more often the case, however, that a state was originally covered partly in forest and partly in grass. Where a state first entered the census records after 1850, we distributed improved land between land originally forested and land originally in grass along lines established by Primack. Primack shows gross increments of each type of improved land between each pair of census years, and net increments of the two types of land taken together. We estimated the net acres of grassland improved during each decade using Primack's gross grassland increment, and his ratio of net to gross increment of forest and grassland together, the ratio being assumed to hold for each type of land as well as for the two taken together. We then cumulated the net figures for improved grassland, and derived net improved forest land figures as residuals.[8] In several of the Southern states, the volume of improved land fell between 1860 and 1870. We assumed that former grasslands and former forests were retired in equal proportions.

Where a state was already in the census records by 1850, it was necessary to distribute the 1850 total of improved land between land originally forested and land originally in grass. We did this in the following way.

First, we established the entire land area of the state, in acres. Then, with a ruler and the *Atlas* map (US Department of Agriculture 1924), we established the fraction of the state originally covered in grass. Multiplying this fraction by the entire land area produced an estimate of the number of acres originally under grass. Finally, we cumulated Primack's decadal increments to improved grassland, 1850–1910, and subtracted this figure from our estimate of the total grassland in the state. This gave us a rough estimate of the amount of grassland improved before 1850. These estimates are subject to error because the procedure ignores the possibility that some grassland was never broken or was first broken after 1910 (an unimportant source of error), and because it ignores "retirements" of grassland. But it is the best procedure available and is probably adequate. Its underlying assumption is that, ceteris paribus, grassland would be selected for clearing and breaking ahead of forest, because the investment involved would be smaller.

In the case of Mississippi, which had some prairie but also much rich, forested river bottom, one might expect the latter to be cleared and broken before the former, because it would be better cotton land. We checked our procedure to make sure that it did not produce results inconsistent with this view of things, and it did not. Our estimate of grassland cleared before 1850 in Mississippi is only a small fraction of the forest (presumably chiefly river bottom) cleared by that date.

In Missouri, by contrast, this procedure did not produce sensible results. We assumed that improved land in 1850 in that state was divided between land originally forested and land originally under grass in the same proportion as was the land cleared in the 1850s (according to Primack).

A number of ad hoc decisions were made.

Primack shows no prairie cleared in Arkansas after 1850, and it is doubtful that any was cleared before that date. Yet Arkansas does contain small amounts of prairie. We chose to ignore this land, which means, ceteris paribus, that our estimates of the value of land improvements in Arkansas are slightly too high. (Improvements to forest land cost more per acre than did improvements to prairie.)

Only five thousand acres were clear in Minnesota in 1850. We assumed that it had all been prairie. We also assumed that all California land improved as of 1850 had formerly been under grass, and all Texas and Oregon land improved as of that date had been under forest.

Primack's data on Oklahoma are inconsistent. We assumed that the total on Primack's page 153 was correct, and divided it between forest and grassland in the proportions shown on Primack's pages 157 and 159.

There are a number of small inconsistencies in Primack's work: tables that do not sum to the totals given, and so on. To correct them all would have required redoing much work, with little substantive gain. Instead, we chose between inconsistent results on the best bases we could find for judgment. We do not believe that these shortcuts substantially reduced the accuracy of our final estimates.

(c) Acres of forested and nonforested land cleared, 1840. We accepted Seaman's estimate of the number of improved acres in 1840 and made a rough division of it among New England, the Middle Atlantic States, the South Atlantic, the East and West North Central, and the East and West South Central, on the assumptions that the totals increased only slightly in the first three regions between 1840 and 1850, more pronouncedly in the fourth and fifth, and quite dramatically in the last two. We assumed that all the improved land in the first three regions in 1840 had formerly been forested land. We distributed the totals between the two types of land in the last four regions in the proportions in which they were distributed in 1850. The estimates are very rough, much more so than is true of the other years.

Table 7.4 contains our estimates of improved land, 1840–1900, by region and by type of original ground cover. The regional definitions follow those of US Bureau of the Census (1960), series A-123 to A-180, rather than those of Primack, for reasons that will become apparent.

(d) Physical inputs into clearing and breaking land. It is probable that most of the cost of clearing and breaking was labor cost. We took into account only the labor requirements, ignoring costs of capital such as oxen, horses, and various tools.

According to Primack (1962, 28), it took about 32 man-days to clear an acre of forest land in 1860 (and earlier); this figure gradually dropped to 26 man-days by 1900 as techniques improved. Grassland was much

TABLE 7.4 **Improved land in farms, by region and by type of original ground cover, 1840–1900, in millions of acres**

	1840	1850	1860	1870	1880	1890	1900
Forest cover							
New England	10.0	11.15	12.22	12.00	13.15	10.74	8.13
Middle Atlantic	19.5	22.80	26.77	29.12	30.74	31.60	29.79
East North Central	11.2	17.17	29.47	38.30	53.66	57.57	63.85
West North Central	0.8	1.20	2.12	4.30	8.06	10.25	13.02
South Atlantic	28.5	30.01	34.90	30.20	36.16	41.67	46.10
East South Central	8.8	17.25	24.02	22.71	29.04	33.77	38.09
West South Central	1.5	3.02	6.94	6.48	14.02	21.89	26.18
Mountain	—	0	0	0	0	0	0
Pacific	—	0.13	1.91	2.97	5.5	6.43	6.85
Totals	80.3	102.73	138.35	146.08	190.33	213.92	232.01
Grass cover							
East North Central	2.8	5.74	11.72	16.60	21.93	21.20	22.82
West North Central	1.2	2.57	9.00	19.20	53.20	95.27	122.63
South Atlantic	0	0	0	0.01	0.01	0.01	0.02
East South Central	1.0	1.77	1.87	1.51	1.78	1.96	2.15
West South Central	0	0	0.40	0.39	4.96	8.66	13.59
Mountain	—	0.18	0.24	0.58	2.21	5.46	8.40
Pacific	—	0.03	1.54	4.56	7.85	11.13	12.91
Totals	5.0	10.29	24.77	42.85	91.94	143.69	182.52
Grand total	85.3	113.02	163.12	188.93	282.27	357.61	414.53

Sources: See text. Primack's data do not square exactly with census data. We adjusted them to cope with this problem. We also adjusted the census data of 1880 to eliminate double counting by the census (see Gallman 1972).

easier to improve, taking about 1.5 man-days per acre in 1860 and earlier, and only 0.5 man-days by 1900. We converted these coefficients to man-months (26 days per month) per acre—which, when applied to the data in table 7.4, yield estimates of the total man-months required to clear, remove tree trunks, and break the improved land reported at each census year, given the techniques of that year. A second set of calculations was made showing the total man-months required to carry out the same procedures, given the techniques of 1860.

These estimates (not shown) clearly overstate the true reproduction cost of land improvements, since they rest on the assumption that all improved land reported at each census had been cleared of trees and stumps and been broken. In fact, however, stumps were typically left in the ground to rot for five to twenty-five years before they were removed (see chapter 4). Thus, a substantial part of the improved land reported in any given census year probably contained stumps. Furthermore, Primack's antebellum estimate of stump-clearing requirements depends on slender evidence and seems somewhat high, while his more abundant postbellum evidence can be given a more optimistic reading than he gave it.

For these reasons we decided that, for our purpose, Primack's stump-clearing estimates should be reduced. How far they should be reduced is by no means clear. We marked them down to one-third of their original value. The adjusted estimates appear in table 7.5.

(e) Valuation. We used Lebergott's (1964, 141, 262, 539) rates of monthly wages paid to farm laborers, adjusted upward by one-half to include the value of board. The Lebergott series have the great virtue of being available at the regional level, and we made use of these regional averages. Lebergott does not have data for 1840 or 1900. For 1840 we used the means of the 1830 and 1850 wage rates; for 1900 we used 1899 wage rates. There is no average for the Mountain region for 1870; we used the Pacific average to fill the gap. The Mountain wage rates for 1850 and 1860

TABLE 7.5 **Labor embodied in the clearing and breaking of improved land, using current techniques and techniques of 1860, 1840–1900, in millions of man-months**

	1840	1850	1860	1870	1880	1890	1900
A. Current techniques							
New England	9.23	10.29	11.28	10.92	11.80	9.36	6.88
Middle Atlantic	18.00	21.05	24.71	26.51	27.58	27.55	25.21
East North Central	10.50	16.18	27.88	35.51	48.78	50.81	54.47
West North Central	0.81	1.26	2.48	4.65	8.77	11.69	13.38
South Atlantic	26.31	27.07	32.22	27.49	32.45	36.33	39.01
East South Central	8.18	16.03	22.28	20.73	26.11	29.50	32.27
West South Central	1.38	2.79	6.43	5.91	12.72	19.34	22.41
Mountain		0.01	0.01	0.02	0.06	0.16	0.16
Pacific		0.12	1.85	2.88	5.16	5.93	6.04
Totals	74.41	95.43	129.14	134.62	173.43	190.67	199.83
B. Techniques of 1860							
New England	9.23	10.29	11.28	11.08	12.14	9.91	7.50
Middle Atlantic	18.00	21.05	24.71	26.88	28.38	29.17	27.50
East North Central	10.50	16.18	27.88	36.31	50.80	54.36	60.26
West North Central	0.81	1.26	2.48	5.08	10.51	14.96	19.09
South Atlantic	26.31	27.70	32.22	27.88	33.38	38.47	42.56
East South Central	8.18	16.03	22.28	21.05	26.91	31.29	35.28
West South Central	1.38	2.79	6.43	6.00	13.23	20.71	24.95
Mountain		0.01	0.01	0.03	0.13	0.32	0.48
Pacific	no data						
Totals	74.41	95.43	129.14	137.31	181.01	205.77	224.69

Sources: See text.

TABLE 7.6 **Monthly farm wage rates, including the value for board, 1840–1900, in dollars**

	1840	1850	1860	1870	1880	1890	1900
New England	18.44	19.47	22.10	29.76	20.91	26.67	27.30
Middle Atlantic	14.77	16.76	19.13	26.84	20.57	23.64	23.97
East North Central	15.13	17.16	20.69	25.41	23.22	23.88	25.35
West North Central	16.61	18.00	20.64	25.65	22.32	23.76	27.06
South Atlantic	11.52	12.30	16.62	14.93	13.22	14.19	13.98
East South Central	14.23	14.40	21.09	19.17	15.24	15.87	16.08
West South Central		16.92	23.30	21.08	19.35	19.26	17.79
Mountain		11.18	26.20	43.79*	37.11	32.51	39.50
Pacific		102.00	51.24	43.79	37.16	33.96	37.65

Note: *Mountain 1870 based on Pacific 1870.
Sources: See text.

are weighted averages of the wage rates for New Mexico and Utah, the weights being drawn from the relative amounts of improved land in the two states.

The wage data are displayed in table 7.6. Table 7.7 contains our estimates of the value of farm land improvements (clearing and breaking), in current and constant prices, derived from tables 7.5 and 7.6. Both input prices and techniques were held constant in producing the estimates expressed in 1860 values.

7.5.4 Detailed Estimating Procedures: Fences

(a) Introduction. We began by establishing the rods of fencing of each type (worm, post and rail, stone, hedge, board, wire) in existence at each census date; the labor required to replace this fencing, given current and 1860 techniques of construction; the materials needed to carry out the replacements; the cost of the required labor and materials, expressed in current and constant (1860) prices; and the depreciation that the fencing had experienced. With this information, we were able to work our gross and net reproduction cost estimates for farm fences. Because tests suggested that these estimates were too low, we derived an adjustment to improve them.

(b) Rods of fencing. We used Primack's estimates of rods of fencing of each type (1962, 206–7) for the census years 1850 through 1880. For 1890 and 1900, Primack (1962, 207) provides the necessary information for every region except New England and the Middle Atlantic, for which Primack (1962, 197) shows only the total rods of fencing of all types.

We extended his 1880 proportions among types in these two regions to 1890 and 1900, modifying them slightly according to the pattern of prior change and Primack's (1962, 208) notes to his table.[9] We estimated the number of improved acres by region (Primack's definitions) in 1840, along lines described in Section 7.5.3.c, and assumed that the rods of fencing per improved acre were the same in each region in 1840 as in 1850. We then distributed fencing (by region) among types of fencing as we had done for 1890 and 1900.

Since plain and barbed wire fences used different amounts and qualities of material per rod, we were obliged to divide wire fencing between

TABLE 7.7 **Value of agricultural land improvements (clearing and breaking), measured in current and 1860 prices, 1840–1900, in millions of dollars**

	1840	1850	1860	1870	1880	1890	1900
Value, at current prices							
New England	170.2	200.3	249.3	325.0	246.7	249.6	187.8
Middle Atlantic	265.9	352.8	472.7	711.5	567.3	651.3	604.3
East North Central	158.9	277.6	576.8	902.3	1,132.7	1,213.3	1,380.8
West North Central	13.5	22.7	51.2	119.3	195.7	277.8	362.1
South Atlantic	303.1	340.7	535.5	410.4	429.0	515.5	545.4
East South Central	116.4	230.8	469.9	397.4	397.9	468.2	518.9
West South Central	19.6*	47.2	149.8	124.6	246.1	372.5	398.7
Mountain	0	0.1	0.3	0.9	2.2	5.2	6.3
Pacific	0	12.2	94.8	126.1	191.7	201.4	227.4
Totals	1,047.6	1,484.4	2,600.3	3,117.5	3,409.3	3,954.8	4,231.7
Value, at 1860 prices							
New England	204.0	227.4	249.3	244.9	268.3	219.0	165.8
Middle Atlantic	344.3	402.7	472.7	514.2	542.9	558.0	526.1
East North Central	217.2	334.8	576.8	751.3	1,051.1	1,124.7	1,246.8
West North Central	16.7	26.0	51.2	104.9	216.9	308.8	394.0
South Atlantic	437.3	460.4	535.5	463.4	554.8	639.4	707.3
East South Central	172.5	338.1	469.9	443.9	567.5	659.9	744.1
West South Central	32.2	65.0	149.8	139.8	308.3	482.5	581.3
Mountain	0	0.3	0.3	0.8	3.4	8.4	12.6
Pacific	0	6.1	94.8	153.7	283.4	337.2	362.3
Totals	1,424.2	1,860.8	2,600.3	2,816.9	3,796.6	4,337.9	4,740.3

*Valued using the average wage for the East South Central region.
Sources: Derived from tables 7.5 and 7.6. See text.

these two types.[10] We did this by cumulating the production of barbed wire, assuming that it all went into agriculture and that no barbed wire fence was retired before 1900. The tendency of the procedure to lead to an overestimate of barbed wire fencing in place is at least partly offset by our inability to establish production before 1880 (production began in 1874 or 1876). For present purposes the estimates, while rough, are certainly adequate.[11]

Table 7.8, panel A, contains our estimates of rods of fencing, 1840–1900, by type.

TABLE 7.8 **Derivation of estimates of the value of fencing, measured in current and 1860 prices, 1840–1900**

		1840	1850	1860	1870	1880	1890	1900
A. Rods of fencing, in millions								
1	Worm	634.40	861.75	1,019.5	1,031.80	1,232.90	1,177.3	1,147.30
2	Post and Rail	63.60	98.91	1,22.09	150.07	173.83	133.92	92.58
3	Hedge			23.14	54.08	76.52	38.48	57.61
4	Stone	56.40	74.41	85.43	89.00	91.92	57.04	54.51
5	Board	26.44	53.37	107.2	186.71	369.67	625.81	758.57
6	Wire							
a	Plain			46.64	108.58	177.79	285.74	863.55
b	Barbed						519.17	1,229.30
B. Labor requirements, in thousands of man-months, using current techniques								
1	Worm	9,760	13,258	15,684	15,873	18,967	18,112	17,651
2	Post and Rail	832	1,293	1,597	1,962	2,273	1,751	1,211
3	Hedge			329	770	1,089	548	820
4	Stone	4,338	5,724	6,572	6,846	7,071	4,388	4,193
5	Board	203	411	825	1,436	2,844	4,814	5,835
6	Wire			161	376	547	2,477	4,829
7	Total	15,133	20,686	25,168	27,263	32,791	32,090	34,539
C. Labor requirements, in thousands of man-months, using 1860 techniques								
1	Wire	0	0	161	376	615	2786	7244
2	Total, B(1) (5) + C(1)	15,133	20,686	25,168	27,263	32,859	32,399	36,954
D. Average monthly wage		15.09	17.26	20.42	23.72	19.25	20.94	21.52
E. Labor cost of fences, value at current prices, in millions of current dollars (line B7 × line D)		228.36	357.04	513.93	646.68	631.23	671.96	743.30
F. Labor cost of fences, value at 1860 prices, in millions of 1860 dollars (line C2 × Line D for 1860)		309.02	422.41	513.93	556.71	670.98	661.59	754.60

TABLE 7.8 ***(continued)***

	1840	1850	1860	1870	1880	1890	1900
G. Rods of board (in millions) in board and wire fences (line A5 × 4.5 + line A6 × 3)	118.98	240.17	622.32	1,165.90	2,196.90	5,230.90	9,692.10
H. Rods of plain wire (mil) in plain wire fences (line A6a × 7)	0	0	326.48	760.06	1,244.50	2,000.20	6,044.80
I. Rods of barbed wire (mil) in barbed-wire fences (line A6b × 4)	0	0	0	0	0	2,076.70	4,917.20
Price per rod of							
J. board	0.189	0.1706	0.1786	0.2851	0.2181	0.231	0.2296
K. plain wire			0.0578	0.0733	0.055	0.0367	0.0326
L. barbed wire					0.1094	0.406	0.0364
M. Value of board in fences, at current prices, in millions of dollars, panel G × panel J	22.49	40.97	111.15	332.41	479.14	1,208.30	2,225.30
N. Same, at 1860 prices	21.25	42.89	111.15	208.24	392.36	934.24	1,731.00
O. Value of plain wire in fences, at current prices, in millions of dollars, panel H × panel K	0	0	18.87	55.71	68.45	73.41	197.06
P. Same, at 1860 prices	0	0	18.87	43.93	71.93	115.61	349.39
Q. Value of barbed wire in fences, at current prices, in millions of dollars, panel I × panel L	0	0	0	0	0	84.31	177.51
R. Same, at 1860 prices	0	0	0	0	0	120.03	284.21
S. Total value of fences, gross reproduction cost, at current prices, in millions of dollars, panels E + M + O + Q	250.85	398.01	643.95	1,034.8	1,178.8	2,038.0	3,343.2
T. Same, at 1860 prices, panels F + N + P + R	330.27	465.3	643.95	808.88	1,135.3	1,831.5	3,119.2
U. Adjusted value of fences gross reproduction cost, at current prices, in millions of dollars	502.2	769.93	1,205.0	1,747.6	1,876.5	2,792.0	4,163.9
V. Same, at 1860 prices	669.86	936.82	1,205.0	1,415.3	1,866.8	2,555.1	3,894.0
W. Adjusted net value of fences reproduction cost, at current prices, in millions of dollars	318.06	432.44	718.86	956.78	1,149.1	1,596.4	2,588.5
X. Same, at 1860 prices	424.24	526.17	718.86	774.88	1,143.2	1,461.0	2,420.8

Sources: See text.

(c) Labor requirements. Primack (1962, 82) gives estimates of man-days required to build a rod of fencing, by type of fence, at each census date. The estimates include the labor time required to prepare farm materials, when appropriate: felling trees, splitting rails, removing stones from fields, and so on. For these types of fences (worm, post and rail, hedge, stone), there was no need to develop materials cost estimates. For plain, barbed, and woven wire fences, table 7.9 provides the estimated required man-days per rod in each period. We converted Primack's coefficients to man-months by dividing through by twenty-six. We then multiplied the results by the number of rods of each type of fence in place at each census date, to produce estimates of the man-months of labor required to reproduce farm fencing.[12] Since labor requirements for wire fence declined over time with improved techniques, we made two sets of estimates, one given current techniques, the other given techniques of 1860. The results are contained in table 7.8, panels B and C.

(d) Labor costs. Once again we used Lebergott's wage data as described in section 7.5.3.e, weighted by regional labor requirements. We computed weights for 1850 and 1880 from regional data on labor requirements for fencing, and interpolated and extrapolated these weights to the other years. The Lebergott (wage data) and Primack (weights) regional definitions are virtually identical for the New England, Middle Atlantic, South Atlantic (Southeast), and Pacific regions, and for all practical purposes they are very close for the Mountain and East South Central (South Central) regions. We matched Lebergott's East North Central to Primack's North Central, Lebergott's West North Central to Primack's Prairie and Lake, and Lebergott's West South Central to Primack's Southwest. This array comes close to achieving a weighting scheme precisely appropriate for the problem at hand. The regional weights are summarized in table 7.10. The weighted average wage rates (adding one-half to take account of the value of board) are contained in table 7.8, panel D. Panels E and F

TABLE 7.9 **Estimated required man-days per rod of fencing, 1850–1900**

	1850	1860	1870	1880	1890	1900	1910
Plain	0.09	0.09	0.09	0.08	0.08	0.06	0.04
Barbed				0.08	0.08	0.06	0.04
Woven					0.09	0.06	0.04

Source: Primack 1962, 82.

TABLE 7.10 **Regional weights, 1840–1900**

	1840	1850	1860	1870	1880	1890	1900
New England	0.24	0.22	0.19	0.16	0.14	0.12	0.10
Middle Atlantic	0.27	0.25	0.23	0.21	0.19	0.17	0.15
East North Central	0.18	0.17	0.17	0.17	0.17	0.17	0.17
West North Central	0	0.02	0.05	0.08	0	0.12	0.14
South Atlantic	0.17	0.16	0.16	0.16	0.16	0.16	0.16
East South Central	0.14	0.14	0.15	0.16	0.17	0.18	0.19
West South Central	0	0.03	0.04	0.05	0.06	0.07	0.08
Mountain	0	0	0	0	0	0.005	0.005
Pacific	0	0.01	0.01	0.01	0.01	0.005	0.005

Sources: See text.

contain the labor component of the reproduction cost of farm fencing, 1840 through 1900, expressed in current (panel E) and constant (panel F) values.

(e) Materials requirements. The values in panels E and F of table 7.8 contain allowances for the labor costs of preparing farm materials for use in fencing, but not for materials acquired outside the farm sector, which we were obliged to estimate. We took account only of boards, posts and wire.

According to the data gathered by the commissioner of agriculture, board fences called for four or five rods of material per rod of fence; we assumed 4.5.[13] Posts and boards were normally made of different types of lumber (black locust was preferred for posts), but we were unable to assemble the price information necessary to make use of this fact. Some fence posts were made of steel or cement; many were made from farm materials, even when board for the fence was purchased. We had no way of introducing these variations into our estimating procedure in an effective way. We doubt that the errors due to neglecting these matters are at all large.

According to Danhof (1944), plain wire fencing (normally number 9, 10, or 11) was usually built with four to eight strands. For swine, eight strands were required; for other animals, "six would be sufficient and even less." We used an average of seven. For posts, supports, and gates, we assumed that an average of three rods of lumber per rod of fence was required.

Hayter mentions barbed wire fences of three and four strands (Hayter 1925, 194–95). Barbed wire was also sometimes used to top off a board, or plain wire or woven wire fence. We assumed that allowing four rods of barbed wire per rod of barbed wire fence would be adequate. We also allowed three rods of lumber per rod of barbed wire fence.

The materials required to build the existing board and wire fences, 1840–1900, are given in panels G, H, and I of table 7.8.

(f) Prices of board and wire. We took wire prices for the period 1860 through 1890 from the *Aldrich Report*, selecting 1 July prices as the closest of those available to the census date to which the capital stock figures apply (US Senate 1893, 183, 190). We extrapolated to 1900 on prices of nails in US Bureau of the Census 1960, series E-109.

We computed an average lumber price for 1871 (weighted by regional requirements) from evidence in a farmers' survey compiled in the *Report of the Commissioner of Agriculture*, and assumed that it held for 1870 (US Bureau of the Census 1960, 508). We then extrapolated this average to 1840, 1850, 1860, and 1890 on a weighted average of July prices of one-inch spruce and pine boards (US Senate 1893, 230, 238).[14] Since spruce was favored in New England and the Middle Atlantic, and pine in the North Central, Lake, and Southeast, we derived weights for spruce and pine prices from the total lumber requirements of these regions. We extrapolated these prices to 1900 on a building materials price index in US Bureau of the Census 1960, series E-21. Prices were then converted to per-rod figures, which are recorded in panels I, K, and L of table 7.8.

(g) Gross value of fences. We estimated the value of materials in fences (current and constant prices) by multiplying the volume of materials of each type by the relevant price. The results are displayed in table 7.8, panels M, N, O, P, Q, and R. The total value of fences (labor plus materials), derived in the ways described, is contained in panel S (current prices) and panel T (constant prices) of table 7.8.

(h) A test of the estimates. The 1871 *Report of the Commissioner of Agriculture* contains an estimate of the value of fences in the US of $1,748 million, substantially higher than our figure for 1870 (table 7.8, panel S) (US Bureau of the Census 1960, 510). Unfortunately, the commissioner does not explain the concept of value he has in mind, but the context suggests that it is gross reproduction cost, the same concept we used. The commissioner had access to considerable evidence, and his work seems careful. We therefore decided to investigate the difference between his figure and ours.

The commissioner worked with the returns of a survey of farmers in all parts of the country, a survey that returned the cost per rod for each type of fencing in each state (US Bureau of the Census 1960, 509). With these materials and Primack's data on the regional distribution of fences in 1870, we produced a weighted national average cost per rod for worm ($0.79), post and rail ($1.14), board ($1.37), and stone ($2.02) fencing.[15] These may be compared with the Gallman-Howle-Primack estimates for worm ($0.36), post and rail ($0.31), board ($1.47), and stone ($1.82) fencing.

In each case in which the fence materials came from the farm, our Gallman-Howle-Primack estimate is much below that drawn from the survey of the commissioner of agriculture. In the one case in which materials (board fence) were purchased, the two estimates are very close. We also found that the difference between our estimate of the gross reproduction cost of all fences in 1870 and that of the commissioner can be fully accounted for by differences between our estimates and his of the average cost per rod of worm, post and rail, and stone fences alone. We take these results to mean that our aggregate estimate is too low, chiefly because we have underestimated the cost per rod of the three types of fences that use farm-produced materials. We do not think it is the commissioner who is mistaken, because in the one case in which we were obliged to estimate the cost of materials directly, our estimate and the commissioner's are very close. Furthermore, while the data are not conceptually unambiguous, it is clear that the commissioner had more primary evidence from his survey than we were able to draw from Primack.

We chose, then, to accept the commissioner's estimate, and to date it to 1870. We then multiplied our estimates of the cost of worm, post and rail, and stone fences in each year (in current and constant prices) by the ratio of the survey average cost per rod to ours. These adjusted figures were combined with our estimates of the cost of hedge, board, and wire fence, and the aggregate series was used as an extrapolator. (Specifically, the commissioner's 1870 figure was extrapolated to all other years on the current price extrapolating series. The 1860 figure thus obtained was then extrapolated to all other years on the constant price extrapolating series [table 7.8, panels U and V].) Thus, Primack's very useful evidence on trends in labor expended per rod of fence affects the movement of the series over time, while the level of the series is adjusted to the evidence from the commissioner's survey.

(i) Net value of fences. We assumed that properly maintained hedge and stone fences do not depreciate. According to Danhof (1944, 173), nineteenth-century wooden fences had a service life of twenty to twenty-five years; just before World War I, Humphrey (1916, 32) placed the service life of wire fence at twenty-two years.

TABLE 7.11 **Derivation of estimates of the value of work directed toward drainage, irrigation, and irrigation for rice, measured in current and 1860 prices, 1840–1900**

	1840	1850	1860	1870	1880	1890	1900
A. Drainage works							
1 Acres drained, in thousands	0	153	386	1,253	3,526	11,011	17,955
2 Man-months of labor	0	17.7	44.5	144.6	406.8	1,270.5	2,071.7
3 Average wage rate	0	16.95	19.62	25.98	22.72	23.85	25.38
4 Value, at current prices, in millions of dollars: (A2 × A3 ÷ 1000)	0	0.300	0.873	3.757	9.241	30.301	52.579
5 Value at 1860 prices, in millions of dollars: (A2 × A3 for 1860 ÷ 1000)	0	0.347	0.873	2.837	7.981	24.927	40.647
B. Irrigation works							
1 Acres irrigated (000)	0	63	96	349	1,600	3,631	7,537
2 Man-months of labor	0	14.5	22.2	80.5	369.2	837.9	1,739.3
3 Average wage rate	0	11.47	27.62	43.79	37.12	33.2	38.98
4 Value, at current prices, in millions of dollars: (B2 × B3 ÷ 1000)	0	0.166	0.614	3.525	13.705	27.667	67.801
5 Value at 1860 prices, in millions of dollars: (B2 × B3 for 1860 ÷ 1000)	0	0.400	0.614	1.982	10.197	23.143	48.039
C. Irrigation for rice							
1 Acres irrigated (000)	218	358	291	140	174	161	338
2 Man-months of labor	419.2	688.5	559.6	269.2	334.6	309.6	650
3 Average wage rate	11.79	12.72	17.02	16.58	13.77	15.11	15.32
4 Value, at current prices, in millions of dollars: (C2 × C3 ÷ 1000)	4.942	8.758	9.524	4.463	4.607	4.678	9.956
5 Value at 1860 prices, in millions of dollars: (C2 × C3 for 1860)	7.135	11.718	9.524	4.582	5,695	5.269	11.063

Sources: Lines A1, B1, C1, 1850 1900, Primack 1962, 214–18, 226, 228; 1840, extrapolated from 1850 on output of rice, Gallman 1960, 47. Line A2: line A1 × 15 to convert to rods (Primack 1962, 222) × 0.2 man-days per rod (p. 224) ÷ 26 (days per month). Line B2: line B1 × 6 (man-days per acre; Primack 1962, 231) ÷ 26 (days per month). C2: Line C1 × 50 (man-days per acre; Primack 1962, 232) ÷ 26 (days per month). A3, B3, C3, see text. A4 and A5, B4 and B5, C4 and C5, see body of table.

We adopted a service life of twenty years for all fences, and computed depreciation in the following ways, beginning with values expressed in 1860 prices. We assumed that two-thirds of the fence in place in 1840 had been built in the 1830s, the other third in the 1820s. We assumed that fence built in the 1830s was an average of four years old in 1840, while fence built in the 1820s was fourteen years old. Thus, fence built in the 1830s had a depreciated value of 0.8 times, and fence built in the 1820s a depreciated value of 0.3 times, its 1840 reproduction cost. Fence built in the 1830s was assumed still to be in the stock in 1850, but then to be fourteen years old on average, with a depreciated value 0.3 times its 1850 reproduction cost. The difference between the gross reproduction cost of all fence in 1850 and that of fence built in the 1830s was taken to be the gross reproduction cost of fence built in the 1840s. Fence built in the 1830s was taken to have a depreciated value of 0.3 times its gross reproduction cost, fence built in the 1840s a value of 0.8 times its gross reproduction cost, and so on. In this manner, we estimated the depreciated value of fence (expressed in prices of 1860) for each census date.

The proportion of depreciated to undepreciated value was computed at each date, and applied to the current price values to derive the depreciated value expressed in current prices (table 7.8, panel W).

7.5.5 Detailed Estimating Procedures: Drainage, Irrigation, Irrigation for Rice

Once again we used data from Primack, to estimate labor requirements, and from Lebergott, to estimate labor costs. The Lebergott regional wage rates (augmented by one-half to allow for board) were weighted up by man-months of labor to produce appropriately weighted average wage rates. Only labor costs were counted. No depreciation was allowed, on the grounds that properly maintained work of this type did not depreciate. Details are contained in Table 7.11.

7.6. Land

The value of farmland was computed by subtracting from the value of farms the value of buildings, clearing and breaking land, fences (depreciated), drainage, irrigation, and irrigation of rice lands.[16] The figures appear in table 7.12, which presents estimates from 1850 to 1900. Since

TABLE 7.12 **Value of farmland at current prices, 1850–1900**

	1850	1860	1870	1880	1890	1900
Total value, in millions of dollars	748	2,039	3,226	3,496	4,905	6,104
Dollars per acre						
Farmland	2.55	5.01	7.91	6.55	7.87	7.26
Improved land	6.62	12.50	17.08	12.39	13.72	14.73

Sources: See text.

farms were valued at market values while many of the improvements were valued at reproduction cost, the residual—the value of farm land—is conceptually ambiguous and clearly subject to error. In all likelihood, the estimates are too low.

The value of farmland per acre of land in farms and per acre of improved land in farms implied by these data also appears in table 7.12. The increases between 1850 and 1860 seem rather rapid, but in other respects the average values behave plausibly. Between 1860 and 1870, events in the South tended to depress land values while general inflation tended to raise them; apparently, inflation was the more powerful force. Thereafter, prices in general declined until the mid-1890s, but the stock of land in the United States did not increase and the economy was experiencing rapid growth—factors that might be expected to raise farmland prices. This may be why our average values fall to 1880 and rise modestly thereafter.

On the whole, then, while the land value data might be expected to be relatively weak, they at least are not inconsistent with the data on the quantity of land, or with reasonable expectations concerning the development of land prices.

There is no good basis for estimating the value of land in 1840.

7.7. Tests of the Estimates of Land Improvements

The census returned the cash value of farms and the number of acres of improved and unimproved land, the two types of land being distinguished. With this information, the total value of improvements per improved acre can be derived by regression analysis. Several estimates of this type have been made, and they can be used to check our figures of the value of improvements. The two sets of estimates, however, are conceptually somewhat different and subject to somewhat different measurement problems. These matters must be considered before the tests are discussed.

The census returns of farm value probably refer to market value. Thus, the value of improvements obtained by regression analysis describes market value. Three of the four elements of our estimates, however, are expressed in reproduction cost. Market value may equal, exceed, or fall short of reproduction cost, depending upon the state of the market. But market value is always net, whereas two elements of our estimates are gross. Thus, a consideration of conceptual differences alone leads one to suppose that our figures of the aggregate value of land improvements might usually exceed estimates derived by regression analysis.

A second reason for believing that this might be the case springs from the nature of several of our series. Most farmland was probably cleared, broken, fenced, drained, or irrigated with resident labor—either family workers or slaves. The value we placed on the work of improvement accomplished by this labor reflects our perception of opportunity costs, based on wage rates, and the value of room and board established in markets. But land clearing and breaking was probably mainly an off-season activity, pursued when local labor markets were slack. It is possible, then, that our estimates of opportunity cost are too high. Certainly, they are more likely to be too high than too low.

There is also some reason to believe that the value of improvements obtained by regression is also too high (Anderson and Gallman 1977). The underlying assumption of the regression analysis is that the improved land and unimproved land on a farm are of equal quality, so far as location and adaptability to agriculture are concerned. But that is unlikely to have been the case. The best land is likely to have been improved first, so that the regression coefficient intended to measure the value of improvements probably also picks up other qualitative differences between the two types of land. The bias is unlikely to be large, however.

For these reasons, the test of our estimates against the regression estimates cannot be expected to be very conclusive. But it is the best overall test available, and well worth considering.

Stanley Lebergott (1985, 188–89) reported regression coefficients for six Midwestern states for 1850, based on census county data, while Robert Fogel and Stanley Engerman (1977, 284) worked out figures for cotton county farms in 1860, computed from the Parker-Gallman sample of farms and plantations. Neither of these two sets of estimates is in the ideal form for comparison with our work, but Lebergott's is close to being so.

Four of his states are from the East North Central region, the one missing state being Ohio. For purposes of comparison with his figures, we assembled an estimate of the total value of improvements per acre, based in part (land clearing and breaking) on our figure for the East North Central region, and in part (buildings and fences) on evidence relating expressly to Lebergott's four states.[17] For Lebergott's four states, the weighted average is $21 per acre for all farmland. The Gallman-Howle-Primack average is $24 per acre. The check is reasonably close, particularly when one recalls that the clearing and breaking experience of Ohio affects our estimate but not Lebergott's. Ohio was originally relatively heavily forested, a factor that probably raised the per acre cost of clearing and breaking above the level of the average cost for the region.

Our estimate checks even more closely with a second set prepared by Lebergott. Lebergott assumed a fixed price for unimproved land in his four states, based on federal land sales records. He then was able to compute the unimproved value of all land in each state and subtract this value from the total value of farms, to obtain the value of land improvements ($23 per acre for improved land).

The check against our figure ($24 per acre) could hardly be closer, especially when one allows for the presence of Ohio data in our estimate. The suggestion is that the market price and reproduction cost of farm improvements were very similar in the East North Central region in 1850, that net and gross values for clearing and breaking were also similar, and that the bias from our calculation of opportunity cost is not serious—all of which is gratifying.

The results obtained by Fogel and Engerman ($18.01 per acre) are more difficult to compare with ours, since they refer to the cotton counties of the South, a geographic entity that we are unable to extract from our data. We are obliged to draw comparisons with our estimates for three large census regions which do not closely approximate the cotton counties of the South. The contrast here (see column 1 in table 7.13) is much greater than in the case of the comparisons with the Lebergott figures.

A possible explanation is that the regions covered by the two sets of estimates are quite different, as previously mentioned. One way to work around this problem is to attempt to apply Lebergott's second method directly to census data for the South. According to Fogel and Engerman, the average value of unimproved land in the cotton South was $4.288 per acre, but this figure is an average, struck from a very high value ($12.613) for farms with more than fifty slaves, and more moderate values for the

TABLE 7.13 **Consistency check for Southern states**

	Gallman-Howle-Primack	Value of improved land per acre, given the following prices of unimproved land		
		2.5	2.9	4.288
South Atlantic	22.99	21.20	19.88	15.74
East South Central	27.52	28.68	27.52	23.51
West South Central	32.79	37.33	34.92	26.56
Weighted average	27.10			

Sources: The methods by which the Gallman-Howle-Primack estimates were computed were similar to those described in the text. But the weights (number of farms) for the weighted average were drawn from "Efficiency and Farm Interdependence in an Agricultural Export Region: Size and Scope of the Matched Sample" (Gallman and Swan 1966). They reflect the regional weights of the Parker-Gallman sample.

more numerous farms with fewer than fifty-one slaves: \$2.572, \$2.533, and \$2.931 for farms with no slaves, one to fifteen slaves, and sixteen to fifty slaves respectively. In columns 2 through 4 in table 7.13, we have applied Lebergott's second procedure, based on three separate assumptions about the average value of unimproved land in the South.

On the whole, these results are much better. The progression of the estimates from one region to the next follows a similar pattern in each column. And the column based on the assumption that unimproved land was worth \$2.90 an acre—not an unreasonable assumption—is almost identical with the column exhibiting our estimates. Clearly, these tests leave much to be desired. Nonetheless, they provide modest support for the levels of the estimates described in this section.

Epilogue

Gallman's procedures for making the 1840 estimates are more opaque than in other years. This is understandable because the census did not enumerate the number, acreage, or value of farms until 1850. In his earlier work on agricultural productivity, Gallman made estimates of the 1840 farmland stock. As noted in the text, Gallman (1972a, 201–2) accepted Seaman's assertion that there were five acres of improved farmland per inhabitant in the United States. This generated the estimate of 85.3 million acres of improved land in 1840 that is reported in table 7.4. Gallman

(1972a, 202) added: "The ratio of unimproved to improved land was about 1:6, in 1850, and 1:5, in 1860. I assumed that the ratio was 1:7 in 1840 and therefore was able to estimate the number of acres of unimproved land at that date." As written, this statement is in error. It would be correct if the colon were replaced by a decimal point. In 1850 the acreage of unimproved land was 1.6 times that of improved land; in 1860 it was 1.5 times. Correcting the typo yields an assumed ratio of 1.7 in 1840 and an estimate of 145.0 million acres of unimproved farmland (1.7 × 85.3 million) and 230.3 million acres of total farm land (2.7 × 85.3 million).

In a 1981–82 grant proposal, Gallman included figures implying that the value of farm real estate in 1840 was $2,222 million (Gallman papers). The estimation method was not reported, and the subcomponent for buildings differ slightly (by 2 percent) from those reported in this chapter. His numbers for 1850 and 1860 match the aggregates reported here. If one accepts that the current value of farm real estate in 1840 was $2,222, and then subtracts the value of structures and land improvements reported in this chapter, the residual value of raw land was $436 million in 1840. The implied value was $1.89 per acre. Gallman obviously did not consider this estimate satisfactory. He writes above: "There is no good basis for estimating the value of land in 1840." Having an 1840 "raw land" price to use in combination with Gallman's conjectured farm acreage would be of great value.