Agricultural Productivity Growth During the Decade of the Civil War

LEE A. CRAIG AND THOMAS WEISS

New evidence based on census data indicates that output per agricultural worker grew faster between 1860 and 1870 than during any other decade of the nineteenth century. Although this evidence seems to support the traditional view that the Civil War was a catalyst for an increasingly productive agricultural sector, we contend that this apparent robust performance results from a measurement problem that afflicts census-based labor force series. An alternative estimate of labor force performance during the decade reveals the importance of increased labor inputs of women and children, in numbers, effort, and—especially—time.

Agricultural historians have traditionally identified the 1860s as the decade in which the first revolution in agriculture occurred.1 Some have attributed the central feature of that revolution, the mechanization of farm tasks, to the need for manpower during the Civil War.2 Others have recognized that the War also inflicted makers of farm machinery with labor shortages, and so have argued that the greatest increases in the use of machinery came in the years after Appomattox.3 Both groups have generally agreed, however, that the Civil War was the catalyst for rising levels of farm productivity and that the decade of the 1860s was an important turning point in the history of American agriculture.4

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1 "... in the judgment of most writers on the subject, the influences that revolutionized the American countryside were generated in that most available if not always exact period of division in American history, the Civil War." Ross and Tontz, "The Term 'Agricultural Revolution'," p. 34.

2 According to Eric Lampard, "The Civil War had been the decisive moment in the mechanization of Western agriculture, since the mobilization of the Union armies had intensified the labor shortage on the farms." Lampard, Rise, p. 190. Along the same lines see Bogart, Economic History, pp. 111-17; Gates, Agriculture; and most recently, Hurt, "Northern Agriculture."

3 Rasmussen claims "... the first American agricultural revolution reached its peak in the years just after the war." Rasmussen, "Agriculture," p. 352. See also Rasmussen, "Civil War," p. 193; Schmidt, "Agriculture," p. 587; and Schlebecker, Whereby We Thrive, p. 151.

4 For some the War's decade was only the beginning, and the entire period 1861 to 1914 has been labeled "The first American Agricultural Revolution." See Rasmussen, Readings, p. 103.
In the 1960s new statistics on agricultural productivity growth cast doubt on this traditional view. At the beginning of the decade, Wayne Rasmussen and Marvin Towne published their comprehensive compilation of statistics on farm gross product extending back to 1800. These data revealed that over the decade of the Civil War real output per worker had increased at 0.87 percent per year, slower than the 1.22 percent per year advance of the 1850s and the 1.17 rate for the period after 1870. This was hardly the sort of advance expected if the decade had experienced the spurt in mechanization envisioned in the traditional view.

Towne and Rasmussen’s productivity series suffered from reliance on Alba Edwards’s labor force statistics, but the mediocre performance of the War decade was confirmed six years later when Stanley Lebergott’s labor force figures became available. When combined with the Towne and Rasmussen output figures they indicated that growth over the Civil War decade was very slow—only 0.29 percent per year—even slower than Towne and Rasmussen’s original calculations had indicated. This was the third slowest decadal advance of the century, a sluggishness completely at odds with the traditional view.

This revisionist view, however, has itself been cast into doubt by Thomas Weiss’s recent estimates of farm labor productivity, based on a revised set of labor force figures. According to Weiss’s series, output per agricultural worker, excluding the value of home manufactures and farm improvements, grew at an average annual rate of 1.62 percent between 1860 and 1870, the fastest rate of the nineteenth century. With the value of home manufactures and farm improvements included, output per worker increased at 1.35 percent per year, also the fastest rate for the century. Under this evidence, the decade of the 1860s did not merely mark a point of transition to a more productive agriculture, it appears to have led the way.

The new productivity series would seem to give renewed credence to the traditional view of historians concerning the pace of nineteenth-century agricultural productivity growth and the influence of the Civil War. We contend, however, that this apparent rapid growth in agricultural labor productivity during the 1860s is largely an artifact of the way labor inputs were measured. We argue that mechanization was relatively unimportant in this period and stress instead an increase in labor inputs, especially an increase in the labor of women and children devoted to market production. Although the output of their increased

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6 Edwards, Comparative Occupation Statistics. Lebergott, “Labor Force,” developed the estimation methods and produced the original estimates, and David, in “Growth,” revised some of the figures. Although both had a hand in the work, for ease of exposition, we call it the Lebergott series.
labor is reflected in the conventional statistics, their input is not fully captured in the census labor force figures.\(^8\)

In this article, then, we address the issue of agricultural productivity from two perspectives. First, we analyze the decade’s performance using Weiss’s revised, conventionally measured output per worker series. This series, like the revisionist one, uses the Towne and Rasmussen estimates of farm output and labor force estimates based on census data. It is this analysis that tells the story of the singular growth of agricultural output per worker during the Civil War decade. We then present an alternative measure of productivity which avoids the problem of underenumeration of female and child workers and captures the effect of any increases in workers’ hours and effort. Our results show that the real value of the marginal contribution of each group of workers (men, women, and children) increased during the Civil War decade, and that most of this rise probably resulted from an increase in the amount of time or effort they spent in agricultural production for the market. The increase in the marketed output of farm products that came from “women’s work” explains much of the enormous increase in output per worker that materialized over the decade. From this perspective, the effect of the Civil War was limited to inducing the initial increase in labor input, especially that of women and children. The higher levels of input were sustained, however, by increased commercialization of product lines associated with female and child labor, as well as the desire to generate a cash flow that would permit the purchase of farm machinery.\(^9\)

**REVISED ESTIMATES OF AGRICULTURAL PRODUCTIVITY**

Table 1 compares the old estimates of agricultural output per worker developed during the 1960s with the new estimates compiled by Weiss. As the table shows, the revised figures give new credence to the traditional view. Between 1860 and 1870 real output per worker (in prices of 1840) increased by $36 using either the narrow or broad definition of output. The narrowly defined series excludes the value of home manufacturing and farm improvements, and the broader one

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\(^8\) Ironically, although the evidence we report is contrary to that produced in the 1960s, our explanation is consistent with the revisionist view of the War’s effects on agriculture. Cochran concluded that the War “does not appear [to have] greatly increased the trend of agricultural mechanization.” Cochran, “Did the Civil War?”, p. 199. Stanley Engerman argued that “the agricultural implement industry is one requiring more study,” but he also concluded that “it is not clear that the war years were an abnormal boom period for [reaper sales].” Engerman, “Economic Impact,” pp. 197–98. For a more recent argument that the War’s effects were not substantial over the decade, see Engerman and Gallman, “Civil War Economy."

\(^9\) Much discussion about the War’s effect is couched in terms of benchmark data for 1860 and 1870, owing to a paucity of data for the war years. We focus on these benchmarks as well, in part for the same reasons, but also because we are interested primarily in the decade-long change in productivity.
### Table 1
**Comparison of Farm Output Per Worker Figures**

(1840 prices)

<table>
<thead>
<tr>
<th>Years</th>
<th>Narrow Definition of Farm Output</th>
<th>Broad Definition of Farm Output</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Old Series</td>
<td>New Series</td>
</tr>
<tr>
<td>1860</td>
<td>223</td>
<td>208</td>
</tr>
<tr>
<td>1870</td>
<td>229</td>
<td>244</td>
</tr>
<tr>
<td>1880</td>
<td>261</td>
<td>281</td>
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</table>

**Average Annualized Rates of Change**

<table>
<thead>
<tr>
<th>Period</th>
<th>Narrow Series</th>
<th>Broad Series</th>
</tr>
</thead>
<tbody>
<tr>
<td>1860-1870</td>
<td>0.29</td>
<td>0.34</td>
</tr>
<tr>
<td>1870-1880</td>
<td>1.32</td>
<td>1.19</td>
</tr>
<tr>
<td>1860-1880</td>
<td>0.80</td>
<td>0.77</td>
</tr>
<tr>
<td>1880-1890</td>
<td>0.71</td>
<td>0.61</td>
</tr>
<tr>
<td>1860-1900</td>
<td>0.75</td>
<td>0.66</td>
</tr>
<tr>
<td>1880-1900</td>
<td>0.71</td>
<td>0.63</td>
</tr>
</tbody>
</table>

Notes: The Narrow series excludes the value of home manufacturing and farm improvements, and the Broad one includes those two items. The Old Series uses labor force figures taken from Lebergott and the original farm gross product figures taken from Towne and Rasmussen and revalued in 1840 prices. The New Series was calculated using a revised Towne and Rasmussen output series and Weiss's labor force estimates. The rates of change were calculated from end points using the unrounded figures. For the century, estimates of the rates of growth are 0.80 for the series in column 1, and 0.74 for the revised series in column 2.

Sources: Lebergott, "Labor Force," table 1; Towne and Rasmussen, "Farm Gross Product"; and Weiss, "Farm Gross Product."

includes those two items. The annual rates of increase were 1.62 percent for the narrowly defined figure and 1.35 percent for the broad one. These were the fastest rates of increase of any decade of the nineteenth century and stand in sharp contrast to the statistical view presented by the series produced in the 1960s.

The contrasting views that the two series give of the Civil War decade do not result from differences in their numerators—that is, from their estimates of agricultural output. The old series uses Towne and Rasmussen’s output figures. The value of output for the many individual products underlying the aggregate numbers were estimated in various ways and are of differing reliability. For the years after 1840, including the decades of interest here, these figures are grounded in a variety of statistics collected by the Census Bureau and the Department of Agriculture. Although the figures may have some shortcomings, including the fact that they are available only for benchmark dates ten years apart and therefore do not cover the War years specifically, they are the best available and have been widely used. For the years 1860-1900, these data were reworked by Strauss and Bean, "Gross Farm Income," and subsequently used by Towne and Rasmussen, "Farm Gross Product." The Towne and Rasmussen output measure, the value of farm output entering gross national product, is calculated as the difference between the total value of output and the value of intermediate products consumed in the process of production.
## Table 2

### COMPARISON OF FARM GROSS PRODUCT FIGURES

(1840 prices)

<table>
<thead>
<tr>
<th>Years</th>
<th>Aggregate Values ($ millions)</th>
<th>Per Capita Values (dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Narrow Measure</td>
<td>Broad Measure I</td>
</tr>
<tr>
<td>1860</td>
<td>1310</td>
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<tr>
<td>1870</td>
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<td>1880</td>
<td>2332</td>
<td>2403</td>
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**Average Annualized Rates of Change**

<table>
<thead>
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<th>Period</th>
<th>Rate of Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1860-1870</td>
<td>1.74</td>
</tr>
<tr>
<td>1870-1880</td>
<td>4.12</td>
</tr>
<tr>
<td>1880-1890</td>
<td>2.92</td>
</tr>
<tr>
<td>1890-1900</td>
<td>2.84</td>
</tr>
</tbody>
</table>

**Notes**: The Broad Measure, variant I, uses the original farm gross-product figures taken from Towne and Rasmussen, revalued in 1840 prices. Version II uses Gallman’s estimates of the value of home manufacturing and farm improvements. The narrow version of the Towne-Rasmussen series has been revised in the years 1800 to 1830, but no adjustments were called for in 1860, 1870, and 1880. The rates of change shown in the table for periods including those early years use the revised figures. The rates of change were calculated from end points using the unrounded figures. Sources: Gallman, “Gross National Product”; Towne and Rasmussen, “Farm Gross Product”; and Weiss, “Farm Gross Product.”

through 1880, Weiss made no revisions to Towne and Rasmussen’s narrowly defined measure (see Table 2). The adjustments he made to the broadly defined estimates are modest and have only a slight effect on the output per worker series, reducing its rate of growth by only 0.2 percent per year.11

Farm gross product, valued in current prices, increased during the 1860s by just over $1 billion dollars or about 70 percent. Much of this rise was, of course, nothing but inflation, the prices of agricultural products having gone up by about 40 percent over the decade. As Table 2 shows, output went up by around 20 percent in real terms, but the exact increase depends on the price base used.12 In per capita terms the change was respectable in current prices, the narrow measure increasing from $47 to $64, or about 35 percent. In real terms, however, there was a slight decrease from $42 to $39. The broad measure shows a

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11 See Weiss, “Farm Gross Product,” for an explanation of the revisions. The changes to the broad measure were to replace Towne and Rasmussen’s figures for home manufacturing and farm improvements by those made by Gallman, revalued in 1840 prices. See Gallman, “Gross National Product.” The changes made to the broad measure raise output per worker by about 12 percent in both 1860 and 1870.

12 Towne and Rasmussen used prices of 1910-1914 and showed a real increase of about 400 million dollars, or 20.4 percent. Towne and Rasmussen, “Farm Gross Product,” p. 266, table 1. In 1840 prices the increase was about $200 million dollars, or 19 percent.
nominal rise from $49 to $66, but in real terms it fell from $44 to $41.\textsuperscript{13} The evidence in Table 2 is consistent with the revisionist view of the impact of the Civil War, namely that output had already accelerated before the conflict and slowed down during the war decade itself.\textsuperscript{14} The slowest growth in agricultural output occurred during the 1860s. Using the narrow definition, farm gross product increased by only 1.74 percent per year over the decade, a full percentage point slower than the century’s average rate of growth of 2.84 percent per year.\textsuperscript{15} In the 60 years preceding the War the rate averaged 3.09 percent per year.

It is Weiss’s revisions of the labor force estimates that almost entirely account for the more rapid growth of output per worker evident in the new series. The differences between the old and new labor force series emanate from three sources. Weiss placed fewer slaves in the 1860 farm labor force (approximately 75 percent of the rural slave population aged ten and over versus 90 percent in Lebergott’s estimates); allocated a larger number of free laborers to farming in 1860, and a smaller number in 1870; and made differential corrections to the census enumerations for 1860 and 1870. Only the first of these revisions works to slow down the growth of output per worker; the other two bias productivity growth upward.\textsuperscript{16}

Weiss’s decision to place a smaller number of slaves in the 1860 farm labor force accords much better than Lebergott’s estimates with other evidence about the occupational distribution of slave workers. Samuel Blodget’s estimate for 1805 implies that only 75 percent of the slaves were engaged in farming, with 300,000 being “slaves to planters” and 100,000 being “variously employed.” John Olson’s sample data from plantation and probate records indicate that between 11 and 27 percent of the rural slaves were engaged in nonfarm activities.\textsuperscript{17} The figure Weiss derived from the county level census data, that nearly a fifth of the rural slave labor force worked at nonfarm activities, falls securely in the range estimated by Olson. This finding is in stark contrast to Lebergott’s estimate that virtually no rural slaves worked at nonfarm

\textsuperscript{13} Towne and Rasmussen, “Farm Gross Product,” p. 265, table 1; and U.S. Census, Historical Statistics. The Towne and Rasmussen constant price series, valued in prices of 1910–14, showed a decline from $63 in 1860 to $61 in 1870. Towne and Rasmussen, “Farm Gross Product,” p. 265, table 1. Weiss revalued each item in 1840 prices in order to have a series that could be linked more easily to Gallman’s estimates of gross national product and its components.

\textsuperscript{14} See for example Engerman, “Economic Impact.”

\textsuperscript{15} The destruction in the South and the disruption of southern markets dragged down the national performance during the 1860s. The slow growth of cotton output over the Civil-War decade (0.08 percent per year) alone reduced the annual rate of growth of farm gross product by about 0.25 percent per year. The rest of farm gross product increased at 1.97 percent per year. Even that rate is below the century’s average. See Weiss, “Farm Gross Product.”

\textsuperscript{16} See Weiss, “U.S. Labor Force Estimates.”

\textsuperscript{17} Blodget, Economica, p. 89, and Olson, “Occupational Structure.” A useful collection of pertinent articles can be found in Newton and Lewis, Other Slaves. See also Starobin, Industrial Slavery.
occupations, clearly an untenable conclusion, given all the other activities that took place on the plantation and in rural areas more generally.\textsuperscript{18}

The effect of placing a smaller number of slaves in the 1860 farm labor force raises the level of productivity, but by only $9 (about 5 percent), and slows the rate of productivity growth between 1860 and 1870. The difference amounts to 0.47 percent per year: if the farm labor force were to include Lebergott's higher figure for slave participation in agriculture, the rate of productivity advance would have been 2.09 percent per year, but the smaller allocation of slaves reduces the rate to 1.62 percent, using the narrow definition of output.

Differences in the number of workers reported by the census as "laborers, not otherwise specified" (n.o.s.) allocated to farming is the single biggest source of the discrepancy between the two series' rates of productivity growth. The disparity springs from two independent adjustments, one affecting the size of the 1870 labor force, the other the figure for 1860. The revised 1870 farm labor force includes fewer of these laborers than does Lebergott's; the revised 1860 figure includes more.

Researchers have long recognized that from 1870 to 1900 the census had included in the category of workers n.o.s. many workers who were engaged in farming. Lebergott developed a method for distributing laborers in this category between farm and nonfarm industries by making use of the close connection between the farm/nonfarm and urban/rural split. He implicitly assumed, however, that all nonfarm laborers would be located in cities. Although most were, there were also many residing in rural areas where a great deal of nonfarm activity was taking place. From the data reported by the census Lebergott obtained a ratio of urban nonfarm laborers to urban population, which he multiplied by the entire urban population to produce an estimate of all nonfarm laborers. The residual count of laborers, predominantly those residing in rural locations, he placed in farming.\textsuperscript{19} This technique resulted in an underestimate of the number of laborers in nonfarm industries and an overestimate of the number in farming.\textsuperscript{20} Weiss

\textsuperscript{18} Lebergott estimated the number of slaves engaged in farming by assuming that 95 percent of the slave population aged ten and over lived in rural areas, 87 to 90 percent of which were engaged in farming. He intended to allocate only 87 percent of the rural adult slaves to farming, but in the calculation the 90 percent figure was used. Weiss used the county level data on employment and population for 1820 and 1840 to estimate that roughly 75 percent of the rural slave population aged ten and over was engaged in farming.

\textsuperscript{19} The Census did not report the population and labor force for all urban areas, but only a subset in each year: the 30 largest cities in 1870, 60 cities in 1880 and 1890, and 160 cities in 1900. The Census did report the number of laborers not otherwise specified living in those cities, and Lebergott felt that such urban laborers would include most nonfarm laborers. Lebergott, "Labor Force," p. 159.

\textsuperscript{20} The use of a ratio that included only urban laborers in the numerator would yield an estimate
corrected for this bias by multiplying the ratio of all nonfarm (urban plus rural) laborers to urban population times the entire urban population.\textsuperscript{21} The result was an allocation of 241,000 laborers to farming in 1870 instead of 568,000, a difference that changes productivity growth by about one-half a percentage point per year. That is, assuming that Weiss's 1860 farm labor force figure is correct, but leaving Lebergott's estimate of unspecified laborers in farming in 1870 uncorrected, would yield a rate of advance of output per worker of 1.11 instead of 1.62 percent per year.

The 1860 figure presents another problem. Although the classification problem was evident in the post-1870 statistics, it was less obvious in earlier census figures apparently because the large numbers of slaves in farming masked the problem at the national level. A careful examination of the state data, and the location of many of these workers in rural areas, argues for the assignment of many of them to farming. In particular, when one looks at just the free states, where slavery could not distort the picture, it is evident that some of these laborers must have been employed in farming.\textsuperscript{22} Weiss allocated 582,000 of the 977,000 laborers enumerated by the census to his 1860 farm labor force; Lebergott put them all in nonfarming. This difference accounts for nearly one full percentage point growth per year: output per worker would have risen by only 0.64 percent per year if those laborers were excluded from the 1860 farm labor force, but rose 1.62 percent per year with them included.

Finally, the rates of productivity advance differ because of minor disparities in the rest of the farm labor force estimates for 1860 and 1870.\textsuperscript{23} The revised 1860 farm labor force is higher than Lebergott's by 135,000 workers, about 2.3 percent, owing primarily to adjustments that Weiss made to the original census counts. These corrections were based on manuscript census data that have become available since Lebergott made his estimates. Weiss's 1870 figure is lower than Lebergott's by 85,000 workers, or about 1.3 percent. The difference appears to derive from the way each corrected for the 1870 census undercount of population in the South. The net effect of these two disparities is to cause the Weiss productivity series to grow faster by about 0.35 percent per year.

\textsuperscript{21} The 1910 cross-sectional evidence for states indicates a high correlation between the urban share of the population and the nonfarm share of the reported laborers, not otherwise specified ($R^2 = .88$).

\textsuperscript{22} Without such laborers, the ratio of the farm workforce to the rural population in the\textit{ free states} was 0.15 in 1850 and 0.16 in 1860, substantially below the average of 0.192 in the years 1870 through 1910. With the addition of these workers, the 1850 and 1860 ratios are 0.196 and 0.189 respectively, very much in line with the values of the ratio in the postbellum years. See Weiss, "Estimation."

\textsuperscript{23} See Weiss, "Assessment."
Any picture of economic change during the Civil War decade hinges on these estimating details. The Weiss series seems preferable because it is more consistent with the behavior of the rural population and the likely effects of the War on that population and the farm labor force.24 The movements of the rural share of the population and the farm share of the labor force should have been in tandem and appear to have been so most of the time, regardless of which series one uses. Over the entire century the rural population share declined by 34 percentage points, whereas the farm share of the labor force declined by 42 points according to the Lebergott series, 38 according to Weiss. For the Civil War decade, however, the series diverge sharply. During the 1860s the rural share of the population declined by 5.9 percentage points; so on average one would expect that the farm share declined by at least that much.25 The Weiss series reveals the expected result, a drop of 6.0 points in the farm share of the labor force, whereas Lebergott’s shows a decline of less than one point.26 This result suggests that the growth of the farm labor force in Lebergott’s series is too great over the decade and that the slower growth in Weiss’s series is more likely. The corollary is that the output per worker series based on the Weiss labor force figures reflects the more likely course of events: output per worker advanced at its most rapid rate of the century over the decade of the Civil War.

MECHANIZATION OR AN INCREASE IN LABOR INPUT?

The rapid advance in output per worker is consistent with the traditional view that the Civil War stimulated growth. In that view, mechanization was spurred by the demand for agricultural products, which pushed up prices and encouraged greater production, and by the shortage of labor resulting from the War’s demands. It is our contention, however, that these were not the forces behind the rapid increase in output per worker that materialized over the entire decade. Although

24 More detailed comparisons between the rural population and the farm labor force can be found in Weiss, “Revised Estimates” and “Assessment.”

25 The farm share may have declined even more because the War drew off many farm youths, some of whom never returned to their families still living in rural locations, and freed the slaves, some of whom chose not to continue in farming. Both northern and southern soldiers came disproportionately from the farm labor force. Forty-eight percent of northern soldiers came from farming, whereas farm occupations represented only 43 percent of the labor force. The southern figures were 62 and 58 percent, respectively. McPherson, *Battle Cry*, pp. 608, 614. Ransom and Sutch argue strongly that the labor force participation of free blacks was lower than that of slaves. Ransom and Sutch, *One Kind*, pp. 44–45.

26 Between 1860 and 1880 the rural share of the population declined by 8.4 percentage points. The farm share of the labor force decreased by only 1.9 percentage points in the Lebergott series, but 8.1 points in Weiss’s. Lebergott had made much of this stability in the farm share that lasted from 1850 through 1880 in his figures. Vatter questioned this pattern, although he focused on the regional differences that might have lain behind the national figures. Vatter, “Industrialization,” pp. 739–48.
prices may have risen sharply during the War, most of the increases were not sustained over the decade, and those that were did not call forth additional output. Moreover, the extent of mechanization appears to have been too limited to explain the decade-long increase in output per worker.

Several factors contributed to higher agricultural prices during the War. There is no question that the demand for agricultural products by the United States and Confederate governments raised agricultural prices and must have encouraged some increased production. The situation was exacerbated by "[c]rop failures in Great Britain from 1860 to 1863, a general shortage of food in continental Europe, . . . and the wasteful methods of Army supply."27 Most of the price increases were temporary, however; although prices rose during the War years, they fell after the conflict. Wheat prices actually declined over the decade, so they could not have been much of an incentive to increase production. The decline in wheat prices is quite telling, because wheat was the crop most likely to have become mechanized, but this was not the only case in which output and price moved in opposite directions. We calculate that the coefficient of correlation between the decadal percentage change in prices and the percentage change in quantity produced for 28 farm products was only 0.06.

There is also no question that there was a labor shortage during the War. The resources (human and material) ultimately demanded by the War surprised most contemporary observers. By 1865 more than two million men had served in the Union armies and 800,000 in the Confederate army.28 Paul Gates claimed roughly one-third of the prewar, nonslave agricultural labor force ended up in uniform.29 Although this proportion might be a little high due to the underreporting of women and children in the farm labor force, there is no question that the drain of farm labor was enormous. The demand for soldiers left farm households, often already hard-pressed for labor during harvest, short-handed. One contemporary noted, "As early as August, 1862, some communities had only women, old men, and boys left."30

Although mechanization offered one possible response to labor shortages, only a narrow segment of agriculture did, in fact, mechanize. Wheat production was the primary focus of mechanization during the decade, based largely on the adoption of the mechanical reaper. Alan Olmstead, however, has raised doubts as to whether relative factor prices changed to induce mechanization, pointing out that farm wages

27 Shannon, Farmers Last Frontier, p. 127.
28 There is some debate about the exact number of persons engaged in the War, but the precise figures are not critical to the point being made here. See McPherson, Battle Cry, p. 306.
29 Gates, Agriculture, chap. 9.
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did not rise more rapidly than other wages and prices.31 Furthermore, whatever the rate at which reapers may have been adopted in the 1860s, the reaper’s contribution to the increase in aggregate output per worker had to be relatively small.32 Wheat production accounted for only 9 percent of total farm output in 1870, and even less in 1860. Although the increase in wheat output was more rapid than that of most other farm products, it nevertheless raised the aggregate output per worker figure by only $7, or about 0.25 percent per year.

One of the more striking features of the 1860s is that the decade had one of the slowest increases in agricultural output in the century and an even slower growth in the farm labor force. Moreover, although output grew faster than the labor force overall, its growth varied greatly by product. The production of only a handful of farm products increased faster than the labor force, but their rise was enough to propel the aggregate output per worker figure upward sharply. Wheat was one of those fast-growing products; the others were chickens and other poultry, eggs, dairy products, and especially hogs. Between 1860 and 1870 the share of farm gross product accounted for by these four livestock items rose by five percentage points, and their increased production pushed output per worker up by $28 dollars (1.1 percent per year) over the decade. Most of this increase was due to the rise in hog production.

A notable aspect of the composition of output during the decade was the shift toward products that typically engaged women and children. Contemporary commentators noted that although household members could be found performing just about every chore imaginable at one time or another, in general a division of labor existed among family members. Men were more likely to perform field work—plowing, sowing, and harvesting—women and children were more likely to work closer to home—dairying, churning, tending the garden, and caring for livestock. The production from these latter activities became more commercialized over the decade.33 This commercialization resulted only in part from the War’s demands and was sustained by the development of the

31 Olmstead, “Civil War.”
32 We estimate that there were 11.8 million more acres of wheat harvested mechanically in 1870 than in 1860. David, “Mechanization,” p. 33, estimated that a self-rake reaper saved 0.36 man-days per acre harvested, and figures given by Atack and Bateman, To Their Own Soil, p. 190, place the bushels of wheat produced per man-day between 1840 and 1860 at 2.4. Thus, reaper usage in 1870 saved labor capable of producing 10.3 million bushels of wheat, only 9 percent of the increase in wheat output between 1860 and 1870.
33 Taking care of the dairy, garden, poultry, and livestock were primarily the responsibility of farm women and children. “It was the universal custom for women to tend the garden, just as they always milked the cows,” wrote one contemporary quoted in Gates, Farmer’s Age, p. 244; another claimed, “Except in a Yankee family no man or boy could be induced to milk cows, it being regarded as woman’s work,” (Bidwell and Falconer, History, p. 163); yet another noted that a woman “has duties to perform to the sick and to the well—to the young and to the aged; duties even to domestic animals” (Boydston, Home, p. 145). For a detailed discussion of the division of labor on northern farms and the role of women and children in the production of livestock and dairy products, see Craig, To Plant or Sow, chap. 2.
stockyards in Chicago, the proliferation of rail lines throughout the Midwest, and the growth of urban markets in the Northeast. These improvements presumably made these items more remunerative and thus induced farmers to increase their production, either by shifting out of the production of other marketed items, reducing nonmarket production, or by reducing leisure time.

It is our contention that a substantial part of the overall increase in output for the decade reflects the fact that women and children were devoting more time and effort to farm tasks related to marketed output in 1870 than they were in 1860. They must have taken up some of the slack on a temporary basis during the War, and at least some of them must have remained more fully employed afterwards. The increased participation of these workers could have taken several forms: increases in their numbers, increased time at work per year, more effort per unit of time, or some combination of these factors.34

Whatever its determinants, the increased labor input of women and children is not fully captured in the census-based labor force statistics, including the revised series underlying the output per worker statistics in Table 1. Because women and children were the workers most likely to be underenumerated by the census, any recorded increase in their numbers between the censuses of 1860 and 1870 may be inaccurate.35 Moreover, because the labor force series counts numbers of workers, not units of labor input or full-time equivalent workers, it cannot be used to measure changes in effort or in the amount of time worked. Although the increased labor input of these workers is not fully captured in the denominator of the conventional output per worker statistic, their increased output is measured in the numerator. It is clear that the labor input of women and children unmeasured by the census would have significant effects on the measured output per worker statistics.

We have devised a method to estimate the extent to which women and children worked more over the decade that bypasses the census enumeration problem. Although we cannot yet say to what extent more women and children worked or worked longer or harder, we can show that there must have been some significant increase in their labor input and that of men as well.

34 Increases in marginal productivity were also possible, perhaps especially those emanating from learning-by-doing. We try to account for this in our subsequent analysis.
35 The Census of 1910 addressed this problem by insisting that census takers record family members working on farms even if they received no wages. The result was a count of farm workers that was out of line with that reported for other years. Various researchers have tried to adjust for this "overcount." Most recently Weiss has estimated that the higher enumeration of female and child workers amounted to 950,000 workers, or approximately 2.5 percent of the farm labor force. See Weiss, "Adjustment," table 23 for a comparison of the various attempts to estimate the extent of the overcount.
We have gauged the increased contribution of men, women, and children by estimating an agricultural production function in which these groups are inputs even though they may not have been recorded as workers by the census. Although the discussion so far has addressed productivity change in agriculture for the entire United States, because of data limitations, we focus on northern agriculture only. We have assumed that the production function for northern agriculture was homogeneous, and that farmers exchanged inputs and outputs in competitive markets. As a result, the value of farm output, \( Y = P \cdot Q \), would have been allocated among the \( N \) inputs, \( X_1, \ldots, X_N \), such that the sum of the product of these inputs and the value of their marginal products is identically equal to \( Y \). This relationship (Euler's equation) is given by

\[
P \cdot Q = \sum_{i=1}^{N} \left( \frac{\partial Q}{\partial X_i} \right) \cdot P \cdot X_i
\]

The value of the marginal product of input \( X_i \) is \( \left( \frac{\partial Q}{\partial X_i} \right) \cdot P \), which in competitive markets would equal its factor price, such as its wage. Unfortunately, we do not know the value of the wages or marginal products for all the inputs, so we estimated the value of the marginal contribution of the various types of labor (including women and children) by subtracting from total output the returns to the nonlabor inputs.\(^36\) The value of output going to the remaining labor inputs is shown as \( Y^* \) in equation 2.

\[
Y^* = Y - \sum_{j=1}^{n} w_j X_j = \sum_{k=n+1}^{N} w_k X_k = \sum_{k=1}^{K} \beta_k X_k
\]

\( X_k \) is the quantity of the \( k \)th different type of labor, and \( \beta_k \) is the marginal product or wage of the \( k \)th labor input.

One drawback to deriving the marginal products in this way is that we cannot measure the inputs by unit of time—that is, hours, days, or months. We know only the number of workers, \( N \), in each category, \( k \). Thus, the equation actually estimated is

\(^{36}\) For an extended discussion and further application of this technique, see Craig, "Value"; and Craig and Field-Hendrey, "Industrialization." Fairly good monthly wage data exist for hired hands, and there are occasional references to wages for female domestics and hired children, but in general, comprehensive wage data are rare for labor not typically exchanged in the market, mainly women and children in the agricultural sector. For wages of hired labor, see Lebergott, Manpower, p. 539.
The coefficients, $\beta_k$, estimated from equation 3 are actually the product of the (unknown) true marginal products, $w_k$, and the (unknown) time inputs, $X_k$, divided by the (known) number of workers, $N_k$.

$$\beta_k = w_kX_k / N_k \text{ or } \beta_kN_k = w_kX_k$$

Although we do not know the values of the true marginal products, $w_k$, we can approximate them. For adult males we have wage data to represent their marginal product, $w_m$. For the others, we can make assumptions about how their productivity, $w_k$, changed in comparison with that of adult males. In that way we can gauge how much their input was likely to have increased. That is, let $w_k$ relative to adult males be given by $\delta_k w_m$. We can derive the time input for any other type of farm labor from

$$X_k = \beta_kN_k / \delta_kw_m$$

We first estimate equation 3 for 1860 and 1870 to obtain values of $\beta_k$. We then solve equation 5, using known values for the number of workers, $N_k$, and the wages of adult males, $w_m$, and substituting likely values for the relative productivity of other types of labor, $\delta_k$, for each date. This procedure yields a measure of the changes in the time input for women and children that occurred between 1860 and 1870. An increase in $X_k$ suggests that input $k$ had increased the amount of time devoted to agricultural production.

The equation we estimated for each year identifies four population groups, broken down by age and sex, as shown in equation 6.

$$Y^* = \beta_1 + \beta_2 BOYS + \beta_3 GIRLS + \beta_4 ADULT MALES$$
$$+ \beta_5 ADULT FEMALES + \beta_6 REGION + \beta_7 SIZE + \epsilon$$

$BOYS$ contains males between the ages of 5 and 18, whereas $GIRLS$ contains females between those same ages. Adults are divided into males and females as well.38 Regional differences in agricultural prac-

37 This method for measuring the number of workers abstracts from the census enumeration problems and in effect assumes that the number of workers was a constant proportion of the farm population. Thus any measured increase in $\beta$ represents an increase in either the amount of time or effort per worker of a given group. Although we cannot disentangle these two possibilities, it is the case that greater effort would likely be reflected in $w_k$, so for the most part the increase in $X_k$ probably represents more time per input.  

38 The 1860 estimates are from the Bateman-Foust sample of northern farms. (See Atack and Bateman, To Their Own Soil, appendices to chaps. 2 and 7, for a description of these data.) No comparable farm-level data exist for 1870. Therefore, we used county-level data from the ICPSR, Historical Demographic, Economic and Social Data.
The Civil War and Agricultural Productivity

Table 3

<table>
<thead>
<tr>
<th></th>
<th>1860</th>
<th>1870</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>364.84</td>
<td>143,424.61</td>
</tr>
<tr>
<td></td>
<td>(11.90)</td>
<td>(2.16)</td>
</tr>
<tr>
<td>Males aged 5–18</td>
<td>70.31</td>
<td>112.61</td>
</tr>
<tr>
<td></td>
<td>(7.75)</td>
<td>(0.65)</td>
</tr>
<tr>
<td>Females aged 5–18</td>
<td>40.84</td>
<td>65.02</td>
</tr>
<tr>
<td></td>
<td>(4.23)</td>
<td>(0.76)</td>
</tr>
<tr>
<td>Adult males</td>
<td>219.44</td>
<td>376.95</td>
</tr>
<tr>
<td></td>
<td>(18.76)</td>
<td>(3.17)</td>
</tr>
<tr>
<td>Adult females</td>
<td>200.53</td>
<td>282.91</td>
</tr>
<tr>
<td></td>
<td>(13.97)</td>
<td>(2.19)</td>
</tr>
<tr>
<td>Midwestern regional dummy variable</td>
<td>-428.69</td>
<td>-499,495.11</td>
</tr>
<tr>
<td></td>
<td>(20.07)</td>
<td>(8.94)</td>
</tr>
<tr>
<td>Frontier regional dummy variable</td>
<td>-579.47</td>
<td>-399,793.86</td>
</tr>
<tr>
<td></td>
<td>(15.97)</td>
<td>(6.14)</td>
</tr>
<tr>
<td>Farm size dummy variable</td>
<td>713.40</td>
<td>192,887.73</td>
</tr>
<tr>
<td></td>
<td>(34.46)</td>
<td>(1.37)</td>
</tr>
<tr>
<td>N</td>
<td>9,154</td>
<td>976</td>
</tr>
<tr>
<td>R² (adjusted)</td>
<td>0.258</td>
<td>0.834</td>
</tr>
</tbody>
</table>

Notes: Figures in parentheses are absolute values of t-statistics. The 1860 estimates are from farm-level data, the 1870 estimates from county-level data; thus the discrepancy between the size of the coefficients for the constant, regional, and size dummy variables in the two periods. For 1870 the Northeast includes the states of Connecticut, Delaware, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont. The Midwest includes Illinois, Indiana, Michigan, Ohio, and Wisconsin. The Frontier comprises Iowa, Kansas, Minnesota, and Nebraska. The 1860 sample contains no farms from Delaware, Maine, Massachusetts, Rhode Island, or Nebraska, and farms in northern Michigan and Wisconsin were included in the Frontier.

Sources: For 1860, we used farm-level data from Bateman and Foust, "Agricultural and Demographic Records." For 1870, we used county-level data from ICPSR, Historical Demographic, Economic and Social Data.

The difference in the specification of the SIZE variable in the two years reflects the difference in the data available.

These estimates differ slightly from those reported in Craig, "Value," p. 74, for three reasons. The age categories are different because of the data limitations for 1870. Our estimates include practice, climate, soil type, and access to markets affected the productivity of labor, and there may have been quasi rents associated with location in a particular region. Therefore, we have also included dummy variables for the different regions: Northeast, Midwest, and Frontier. The model also includes a dummy variable for the size of northern farms, SIZE, that captures the potential returns to the management of larger farms. For 1860 this variable takes on the value one for farms with more than 80 acres, zero otherwise. For 1870 it takes on the value one for counties in which more than 50 percent of the farms were greater than 80 acres, zero otherwise.39

Table 3 contains the results from estimating equation 3 for 1860 and 1870.40 According to these estimates, the real value of the marginal
The contribution of every category of labor increased substantially during the decade.\(^{41}\) As we have noted, these changes may have resulted from a true increase in productivity, an increase in the amount of time devoted to market production, or some combination of the two. In Table 4 we estimate likely weights for these two possibilities for each type of worker. For adult males we can calculate in a straightforward manner the percentage increase in the amount of time spent working by using equation 4 and available evidence on productivity change.\(^{42}\) For women and children it was necessary to make some assumptions about how their productivity behaved relative to that of adult males; after we specified their relative productivity, \(\delta\), at the two dates, we solved equation 5. We made the calculation under three different specifications about the changes in their relative productivity: constant, increasing, and decreasing (see Table 4).\(^{43}\)

The results indicate that even adult males appear to have increased the amount of time they devoted to production for the market. If their productivity advance is gauged accurately by the change in their real wages, then the amount of time they put in at work increased by 29

<table>
<thead>
<tr>
<th>Boys</th>
<th>Girls</th>
<th>Adult Males</th>
<th>Adult Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.04</td>
<td>0.93</td>
<td>1.53</td>
<td>1.34</td>
</tr>
<tr>
<td>0.89</td>
<td>0.83</td>
<td>1.40</td>
<td>1.44</td>
</tr>
</tbody>
</table>

\(^{41}\) Note that the signs and magnitudes of the other coefficients make sense. The omitted regional dummy variable was the Northeast, the region with the best access to urban markets; thus there was a premium in terms of net output from being located in that region. Similarly, there was a premium to owning a larger farm. Both of these results are supported by those reported in Atack and Bateman, To Their Own Soil, chap. 14; and Craig and Field-Hendrey, "Industrialization."

\(^{42}\) We used the change in the real monthly male wage to measure productivity change. Those wages were $13.66 in 1860 and $16.57 in 1870. See Lebergott, Manpower, p. 539.

\(^{43}\) According to the narrative accounts of farm wages for hired boys and women in northern farming, their relative productivity in 1860 was between 0.50 and 0.66. For 1860 we fixed the value at 0.66. See Schob, Hired Hands, especially the chapter entitled "Hired Boy" and "Hired Girl." Craig, and Craig and Field-Hendrey argue that the true relative productivity must have been close to this proportion. See Craig, "Industrialization"; and Craig and Field-Hendrey, "Industrialization." In the increasing productivity case, we raised the ratio to 0.75, and in the decreasing case we lowered it to 0.50.
The Civil War and Agricultural Productivity

<table>
<thead>
<tr>
<th></th>
<th>Value of Household Labor</th>
<th>Productivity</th>
<th>Time Spent Working</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult males</td>
<td>71.8</td>
<td>21.3</td>
<td>29.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Case A: Constant Relative Productivity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adult females</td>
<td>41.1</td>
<td>21.3</td>
<td>25.0</td>
</tr>
<tr>
<td>Boys</td>
<td>60.2</td>
<td>21.3</td>
<td>13.0</td>
</tr>
<tr>
<td>Girls</td>
<td>59.2</td>
<td>21.3</td>
<td>17.1</td>
</tr>
<tr>
<td>Case B: Increasing Relative Productivity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adult females</td>
<td>41.1</td>
<td>37.8</td>
<td>10.0</td>
</tr>
<tr>
<td>Boys</td>
<td>60.2</td>
<td>37.8</td>
<td>-0.6</td>
</tr>
<tr>
<td>Girls</td>
<td>59.2</td>
<td>37.8</td>
<td>3.1</td>
</tr>
<tr>
<td>Case C: Decreasing Relative Productivity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adult females</td>
<td>41.1</td>
<td>-8.1</td>
<td>65.0</td>
</tr>
<tr>
<td>Boys</td>
<td>60.2</td>
<td>-8.1</td>
<td>49.1</td>
</tr>
<tr>
<td>Girls</td>
<td>59.2</td>
<td>-8.1</td>
<td>54.6</td>
</tr>
</tbody>
</table>

Notes: The percentage increase in time is calculated using equation 4 for adult males and equation 5 for the other workers. The values of household labor come from Table 3. The productivity increase for adult males is the percentage increase in the monthly wage obtained from Lebergott. For the others, we assumed that their productivity remained constant (case A), increased (case B), or decreased (case C) relative to that for adult males. The two components do not account for the entire change in the value of farm labor; there were also changes in the number of workers (see equation 4 and note 40).

Source: Lebergott, Manpower, p. 539.

percent. This increase in time worked was greater than their productivity increase, a result that implies it was the more important source of growth. If, for example, their time input changed as we have estimated but their productivity remained at its 1860 level, then the value of their labor would have risen by 41.3 percent. In the alternative case, where productivity increased as indicated but their time input remained constant, then the value of their labor would have gone up by only 32.6 percent.

For the other workers, the assumption of constant relative productivity per unit of time seems most likely. The little evidence that exists on relative wages, for instance, indicates comparable percentage changes over the period 1850 to 1900. In this case women increased the amount of time they devoted to farm work by around 25 percent, with boys and girls showing increases of 13 and 17 percent respectively.

The outcome of the other simulations shows either a constant or an increasing amount of time at work for women and girls, with the increase ranging from 3 to 65 percent. The result for boys is mixed, but nevertheless suggests strongly that they must have increased the amount of time spent in agricultural production. The greater the assumed increase in their productivity, the smaller the increase in any input's time at work. Yet even under the assumption of a substantial 38 percent increase in the productivity of boys, their time at work fell by less than one percent.

We believe these results generally support our hypothesis that farm workers increased the time they committed to agricultural production during the 1860s. Although we reached the same conclusion for all workers, the finding for women is especially telling. The increase in their time was substantial and resulted in an increase in the output of agricultural products in which they most likely specialized.

**CONCLUSION**

Using the conventional output and labor force data, we have shown that the 1860s saw the greatest increase in output per farm worker of any decade in the nineteenth century. This finding might seem to confirm the traditional view that the Civil War spurred an agricultural revolution, but we contend that the source of this apparent rise in productivity was actually an increase in labor inputs not captured by the conventional series. More important than mechanization was an increase in the time and effort men, women, and children devoted to the production of marketable farm products. The fact that much of this increase came from women is of particular interest. Perhaps the story of the Civil War's economic effects should be changed to correspond with that of another great conflagration, World War II. The Civil War had its counterpart to Rosie the Riveter—perhaps Hilda the Hog Herder—but unlike Rosie, Hilda appears to have continued in her new job after the War.

Our evidence has been confined to this one decade, and indeed to a comparison of just the beginning and terminal dates. We think it likely that during the War more women and children were used than in other years of the decade, and those employed during the War worked even more intensely than in other years. We also think it likely, however, that the increased participation of women and children persisted beyond 1870, as the commercialization of livestock production and the rise of garden and truck farming made their efforts more valuable. The share of farm output accounted for by dairying, eggs, poultry, and garden farming increased by 13 percentage points (in constant prices of 1910/14) between 1870 and 1900.

Increased man- or woman-hours is, of course, not the kind of "source
of growth” one usually looks for to explain improvements in economic welfare, although it has been common in the early years of rapid growth in the newly industrializing countries of Asia. In western economies, we are accustomed to envisioning increases in capital per worker or improvements in machinery and technique as bringing about increased output per worker. According to Jeremy Atack and Fred Bateman, mechanization—and its converse, a reduction in man-hours per unit of output—was by far the chief source of productivity advance in grain farming over the long term, between 1840 and 1910.\textsuperscript{45} Perhaps in the short run, over the Civil War decade, mechanization was the key factor in that subsector as well. In some lines of activity, however, especially livestock, dairy, and poultry production, mechanization was not much of a force: the sharp increases in output of those products were brought about by an increase in the amount of time devoted to their production.\textsuperscript{46} Although the increase in inputs may have occurred initially as an attempt to support the War, the commercialization of livestock production apparently made it worthwhile to continue the increased work effort after 1865.

Our evidence suggests that the long-term effects of the Civil War—or the true nature of the transition that took place over the decade—need to be reconsidered. The focus of past analysis has been on industrialization and how that might have been stimulated in the long run by certain forces set in motion by the War, or at least during the decade of the War. The transformation we have uncovered is a different sort of influence, one that freed up labor for industry but without bringing about extensive mechanization of agriculture.

The source of growth that we have emphasized also highlights the need to determine what women and children were doing before the War. How did they manage to devote more time and effort to the products that became more commercialized after the War? One possibility is that they reduced their leisure time, if not on a daily basis over the year, at least at those times of the year that had not been periods of peak labor demand in crop production.\textsuperscript{47} This is certainly part of the story Bateman tells for the increase in dairy output, and Robert Gallman’s estimates of annual hours worked in agriculture indicate there was room for expanded effort. As he says, “the typical agricultural worker—slaves

\textsuperscript{45} Atack and Bateman, \textit{To Their Own Soil}, pp. 186–94.
\textsuperscript{46} Bateman’s studies of the dairy industry indicate how unimportant mechanization was in that sector. There was in fact a decline in output per worker between 1850 and 1910 in dairying, reflecting the fact that increased output was brought about entirely by increases in the number of man-hours devoted to the dairying tasks. See Bateman, “Improvement” and “Labor Inputs.”
\textsuperscript{47} Our evidence highlights the importance of studying the allocation of time among household activities in the agricultural sector and the implications a changing allocation has for economic growth—conventionally defined. These issues have been raised most recently by Folbre and Wagman, “Counting Housework.”
apart—was unable (and perhaps unwilling) to fill his year with work."48 For those who adhere to the idea that every member of the farm family worked from sunup to sundown, the additional output could have come from increased intensity during the workday, although we would expect that this increased productivity would be primarily reflected in the corresponding wage rates. If one holds an even more Spartan view of farm life, that each family member worked relentlessly and as hard as possible from sunup to sundown, then the increased output must reflect some optimizing decisions about the composition of output; women and children shifted their time from unmeasured household tasks to marketed activities or reallocated their efforts among farm and nonfarm market work. Evidence of seasonal work and dual occupations during the nineteenth century suggests the latter was a likely influence.49 The determination of which of these sources were important would seem to require the compilation of evidence from diaries and account books. Our results indicate that the search for such material is worthwhile.

48 Gallman, "Agricultural Sector," p. 56. He does allow that some of their time may have been devoted to production in other sectors, such as road building and forestry, and it is possible that farm laborers and family members spent less time at these activities (and others, such as teamstering) as they became the fulltime pursuits of workers who left the farm labor force.

49 See Engerman and Goldin, "Seasonality."

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