

## **Were Antebellum Cotton Plantations Factories in the Field?**

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29 November 2013

Preliminary: Comments Welcome!

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Acknowledgements: we have benefitted from comments and discussions with Gregory Clark, William Collins, Sumner La Croix, and David Weiman.

In his 1956 classic volume on American slavery, Kenneth Stampp wrote “each of the southern staples demanded its own kind of specialists. These agricultural enterprises, with their business directors, production managers, labor foreman, and skilled and unskilled workers, approached the organizational complexity of modern factories. Though agriculture was not yet mechanized, the large plantations were to a considerable extent ‘factories in the field.’”<sup>1</sup> The phrase *Factories in the Field* dates back at least to Carey McWilliams’ 1939 screed by that name, criticizing California’s huge farming empires.<sup>2</sup> Both authors were contrasting large-scale agricultural enterprises with the family farm and the industrial factory.

On the family farms that prevailed in the East and Midwest, the cultivators applied their labor to their own land to produce a mix of livestock, grains, and specialty crops. In *To Their Own Soil*, Jeremy Atack and Fred Bateman described the evolution of northern agriculture. In the early stages of settlement, the major “order of business was to provide at least a basic subsistence for the family....” Gradually, northern farmers in a given area became more commercially oriented and accumulated more capital, cleared more land, and adopted labor saving machinery and more animal and steam power. But throughout these changes, family members remained the primary source of labor.<sup>3</sup> The availability of land coupled with the family farm organization heavily influenced key demographic patterns, community development, education, wealth distribution, and other important socio-economic characteristics.<sup>4</sup> Industrialization in the North created both tension and opportunities for family farmers. Atack and co-authors later provided a rich account of the rise of the factory in the United States.<sup>5</sup> As with agriculture, the

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<sup>1</sup> Kenneth Stampp, *The Peculiar Institution: Slavery in the Ante-Bellum South* (New York: Vantage Books, 1956), p. 42.

<sup>2</sup> Carey McWilliams, *Factories in the Field: The Story of Migratory Farm Labor in California* (Santa Barbara: Peregrine Smith, 1971; first published in 1939).

<sup>3</sup> Jeremy Atack and Fred Bateman, *To Their Own Soil: Agriculture in the Antebellum North* (Ames, IA: Iowa State University Press, 1987), pp. 11-12.

<sup>4</sup> Atack and Bateman, *To Their Own Soil*, pp. 37-101.

<sup>5</sup> Jeremy Atack, Michael R. Haines, and Robert A. Margo, “Railroads and the Rise of the Factory: Evidence for the United States, 1850-70,” in Paul W. Rhode, Joshua Rosenbloom, and David Weiman,

manufacturing sector was evolving, with small-scale artisan shops being rapidly replaced by factories employing both power-driven machinery and a more extensive division of labor.

The cliometric literature, while critical of Stamp's scholarship, has adopted and embellished his association of plantations with factories. As an example, Jacob Metzger quoted the relevant passage with approval.<sup>6</sup> But do southern plantations merit that title, "factories in the field"? What was the relationship between plantation management practices and Alfred Chandler's modern business enterprise or to Frederick Taylor's scientific management? Are standard interpretations in the cliometric literature of the assembly-line-like operations of slave labor accurate? Could assembly lines or coordination economies more generally truly account for the supposed productivity advantage of plantations over the family farms?

We will concentrate our analysis on cotton plantations. Cotton was the slave South's leading crop. Its production arrangements occupied an intermediate ground between sugar and tobacco. We argue that the analogies between plantations and factories, assembly lines, and labor systems employing "modern" management techniques are misleading and obscure far more than they reveal. Furthermore, the conclusions about the sources of supposed plantation efficiency based on these analogies are unsound.

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eds., *Economic Evolution and Revolution in Historical Time* (Stanford, CA: Stanford University Press, 2011), pp. 162-79.

<sup>6</sup> Jacob Metzger, "Rational Management, Modern Business Practices, and Economies of Scale in Antebellum Southern Plantations," *Explorations in Economic History* 12:2 (April 1975), pp. 123-50, esp. pp. 148-49. Daniel C. Littlefield, "The Varieties of Slave Labor," raised and critiqued the analogy owing to the differences in slave labor across time, place, and activity. "Slavery was work, often very hard work...it was routinized and mind-numbing, a repetition of the same tasks or movements, changed only by the season of the year or time of day. This image gave rise to the expression "factories in the field," evoking an early industrial model where workers were no more than cogs in a machine. Yet plantation labor was not always and everywhere the same." Daniel C. Littlefield, "The Varieties of Slave Labor," National Humanities Center, TeacherServe, <http://nationalhumanitiescenter.org/tserve/freedom/1609-1865/essays/slavelabor.htm>, accessed 14 Nov. 2013.

Referring to "the extremely large sugar plantations in the Caribbean and in South America," the Walton and Rockoff textbook, observes "[t]hese plantations were more like factories than farms, with the organization of slaves resembling an assembly line of workers." The contrast for U.S. cotton plantations was "less striking" but similar. Gary M. Walton and Hugh Rockoff, *History of the American Economy*, 12 ed. (Mason, OH: South-West, 2012), p. 230

This paper has the following form. In Section 1, we define terms. In Sections 2 and 3 we assemble the quantitative evidence on scale, labor force numbers, and the capital stock for plantations, family farms, and manufacturing establishments from the 1860 Census and then compare the operating characteristics of the three sets of organizations. In Section 4, we investigate the extent of the division of labor, the seasonality of work, regimentation at antebellum plantations, farms, and factories. We move on in Sections 5 and 6 to a more qualitative exploration of the relevance of analogies of slaves to machine parts and of plantation practices to modern management techniques. In Section 7, we assess whether the gang system achieved “assembly-line” like efficiencies. Section 8 sums up our evaluation of the popular claim that antebellum cotton plantations operated as “factories in the field.”

### *Defining Terms*

In his “Report on the Factory System” for the *Tenth Census of the United States*, Carroll D. Wright defined a factory as a “establishment where several workmen are collected for the purpose of obtaining greater and cheaper conveniences for labor than they could procure individually at their homes; for producing results by their combined efforts which they could not accomplish separately; and for preventing the loss occasioned by carry the articles for place to place....” The core principle was of *association*: “each laborer, working separately...directs his producing powers to effect a common result....” The more prominent is the “principle of association” the more the establishment is “entitled to the name of factory and the more generally does it receive the name in common parlance.”<sup>7</sup> Wright drew on writings of the British authority, Andrew Ure, for whom “the term factory system, in technology, designates the combined

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<sup>7</sup> Carroll D. Wright, “Report on the Factory System of the United States,” in U.S. Census Office, *Tenth Census of the United States: Manufactures, 1880* (Washington, DC: GPO, 1882), p. 1 of report; p. 523 of volume. Wright’s text is taken with attribution but without quotes from William Cooke Taylor, *Factories and the Factory System: From Parliamentary Documents and Personal Examination* (London: Jeremiah How, 1844), pp. 1-2. Taylor noted the definition is broad and “[e]ven a farm must be regarded as a species for factory, the separate operations of the individual husbandmen being combined to produce a result which the aggregate of their isolated efforts would not have accomplished.” In an “extension of the factory principle,” Taylor excludes those farming operations where the implements are so “few, simple, and cheap” that the workers themselves own the tools. With tools of their own, the farm-laborers go “from one place to another, and rarely form with their employers, or with each other, any but temporary and casual associations.”

operation of many orders of work-people, adult and young, in tending with assiduous skill a series of productive machines continuously impelled by a central power.”<sup>8</sup>

In courses on the Industrial Revolution, the “factory” is commonly defined as a manufacturing establishment utilizing a power source (water or steam) and employing a number of wage-earners (the lower-bound cutoff is often around 15). Many scholars add the use of supervision (or what is known as “factory discipline”) and the application of extensive specialization or the division of labor.<sup>9</sup> Applying the concept to Census data, which are silent on the organization of work within the establishment, requires modification. We can follow the guide of Jeremy Attack, a leading investigator in this area. In his earlier work, he defined a factory as “an inanimately powered plant employing over twenty-five workers.” “Factory production depended upon steam or water power to drive machinery. Artisan shops, sweatshops, and manufactories, on the other hand, relied on hand tools. Human muscle was sufficient for their power needs.”<sup>10</sup> Factory production also entailed specialization, which “could not be practiced extensively” unless the plant operated on a sufficient scale. Attack later lowered the employment threshold from over 25 to over 15 workers.<sup>11</sup> Even this downward revision

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<sup>8</sup> Andrew Ure, *Philosophy of Manufacturers: Or, An Exposition of the Scientific, Moral, and Commercial Economy of the Factory System of Great Britain* (London: Charles Knight, 1835), p. 13. For Ure, the factory “excludes those in which the mechanisms do not form a connected series, nor are dependent on one prime mover.” While some include in the definition “all extensive establishments wherein a number of people co-operate towards a common purpose of art,” Ure contended that a factory “in its strictest sense, involves the idea of a vast automaton, composed of various mechanical and intellectual organs, acting in uninterrupted concert for the production of a common object, all of them being subordinated to a self-regulated moving force.” See also

<sup>9</sup> Paul Mantoux, *The Industrial Revolution in the Eighteenth Century: An Outline of the Beginnings of the Modern Factory System in England* (New York: Harper and Row, 1961, orig. published in 1928), pp. 38-39; Maxine Berg, “Factories, Workshops, and Industrial Organization,” in Roderick Floud and Donald McCloskey, eds., *The Economic History of Britain Since 1700: Vol. 1, 1700-1860*, 2<sup>nd</sup> ed. (New York: Cambridge Univ. Press, 1994), pp. 123-50

<sup>10</sup> Mills also relied on inanimate power sources but did not utilize specialization or the division of labor as extensively as factories. Attack acknowledged the dividing line between mills and factories was “arbitrary,” but he assumed “specialization could not be practiced extensively” unless the plant employed more than 25 workers. Jeremy Attack, “Economies of Scale and Efficiency Gains in the Rise of the Factory in America, 1820-1900,” in Peter Kilby, ed., *Quantity & Quiddity: Essays in U. S. Economic History* (Middletown, CN: Wesleyan Univ. Press, 1987), pp. 286-335, esp. pp. 287-88. In this piece, Attack defined the following categories: Artisan shop (no power, 1-6 employees); Sweatshops (no power, 7-25 employees); Manufactories (no power, over 25 employees); Mills (power, 1-25 employees); and finally Factories (power, over 25 employees).

<sup>11</sup> Jeremy Attack, Fred Bateman, and Robert A. Margo, “Capital Deepening and the Rise of the Factory: the American Experience during the Nineteenth Century,” *Economic History Review* 58:3 (Aug. 2005), pp. 586-95; Jeremy Attack, Fred Bateman, and Robert A. Margo, “Steam Power, Establishment Size, and Labor Productivity Growth in Nineteenth Century American Manufacturing,” *Explorations in Economic History*

set a high bar: as the evidence in Table 1 shows, fewer than one-in-twenty (4.5 percent) of American manufacturing establishments in 1850 met the joint standard of employing 16 or more workers and using water/steam power. Such establishments did employ 33.2 percent of all workers and produce 23.9 percent of all value added. By 1880, the shares of establishments meeting the joint standard had increased to 8.3 percent of units, 49.4 percent of workers, and 38.6 percent of manufacturing value added.<sup>12</sup>

In the economic history and agricultural history literatures, the dividing line separating farms from plantations is not sharply defined. On one side of the spectrum, operations employing only free labor, which include all northern units and about one-half of southern units—are clearly farms; their operators are farmers. And those operations with only a few slaves are rarely called plantations; the owners are hardly ever styled planters. On the other side of the spectrum, units with units with 50 or more slaves are clearly plantations; the owners of these operations are undisputedly “planters.” But authors differ about where to set the dividing line between the largest slave farm and the smallest slave plantation. Resolving this semantic issue is not crucial. It is important to note that the total number of slaves of a unit includes non-working family members (both young and old) and is not directly comparable to the number of wage-earners employed in a manufacturing establishment.

In addition to comparing plantations to factories, scholars have also associated or related plantation operations with those of modern business enterprises, with practices of Taylor’s Scientific Management, and with the moving assembly line. Alfred D. Chandler offered a definition of a “modern business enterprise” as a firm operating two or more distinct production/distribution units and run by a hierarchy of salaried managers who monitor and coordinate the activities at these units. This is contrasted with a “traditional business enterprise,” a firm which is engaged in a single production activity, is owned and managed by family members, and buys its inputs from and sell its outputs to the

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45 (2008), pp. 185-98. In addition to using a reduced scale threshold, this work also separated the power use and scale dimensions (so factories could include manufactories that did not use steam or water power). These changes brought the analysis closer in line with the definitions in Kenneth Sokoloff, “Was the Transition from the Artisanal Shop to the Nonmechanized Factory Associated with Gains in Efficiency?: Evidence from the U.S. Manufacturing Censuses of 1820 and 1850,” *Explorations in Economic History* 21:4 (1984), pp. 351-82.

<sup>12</sup> Atack, Bateman, and Margo, “Capital Deepening,” p. 593.

market.<sup>13</sup> “Scientific Management” was a set on management practices developed by Frederick Taylor and his followers to prevent “soldiering” and to improve work efficiency. The practices included implementing incentive pay and designing “optimal” work methods based on time-and-motion studies rather than “rules of thumb.”<sup>14</sup>

The “assembly line,” according to David Nye’s recent book, was a production technique combining five key components—the subdivision of labor, interchangeable parts, single-function machines, the sequential ordering of machines, and the movement to work to worker by belts and slides. Work was divided “into small operations of nearly equal duration;” “every job could be learned quickly.” Use of precision-made interchangeable parts allowed assembly to proceed smoothly without “any last-minute sanding, filing, or polishing.” Each machine tool was designed to do one thing, and one thing only, as quickly as possible. The machines and tasks were arranged to ensure the smooth flow of the product through the assembly process. And this flow of parts and sub-assemblies through the production process was automated. As Nye argues, the invention of the assembly line has a powerful influence on twentieth-century thought.<sup>15</sup> Its effect on the work process was also dramatic.<sup>16</sup>

As noted above, the “factories in the field” phrase appears to be of mid-twentieth century coinage. Its first popular use was in Carey McWilliams’ 1939 book on large California farms, a pioneering critique of the industrialization of agriculture. McWilliams decried the exploitation of migrant labor, the vastly unequal distribution of wealth, and the violation of the Jeffersonian ideal of the ownership of the soil by its actual cultivators. In closely-related work, McWilliams complained of the adoption of power farming and extensive mechanization, the employment of non-family (often

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<sup>13</sup> Alfred D. Chandler, Jr., *The Visible Hand: The Managerial Revolution in American Business* (Cambridge, MA: Harvard Univ. Press, 1977), pp. 1-3.

<sup>14</sup> Frederick W. Taylor, *The Principles of Scientific Management* (New York: Harper, 1913), pp. 9-29. “Soldiering” involves making a show of working in order to escape punishment.

<sup>15</sup> David Nye, *America’s Assembly Line* (Cambridge, MA: MIT Press, 2013), pp. 22-27.

<sup>16</sup> Henry Ford in collaboration with Samuel Crowther, *My Life and Work* (Garden City, NY: Garden City Publishing Co., 1923), p. 80 observed: “[W]e began taking the work to the men instead of taking the men to the work. We now have two general principles in all operations-- that a man shall never have to take more than one step... and that no man need ever stoop over....[A]s nearly as possible, [a worker does] only one thing in only one movement.”

migrant) labor, and of the growing scale of agricultural production units.<sup>17</sup> The slogan “No hands touch the land” captures a current-day extension of this critique.<sup>18</sup> When calling mid-nineteenth century slave plantations “factories in the field,” one would be well advised to bear in mind what images the phrase this is likely to evoke for members of the modern audience.

### *Assembling the Evidence*

To compare cotton plantations with farms and factories in the same period, we can draw on the wealth of micro-level data on mid-nineteenth century business organizations generated by economic historians in the 1960s, 1970s, and 1980s. The Parker-Gallman sample (ICPSR 7419) covers farms and plantations in cotton producing counties in 1860.<sup>19</sup> The Bateman-Foust sample (ICPSR 7420) covers northern farms in the same year.<sup>20</sup> And the Attack-Bateman samples cover manufacturing establishments.<sup>21</sup>

Creating comparable labor and output aggregates is challenging, but fortunately we again have the work of Attack and other economic historians to help. For manufacturing, Attack, Bateman, and Margo present total employment and an effective (or adult-male-equivalent) employment.<sup>22</sup> For northern agriculture, Lee Craig has created

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<sup>17</sup> Carey McWilliams, “Farms into Factories: Our Agricultural Revolution,” *Antioch Review* 1:4 (Winter 1941), pp. 406-31. Writing in roughly the same period as McWilliams, two leading scholars of agricultural history with very different social orientations—Paul S. Taylor and Ulrich B. Phillips—drew parallels between the large-scale California farms and, the southern slave plantation. Paul S. Taylor, “Plantation Agriculture in the United States: Seventeenth to Twentieth Centuries,” *Land Economics* 30:2 (May 1954), pp. 141-52. Ulrich B. Phillips, “Plantations with Slave Labor and Free,” *American Historical Review* 30:4 (July 1925), pp. 738-53.

<sup>18</sup> Debates over “factory farming/ high density” versus “free-range/ low density” methods of raising livestock is another current-day extension. See Michael Pollan, *The Omnivore’s Dilemma* (New York: Penguin, 2006).

<sup>19</sup> William N. Parker and Robert E. Gallman, Southern Farms Study, 1860 [Computer file]. ICPSR07419-v1. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 1991. doi:10.3886/ICPSR07419.

<sup>20</sup> Fred Bateman and James D. Foust, Agricultural and Demographic Records for Rural Households in the North, 1860. ICPSR07420-v1. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 1976. doi:10.3886/ICPSR07420.v1.

<sup>21</sup> We use the 1860 national sample downloaded from [my.vanderbilt.edu/jeremyatack/data-downloads/](http://my.vanderbilt.edu/jeremyatack/data-downloads/).

<sup>22</sup> Attack, Bateman, and Margo, “Capital Deepening,” p. 591. Total employment sums the men, women, and children in the factory labor force; effective (or adult-male-equivalent) employment assigns a weight of 1 to adult males; 0.5 to adult females, and 0.33 to children. We did not follow their practice of imputation entrepreneurial inputs by adding one worker. We did follow their practice of dropping observations for establishments reporting non-positive value added (the value of product minus the cost of materials), raw materials, total employment, or capital.

a set of weights to calculate adult male equivalents.<sup>23</sup> For southern agriculture, a veritable cottage industry operated for a time in the economic history community to create weights to calculate adult male equivalents (see Appendix A). In a way, the scholars creating these weights were replicating the practices of slaveholders who assigned hand ratings to their labor force. To enhance comparisons with early work, we will use both the total labor force and the “adult-male-equivalent” labor force derived based on the weights of Fogel and Engerman.<sup>24</sup>

We calculate industrial output as values added—that is, the value of product minus the cost of materials. We gauge farm output as the value of all crops (at national prices) and the reported value of animal slaughtered.<sup>25</sup> We proceed with the sense that this procedure understates the output associated with the production and sale of livestock.

To compare the use of power and machinery in manufacturing and agricultural operations, it is desirable to take into account differences in the nature of production activities. Given the locational dispersion of cultivation activity, most agricultural units used mobile power sources (such as draft animals) rather than fixed power sources (such as steam engines or water wheels) when driving machinery. The dispersion and out-of-doors nature of most farming activities is an important feature to be noted and is indeed captured by the “in the fields” part of the phrase. To measure the extent of substitution

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<sup>23</sup> Lee A. Craig, *To Sow One Acre More: Childbearing and Farm Productivity in the Antebellum North* (Baltimore, MD: Johns Hopkins Univ. Press, 1993), p. 80 provides regression results on the dollar value of household labor in northern agriculture that consistent with prime-age-adult-male (age 18-54) weights of 0.67 for adult females (18 years and over), 0.77 for senior adult males (55 years and over), 0.10 for teenage females (13-17 years), and 0.25 for teenage males (13-17 years).

<sup>24</sup> Gavin Wright, *Slavery and American Economic Development* (Baton Rouge, LA: Louisiana State Univ. Press, 2006), p. 106 highlights the sensitivity of the empirical outcomes in the cliometric literature regarding the relative efficiency of slave plantations and free farms to the labor weights assumed. He also points (pp. 102-06) to the difficulties arising from the valuation of land.

<sup>25</sup> The national crop prices for 1860 are from Marvin W. Towne and Wayne D. Rasmussen, “Farm Gross Product and Gross Investment in the Nineteenth Century,” in William Parker, ed. *Studies in Income and Wealth, Vol. 24 Trends in the American Economy in the Nineteenth Century* (Princeton, NJ: Princeton Univ. Press for the NBER, 1960), pp. 255-316. We made no adjustment as in Elizabeth Field-Hendrey’s work to re-estimate meat production in the South or to include estimates of output of products (lumber, poultry, and eggs) that the Census did not enumerated. We did not include the value of orchard or market garden products or of home manufacturing (but could so). We made not adjustment for the differences in sampling procedures used to create the Bateman-Foust and Parker-Gallman samples. Such refinement, while desirable, would not likely alter our main findings.

away from tools powered by human muscles, we will include statistics on draft animals and implements.<sup>26</sup>

We calculate employment and capital-to-labor ratios using the total labor force and the adult male equivalent labor force. (We treat slaves as labor, not as capital; their value is not included in the capital stock.) The capital stock ratios in agriculture can be subdivided in components including “farm land and buildings,” “implements and draft stock,” and implements alone. Census enumeration procedures in 1860 unfortunately do not allow the manufacturing capital stock to be subdivided in an equivalent way at the establishment level. According to Robert Gallman’s estimates for 1860, equipment made up 22 percent of the aggregate manufacturing capital stock, buildings 23 percent, and land 24 percent.<sup>27</sup> The share of agricultural capital stock devoted to machinery and power sources (including draft animals) was much lower.

The rise of the factory in the late-nineteenth century United States was associated with capital deepening and the growth of the capital-to-labor ratio. In careful analysis of the detailed 1880 manufacturing data, Attack, Bateman, and Margo showed that the capital-to-labor ratio and capital-to-effective-labor ratios were higher for those establishments employing 16 or more workers than those employing 15 and fewer and much higher for those establishments using inanimate power than those that did not.<sup>28</sup> Focusing on the antebellum agricultural sector, Haywood Fleisig contrasted differences in the use of specific forms of capital, most notably implements, on plantations and free farms.<sup>29</sup> He argued plantations could expand output by adding slave workers whereas free farms, facing a family labor constraint, could expand output only by mechanizing,

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<sup>26</sup> We calculate the estimated value of capital in draft stock by multiplying the sum of horses, mules, oxen (weighted by one-half) times the national equine price of \$59 per head from Towne and Rasmussen, “Farm Gross Product,” p. 286. The one-half weight on oxen roughly captures the typical price ratio between bovine and equine draft power sources. See Alan L. Olmstead and Paul W. Rhode, *Creating Abundance: Biological Innovation and American Agricultural Development* (New York: Cambridge Univ. Press, 2008), p. 364. This calculation ignores regional differences in prices.

<sup>27</sup> Gallman based the estimates on figures in US Census Office, *Twelfth Census of the United States*, Vol. 7, Pt. I (Washington, DC: GPO, 1902), p. xcvi; Carroll D. Wright, *A Compendium of the Census of Massachusetts: 1875* (Boston: Albert J. Wright, 1877), p. 139 recorded that for the Massachusetts manufacturing establishments, machinery made up 30.1 percent of the capital stock, inventories 36.6 percent, and buildings 33.3 percent; for the state’s farms (p. 225), land comprised 55.5 percent of the capital stock; buildings 31.4 percent; trees and vines 2.2 percent; domestic animals 8.2 percent; and agricultural implements 2.5 percent.

<sup>28</sup> Attack, Bateman, and Margo, “Capital Deepening,” p. 591.

<sup>29</sup> Haywood W. Fleisig, “Slavery, the Supply of Labor, and the Industrialization of the South,” *Journal of Economic History* 36:3 (Aug. 1976), pp. 572-97.

adopting machinery and draft power to increase the land-to-labor ratio. Wright shows that the value of implements per unit of labor rose sharply in the North in 1860 as the scale of operations (as measured by acres of improved land) rose where the ratio fell on Virginia Piedmont farms as scale (here measured by the number of slave) rose.<sup>30</sup>

Comparing the scale of operations and the capital-to-labor ratios of plantations, farms, and manufacturing establishments promised to shed more light on the relevance of the “factories in the field” appellation.

### *Comparing Plantations, Farms, and Factories*

Figure 1 graphs the distribution of output in manufacturing, agriculture in the North, and agriculture in the cotton South by size of operation in 1860. Size is measured in two ways: the total number of workers per establishment and the number of adult male equivalent works. By either measure, agricultural production is concentrated in in far larger units in the cotton South than in the North. This is no surprise. The larger production units in the South, which as almost exclusively slave plantations, have no real counterparts in northern agriculture.<sup>31</sup> In our sample drawn from the Bateman-Foust data set, the largest northern farm, measured by the total number of workers, has a labor force of 28. (This Iowa farm accounted for a negligible share of total output.) In our sample drawn from the Parker-Gallman data set, 4 percent of units, accounting for 32 percent of output, are of this size or larger. In this sample, the largest unit, a Rapides, Louisiana plantation, had 257 workers.

Comparing the cotton farms and plantations with manufacturing establishments puts the “factories in the field” notion into perspective. The very large units in the cotton sample account for a far smaller share of output than their counterparts in the manufacturing sample. The top five percent of manufacturing units (on a workers per establishment basis) employed 46 or more workers and accounted for 45 percent of total output. (The largest industrial establishment in the sample was a water-powered textile

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<sup>30</sup> Wright, *Slavery*, pp. 119-21.

<sup>31</sup> The number of workers on an individual northern farm typically understated the size of the labor force that could be assembled to perform specific tasks such as harvesting and threshing small grain. See Alan L. Olmstead and Paul W. Rhode, “Beyond the Threshold: An Analysis of the Characteristics and Behavior of Early Reaper Adopters,” *Journal of Economic History* 55:1 (March 1995), pp. 27-57.

mill in Maine that employed 1825 workers.) The top five percent of units in the cotton sample had 25 or more workers and accounted for 36 percent of total output. The top five percent in northern farm sample had 7 or more workers and accounted only 10 percent of total output. Table 2 describes how output varied across the organization units in the different sectors. Even the largest category of slave plantations --those with 50 or more slave-- produced less output on average than factories (the omitted category in the regression).

Tables 3 and 4 present statistics on the capital-to-labor ratio in manufacturing, agriculture in the North, and agriculture in the cotton South. Based on the numbers in Table 4, one can calculate that implements and draft stock made up about 10 percent of capital on the farms in the northern agricultural sample; land and building accounted for 85 percent. In all farms in the cotton sample, implements and draft stock made up about 15 percent of capital; land and building about 76 percent. On slave-holding farms and plantations, the share of implements and draft stock was lower and the share of land and buildings higher than on free southern farms.

These data reveal that the difference in the aggregate capital-to-labor ratios across these broad activities were not large. Differences at the more fine-grained level are apparent. In the 1860 sample, manufacturing establishments in the larger employment scale category have lower capital-to-labor ratios than establishments in the small scale category. This is consistent with increasing scale saving capital by spreading a fixed stock over a larger employment base. In the 1860 sample, manufacturing establishments powered by water or steam have higher lower capital-to-labor ratios than those which are not. The first result differs from the findings of Atack, Bateman, and Margo for 1880; the second result is consistent with their findings. Note the results reported here do not include the same rich set of controls.

One may be concerned that the capital-to-labor ratio is influenced by the level of output per establishment, which varied greatly across sectors. Tables 5 and 6 show the magnitudes of these effects in the manufacturing and in two agricultural samples. For the manufacturing sector as a whole and for the factory component, the total capital-to-labor ratio (measured in both ways) rises with output. The same is true of the total capital/labor ratio for northern farms and medium-size and large southern cotton

plantations. The expansion path of physical capital-to-labor ratio does not increase with output as fast in the cotton sample as the other two samples, but it does rise.

These observations suggest that we compare plantations, free farms, and factories controlling for the level of output per operation. Table 7 reports the results for the heroic endeavor of combining the capital/labor ratios and output levels for the three sectors into a common framework. The regression model takes the factory as the reference and asks whether, controlling for output, other organizational forms have measurably different capital/labor ratios? It presents two sets of standard errors, those that correct for heterogeneity alone and those that are clustered by sector. If one takes into account controls for sectors, slave plantations have higher capital-to-labor ratios than factories; the differences are statistically significant at conventional levels using either set of standard errors. The plantations with a greater numbers of slaves—those with 50 plus are a subset of those with 16 plus, which in turn are a subset of all slave-holding units—have progressively lower capital-to-labor ratios than cotton producers with fewer slaves. But again, the plantations have higher capital-to-labor ratios than factories and the differences are statistically significant at conventional levels using either set of standard errors. This test is admittedly heroic, but it calls into question the use of the “factories in the field” label for plantations.

One may object that the full specifications reported in Table 7 include sector controls and units other than plantations and factories. What about a straight-up comparison of factories with plantations, say of units with 16 or more slaves? The head-to-head specification reported in the bottom panel of Table 7 shows these results (with only robust standard errors). Again, plantations are distinct, with higher capital-to-labor ratios controlling for output levels. Total capital includes land. Limitations in the manufacturing data prevent us from focusing on power and machinery; these capital-to-labor ratios are almost surely lower for plantations. The data in Table 4 point to this core difficulty for the “factories in the fields” appellation. The capital mix of southern plantations is heavily weighted to “fields” (i.e. land) and not to the accoutrements of “factories” (i.e. machinery and power sources).

*Division of Labor, Regimentation, and Seasonality of Work*

What about other attributes of the factory system, such as the use of the division of labor? By most accounts, the harvest was the binding constraint in cotton production. Stampff asserted this view and added that during the peak of harvest season almost all able-bodied hands, including those skilled in a craft and working in the big house, were sent to the field to pick.<sup>32</sup> In our investigation of plantation production activities, we are exploring the allocation of the labor force over the harvest season. The surge of laborers into the picking work during late September and October is plainly evident. It was all hands on deck, or rather into the fields. While there was a degree of specialization on plantations with specific workers trained as smiths, wrights, and carpenters, we have seen nothing to such as greater overall division of labor than within northern rural communities where farmers could purchase such services in village markets.

Southerners did not typically consider plantations closely akin to factories. In *Deplorable Scarcity*, Fred Bateman and Thomas Weiss document how uncommon manufacturing activities were in the South.<sup>33</sup> Kenneth Sokoloff and Viken Tchakerian show this was especially true of the cotton producing areas.<sup>34</sup> The rates of profitability calculated by Bateman and Weiss for southern manufacturers suggest that local investors found activity novel and strange; they required a large risk premium to divert their funds away from the more familiar activities such as investing in slave plantations.

According to the conventional view, work in factories was regular and freed from dependence of seasonal conditions. Factories are typically in-door spaces where external forces may be largely controlled. Atack and co-authors show this ideal took time to be fully realized and that many industrial workplaces in the mid-nineteenth century America reduced their hours of operation in the winter due to weather conditions, darkness, and lack of flowing water to drive power equipment. In the early nineteenth century, industrial work had been “from sun to sun.” By the early post-bellum period (1870 and 1880) when the relevant data on the seasonality of manufacturing activity first became

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<sup>32</sup> Stampff, *Peculiar Institution*, pp. 37-38.

<sup>33</sup> Fred Bateman and Thomas Weiss, *A Deplorable Scarcity: The Failure of Industrialization in the Slave Economy* (Chapel Hill, NC: Univ. of North Carolina Press, 1981).

<sup>34</sup> Kenneth L. Sokoloff and Viken Tchakerian, “Manufacturing Where Agriculture Predominates: Evidence from the South and Midwest in 1860,” *Explorations in Economic History* 34 (1997), pp. 243-64.

available, “the typical establishment (weighted by the value of its capital stock or by employment) was ‘full-year’—that is, operated for 12 months on a full-time-equivalent basis.” Part-time establishments had not disappeared, but they were smaller and less capital intensive. A substantial “majority of the establishments enumerated in both the 1870 and 1880 censuses of manufacturing operated on a full-time basis for the entire census year.”<sup>35</sup>

Historians have debated the role of natural time and clock time in the antebellum South. Eugene Genovese, reflecting the dominant view, argued that the southern plantation “setting remained rural, and the rhythms of work followed seasonal fluctuations. Nature remained the temporal reference point for the slaves.”<sup>36</sup> Mark M. Smith has pushed a revisionist perspective, asserting that after 1830 southerners came to view the clock as the “legitimate arbiter of time.”<sup>37</sup> To address the regularity, seasonality, and duration of work on slave plantations, we have surveyed about 800 slave narratives and oral histories. Of these, about one-in-four give an account of the daily hours of work including both starting and ending times. Of this latter group, 90 percent were consistent with the notion that the hours extended from “sunrise to sunset,” from “kin to can’t” or from “before daylight to dark” (or “almost dark” or “after dark”), or “all day.” Clearly the plantation work schedule depended on natural conditions, such as the seasonal variability of light. The same was undoubtedly true of northern farms as well.<sup>38</sup>

Work and life on slave plantations were far more regimented than on northern farms (or even in factories). The bulk of the plantation labor force was awoken by the same horn and sent into the fields under the same set of supervisors. Under the gang

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<sup>35</sup> Jeremy Atack, Fred Bateman, and Robert A. Margo, “Part-Year Operations in Nineteenth Century American Manufacturing: Evidence from the 1870 and 1880 Censuses,” *Journal of Economic History* 62:3 (Sept. 2002), pp. 792-809, esp. p. 793 and 807. See also Jeremy Atack, Fred Bateman, and Robert A. Margo, “Productivity in Manufacturing and the Length of the Working Day: Evidence from the 1880 Census of Manufactures,” *Explorations in Economic History* 40:2 (April 2003), pp. 170-94.

<sup>36</sup> Eugene Genovese, *Roll, Jordan, Roll: The World the Slaves Made* (New York: Pantheon, 1974), p. 291.

<sup>37</sup> Mark M. Smith, *Mastered by the Clock: Time, Slavery, and Freedom in the American South* (Chapel Hill, NC: Univ. of North Carolina Press, 1997), p. 240.

<sup>38</sup> Our search of slave narratives is still ongoing. To date, we have examined narratives posted online by the Library of Congress, *Born in Slavery: Slave Narratives from the Federal Writers’ Project, 1936-1938*, <http://memory.loc.gov/ammem/snhtml/snhome.html>; we have also mined information found in numerous published slave narratives. Lee A. Craig and Thomas Weiss, “Hours at Work and Total Factor Productivity Growth in Nineteenth-Century U.S. Agriculture,” in Kyle D. Kauffman, ed., *New Frontiers in Agricultural History: Advance in Agricultural Economic History* 1 (2000), pp. 1-30, esp. 6-15 summarized the state of knowledge about hours of work in American agriculture in this period.

system, individuals returned home from the fields at the same time.<sup>39</sup> Even under the task system, slaves were categorized by hand rating according to the amount of work expected. The provision of food, clothing, and housing were also highly regimented. The goal was to maximize the output of the slave work force for minimum cost.

### *Slaves as Machine Parts*

In 1956, Martin Luther King, Jr. observed that under slavery African-Americans were “considered a thing to be used, not a person to be respected. He was merely a depersonalized cog in a vast plantation machine.”<sup>40</sup> King was neither the first nor last to conger the image of slaves working like machines or being treated as parts of a larger mechanism. The “Rules” of Bennet H. Barrow’s Highland Plantation read “A plantation might be considered as a piece of machinery, to operate successfully, all of its parts should be uniform and exact, and the impelling force regular and steady; and the master, if he pretended at all to attend to his business, should be their impelling force....”<sup>41</sup> In his *Journey in the Back Country*, Frederick Law Olmsted characterized slaves on Mississippi Valley cotton plantations as laboring in a “stupid, plodding, machine-like manner.” As an example, he noted the case of “nearly two hundred hands... moving across the field in parallel lines, with a considerable degree of precision...” Even when he and others charged by on horse, the slaves toiled without “the smallest change or interruption...”<sup>42</sup>

The immediate victims of the slavery often invoked a different analogy, one that was more organic and less mechanical. In his autobiography, Frederick Douglass described slaves as being treated akin to livestock. Upon his master’s death and the

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<sup>39</sup> David Weiman related a part of the Yale Oral Tradition. William Parker observed that there was an element of coercion facing young family workers, especially teenage males, on free farms.

<sup>40</sup> Martin Luther King, Jr., *A Testament of Hope: The Essential Writings of Martin Luther King, Jr.*, James M. Washington, ed. (San Francisco: Harper & Row, 1986), p. 136.

<sup>41</sup> Bennet Hilliard Barrow, and Edwin Adams Davis, *Plantation Life in the Florida Parishes of Louisiana, 1836 - 1846: As Reflected in the Diary of Bennet H. Barrow* (New York: AMS Press, 1967), pp. 406-10. Barrow maintained a system of punishment inconsistent with treating his slaves as mere machine parts. Herbert Gutman and Richard Sutch, “Sambo Makes Good, or Were Slaves Imbued with the Protestant Work Ethic?” in Paul David, Herbert G. Gutman, Richard Sutch, Peter Temin, and Gavin Wright, *Reckoning with Slavery: A Critical Study in the Quantitative History of American Negro Slavery* (New York: Oxford Univ. Press, 1976), pp. 55-93, esp. 60-68.

<sup>42</sup> Frederick Law Olmsted, *A Journey in the Back Country* (New York: Mason, 1860), pp. 81-82. Olmsted noted the slaves were assembled from two different plantations; one then might presume that they did not commonly work together. The passage also appears in Olmsted’s *Cotton Kingdom*.

division of the estate: “We were all ranked together at the valuation. Men and women, old and young, married and single, were ranked with horses, sheep, and swine. There were horses and men, cattle and women, pigs and children, all holding the same rank in the scale of being, and were all subjected to the same narrow examination...the same indelicate inspection.”<sup>43</sup> Solomon Northrup referred to slaves in transport and trade as being treated like “human cattle.”<sup>44</sup> Slave owners were deeply interested in the rate of increase of their slave population and exerted extensive control over family life and the raising of children.

In *Twelve Years a Slave*, Solomon Northrup repeatedly called the attention of his audience to the widespread use of corporal punishment on plantations.<sup>45</sup> And in the passage mentioned above, Olmsted observed the hoe hands were being threatened by a driver brandishing a whip. The sound of the whip cracking was intimidation enough. Olmsted reported he saw no one actually subjected to its lash. Threats and displays of violence matter only for conscious beings making choices.

Apologists for the plantation system also emphasized its living and personal dimensions, including its penetration into almost every aspect of the slave’s life. In 1918, Ulrich Phillips noted that on southern plantations there was “little of that curse of impersonality and indifference which too commonly prevails in the factories of the present-day world where power-driven machinery sets the pace, where the employers have no relations with the employed outside of work hours, where the proprietors indeed are scattered to the four winds, where the directors confine their attention to finance, and where the one duty of the superintendent is to procure a maximum output at a minimum cost.”<sup>46</sup> In 1929, Phillips opined that contemporary urban industry “did not give work to women, their administration did not facilitate a cherishing of health or a training of the youth, and their limitations of capital excluded investment in persons who were not

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<sup>43</sup> Frederick Douglass, *Narrative of the Life of Frederick Douglass, an American Slave* (Garden City, NY: Doubleday, 1963, originally published in 1845), pp. 47-48.

<sup>44</sup> Solomon Northrup, *Twelve Years a Slave*, ed. by Sue Eakin and Joseph Logsdon (Baton Rouge: Louisiana State Univ. Press, 1975, originally published in 1853), pp. 134, 138. “Cattle” and “chattel” do share the same linguistic root.

<sup>45</sup> Northrup, *Twelve Years*, passim.

<sup>46</sup> Ulrich B. Phillips, *American Negro Slavery* (Baton Rouge: Louisiana State Univ. Press, originally published 1918, reprinted 1966), p. 307.

laborers. These, in short...were masculine enterprises conveniently ignoring family complications.”<sup>47</sup>

Phillips did note that as an enterprise, either in agriculture or industry, grew in scale, eventually its owner could “no longer combine manual work with supervision.... [W]here full differentiation of administration from labor occurs, the shop becomes a factory, the farm changes into a factory, whatever the number of its operatives may be.”<sup>48</sup> But in keeping with his general perspective, Phillips applied the factory analogies to West Indian plantations but found them less appropriate for the American South. Phillips wrote: “On the generality of the [West Indian sugar] plantations the tone of the management was too much like that in most modern factories. The laborers were considered more as work-units than as men, women, and children. Kindliness and comfort, cruelty and hardship, were rated at balance-sheet value; births and deaths were reckoned in profit and loss, and the expense of rearing children was balanced against the cost of new Africans. These things were true in some degree in the North American slave-holding communities, but in the West Indies they excelled.”<sup>49</sup> The slave owner in the American South often lived on the farm or plantation where his bondmen and bondwomen worked. Even the owners of the largest estates resided on or nearby their holdings. They were not absentees but rather styled themselves as the heads of large plantation families.

The southern plantation went beyond the company town associated with some manufacturing and mining enterprises. In the company town, the firm served as the employer, landlord, store-keeper, and local government. (As Price Fishback notes, the very scope of the company’s domain bred resentment and protest.<sup>50</sup>) The plantation owner controlled or sought to control family life, education, and religious life. More fundamentally, the plantation owner determined the slave’s geographic location and, together with the surrounding community, prevented his or her escape. Even the most paternalistic manufacturing employer of the 1910s and 1920s when Phillips wrote did not exercise these powers.

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<sup>47</sup> Ulrich B. Phillips, *Life and Labor in the Old South* (New York: Little-Brown, 1929), p. 173.

<sup>48</sup> Phillips, *Life and Labor*, p. 305. For commentary, see Metzger, “Rational Management,” pp. 124-25.

<sup>49</sup> Phillips, *American Negro Slavery*, p. 52.

<sup>50</sup> Price V. Fishback, *Soft Coal, Hard Choices: The Economic Welfare of Bituminous Coal Miners, 1890-1930* (New York: Oxford Univ. Press, 1992), pp. 133-70, esp. 166.

These issues are related to the question about whether plantation agriculture was a business or a way of life. Whether it was a capitalist profit-seeking enterprise or a system for social control? For the apologist Phillips, the social control motives—maintaining white supremacy over African-Americans—was the dominant consideration. For most economic historians, the profit motive dominated the calculus. As Conrad and Meyer famously asserted, investing in a slave was like investing in any other capital asset.<sup>51</sup> But it does not impoverish one’s historical analysis to acknowledge that both motives were at play.

### *Modern Management*

A number of scholars have equated systematic exploitation of slave labor to factory discipline and later doctrines of scientific management. R. Keith Aufhauser argued that in their administration of labor, southern slaveholders anticipated and conformed to F. W. Taylor’s school of scientific management. As an example, planter George Fitzhugh shared many of the Taylor’s precepts regarding the lack of motivation, self-discipline, and intelligence among workers and about the need for constant supervision. Both Taylor and southern slaveholders sought through routine, task design, job enrichment, and physical coercion to secure greater work effort.<sup>52</sup>

Drawing such connections has a long history. Lewis Gray reads in George Washington’s 1769 description of his wheat harvest an account that “savors a sort of Scientific Management.”<sup>53</sup> Washington sought to reduce his use of hired cradlers and rely solely on his own enslaved labor force. So he proposed to stagger his planting to spread out the harvest demands and to separate his cradler-binder crews into individual teams to speed up the pace of work above that achieved when all the cradlers worked together. Surely concerns about work effort in groups long preceded Frederick Taylor.

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<sup>51</sup> Alfred H. Conrad and John R. Meyer, “The Economics of Slavery in the Ante Bellum South,” *Journal of Political Economy* 66:2 (April 1958), pp. 95-130.

<sup>52</sup> R. Keith Aufhauser, “Slavery and Scientific Management,” *Journal of Economic History* 33:4 (Dec. 1973), pp. 811-43.

<sup>53</sup> Lewis C. Gray, *History of Agriculture in the Southern United States to 1860* (Washington, DC: Carnegie Institution, 1933), Vol. I, p. 550. See also Metzger, “Rational Management;” Steven G. Collins, “System, Organization, and Agricultural Reform in the Antebellum South, 1840-1860,” *Agricultural History* 75:1 (Winter 2001), pp. 1-27.

Taylor attributed slow work to two causes. The first cause, associated with so-called “natural soldiering,” was “natural laziness” or “natural instinct and tendency of men to take it easy.” Taylor believed this characterized “the average man (in all walks of life)” and only “men of unusual energy, vitality, and ambition “choose on the own to work hard. The second cause, associated with so-called “systematic soldiering,” was due to the “fallacy, which has from time immemorial been almost universal among workmen, that a material increase in the output of each man or each machine in the trade would result in the end in throwing a large number of men out of work.”<sup>54</sup> The first cause has been the subject of great debate in the literature on slavery. One observer’s “laziness” is another observer’s “slave resistance and exercise of agency.” The second cause is irrelevant, or largely so, in operation of slavery. The fear of losing work was not an issue, and Taylor’s remedies do not apply.<sup>55</sup>

The dean of American business historians, Alfred D. Chandler, offered a mixed opinion on appellation of “factories in the field” to antebellum southern plantations. In his 1977 classic, *Visible Hand*, he argued that southern plantations were not in any meaningful way precursors to the development of modern business enterprise in America.<sup>56</sup> True, southern plantations were larger than contemporary family farms but they were not as large as New England textile factories. Chandler asserted that plantation owners did not commonly employ white-overseers and that management was not widely separated between ownership. When the plantation owners did employ overseers, their instructions (as reflected in the plantation rules) typically dealt with the treatment of slaves rather than other forms of capital. According to Chandler, the plantation books did not allow the comparison of performance of individual workers or the entire operation over meaningful stretches of time.

Other scholars have pointed out that many plantations met Chandler’s definition of modern business enterprise. Many plantation owners did utilize overseers and drivers

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<sup>54</sup> Taylor, *Principles*, pp. 22-24.

<sup>55</sup> Slave labor was often treated as a fixed rather than a variable cost. Ralph Anderson and Robert E. Gallman, “Slaves as Fixed Capital: Slave Labor and Southern Economic Development,” *Journal of American History* 64:1 (June 1977), pp. 24-46. House slaves may have feared being moved to harder labor in the field, but this is explained by greater effort inducing disutility rather than a fear of unemployment.

<sup>56</sup> Chandler, *Visible Hand*, pp. 64-67.

to manage their operations.<sup>57</sup> And a considerable number of plantation owners had multiple units, within the same regions or even in different regions. And for those operating plantations within the same region—for example, those with a home plantation and a bottomland plantation—they often decided how to split the combined labor force and to transfer supplies (food, seed, feed) between the units. In a technical sense, these plantations did fit Chandler’s bill as employing salaried managers to allocate resources across distinct operating units without using market mechanisms. In Bill Cooke’s phrase, the “visible hand was holding a whip.”<sup>58</sup> Moreover, it seems a stretch to conclude that employing managers who frequently moved (in an industry for which local knowledge was especially important), and who were often described as drunks and brutes qualifies as advancing scientific principles.

In interesting forthcoming work, Caitlin Rosenthal adopts a more nuanced position.<sup>59</sup> Based on archival research, including an examination of the use of pre-printed account books, Rosenthal “found that southern plantation owners kept complex and meticulous records, measuring the productivity of their slaves and carefully monitoring their profits—often using even more sophisticated methods than manufacturers in the North. Several of the slave owners’ practices, such as incentivizing workers (in this case, to get them to pick more cotton) and depreciating their worth through the years, are widely used in business management today.”<sup>60</sup>

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<sup>57</sup> William Kauffman Scarborough, *The Overseer: Plantation Management in the Old South* (Baton Rouge, LA: Louisiana State Univ. Press, 1966).

<sup>58</sup> Bill Cooke, “The Visible Hand was Holding a Whip: The Denial of Slavery in Management Studies,” Institute for Development Policy and Management, Univ. of Manchester, Discussion Paper No. 68 (July 2002); Bill Cooke, “The Denial of Slavery in Management Studies,” *Journal of Management Studies* 40:8 (2003), pp. 1895-1918.

<sup>59</sup> Caitlin C. Rosenthal, “Slavery’s Scientific Management: Accounting for Mastery,” in *Slavery’s Capitalism*, Seth Rockman, S. Beckert, and D. Waldstreicher, eds. (Philadelphia, PA: Univ. of Pennsylvania Press, forthcoming).

<sup>60</sup> Katie Johnston, “The Messy Link between Slave Owners and Modern Management,” Harvard Business School Working Knowledge Blog, Jan. 16, 2013, <http://hbswk.hbs.edu/item/7182.html>. For earlier investigations on plantation record keeping by historians of accountancy, see Dale L. Flescher and Tonya K. Flescher, “Human Resource Accounting in Mississippi before 1865,” *Journal of Accounting and Business Research* 10 (Supplement, 1981), pp. 124-29; D. Barney and Dale L. Flesher, “Early Nineteenth-Century Productivity Accounting: the Locust Grove Plantation Ledger,” *Accounting, Business and Financial History* 4:2 (1994), pp. 275-94; Richard K. Fleischman and Thomas N. Tyson, “Accounting in Service to Racism: Monetizing Slave Property in the Antebellum South,” *Critical Perspectives on Accounting* 15 (2004), pp. 376-99.

The most popular cotton account book was produced by Thomas Affleck, of Mississippi and later Texas.<sup>61</sup> The first edition of the *Affleck Plantation Journal and Account Book* appeared in 1847. Within a few years he offered three different volumes—one for small plantations with up to 40 slaves, one for mid-size plantations with 80 hands or less, and one for plantations with up to 120 hands. In addition to space for a journal of daily activities, Affleck provided forms for listing the slaves' names, ages, and values, births and deaths, stock and equipment inventories, the weight of individual cotton bales, the pounds of cotton picked daily by individual slaves, and other valuable information.<sup>62</sup> According to one source, Affleck sold between two and three thousand books per year.<sup>63</sup>

Thomas Affleck was the most famous but hardly the only or first producer of pre-printed cotton books.<sup>64</sup> In the 1850s, W. H Fox of Natchez, Mississippi sold a similar product under the title "Statement of Cotton."<sup>65</sup> Other publishers released were copycat versions with similar general appearance as Affleck books.<sup>66</sup> In the early 1850s, J. W. Randolph of Richmond, Virginia produced a "Plantation & Farm Instruction, Regulation Record, Inventory & Account Book" with pre-printed pages for "Manager's Journal or Daily Record" as well as larger editions with "Daily Record of Cotton Picked."<sup>67</sup> There were a variety of earlier cotton books printed by others.<sup>68</sup> Even in the absence of pre-printed forms, planters and overseers often kept records in other, more generic, bound volumes.

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<sup>61</sup> Robert W. Williams, "Thomas Affleck: Missionary to the Planter, the Farmer, and the Gardener," *Agricultural History* 31:3 (July 1957), pp. 40-48.

<sup>62</sup> Alan L. Olmstead and Paul W. Rhode, "Biological Innovation and Productivity Growth in the Antebellum Cotton Economy," *Journal of Economic History* 68:4 (Dec. 2008), pp. 1123-71, esp. pp. 1144-46.

<sup>63</sup> Blake Touchstone, "Planters and Slave Religion in the Deep South," in John B. Boles, ed., *Masters & Slaves in the House of the Lord: Race and Religion in the American South, 1740-1870* (Lexington, KY: University Press of Kentucky, 1988), pp. 99-126, 213-29, esp. pp. 224.

<sup>64</sup> B. M. Norman also printed and sold Affleck books. See Robinson Papers (LSU 1413), RASP, Series I, Part 2 Reel 20, frame 701. RASP is Records of Ante-Bellum Southern Plantations: From the Revolution through the Civil War, ed. by Kenneth M. Stampp (Frederick, MD: University Publications of America, various dates after 1985).

<sup>65</sup> Robert Stewart, Account Books, Mss. 404, 4732, Louisiana and Lower Mississippi Valley Collections, Louisiana State University Libraries (Baton Rouge, LA).

<sup>66</sup> Lewis papers at Univ. of North Carolina (Southern Historical Collection 2528) and A. F. Smith plantation records (Western Reserve Historical Society).

<sup>67</sup> Robinson Papers (RASP, Series I, Part 2, Reel 20, frame 546) and Branch family (SHC 2718, RASP, Series J, Part 4, Reel 46, frame 689. Randolph's books date to 1852 at the latest.

<sup>68</sup> James H. Hammond (RASP, Series A, Part 1, Reel 14). LeBlanc family papers ( RASP, Series I, Part 2, Reel 17, frame 678) has a plantation book from the 1830s with sheets that look much like an Affleck book. The Hope and Experiment plantation in the SC Historical Society records has a cotton book for 1812.

The "factories in the field" notion runs into a problem in the plantation account books. "Fields" have little role in pre-printed account books. None of the books that we studied offered any specific form relating to fields, their size, use, rotation, daily activities, or production. The layout of the Affleck ledgers and other account books are in accord with Gavin Wright's depiction of southern masters being first and foremost labor lords rather than landlords.<sup>69</sup> The record-keepers mention what is happening in specific fields, but the books are not structured to make an organized accounting easy. In the account books that we have surveyed, a small fraction of record keepers do craft their own schedules summarizing production (output and acreage) by field by year. Most do not.

The pre-printed plantation books were not set up to record the systematic use of incentives, negative or positive. Neither Thomas Affleck nor his competitors provided specific sheets for tallying whippings, for example. (Affleck's instructions explicitly warned overseers against punishing slaves in passion.) A few record keepers did note lashing in the "Daily Record of Passing Events," but most were silence. The books included no pages to enumerate payments to slaves for the produce (eggs or extra cotton grow on slave plots) and none specifically to document prize contest or tournament results. Again, surviving evidence depends on what the record keepers chose to add. In the records that we have seen, picking contests were not as common as the literature suggests. We counted fewer contests than examples of picking on Sunday, a practice which Affleck, both in the books' design and in his explicit instructions, discouraged.

While plantation book keeping was far more common than one might think, it was rarely meticulous. Even in the pre-printed books, practices were typically idiosyncratic and often incomplete. We have assembled a data base of picking records from antebellum cotton books for some 113 plantations covering 396 crop years. In our sample, number of years covered for individual plantations range from a one (the modal coverage with 43 cases) to 22 (in the remarkable records of Francis Terry Leak in Tippah, Mississippi). The mean coverage was 3.5 years; the standard deviation was 3.64 years; and the median coverage was 2.0 years. Among those 67 plantations with records covering more than a

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<sup>69</sup> Gavin Wright, *Old South, New South: Revolutions in the Southern Economic Since the Civil War* (New York: Basic Books, 1986), pp. 17-50.

single year, 30 (or about 45 percent) have a break in the middle of the available records of one crop-year or more. The short span covered and the breaks in some of the records are undoubtedly, in part, due to destruction, loss, and failure of books to be archived. But chronological jumps with the coverage in the surviving books—starting in one year, stopping, and then picking up again after of months or even years—indicate gaps in the recording were common as the books were being kept. Making long-run comparisons for individual plantations is difficult now and would have hard even in the antebellum period. In a prize-winner essay in accounting history, Jan Hierer found that in a sample of over 50 antebellum plantation books from Alabama and Mississippi, the record-keepers deviated significantly from the protocols that Affleck had established.<sup>70</sup> It is important to recall that decades of research by historians with access to such records could not resolve the debate about whether antebellum southern plantations were profitable. Systematic generalization from the individual cases proved impossible. The alternative approach of Conrad and Meyer to addressing the profitability question is celebrated with good reason.

Showing that the managerial practices of these southern plantations actually informed those implemented at large industrial enterprises in the late nineteenth and early twentieth centuries remains to be demonstrated. But the lack of evidence suggests that this line of causality was weak at best. A fair assessment is that many plantation owners desired an accounting of farm activities to judge the work of their overseers and to reckon how their business affairs changed over time, but the records kept (by design and practice) and the actual operations were far removed from the dictates of Taylor and other apostles of modern business management.

### *Assembly Lines in the Fields?*

In *Time on the Cross*, Fogel and Engerman go beyond the previous uses of the “factories in the field” appellation to emphasize the assembly-line driven efficiency of

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<sup>70</sup> Jan R. Hierer, “A Content Comparison of Antebellum Plantation Records and Thomas Affleck’s Accounting Principles,” *Accounting Historians Journal* 15:2 (Fall 1988), pp. 131-50.

gang-labor plantations.<sup>71</sup> They note that "...there was widespread agreement that the ultimate objective of slave management was the creation of a highly disciplined, highly specialized, and well-coordinated labor force. Specialization and interdependence were the hallmarks of the medium- and large-sized plantations. On family-sized farms, each worker had to perform a multiplicity of duties according to a pace and pattern which were quite flexible and largely independent of the actions of others. On plantations, hands were rigidly organized as in a factory."<sup>72</sup> The larger plantations, according to this argument, could better take advantage of specialization and the division of labor.

In addition, large plantations could better coordinate their slaves into gangs that then could be induced to work both hard and as a team. To pound home the point, over the next two pages the word "interdependence" occurs five times, and this emphasis is bolstered by the terms "interdependent," "assembly-line type pressure," "interaction" (between gangs), "productive tension," etc. The emphasis on teamwork and assembly-line-like pressure differed from the interpretation of other authors such as Stamp and Frederick Law Olmsted.<sup>73</sup> When Olmsted witnessed lines of slaves hoeing, he described them as being driven by a man with a whip; what he failed to perceive, according to Fogel and Engerman, was their "remarkable demonstration of teamwork..."<sup>74</sup> In his later writings, Fogel treated the gang system as a revolutionary technological advance, one

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<sup>71</sup> Nye, *America's Assembly Line*, p. 2 observes: "The assembly line emerged in a specific place (Detroit), at a specific time (between 1908 and 1913), in a specific industry (the automobile industry). But it also expressed trends in American society that can be discerned during the nineteenth century." Henry Ford and his colleagues looked to the Cincinnati pork-processing plants for inspiration. See also David A. Hounshell, *From the American System to Mass Production, 1800-1932: The Development of Manufacturing Technology in the United States* (Baltimore, MD: Johns Hopkins Univ. Press, 1984), pp. 217-62. Neither Hounshell nor Nye suggests that Ford's engineers consciously built on the example of the gang system of slave labor.

<sup>72</sup> Robert W. Fogel, and Stanley L. Engerman, *Time on the Cross: The Economics of American Negro Slavery* (Boston: Little, Brown, 1974), Vol. I, p. 203.

<sup>73</sup> This argument largely follows Stamp's lead. In the *Peculiar Institution*, Stamp (p. 34) clearly thought that there were coordination and scale economies in southern agriculture. He noted that the southern master of slaves "devoted much of his attention"... "to the problem of organizing and exploiting their labor with maximum efficiency..." Furthermore (p. 38) that: "The planters who owned more than thirty slaves were the ones who achieved maximum efficiency, the most complex economic organization, and the highest degree of specialization within their labor forces." However, on p. 53, he adds: "In cotton production those with modest slaveholdings faced no overwhelming competitive disadvantage."

<sup>74</sup> Frederick Law Olmsted, *A Journey in the Back Country* (New York: Mason, 1860), pp. 81-82; Fogel and Engerman, *Time on the Cross*, Vol. I, pp. 204-05.

worthy of mention in the same breath as the “blast furnace, electricity, and medical surgery.”<sup>75</sup>

Gang interdependence almost comes alive in the *Time on the Cross*: “A planting gang consisted of five types of hands who followed one another in a fixed procession. Leading off the procession were plowmen who ridged up the unbroken earth; then came the harrowers who broke up the clods; then drillers who created the holes to receive the seeds, each hole a prescribed distance apart from the next one; then droppers who planted the seeds in the holes; and finally rakers who covered up the holes.”<sup>76</sup> This highly interdependent process was represented a conscious decision in the “managerial revolution” that “rigidly galvanized” slaves on large plantations as if they were in a “factory.” The strongest and fastest workers set the pace for the “assembly line,” sucking less productive workers along in their wake.

More or less the same occurred during cultivation with “plow and hoe gangs.” By this account the hoe gangs weeded and thinned the cotton. “The plow gangs followed behind, stirring the soil near the cotton plants and tossing it back around the plants. Thus the plow and hoe gangs each put the other under an assembly-line type pressure. The hoeing had to be completed in time to permit the plow hands to carry out their tasks. At the same time the progress of the hoeing... set the pace for the plow gang. The drivers or overseers moved back and forth between the two gangs, exhorting and prodding each to keep up the pace of the other, as well as inspecting the quality of the work.”<sup>77</sup> Fogel repeats this language almost verbatim in *Without Consent or Contract*.<sup>78</sup>

Fogel and Engerman chose to eschew footnotes in *Time on the Cross*, so we can only speculate where they obtained some of their vivid depictions of gang

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<sup>75</sup> Robert W. Fogel, *The Slavery Debates, 1952-1990: A Memoir* (Baton Rouge: Louisiana State Univ. Press, 2003), pp. 46-47. Drawing on Olson’s analysis of hours worked, Fogel asserted on p. 36, that slaves “who toiled in the gangs of the intermediate and large plantations were on average over 70 per cent more productive than either free farmers [northern and southern] or slaves on small plantations. These gang laborers...worked so intensely that they produced as much output in roughly thirty-five minutes as did free farmers in a full hour.”

<sup>76</sup> Fogel and Engerman, *Time on the Cross*, Vol. I, p. 203-04.

<sup>77</sup> Fogel and Engerman, *Time on the Cross*, Vol. I, p. 204.

<sup>78</sup> Robert W. Fogel, *Without Consent or Contract: The Rise and Fall of American Slavery* (New York: Norton, 1989), pp. 27-28. On p. 72-74, he recasts the gang-system advantage in terms of relative total factor efficiency. And on pp. 99-101, he argues that the “breakup of the gang system” was primarily responsible for the post-emancipation decline in agricultural productivity in the South.

interdependence. The five gang sequence may well have come from Gray.<sup>79</sup> The phraseology in *Time on the Cross* was similar to a letter that Gray quotes that had been published in 1850 by a South Carolina planter over the name “Colo.” This latter source is revealing for several reasons. First, the plowers were not an integral part of the planting unit. The heavy plowing and bedding had been done weeks earlier and the work performed at the planting time was a cultivation operation that, owing to his specific soil conditions, Colo chose to conduct when seeding. Other farmers did this operation well before planting or well after planting or not at all. Secondly, the Colo letter describes a “set” of hands as consisting of four workers—this was the operational team. Colo required each “set” of workers plant 10 acres a day, a description more in keeping with the use of the “task system” than of the “gang system.” (Under the “task system,” the master established a work quota, typically for the day, and allowed the slaves to set their own pace and enjoy free time upon the task’s completion. This contrasted with the gang system where slaves worked in groups under the control of a driver or overseer, typically for the entire day.<sup>80</sup>) In principle, a farm with four workers could capture the division of labor and team or coordination economies described by Gray and Colo.<sup>81</sup>

In any case, four and five stage planting operations were probably a rarity. The first two operations—plowing and harrowing—were separate activities that took a long time, the fields were often plowed more than once to weed, to cut water furrows, and then to ridge-up or make the seed bed, and this work was done by many of the same people who later planted. Records show that while the plows were at work preparing the fields many (often most) slaves were involved in a number of other jobs associated with other crops, splitting and hauling rails, spreading manure, and the like. These jobs physically took place in widely different locations and the slaves often worked in small groups. Although there was a division of labor (as on northern farms), there was little or no interdependency. So unless “a fixed procession” allows for days and even weeks to pass

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<sup>79</sup> Gray, *History*, Vol. I, pp. 549-50.

<sup>80</sup> Gray, *History*, Vol. I, pp. 550-51; Stampp, *Peculiar Institution*, pp. 54-55; Fogel, *Without Consent*, pp. 27, 192-94; Phillips, *American Negro Slavery*, p. 228 compared the gang system to “time-work” and the task-system to “piece-work.”

<sup>81</sup> For the Colo letter, see *Southern Cultivator* 8:1 (Jan. 1850), p. 7. The letter also appears in Joseph A. Turner, *The Cotton Planter's Manual: Being a Compilation of Facts from the Best Authorities on the Culture of Cotton; its Natural History, Chemical Analysis, Trade, and Consumption, and Embracing a History of Cotton and the Cotton Gin* (New York: C. M. Saxton, 1857), pp. 28-31.

between different elements of the parade and allows for the same people to reappear many times, we are left with the possibility of three rather than five gangs working in unison—each supposedly making the other more productive.

The plantation records we have studied clearly show that work groups or gangs existed, but it is hard to find many hints of closely-choreographed teamwork between gangs during major field operations. To address the issue of gang interdependency, we first assume that an assembly-line required that different people performed different tasks. Moreover, for the gangs to have created constant pressure on each other in order to generate inter-team coordination efficiencies, we assume that the gangs must have been in reasonably close proximity to each other. To measure proximity crudely we ask if two or more gangs were even in the same field on the same day.

The more we look the more we have become skeptical of the gang hypothesis. Our examination of several of the key plantations studied by Metzger yielded little hint of factory-type efficiency or of interdependent gangs incessantly pushing one another as he claimed. In reality, the different gangs which were supposedly putting constant pressure on each other were seldom in close proximity. Francis Terry Leak's plantation located in Tippah, Mississippi is worthy of special note, because Metzger and many others have relied heavily on Leak's records for examples of how cotton plantations worked. In spite of all the claims to the contrary, Leak's account suggests that daily gang interdependence was of minor importance. For example, starting on May 24, 1853 and ending on July 25<sup>th</sup>, when the fields were "laid in," Leak provided almost daily accounts of the location of his hoe and plow gangs. In this two month period, there are 40 days when we can identify the locations of both types of workers. On 26 of these days, or 65 percent of the time, the hoe and the plow gangs never even set foot in the same fields on the same day. On the days when they did overlap it was typically not very significant. As an example, on May 24<sup>th</sup> the hoe gang(s) worked in three fields and the plow gang(s) labored in five fields, but only one of these fields appeared in both sets. As another example, on June 1, 1853 the plow and hoe gangs were in fields not visited by the other for about a week. More telling is that Leak appeared to task assign tasks to *individual* slaves working the

hoes and plows.<sup>82</sup> Metzger also relied heavily on the records of Eli J. Capell, a successful planter in Amite County, Mississippi. How did Capell organize his field operations? He almost always used the task system!<sup>83</sup> Our examination of several other plantations cited in the gang literature yields a similar result: there is little evidence of inter-team coordination economies, little evidence of different gangs pushing each other, and little evidence of assembly lines.<sup>84</sup>

The result is that the very planters, whose labor-management systems have been cited to support the gang-labor assembly-line-efficiency hypothesis, actually behaved in ways that either directly contradict the hypothesis or, at best, are in accordance only by happenstance even during the plowing, planting, and cultivating seasons. Picking was the binding constraint in cotton production and the intense picking season lasted several months—during about two additional months at the beginning and end of the intense period it was a major activity. Picking was not a gang activity. There was little gang activity during the winter season. This further weakens the claims to the importance of the gang system and of the analogy of plantation agriculture resembling a factory system. Fogel has asserted that slaves working on gang plantations were 70 percent more productive than the workers who toiled on northern farms. Even if the gang system was in full force on the larger plantations for 6 months a year means that in that period the slaves would have had to have been 140 percent more productive than free farmers in performing such activities as plowing and seeding. In fact, our reading of the plantation accounts suggest that interdependent gang activity perhaps occurred for a few weeks a year (if at all) and in these instances there is little evidence of incessant pressure and the rationalization of individual and team movements that warrants the analogy with an assembly line. If we are correct, the productivity gap between medium and large slave enterprises and free farms during these brief periods would have had to have been absurdly astronomical in order to explain the differences that Fogel asserted.

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<sup>82</sup> See Anthony E. Kaye, *Joining Places: Slave Neighborhoods in the Old South* (Chapel Hill: Univ. of North Carolina Press, 2007), p. 101 and footnote 112 for this claim.

<sup>83</sup> This is evident from reading the manuscript and is consistent with the one published article we are aware of on this plantation. Wendell H. Stephenson, "A Quarter-Century of a Mississippi Plantation: Eli J. Capell of Pleasant Hill," *Mississippi Valley Historical Review* 23:3 (Dec.1936), pp. 355-74, esp. pp. 368-69.

<sup>84</sup> See Alan L. Olmstead and Paul W. Rhode, "Gangs, Assembly Lines, and the Efficiency of Slavery: Evidence from Plantation Records," working paper, and "McDuffie: Fact or Fiction," working paper.

## *Conclusion*

A formalist approach requiring constant definitions and standards shows plantations had some similarities and many differences with factories. Plantations used considerable labor—more than the median factory; plantations also had a high capital/labor ratio (counting land but not slaves as capital); many plantations employed professional managers as did many factories, and many plantation owners operated at more than one location. On the other hand plantations carried on their primary business outdoors and were more susceptible to the conditions of daylight, the elements, and the season, and they used relatively little machinery. Plantations kept records, but these were often unsystematic and incomplete (we lack the expertise to compare these accounts to those kept by contemporary factories). The analogy of slave and machines appears not to work; the victims of the system compared their treatment to that of draft animals. The management of offspring, along with the doling out of whippings and rationing of food, had little parallel with machines in a factory. Plantations did not employ anything approaching an assembly line or even the batch system found in northern factories. In this key area the evidence does not support the popular claims in the clinometric literature.

There were also many differences between plantations and the northern farms—the scale of operations, the form of labor organization, the use of mechanical equipment, the crops grown, and the climate to name a few. Many of these differences generated significant externalities defining the broader nature of northern and southern societies: urbanization, income and wealth distributions, education, and the existence of a pervasive, corrosive, and brutal police state in the South come to mind. It has long been understood that the North was different and the family farm organization shaped on regional development in what is generally considered a positive way.<sup>85</sup> The North's institutions, to use the phraseology made introduced and popular by Daron Acemoglu and

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<sup>85</sup> Jeremy Atack and Fred Bateman, "Yeoman Farming: Antebellum America's Other 'Peculiar Institution'," in Lou Ferleger, ed., *Agriculture and National Development: Views on the Nineteen Century* (Ames, IA: Iowa State Univ. Press, 1990), pp. 25-51.

James A. Robinson, were “inclusive” rather than “extractive.”<sup>86</sup> But lingering in the background has been the notion that northerners—the farmers owners, their family members, and the relatively few laborers they employed—were somehow less efficient than those grandees and their chattel residing in the South. This was supposedly because the northerners could not capture the scale and coordination economies available to the southern “factories in the field.” The gang system may have made supervision, driving, and speedups easier to manage, but it is unlikely that it gave southern planters true productivity advantages.

This paper is a part of a larger project. Here, we argue that, although the term “factories in the field” may have a nice ring to it, southern plantations had few of the characteristics associated with emerging northern factories. We further argue that the claims of gang coordination implied by the vision of assembly lines have been vastly overstated for southern plantations (and for that matter underappreciated for northern farms). The prevailing view of plantation efficiency based on gang labor stems from a misreading of the primary evidence and on a misunderstanding of the agricultural production function.

In future work we will explore the deeper questions associated with the presumption of southern plantation efficiency. We do not take for granted that northern farm practices and the positive externalities associated with northern land and labor systems came at a static cost of lower productivity. In a dynamic world allowing for technological change within agriculture and within the broader society; interactions between sectors, including the movement of people out of the agricultural sector into more productive pursuits; and the creation of the human capital essential for economic

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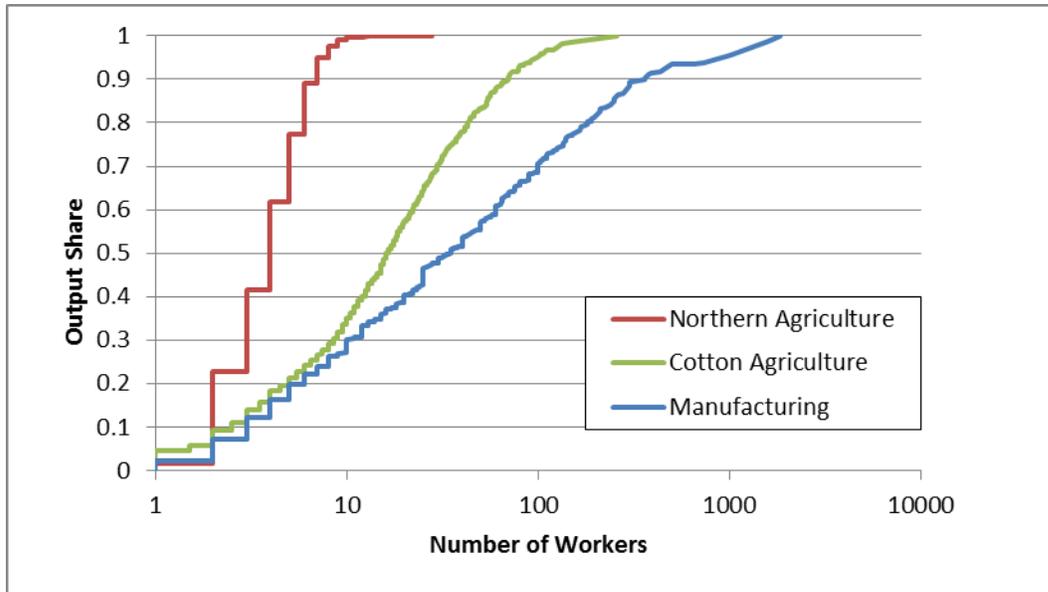
<sup>86</sup> Daron Acemoglu and James A. Robinson, *Why Nations Fail: The Origins of Power, Prosperity, and Poverty* (New York: Crown Business, 2012), pp. 73-83. Acemoglu and Robinson (pp. 74-75) define inclusive economic institutions as those featuring “secure private property, an unbiased system of law, and a provision of public services that proves a level playing field in which people can exchange and contract; it also must permit the entry of new business and allow people to choose their career.” The Acemoglu-Robinson argument that such institutions create “inclusive markets,” promote technological innovation, and stimulate investments in education—the engine of prosperity—would have been familiar to virtually every northerner in the mid-nineteen century. So would be their assertions (p. 80) that “inclusive economic institutions arise from” pluralist” political institutions that “distribute power broadly in society and subject to constraints” and “sufficiently centralized and powerful states” which exercise a “monopoly of legitimate violence” and that (p. 243) extractive economic institutions, which “extract resources from the many for the few,” are linked to political institutions which concentrated unconstrained power within an elite and are inconsistent with long-run growth.

development (and human fulfillment), the northern agricultural sector proved more flexible and efficient than the South's. But even in a narrow static world this was likely the case.

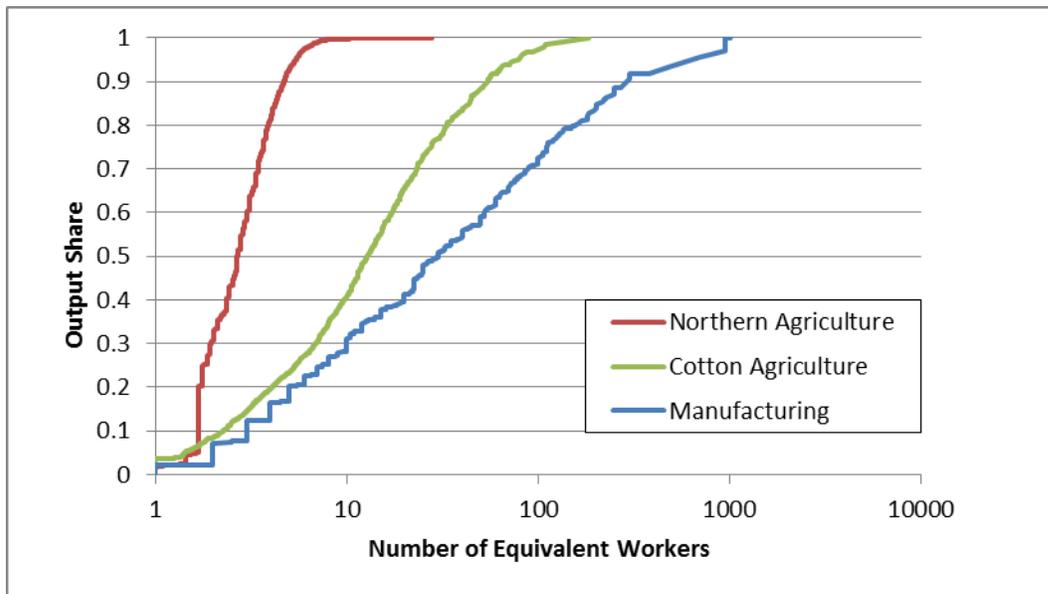
## Figure and Tables

**Figure 1: Distribution of Output by Size of Operation, 1860**

**a. Number of Workers**



**b. Number of Adult Male Equivalent Workers**



Notes and Source: See text for weights used to calculate equivalent workers. Data from Bateman-Foust, Parker-Gallman, and Atask-Bateman samples.

Table 1:

Percentage Distribution of Manufacturing Activity by Scale and Power, 1850 and 1880

	Scale	1850		1880	
		No Power	Power	No Power	Power
Establishments	Small	61.0	29.2	59.6	26.4
	Large	5.3	4.5	5.7	8.3
Workers	Small	28.2	12.7	16.8	9.3
	Large	26.0	33.2	24.5	49.4
Value Added	Small	21.0	22.4	11.3	14.2
	Large	32.7	23.9	35.9	38.6

Source and Notes: Atack, Bateman, and Margo, "Capital Deepening," p. 593. Small Scale is 15 or fewer employees; Large Scale is 16 or more. Power includes the use of steam or water power.

**Table 2: Comparing Output Across Organization Forms**

Summary Statistics	Mean	St. Dev	Min	Max	Obs
Log(Output)	6.445	1.210	-2.120	13.560	18953
Northern_Agriculture	0.561	0.496	0	1	18953
Log(Output)	6.080	0.789	0.507	10.437	10662
Cotton_Agriculture	0.256	0.436	0	1	18953
Log(Output)	6.362	1.301	-2.120	11.668	4855
Slave	0.132	0.338	0	1	18953
Log(Output)	7.082	1.236	-2.120	11.668	2502
Slave_16+	0.041	0.199	0	1	18953
Log(Output)	8.208	0.993	1.962	11.668	784
Slave_50+	0.008	0.087	0	1	18953
Log(Output)	9.153	0.872	4.449	11.668	146
Manufacturing	0.183	0.386	0	1	18953
Log(Output)	7.621	1.389	3.219	13.560	3466
Mill	0.066	0.249	0	1	18953
Log(Output)	7.441	1.232	3.219	11.963	1261
Art_Shop	0.094	0.293	0	1	18953
Log(Output)	7.219	0.985	4.317	11.626	1796
Manufactory	0.010	0.010	0	1	18953
Log(Output)	9.628	1.014	6.751	13.137	196
Factory	0.011	0.104	0	1	18953
Log(Output)	10.234	1.102	6.380	13.560	213

	Log(Output)		
	Coeff.	RSE	Cl. SE
Full Specification			
Northern_Agriculture	-4.154	(0.076)	(7.8E-11)
Cotton_Agriculture	-4.638	(0.077)	(7.8E-11)
Slave	0.973	(0.029)	(2.0E-13)
Slave_16+	1.432	(0.042)	(4.6E-13)
Slave_50+	1.162	(0.080)	(8.0E-13)
Mill	-2.794	(0.083)	(8.1E-11)
Art_Shop	-3.016	(0.079)	(7.9E-11)
Manufactory	-0.607	(0.104)	(7.7E-11)
Constant	10.234	(0.075)	(7.8E-11)
R-sq	0.47		
Obs.	18953		

Notes: Robust standard errors correct for heterogeneity only; clustered standard errors are clustered at the sector level. A “Factory” is defined as an establishment with an inanimate power source and 16 or more employees; a “Mill” is establishment with an inanimate power source and 15 or fewer employees; a “manufactory” is defined as an establishment with no inanimate power source and 16 or more employees; an “Artisanal Shop” is an establishment with no inanimate power source and 15 or fewer employees.

**Table 3: Capital/Labor Ratios in Manufacturing, 1860**

		Capital/Labor Ratio		Value Added	Obs.
		All			
		Labor	Equiv. Labor	Dollar/Est	
		Dollar/Wkr	Dollar/Wkr	Dollar/Est	
All	Mean	901.4	923.8	7285.9	3466
	SD	(1259.8)	(1266.6)	(27206.4)	
Factory	Mean	927.6	1026.7	51787.1	213
	SD	(896.4)	(934.2)	(84511.7)	
Non-factory	Mean	899.8	917.0	4372.1	3253
	SD	(1280.0)	(1285.2)	(13596.3)	
Scale>15	Mean	676.9	755.2	39461.9	409
	SD	(899.1)	(936.3)	(69144.8)	
Scale<=15	Mean	931.5	946.3	2981.1	3057
	SD	(1297.6)	(1302.9)	(6622.2)	
Power	Mean	1385.7	1412.6	10758.3	1474
	SD	(1538.5)	(1412.6)	(37140.4)	
No Power	Mean	543.2	562.0	4716.6	1992
	SD	(841.8)	(849.8)	(15878.1)	

Sources and Notes: “Factory” is defined as an establishment with an inanimate power source and 16 or more employees. “Power” is defined as an establishment reporting steam or water power or both. Equivalent labor assigns a weight of 1.0 to adult males, 0.5 to adult females and 0.33 to children. There is no imputation of entrepreneurial inputs. Data compiled from Attack-Bateman national sample for 1860. The data exclude establishments with non-positive employment, value added, raw materials, or capital.

**Table 4: Capital/Labor Ratios in Agriculture, 1860**

		North		Cotton Sample			Slave
		All	All	Free	Slave	Slave 16+	50+
<b>All Labor</b>							
Total capital	Mean	1020.3	873.2	905.3	843.0	797.0	957.1
	SD	(921.9)	(997.2)	(1170.1)	(800.1)	(778.1)	(1204.0)
	Obs.	10662	4855	2353	2502	784	146
Farm Land + Building	Mean	850.1	646.2	636.3	655.4	648.4	834.3
	SD	(826.6)	(893.6)	(1046.2)	(721.3)	(708.1)	(1154.6)
	Obs.	10662	4855	2353	2502	784	146
Implements	Mean	32.4	31.0	32.8	29.4	27.2	29.2
	SD	(34.2)	(54.4)	(63.1)	(44.4)	(32.3)	(44.3)
	Obs.	10662	4855	2353	2502	784	146
Implements + Draft Stock	Mean	95.9	129.0	163.3	96.8	72.9	65.4
	SD	(84.8)	(403.1)	(558.4)	(111.3)	(61.2)	(51.9)
	Obs.	10662	4855	2353	2502	784	146
<b>Equivalent Labor</b>							
Total capital	Mean	1399.5	998.3	957.0	1037.2	1014.7	1224.2
	SD	(1265.4)	(1097.0)	(1200.4)	(988.6)	(981.6)	(1531.2)
	Obs.	10662	4855	2353	2502	784	146
Farm Land + Building	Mean	1166.9	742.0	671.8	808.1	826.7	1067.0
	SD	(1136.8)	(983.0)	(1065.9)	(893.2)	(902.2)	(1470.2)
	Obs.	10662	4855	2353	2502	784	146
Implements	Mean	44.1	35.3	34.4	36.1	34.6	37.4
	SD	(45.2)	(59.7)	(66.3)	(52.7)	(40.4)	(54.9)
	Obs.	10662	4855	2353	2502	784	146
Implements + Draft Stock	Mean	131.2	144.2	171.8	118.2	92.8	83.7
	SD	(115.9)	(400.4)	(558.8)	(128.0)	(74.3)	(64.4)
	Obs.	10662	4855	2353	2502	784	146
<b>Output</b>	Mean	594.4	1503.3	385.9	2554.2	5854.6	13111.9
	SD	(736.4)	(3790.0)	(575.1)	(5028.7)	(7883.2)	(12925.9)
	Obs.	10662	4855	2353	2502	784	146

Notes and Sources: See text for weights used to calculate equivalent workers. Data from Bateman-Foust and Parker-Gallman samples. All capital is the sum of the value of farm land and building, implements, and livestock. Draft stock is the value of horse, mules, and working oxen valued at national prices. “Slave 16+” includes plantations with 16 or more slaves; “Slave 50+” includes plantations with 50 or more slaves. The identical mean and SD for the implement-to-all-labor ratios for “Slave” and “Slave 50+” are not typos. The numbers differ slightly at the higher decimals.



**Table 6: Relationship between Capital/Labor Ratios and Output in Agriculture, 1860**

		Log(Capital/Labor)				Log(Capital/Equivalent Labor)			
		Constant	Log(Output)	Obs.	R-sq	Constant	Log(Output)	Obs.	R-sq
<b>Total capital</b>									
North	Coeff.	3.785	0.465	10662	0.21	3.999	0.484	10662	0.23
	RSE	(0.068)	(0.011)			(0.068)	(0.011)		
Cotton	Coeff.	6.014	0.072	4855	0.02	5.910	0.110	4855	0.04
	RSE	(0.054)	(0.008)			(0.053)	(0.008)		
Free	Coeff.	5.394	0.193	2353	0.04	5.461	0.192	2353	0.04
	RSE	(0.124)	(0.022)			(0.123)	(0.021)		
Slave	Coeff.	5.969	0.070	2502	0.01	6.086	0.084	2502	0.02
	RSE	(0.094)	(0.013)			(0.094)	(0.013)		
Slave 16+	Coeff.	4.393	0.246	784	0.12	4.641	0.246	784	0.12
	RSE	(0.230)	(0.028)			(0.225)	(0.027)		
Slave 50+	Coeff.	3.560	0.319	146	0.13	3.916	0.311	146	0.12
	RSE	(0.712)	(0.071)			(0.700)	(0.076)		
<b>Farm Land + Building</b>									
North	Coeff.	3.458	0.481	10662	0.18	3.673	0.499	10662	0.20
	RSE	(0.076)	(0.012)			(0.076)	(0.012)		
Cotton	Coeff.	5.290	0.122	4855	0.03	5.187	0.160	4855	0.05
	RSE	(0.068)	(0.010)			(0.069)	(0.010)		
Free	Coeff.	4.806	0.214	2353	0.04	4.872	0.213	2353	0.04
	RSE	(0.144)	(0.026)			(0.144)	(0.025)		
Slave	Coeff.	5.353	0.109	2502	0.02	5.470	0.122	2502	0.03
	RSE	(0.113)	(0.016)			(0.113)	(0.016)		
Slave 16+	Coeff.	3.864	0.276	784	0.11	4.111	0.276	784	0.11
	RSE	(0.263)	(0.032)			(0.259)	(0.031)		
Slave 50+	Coeff.	3.159	0.341	146	0.11	3.479	0.334	146	0.10
	RSE	(0.802)	(0.088)			(0.790)	(0.087)		

		Constant	Log(Output)	Obs.	R-sq	Constant	Log(Output)	Obs.	R-sq
<b>Implements</b>									
North	Coeff.	0.259	0.464	10662	0.15	0.473	0.483	10662	0.17
	RSE	(0.076)	(0.012)			(0.076)	(0.012)		
Cotton	Coeff.	1.979	0.144	4855	0.03	1.820	0.182	4855	0.00
	RSE	(0.074)	(0.011)			(0.074)	(0.011)		
Free	Coeff.	1.498	0.240	2353	0.04	1.564	0.240	2353	0.03
	RSE	(0.170)	(0.030)			(0.169)	(0.030)		
Slave	Coeff.	1.858	0.154	2502	0.04	1.974	0.167	2502	0.05
	RSE	(0.123)	(0.017)			(0.124)	(0.017)		
Slave 16+	Coeff.	0.884	0.252	784	0.10	1.131	0.252	784	0.10
	RSE	(0.287)	(0.034)			(0.285)	(0.034)		
Slave 50+	Coeff.	-0.806	0.407	146	0.17	-0.486	0.399	146	0.16
	RSE	(0.682)	(0.075)			(0.686)	(0.076)		
<b>Implements + Draft Stock</b>									
North	Coeff.	1.847	0.402	10662	0.16	2.062	0.421	10662	0.19
	RSE	(0.070)	(0.011)			(0.070)	(0.011)		
Cotton	Coeff.	4.627	-0.023	4855	0.01	4.522	0.014	4855	0.00
	RSE	(0.064)	(0.009)			(0.062)	(0.009)		
Free	Coeff.	3.549	0.194	2353	0.03	3.615	0.194	2353	0.04
	RSE	(0.143)	(0.024)			(0.142)	(0.024)		
Slave	Coeff.	4.289	0.006	2502	0.00	4.406	0.019	2502	0.10
	RSE	(0.009)	(0.012)			(0.087)	(0.012)		
Slave 16+	Coeff.	2.912	0.147	784	0.07	3.159	0.147	784	0.07
	RSE	(0.205)	(0.024)			(0.202)	(0.024)		
Slave 50+	Coeff.	1.716	0.251	146	0.18	2.036	0.244	146	0.17
	RSE	(0.587)	(0.064)			(0.580)	(0.063)		

**Table 7: Comparing Capital/Labor Ratios Across Organization Forms Controlling for Output**

Summary Statistics	Mean	St. Dev	Min	Max	Obs
Log(Capital/Labor)	6.498	0.880	1.708	10.451	18953
Log(Capital/Equiv_Labor)	6.672	0.894	2.54	10.449	18953
Log(Output)	6.445	1.210	-2.120	13.560	18953
Northern_Agriculture	0.561	0.496	0	1	18953
Cotton_Agriculture	0.256	0.436	0	1	18953
Slave	0.132	0.338	0	1	18953
Slave_16+	0.041	0.199	0	1	18953
Slave_50+	0.008	0.087	0	1	18953
Mill	0.066	0.249	0	1	18953
Art_Shop	0.094	0.293	0	1	18953
Manufactory	0.010	0.010	0	1	18953
Factory	0.011	0.104	0	1	18953

Full Specification	Log(Capital/Labor)			Log(Capital/Equiv_Labor)		
	Coeff.	RSE	Cl. SE	Coeff.	RSE	Cl. SE
Log(Output)	0.304	(0.008)	(0.110)	0.314	(0.008)	(0.114)
Northern_Agriculture	1.442	(0.071)	(0.454)	1.685	(0.070)	(0.476)
Cotton_Agriculture	1.448	(0.074)	(0.508)	1.434	(0.073)	(0.531)
Slave	-0.277	(0.026)	(0.107)	-0.157	(0.025)	(0.111)
Slave_16+	-0.533	(0.033)	(0.156)	-0.500	(0.032)	(0.163)
Slave_50+	-0.232	(0.066)	(0.127)	-0.238	(0.066)	(0.133)
Mill	1.253	(0.073)	(0.306)	1.168	(0.071)	(0.320)
Art_Shop	0.272	(0.071)	(0.330)	0.214	(0.070)	(0.345)
Manufactory	-0.991	(0.106)	(0.066)	-0.905	(0.101)	(0.069)
Constant	3.323	(0.103)	(1.121)	3.340	(0.101)	(1.172)
R-sq	0.19			0.25		
Obs.	18953			18953		

Head-to-Head Specification	Coeff.	RSE	Coeff.	RSE
Log(Output)	0.246	(0.026)	0.246	(0.025)
Slave_16+	0.476	(0.085)	0.592	(0.083)
Constant	3.922	(0.277)	4.049	(0.268)
R-sq	0.11		0.11	
Obs.	997		997	

Notes: Robust standard errors correct for heterogeneity only; clustered standard errors are clustered at the sector level. A “Factory” is defined as an establishment with an inanimate power source and 16 or more employees; a “Mill” is establishment with an inanimate power source and 15 or fewer employees; a “manufactory” is defined as an establishment with no inanimate power source and 16 or more employees; an “Artisanal Shop” is an establishment with no inanimate power source and 15 or fewer employees.

## Appendix A

There is a large economic history literature concerning overall worker-to-population ratio on slave plantations and how to convert the work efficiency of men, women, and children into “full hands” equivalents.<sup>87</sup> The conventional view is that one-half of the slave population worked, making the worker-slave conversion ratio equal 0.5.<sup>88</sup> The planter literature often focused on the number of bales, or acres, or maintenance expenses per “hand.” In their pioneering contribution, Conrad and Meyer made their profitability calculations on a “per hand” basis. A strand of the following literature sought to refine the prime-hand-to-population conversion ratio.

In an effort to relate to this literature and adjust for both labor force participation and productivity, Fogel and Engerman argue in favor of a population conversion ratio into *prime field hand equivalents* of 0.39.<sup>89</sup> The major source of the adjustment is the relative productivity of females to males, which not surprisingly is a highly contested issue. Conrad and Meyer asserted “The prime field wench was one-half to two-thirds as productive as a prime field hand when she was actually at work in the field.”<sup>90</sup> And a number of scholars have adopted a female-to-male productivity ratio of 0.5.<sup>91</sup> In the 1970s, producing estimates of the relative productivity of slaves by age and gender became something of a cottage industry among agricultural and economic historians. Figure A1 displays the estimates from Foust and Swan, Battalio and Kagel, Vedder and Stockdale, Ransom and Sutch, Fogel and Engerman, and Fogel of the productivity of

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<sup>87</sup> Raymond C. Battalio and John Kagel, “The Structure of Antebellum Southern Agriculture: South Carolina, a Case Study,” *Agricultural History* 44:1 (Jan. 1970), pp. 25-37; Fogel and Engerman, *Time on the Cross*; James D. Foust, *The Yeoman Farmer and Westward Expansion of U. S. Cotton Production* (New York: Arno Press, 1975); Gavin Wright, *The Political Economy of the Cotton South: Households, Markets, and Wealth in the Nineteenth Century* (New York: Norton, 1978); Roger L. Ransom and Richard Sutch, *One Kind of Freedom: The Economic Consequences of Emancipation* (New York: Cambridge Univ. Press, 1977).

<sup>88</sup> Gray, *History*, Vol. 1, p. 544; Stampp, *Peculiar Institution*, p. 57; and James D. Foust and Dale E. Swan, “Productivity and Profitability of Antebellum Slave Labor: A Micro-Approach,” *Agricultural History* 44:1 (Jan. 1970), pp. 39-62.

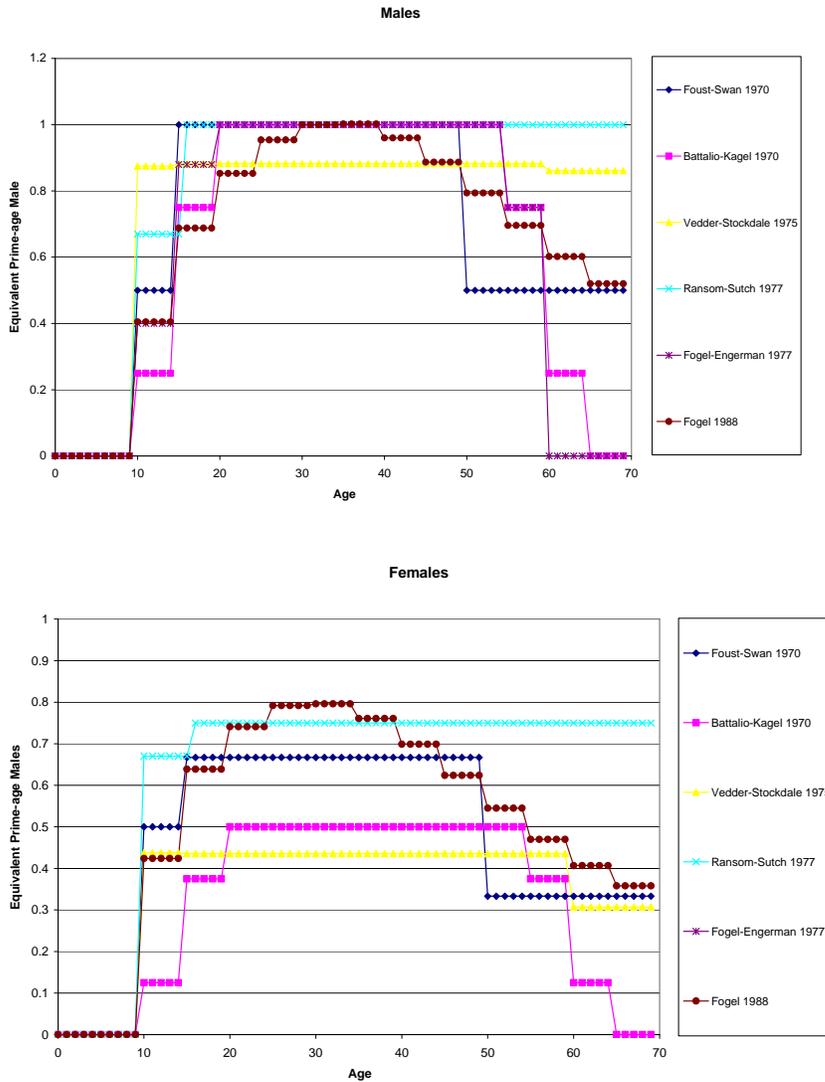
<sup>89</sup> Robert W. Fogel, and Stanley L. Engerman, “The Economics of Slavery,” in *Re-Interpretation of American Economic History*, ed. by Robert W. Fogel and Stanley L. Engerman (New York: Harper and Row, 1971), pp. 331-41, esp. pp. 326-27.

<sup>90</sup> Alfred H. Conrad, and John R. Meyer, *The Economics of Slavery and Other Studies in Econometric History* (Chicago: Aldine, 1964), p. 62.

<sup>91</sup> Battalio and Kagel, “Structure,” p. 27; Richard K. Vedder and David C. Stockdale, “The Profitability of Slavery Revisited: A Different Approach,” *Agricultural History* 44:2 (April 1975), pp. 392-404.

slave by age and gender relative to active prime-age males.<sup>92</sup> After performing their own age-by-gender productivity adjustments, Swan and Foust argue the conventional worker-population ratio of 0.5 remains serviceable. Wright sums male and female labor, effectively assuming equal participation and productivity.<sup>93</sup>

Figure A1: Estimates of age/gender conversion ratios into equivalent prime-age males



<sup>92</sup> Fogel and Engerman, “Explaining,” pp. 275-96; see also Fogel, *Without Consent or Contract*, Vol. I.

<sup>93</sup> Wright, *Political Economy*, pp. 74-82. See also Wright, *Slavery*, p. 106.