Slave Productivity in Cotton Production

by Gender, Age, Season, and Scale

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March 2010

Preliminary: Do not cite without permission of the authors.

This research is supported by National Science Foundation Collaborative Research Grants, "Seeds and Slaves: Technological Change, Plantation Efficiency, and Southern Economic Development" SES-0550913 and SES-0551130.

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The differences by age and gender in labor productivity in cotton production are of great interest in light of long-standing debates about performance and operation of antebellum southern plantations and about the day-to-day regiment of enslaved African-Americans. Such productivity differentials influenced the participation of women and children in market-oriented production under slavery and affected the allocation of the labor force across regions. According to Wright (2006, p. 112), the ability to direct female labor into cotton production was the key to the economic success of southern plantations in the late antebellum period.

The gender/age productivity differentials also had important ramifications off the plantation. In a series of influential articles, Goldin and Sokoloff (1982, 1984) emphasize that early manufacturing used the labor of women and children intensively. They further note that the ratio of female-to-male productivity was much higher in cotton production than in grain production. Goldin and Sokoloff argue that in the Cotton South, the narrow female-to-male productivity gap (as measured by slave "earnings" profiles) delayed industrialization compared with the northeastern United States where the gender gap was much larger. This paper offers a fresh look at the male-female productivity gap in antebellum cotton production. We will provide direct physical measures by gender and age of productivity in cotton picking—the largest user of labor and most critical peak activity of a cotton plantation's production cycle. Our analysis will also relate to the literature on the seasonality of agricultural production and its impacts on the extent of other economic activities.

Coming to grips with male and female picking productivity is complicated because the gap may have changed over time due to the introduction of new cotton varieties. Our previous work (Olmstead-Rhode 2008ab, 2010) demonstrated the dramatic increase in cotton picking rates between 1800 and 1862. These changes appear chiefly associated with biological learning, specifically the introduction, adaptation, and diffusion of Mexican cotton varieties. There is little doubt that these biological

innovations dramatically increased overall picking efficiency, but did they also have significant distributional effects? For example, did they shift the relative efficiency of the men and women, boys and girls; did they change the peak-load problem in ways that may have increased the comparative advantage by gender in picking; and did the higher picking rates serve to draw men (or women) disproportionally out of other tasks into cotton production. The plantation records shed greater light on the changing balance of these effects.

Our results indicate that the gender differentials in picking rates were very small but appear to have grown over the antebellum period. That is, over the 1840-62 period, adult females picked from 7-11 percent less cotton per day than adult males. In the 1801-39 period, the differences were essentially nil. Cotton picking under slavery was an unusual crop production activity because females participated as much as or even more fully than males. One of our results shows that there were scale effects on picking rates—this was not expected given picking was an individual rather than a gang activity. This finding raises the possibility that something else besides gangs was causing the productivity advantages in both picking and non-picking activities. This hunch leads us to begin reexamining the supposed attributes of the gang system in fieldwork. This inquiry is pushing us to rethink both the dynamic and distributional issues associated with slave-plantation productivity and efficiency.

Worker-to-Hand and Marginal Product Comparisons

The slavery literature offers many estimates of ratios to convert workers in various gender/age categories into prime-age male (or "full hands") equivalents. The choices of conversion ratios have important consequences. For example, Wright (2006, p. 106) argues that the main findings of the cliometrics literature regarding the efficiency of larger plantations relative to smaller units rest critically on how the labor of female slaves is treated.[1] The use of conversion ratios remains contested.

[1] In *Slavery and American Economic Development*, Wright (2006) highlights the importance of the labor weights for the empirical outcome of the productivity analysis standard in the cliometrics literature. He

In their influential and pioneering analysis, Conrad and Meyer (1958, p. 107) 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." This ratio was based on hiring rates and did not reflect time lost due to pregnancies.[2] Taking the lost time into account reduced the ratio of female-to-male productivity to one-half. A number of other scholars, including Yasuba (1961), Battalio and Kagel (1970, p. 27) and Vedder and Stockdale (1975), have adopted the female-to-male productivity ratio of one-half. In the 1970s, making estimates of the relative productivity of slaves by age and gender became something of a cottage industry among agricultural and economic historians. Figure 1 displays the estimates from Foust and Swan (1970), Battalio and Kagel (1970), Vedder and Stockdale (1975), Ransom and Sutch (1977, p. 223), Fogel and Engerman (1977), and Fogel (1988, Vol. 3, Evidence and Methods, p. 206) of the productivity of slave by age and gender relative to active prime-age males.[3] Adult females are treated as being 43 to 80 percent as productive as adult males.

As an alternative to weighing different categories of workers to create a single labor input, other scholars have treated the different types of labor as imperfect substitutes and compared their prices, earnings, or marginal products. Goldin and Sokoloff (1984), Craig and Field-Hendrey (1993), Toman (2005), and Wright (2006) have modeled slave and free men, women, and children as separate inputs and generated a range of estimates of their relative productivities in southern agriculture.

To support their industrialization hypothesis, Goldin and Sokoloff (1984, p. 472) provide evidence on the relative wages for females and for boys relative to men in the

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argues that "the primary effect is to reduce the 'hand equivalence' of female slaves by about 30 percent (p. 106)." His investigation "demonstrates the sensitivity of total factor productivity estimates to … the application of age-sex weights to convert the labor force into 'equivalent hands.' The entire finding on the efficiency advantage for large-scale plantations rests on this procedure…. When an unweighted measure of the labor force is used (i.e. all free males and slaves aged fifteen to sixty-four, retaining the assumption that free females were not in the labor force), only the middle-size plantations of the Southwest would have any productivity edge."

[2] Conrad and Meyer assume (1958, p. 107) "three months' productive field time was lost for each successful pregnancy." Nursery costs were $50 per successful pregnancy" (p. 108) and annual maintenance cost per child was $10 per year for those 1-6 years old, $15 per year for 7-12 years old; and $20 per years for those 13 and older (p. 109). Successful pregnancies occurred every two years.

[3] Fogel and Engerman (1977, Table 1, p. 277) do not report explicitly the female ratios, instead noting they are "70-78 percent of corresponding weights for males." Vedder and Stockdale (1975) utilize the labor force participation ratio from Lebergott, which are less than unity for every age group.

North and South. For the South, they use estimated "earnings" in the Old South in 1850 for slaves aged 15-29 years as read off Figures 19 and 22 of Fogel and Engerman, (1974, Vol. I, pp. 76 and 82).[4] Goldin and Sokoloff report that the earnings of slave women relative to men ranged between 0.57 and 0.76 and those of boys relative to men ranged between 0.25 and 0.43. These ratios were roughly double those in the North. They attribute the differences chiefly to the greater relative productivity of females and children in cotton and tobacco than in grain crops.[5]

In a critique of the Goldin-Sokoloff industrialization hypothesis, Craig and Field-Hendrey (1993) estimate the marginal product of farm workers by age and gender in 1860usingthe Bateman-Foust sample for the North and the Parker-Gallman sample for the South. Their main finding is that ratio of female-to-male marginal products was 0.599 for adult slaves in the South (p. 71). This was slightly below the 0.611 ratio that they report for the North. The gap is very small and of the wrong sign to support the gender-gap industrialization hypothesis. Toman (2005) also provides the marginal product estimates of labor in cotton plantations in 1860. Her results can be interpreting as showing how the relative productivity of males and females varied with scale. Using a broad gender division, she finds the marginal product of females relative to males of 40 percent on small units (those with fewer than 6 prime-age male equivalent workers) and 60 percent on large units (those with 6 or more). Using narrow age/gender categories, she finds relative marginal product for adults was 32 percent on small units, but jumped to 75 percent on large units. Teenagers of both genders were also more productive on the large plantations than on small units.[6]

Serious concerns remain. Wright (2006, pp. 106-113) has argued that many of the findings of marginal product by gender based on the 1859/60 Parker-Gallman sample are not robust over space and time. When he performed a similar analysis using the 1849/50

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[4] The earnings estimates are intended to include only the value of field work, exclude the value of offspring, and net out the costs of board, clothing, and medicine. The earnings profiles rest on Fogel and Engerman's estimates of the lifecycle profile of slave prices from probate records in the Old South. See Fogel and Engerman, (1974), Vol. II, pp. 80-81.

[5] Goldin and Sokoloff (1984, p. 473) cite Metzer (1975).

[6] Some have questioned the interpretation of changes in output associated with changes in changes in the labor force/household composition as a pure measure of marginal product of labor.

Foust sample of southern farms and plantations, he obtained far different marginal product ratios. For the Southeast in 1860, Wright found the marginal product of females relative to males was 73 percent, in line with other research. But in the Southwest, it was 113 percent, favoring females. In 1850, the ratios were 127 and 307 in the Southeast and Southwest, respectively, suggesting females were vastly more productive than males.

The cacophony of results arising from both the literatures that generate conversion ratios and that measure marginal product the inputs separately is troubling. We will take a more direct approach to assess how productivity varied by gender and age by employing a new microdata set measuring the output per worker in cotton picking. Picking was typically the operation utilizing the most labor and by most accounts represented the binding constraint on production.

Assembling a New Data Set

To assess the performance of their workers, many masters kept logs detailing the daily picking output of individual slaves. Absentee owners often required their overseers to keep such records in order to better assess day-to-day farm activities, but many resident owners also caught the record-keeping bug. The data allowed for comparisons with past years, and helped set expectations for tasking the pickers. Plantation managers recorded picking data in various documents including plantation journals, diaries, cotton books, ledgers, and the like. Over time record keeping became more formalized with many planters employing bound account books with printed templates designed especially for this purpose. The most popular cotton account book was produced by Thomas Affleck, a noted nurseryman, experimenter, and farm journalist. 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 (Williams, 1957). In addition to the pages efficiently laid out for recording picking, the Affleck books provided forms for listing the slaves' names, ages, and values, births and deaths, stock and equipment inventories, the weight of individual bales, and other valuable information. The entries and marginal notes often provide a detailed sense of the pulse of plantation life, including the days lost to rain, and whether or not the

slaves worked a full or half day, whether the slaves worked on Saturdays, and the like. Only rarely did the slaves pick cotton on Sundays. The records also indicated which slaves were sick on a given day and which were assigned to other tasks such as making baskets, cutting timber, tending other crops, hauling, and working in the gin. Of course the overseers and owners differed significantly in their attention to detail, but in many instances when the key information was not recorded in the Affleck volumes, we were able to extract it from surviving diaries and other farms journals.

Figure 2 shows an example of a "user friendly" page from an Affleck book—one that is legible, reasonably complete, and in this lone case one that was already scanned into a machine-readable form. This record comes from the Eustatia Plantation in Mississippi.[7] These records detail the picking of nearly 60 slaves throughout the 1860 picking season.

Our sample for the period 1801-1862 consists of 602,219 individual observations of daily cotton picking performed by 5598 enslaved African-Americans. This sample includes only individual-level observations. (It excludes the aggregate plantation-level averages that we used in our previous work; such averages were especially useful to fill the picture for the Old South region.) The current sample includes data from 114 separate plantations and a total of 397 plantation-years. A full list of the plantation records that we consulted appears at the end of the References.

Table 1 presents selected statistics of our sample variables. Our sample is concentrated in the New South (the states not touching the Atlantic Ocean). Some 519,225 observations are from this region; 82,994 are from the Old South. The data become more abundant over time. Over all of the states, we have 15,078 observations for the years before 1820; 17,370 for the decade of the 1820s; 47,757 for the 1830s; 144681 for the 1840s; 279,271 for the 1850s; and 98,062 for the early 1860s.

Picking by Age, Gender, and Season

[7] http://dbs.ohiohistory.org/africanam/page.cfm?ID=13902

Several existing accounts assert that females were better pickers than males, at least through the teenage years. Jones (1985, p. 17) notes: "women frequently won regional and interfarm competitions conducted during the year." Schwartz (2000, p. 136) writes "(a)lthough men eclipsed women as cotton pickers in adulthood, girls proved better cotton pickers than boys until about age sixteen." Schwartz relies on selected records from the Sturdivant plantation in Alabama and on Metzer's pioneering work.

Metzer conducted an econometric analysis on picking by age and gender on a handful of plantations, specifically the Mississippi holdings of Francis Terry Leak and Eli Capell. Metzer noted that during cotton picking "individual marginal productivities were quite independent of one another (p. 201)." He further found that children started "…to pick cotton as early as at age five or less. On Leak plantation, for example, the average age of pickers in the 4-12 age group was 8.7 years; moreover, on the same plantation … the number of days in which slaves were engaged in picking declined with age, and females over age 12 picked for more days per season than males (p. 201)." Based on his sample of weekly picking data for this one plantation, Metzer reported "that females were better pickers than males in the four to twelve or thirteen to sixteen age group, but fell behind in adulthood. The relative decline in adult female picking performance was probably due to a considerable extent to the lower physical capacity during pregnancy and nursing periods (1975, pp. 201-202)."

Metzer also offered insights into the efficiency of plantation labor allocation policies that have been widely reproduced. He observed that it was at first puzzling "that females on Leak plantation were engaged more intensively in picking (in terms of days per season) than males in the seventeen and older age group despite their inferior performance in this operation. This apparent contradiction between actual and efficient resource allocation is easily resolved by examining work routines records for the cotton-picking season (1975, p. 202)." The records of the Capell and Killona plantations (Leak offered no data on this issue) showed that although males were heavily engaged in

picking, many were assigned to other, more strenuous jobs that competed with picking.[8] Thus according to Metzer, planters understood the principle of comparative advantage.

Campbell's (1988) study of the gender division of labor in the Old South adds valuable perspective.[9] Based on picking data from eight upland cotton plantations, he observed that, before the advent of the Mexican varieties, women picked on average 80 to 90 percent as much cotton per day as men. He argued this gap exaggerated the real differences because women often picked when the crop was light and were more likely to spend part of their time on picking days performing domestic chores. He estimated that the inclusion of pregnant women accounted for as much as one-third of the gender gap. Campbell also reasoned that little of the male-female difference was due to differences in strength, because when picking rates increased during the peak harvest period and thus more strength was required lugging cotton in the rows, the gender gap did not widen. And when picking rates increased with the introduction of Mexican hybrids he reckoned that the gender gap narrowed. Given this evidence he reckoned that the Mexican cotton made it relatively easier for women to pick (Campbell, 1988, pp. 49-65).

Aggregate Results from the Daily Picking Sample

Hitherto the empirical evidence to support claims about the relative efficiency of women and children in cotton picking has been chiefly antidotal or relied on the records of small number of plantations. Our sample substantially broadens the picture. An examination of the aggregate results regarding the gender and age patterns places the earlier findings into context.

A robust feature of cotton production on the antebellum slave plantations in our sample was its intensive use of the labor of women and children. In this regard, cotton was an unusual crop. As Panel A of Figure 3 indicates, adult females typically performed more cotton-picking labor --working more days in the operation-- than their male

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[8] Metzer (1975) alludes to strenuous work in other crops, but men also were assigned to ginning and to transporting cotton. These latter assignments had to be done during the peak picking season.

[9] Six of the seven South Carolina plantations were located in the District (County) of Darlington. Based in part on Campbell's study, Wright (2006, p.111) asserts: "[i]n cotton picking, average gender differentials were much less and one-third, and reports of females outperforming males are common."

counterparts. The one exception is the 1800-09 period. The difference was especially pronounced in the 1820s, 1830s, and 1840s with the gap closing substantially in the 1850s and early 1860s. The data for the 1820s on also suggest that children accounted for an increasing share of picking days.[10] (For the purposes of our analysis, we are considering those age 15 and younger to be children.) Seen in a different light, the degree of gender segregation of cotton picking was remarkably small. Males, females, adults, and children all participated.

As many have claimed, adult males on average picked more cotton per day than adult females or children. (See Panel B). However, among adults the differences are quite small until the 1840s and 1850s. Indeed, our data are consistent with Campbell findings that the gap, small as it was, closed over the 1800-40 period when the Mexican cottons initially diffused. But a meaningful gap re-emerged later. Among children, the changes in the gender ratios were more uneven, but a general pattern was for female picking rates to outpace male rates. Panel C combines the information on picking days with picking rates to calculate shares by gender and age group of total cotton picked. Again, the crop's characteristic intensity in using the labor of women and children comes through. Collectively they picked more than one-half of the cotton crop in every period except 1800-09.

Individual Level Results from the Daily Picking Sample

Employing our sample we can investigate picking productivity at the individual level. Table 2 reports results of the determinants of (the log of) daily picking rates for various age and gender categories. It also includes indicators for the days of the week, whether the day was a half day, the time of the season (July 1=day 1), and the crop year. The White robust standard errors are reported in the parenthesis. The sample is subdivided between the 1801-39 and 1840-62 periods. The 1840-62 period subsample is divided between the Old and New South regions. The New South subsample is further

[10] But note the patterns in the early period need to be treated with care. The data for the pre-1819 period are relatively sparse–totaling about 15,000 observations or 2.5 percent of the total—and the coverage is not as full as the later sample.

divided between the observations for Francis Terry Leak, upon which Metzer and much of the literature has relied, and the other plantations in the region.

In all the regressions, adult females picking productivity was quite close to that of adult males. For the entire sample over the 1840-62 period, adult females picked only about 11 percent less cotton per day as adult males. This differential is even smaller than that suggested by Goldin and Sokoloff based on gender "earnings." It is much narrower than the conventional view that women were only one-half as productive as men in southern agriculture, taken as a whole. Finding a narrow gap in our large dataset covering over 100 plantations and nearly 400 plantation years is consistent with the evidence from antidotal sources and the Leak plantation. (Notably, relative female adult productivity on the Leak plantation was abnormally high compared to other plantations in the New South or Old South, making this plantation an outlier.) The productivity differentials for children are less definitive although female children were often more productive than male children.[11]

Comparing the 1840-62 and 1801-39 estimates suggests the gap between adult female to adult male picking rates was even smaller in the early period. Indeed, the gap over the 1801-39 period, taken as a whole, is not statistically different from zero at conventional significance levels. The gap certainly is not economically different from zero. This conforms to the patterns in the aggregate data presented in Figure 3, Panel B. But after 1840 our results are not consistent with Campbell's finding that the spread of Mexican varieties increased the relative productivity of women. With the growth of the height of the cotton plants ("high cotton") and with heavier picking loads, the strength and size of males could have been increasingly favored. But again one should not lose sight of the main result: the gender differentials remained small while the productivity of both groups soared.

[11] A further complication to consider in future work is the labor force participation rate for children – this will require a fuller accounting on potential workers

The day-of-the-week effects are not what we expected. Mondays are the omitted category; so all results are relative to that day.[12] The peak picking occurs at mid-week, not as one might expect on Monday or Tuesday when the cotton bolls had an extra day to open since the last picking. Saturdays were typically the lowest day, even when an indicator is included to reflect the plantation owner or overseer's explicit notation that only "a half day" of picking occurred. The contrast in the days-of-the-week patterns between the Old and New regions is also intriguing. In the Old South, rates continue to rise later into the week. This pattern is consistent with the use of weekly quotas.

The results dealing with the seasonality of picking suggest little difference in peak picking over space or across time. The peak was the 27th September in the 1801-39 period and the 19th September in the 1840-62 period—a change of eight days But during each span of years, picking on the 19th and 27th of September differed by less than one percent. Picking remained at a relatively high level for about three months. The1840-62 estimates reveal that a period of over two months (64 days) in which picking rates on picking days is within 10 percent of the peak and a period of over three months (97 days) within 20 percent of the peak. These spreads are not meaningfully different from those prevailing in the 1801-1839 sample. The peak in the Old South and New South in the1840-62 period differed only by one day. Note this discussion refers to picking on picking days allowing for interruptions (rainy days, Sundays, and other non-picking days) during the picking season.

The rate of growth of the picking rate was more rapid in the total sample over the 1801-39 period than in the 1840-62 period. In the second period, growth was more rapid in the Old South than in the New South. But picking levels (for adult males) were about twice as high in the New South as in the Old South circa 1840. As a result, the faster growth in the Old South after 1840 may be interpreted as part of a "catching-up" process as biological innovations created in the New South were adapted for the Old South.

[12] Technically Sundays are lumped with Monday. Sunday work picking the plantation fields is rare – accounting for 1.7 percent of the observations or about one-tenth the fraction of other days of the week. Sunday picking was associated with the harvest rush and its inclusion raises the Sunday/Monday average.

We are able to assign the pickers' age for about 45 percent of the daily picking observations in our sample. For this group, the plantation records include birth registers, ages, and sales receipts allowing us to infer the ages at each year. The more specific age information allows a refinement of the analysis by breaking up the broad age categories (used in Table 2) and preventing differences in age-composition of the population within the categories from obscuring the differences over time or across space. Figure 5 displays histograms of the fraction of picking observations for each gender binned by age categories. Over 90 percent of observations are for those below 40 years on age. (Still a small share is not a small number of observations given the size of the total sample.)

Table 3 presents results for the sub-sample including ages based on the specification employed in Table 2. The most notable differences appear for the Old South sub-sample where relatively few of the upland cotton operations reported information allowing inference of age. Those that did so had picking rates exceeding those in the New South. This pattern inverts both the regional relationship found in the overall micro sample, in the picking rate data including plantation-level aggregates, and in the bales-to-cotton worker ratio we have derived based on state- or county-level labor force and production data (Olmstead-Rhode 2008ab, 2010). This hints at differing degrees of selectivity in the contemporaneous keeping of accounts and in the survival of such records. Such considerations indicate the importance of applying proper care in interpreting the statistical results based on the disaggregated age data.[13]

Table 4 present results for a specification with a cubic function of age for males and females. The patterns of effects implied by coefficients on days of the week indicators and the "half day," "crop year," and seasonal variables are not sufficiently different from those in Table 2 to warrant extensive discussion. Let us focus on the age-gender effects. As a simpler way to see these estimates is to examine Figure 5, Panel A

[13] Southeast plantations, as a rule, were deficit in neither keeping records nor donating them to archives. But many of the available records are for operations producing Sea Island cotton and /or rice. In fact, operations on the Georgia and Carolina coasts have been cited to an extent unequal to their importance. This cast a shadow over the understanding of antebellum economy of the Southeast. As but one example, the cliometrics literature frequently cites data on the monthly employment of labor in cotton, corn, and other activity on the George Kollock's Ossabaw, Georgia plantation. But Kollock specialized in Sea Island cotton production, which differed in crucial ways from upland cotton production.

which traces the implied profiles for males and females from age 5 to 60 from the entire sample over the 1840-62 period. The picking rates for females slightly exceed those for males up to age 10. For both gender, picking rates grow rapidly over the pre-teen and teen years. The female profile peaks at age 27; the male profile at age 29. Thereafter males peak about 25 pounds per day more than females. Again, the take-home message is how narrow the gender differentials are.

Given the fit of the cubic function form, the profiles reach a local minimum in the late-40s- to early-50s-age range and then turn up. This upturn among the elderly obviously could be an artifact of extrapolating from parameters fit using abundant data at younger ages. Using the more flexible functional specification allowed by the lowess locally-weighted regression helps us address this concern. See Figure 5, Panel B. The illogical upturn for the elderly disappears. The cross-point where males out-pick females occurs between 16 and 17 years of age; the differences before this age are small. The female peak occurs at age 28 at 113 pounds per daywhereas the male peak occurs at age 31 at about 130 pounds. A more pertinent observation is that the lowess profiles for adults are flatter than those implied by the cubic specification. This observation suggests that examining the broad age/gender categories is adequate for our main purposes (i.e that small differences in the age composition among the adult labor force will not create great distortions). The gap between adult males and females was typically in the 12-17 pound range.

In line with the work of Fogel and Engerman, Field, Toman, Wright, and others we can also consider plantations of different scales. Table 5 conducts an investigation analogous to Table 2 for sub-sample of plantations with different-sized picking forces. We utilize a breakdown of plantations with 10 or fewer different pickers recorded in the year, 11 to 50 different pickers, and 51 and more. It is notable that observations are scarce for small operations. Indeed, why would a small owner-operator bother to record such information? Yet for understanding antebellum cotton production, it is clearly the larger operators that matter most.[14]

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[14]Based on statistics compiled from the 1860 Parker-Gallman sample reported in Foust (1975), p. 161, slaveless farms accounted for 4.0 percent of cotton production, those with 1-9 slaves for 9.9 percent,

The results for picking differ across scale, though not as the existing literature suggests. For example, female adults appear more productive on the smallest units (contra to Toman). The key point that comes out of this exercise is that scale is important even for picking, an activity which by all account was performed on an individual basis.[15] The last two columns run specifications including, respectively, the (log of the) number of pickers appearing in the records that crop year and appearing that day. In both cases, the coefficient is positive, significant, and in the range around 0.15 and 0.20. The coefficient is high for the (log of the) daily number of pickers; this is consistent with the notion that more workers will be allocated to picking if there is more cotton in the field. The findings is not completely transparent because the regressions do control for season and it is conceivably that adding more worker would cause them to interfere with one another and reduce average individual picking rates. Moreover, a significant positive coefficient appears in the specification using the total number of different pickers appearing at any time during the crop-year. These findings direct us to explore further the role (both correlative and causal) of scale on productivity more generally to re-evaluate of the impact of gang system in non-picking activities.

One might worry that the balances/scales used to weigh cotton varied across plantations or over time. In our past research, we conduct a series of selected checks, comparing the total volume of cotton picked in the field with the reported bale weights. In all cases, the ratios were within reasonable bounds of the prevailing seed cotton to lint conversion rates. Our large sample also helps allay this concern because whatever weight noise that exists should cancel out. The regressions reported in Table 6 provide more direct reassurance. They include (a) plantation fixed effects to control from difference across units and (b) plantation crop year fixed effects to control for difference across units and within units over crop years. Clustered standard errors are reported as well in the < > brackets. The gender differentials remain small in the 1840-62 period and are non-existence in the 1801-39 period.

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plantations with 10-19 slaves for 12.7 percent, 20-49 slaves for 27.7 percent, 50-99 slaves for 23.2 percent, and 100 and more slaves for 24.1 percent.

[15] Fogel (1989), p. 27; Metzer (1975), pp. 123-50; Fogel and Engerman (1974), Vol. I, p. 206.

Labor Allocation and Selection Issues

Another important robustness concern arises due to the unbalanced nature of our panel, or rather of the plantation work routines. Most of the slave labor force, including many house hands, picked at some time during the harvest season. But not all pickers picked each day. Pickers were missing at time because they were ill, had run away, or were called off to perform other work such as ginning, hauling, repairing roads, and so on. The effect of the differential allocation of labor to other activities raises concerns about selection in line with the standard Roy model. It is possible, for example, that the workers most skilled in picking were also the most productive at the gin.[16] As the season progressed, the picked seed cotton that required ginning would build up and the gin workers, who were typically male, were called out of the fields. If this occurred during the high picking season, their highest potential picking days are censored from the sample. This would lead to an understatement of the relative productivity of males.

An examination of the evidence suggests the selection problem is not likely to lead to large biases, at least in this direction. The plantation records indicate in many cases the cause of the workers' absences. If one includes in the picking regression (results not shown) an indicator variable for cotton pickers who ever ginned on plantations recording ginning activity, the coefficient is negative and significant. This suggests the ginning status (controlling for adult status and gender) is not positively correlated with potential picking productivity. Among the possible explanations are the following: (1) the owners/overseers did not allocate the top pickers to ginning or (2) the gin workers did not feel compulsion to attain maximum picking to avoid punishment, earn rewards, or achieve status. In any case, ginning was also relatively uncommon, accounting for 2.2 percent of absences for these plantations. Sickness was a much more common cause of absence.

In addition, the largest differences in the gender composition of the picking labor force occur at the beginning or end of the season, not in the peak period of high picking.

[16] Metzer (1975) emphasizes that exploitation of comparative advantages as a sign of planter rationality. The most able workers, those with an absolute advantage in picking, are assigned to other more difficult tasks where they possess even greater advantage.

It was in August and early September that women and children picked while men prepared the gin and scaffolds, pulled fodder, and performed statue labor on the roads. The mean first recorded picking day for individual adult females in our sample was September 5th; for adult males September 9th. Male labor was also withdrawn in early December at slaughter time. Figure 6 presents a lowess plot for the share of adult males picking days by plantation between August 15 (season=45) and January 31 (season=210). The adult male share is quite flat. Again, picking was an operation that was not greatly segregated by gender over much of the picking season.

Our main strategy to address the allocation problem is to include plantation-picking-day fixed effects in the regression. That is, we include one indicator for each picking day on each plantation. This captures conditions on each specific day such as the amount of cotton available to be picked (and soaks up seasonal and days-of-the-week effects). The measurements then become relative to the other pickers in that plantation's field on that day. Workers who are differentially absent in high picking period are not penalized; those absent during low period are not rewarded.[17] This is not a perfect fix.

Table 7 present the results for the major gender/age divisions including plantation-day fixed effects. Table 8 presents the results for the age-gender cubic specification. Two sets of standard errors are reported—the White-robust standard errors in the parenthesis and Robust-Cluster-corrected standard errors clustered on the plantation year in the < > brackets. The latter attempt to control for correlation among the picking observations on a specific plantation for a given crop year. Gender differences remain small. For the entire sample over the 1840-62 period, the estimated gender differential is 6.7 percent. If anything, controlling for allocation/selection issues by adding plantation-day fixed-effects implies the female adult productivity were even closer to the male adult productivity than in our results presented earlier. Adding controls for the effects of pregnancy, as suggested in the work of Metzer, Campbell, and others, would likely result in even smaller estimates of the differences.

[17] The idea is this: suppose there are two pickers, A and B. Suppose A always picks X percent more than B when both are present. Suppose there are two days—Low and High—and B picks Qlo and Qhi. Were A present he would, by assumption, pick XQlo and XQhi. But A is allocated to gin on High days, so is only observed to pick XQlo. Comparing XQlo and 0.5(Qlo+Qhi) understates A's relative productivity.

Picking as the Binding Constraint

Our evidence on picking rates is particularly significant because, by almost all accounts, picking was the key binding constraint in cotton production. Most prominent observers have long espoused this view. The acreage of cotton that a plantation or farm could grow depended critically on the size of the plantation labor force available at the picking season. In *American Negro Slavery* (1918, reprinted 1966, p. 207), Ulrich B. Philips observed:

> Whether on a one-horse farm or a hundred-hand plantation, the essentials in cotton growing were the same. In an average year a given force of laborers could plant and cultivate about twice as much cotton as it could pick. The acreage to be seeded in the staple was accordingly fixed by a calculation of the harvesting capacity, and enough more land was put into other crops to fill out the spare time of the hands in spring and summer. To this effect it was customary to plant in corn, which required less than half as much work, an acreage at least equal to that in cotton, and to devote the remaining energy to sweet potatoes, peanuts, cow peas and small grain. In 1820 the usual crop in middle Georgia for each full hand was reported at six acres of cotton and eight of corn; <*The American Farmer* (Baltimore), II, 359> but in the following decades during which mules were advantageously substituted for horses and oxen, and the implements of tillage were improved and the harvesters grew more expert, the annual stint was increased to ten acres in cotton and ten in corn.

Similar statements appear in the contemporary planter testimony (see, as an example, Lyman, 1868). They also appear in the economic history literature. For example, Robert Gallman (1970, p. 23) asserted that "a field hand could raise very much more cotton than he could pick" and the plantation's "capacity to pick…governed the volume of land put to cotton." (See also Anderson and Gallman, 1977, p. 36 and Wright, 1978, pp. 57-60.)

One voice in the wilderness on this issue was Carville Earle (1992). He sought to overturn the conventional wisdom that picking formed the binding constraint on cotton production.[18] He argued that in most parts of the Cotton South, "[t]illage and not picking… constituted the most formidable labor constraint in cotton planting." (p. 28)

[18] Fogel (2003), p. 38 asserts that cultivating was the peak of several peak periods including planting and picking, but offers no evidence or sources for this view.

"[T]he short two-month tillage season restricted the acreage in row crops to 20 acres or less tillage capacity."[19] In addition, he claimed that during the planting and cultivation season, farmers and planters found the labor requirements of cotton and corn were competitive.

Earle argued that in most areas in most crop years the picking capacity was much higher than 18-20 acres per worker. He noted that picking capacity was then the ratio of the length of the season times the customary picking rate divided by the yield per acre. "[C]onsider typical example in which the picking season lasts 90 days, the picking rate is 200 pounds per worker per day, and the soil yields 400 pounds per acre. Picking capacity in this case equals 45 acres per worker—or substantially more than the usual tillage constraint (pp. 32-33)." To supplement his typical case, Earle (p. 34) provided the sensitivity analysis with varying yields and lengths of picking seasons appearing in Table 9. Except in the high-yielding areas of the Southwest, the picking capacity was greater than his tillage estimates.

But Earle's calculations of the picking capacity appear off in several dimensions– the normal amount picked per day, the number of days an individual picked (in the numerator of the ratio), and yields per acre (in the denominator). The effects all reinforce one another, leading to an exceedingly high estimate of picking capacity.

Let us focus first on picking per hand. Earle (pp. 33-34) asserted: "A male worker of ordinary skill customarily picked at the rate of about 200 pounds per day. Projecting this rate over the picking season, a worker could gather 13,000 pounds of cotton in a short season and 17,000 pounds of cotton in a normal one. These estimates represent the lower and normal range of cotton output for an adult male of ordinary skill." Assuming a conversion of 3 pounds of seed cotton per pound of lint and bales of 400 pounds of lint, this implies a normal bales-to-hand ratio of 14.2.

This is indeed high. In the agricultural literature of the antebellum period bale-to-hand ratios above 10 were considered an exceptional amount to pick and a matter of great

[19] Earle (1992), p 28. He based the combined tillage constraint for cotton and corn on the assumption of a 54-day season at a rate of one acre tilled per day with three cultivations for each crop. He states (p. 28) that antebellum planters, both large and small, typically used a crop rotation with 18 total acres of row crops per worker, with a two-to-one mix of cotton and corn, that is, "usually 12 acres of cotton to 6 acres of corn/cowpeas."

boasting. On the plantations in our sample with picking records spanning over 90 working days in a given crop year during the 1840-1862 period, adult males picked an average of 10,740 pounds per season. This is only 63 percent of Earle's estimates of normal annual picking capacity. Just slightly more than 5 percent of adult males picked as much in a season as Earle's annual norm.

The differences with Earle's calculations are due both to the differences in daily picking quantities and length of the picking season. By the end of the antebellum period, picking 200 pounds per day is a commonly-cited standard. But it applied to "excellent pickers" working in fields with open cotton, not to ordinary pickers toiling under typical conditions through highs and lows of the entire season. In the subsample defined above, adult males picked 200 pounds or more on only 22.6 percent of all days. They did so on 28.1 percent of days at the peak in the first two weeks of October but on a much smaller fraction of days early and late in the season. The mean daily picking rate for adult males in the sample with a full picking season was 148.5 pounds, or about 75 percent of Earle's daily standard. And the typical worker, considering all adults and children of both genders in this sample, picked 127.3 pounds per day and 9,511 pounds per season.

Regarding the length on the normal picking season, Earle argued that 85 working days—a four-month period interrupted by rain on 20 percent of days—represented a lower-bound estimate in his typical case. In the subsample defined above, the period between first and last days of recorded pickings averaged 122.4 days, that is, four months. On 84.8 days in this span, someone on the plantation was picking. Both are in line with Earle's conjectures. Earle attributes breaks in picking to rain. But Sunday was almost always a day of rest. The Sabbath would account for a little less than one-half of the days not spend picking. And not everyone could or did pick every day. The typical individual picked, on average, on 75 days during the season and hence was "absence" on about 11.6 percent of days picking occurred on the plantation. In summary, Earle's estimate of the number of pounds picked per hand appears very high, making his estimate of the picking acreage capacity high.[20]

[20] This is not conclusive because remains possible that a binding tillage constraint limited the cotton available for picking. A major problem with calculations suggesting slaves could pick a given amount of cotton over the length of the entire season is that such reasoning essentially allows cotton that became ripe

Earle's calculation must be revised downward for another reason. His estimates of yields—pounds of cotton per acre—are extraordinarily low. Given yields are in the denominator of his picking capacity ratio, this also works to elevates his estimate of picking capability. Earle uses 400 pounds per acre as his typical yield.[21] Evidence on yields in the antebellum period is fragmentary. The most comprehensive data appears in the U.S. Census in 1860. In that year, Census officials inquired of the local marshals about the "usual yields" of the various important crops in their county. In the 153 reports for cotton, the mean of yield was 871 pounds of seed cotton per acre (with a standard deviation of 293 pounds). The median was 800 pounds. (These figures are based on bales of 400 pound of lint and a lint turnout of 33 percent; that is 1200 pounds of seed cotton.) In just 5 counties (3 percent) were yields as low as 400 pounds. In only 10.4 percent of the counties were yields equal to or below 500 pound—Earle's medium yield. In nearly 40 percent of the counties, yields were equal to or above 1000 pounds—his estimate of high yield.

Dividing the mean annual picking totals for adult males in our plantation subsample by the average of the reported "usual yields" in 1860 generates a ratio of 12.33 acres. This is very close to the 12 acres of cotton per hand Earle asserts was standard in the antebellum South. It is well below the 42.5 acres of cotton he asserts adult males could potentially pick in "his typical case" and below the 18-20 acres of row crops he maintains could be tilled. Our picking sample overweighs the high-productivity New South, raising the possibility that our annual picking totals are still too high. The ratio of picking to yields would also then be high. The late antebellum standard of 10 acres of cotton per hand may be closer to the mark. In this case, even accepting Earle's assertion about the spring tillage constraint, one can rationalize the observation of U. B. Phillips that slaves could plant and cultivate twice the cotton acreage that they could pick. Given

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in September and October to be picked in November or December. Surely parts of the picking season were not as labor-binding as other parts, and plantation records show that planters allocated some potential pickers into other activities. The real bind was during the roughly two months when the cotton was heaviest and would lose economic value if left long in the field.

[21] In the sensitivity analysis, Earle (1992) explicitly considers a range of yields with 300 pounds as the low case, 500 pounds as the medium, and 1000 pounds as high. These are combined with the season length and picking rates to estimate the potential acreage picked. By considering different geographic scenarios, Earle allows for correlation between yields and season length. He does not model picking rates as varying with yields.

that picking was the binding constraint, other issues such as the asserted role of the gang system lose salience.

Gang Interdependence and Slave Efficiency

For many the gang system of slave management has become the sine qua nom for slave efficiency. In *The Slavery Debates* (2003), Robert Fogel offered his view on the state of knowledge of slave and plantation efficiency. Notwithstanding all of the fireworks concerning *Time on the Cross*, Fogel concluded that its major findings remain intact. In particular, he maintains that slavery was a viable and robust labor system, and slave plantations were highly profitable, efficient, and fully capable of out-competing free farms. The greater efficiency of plantations stemmed from their ability to exploit the gang system. 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 (Fogel, 2003, p. 36)." In his view the gang system was a revolutionary technological advance worthy of mention along side the "blast furnace, electricity, and medical surgery (Fogel, 2003, pp. 46-47)."

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. But in principle large farms that tasked their laborers could do so in a fashion that took advantage of specialization and the division of labor—not everyone had to do the same tasks. The real case for the efficiency of the gang system lies in the ability of planters to increase output through coordinated team interdependence. In *Time on the Cross*, Fogel and Engerman note that "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 apace and pattern which were quite flexible and largely independent of the actions of others. On plantations, hands were rigidly organized as in a factory (Fogel and Engerman, 1974, Vol. I, p. 203)." To pound home the point over the next page and one half the word "interdependence" occurs

five times, and this emphasis is bolstered by the terms “interdependent,” “assembly-line type pressure,” etc.

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 wholes 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 (Fogel and Engerman, 1974, Vol. I, pp. 203-04).” 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. All this was guaranteed by drivers and foreman who made sure the plowmen went fast enough and that the others kept up. 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 (p. 204).”

Part of the claim that five gangs moved though the field one after the other can be dismissed out of hand. The cliometrics literature offers no citations to or specific examples of such five-stage interdependent behavior, and such a five-state procession would have been rare. The first two operations—plowing and harrowing (not a universal procedure)—were separate tasks that took a long time, the fields were often plowed more than once to weed, to cut large or water furrows, and then to ridge-up, 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. Although there was a division of labor (as on northern farms), there was little or no interdependency interaction of teams. So unless “a fixed procession” allows for days and even weeks to pass between different elements of the parade and allows for the same people to reappear

many times, we are left with three rather than five gangs working in unison—each making the other more productive.[22]

McDuffie: Fact or Fiction

In *Explorations in Economic History* and later in the supplemental volume of *Without Consent or Contract*, Jacob Metzer offers the main slave-era quotation that has come to underpin much of the interdependency-efficiency argument. He describes the practices of Governor George McDuffie of the Abbeville District, South Carolina:

"'When the period for planting arrives, the hands are divided into three classes: 1st, the best hands, embracing those of good judgement [sic] and quick motion. 2d, those of the weakest and most inefficient class. 3d, the second class of hoe hands. Thus classified, the first class will run ahead and open a small hole about seven to ten inches apart, into which the 2d class drop from four to five cottonseed, and the third class follow and cover with a rake.'"[23]

This McDuffie quote, as cited by Metzer, appears in Fogel and Engerman's 1977 *American Economic Review* article, in Fogel's essay in the lead volume of *Without Consent or Contract*, (1989, p. 27) and in many editions of Walton and Rockoff's popular textbook, *History of the American Economy* (10th Ed, p. 249). Toman (2005) also highlights the McDuffie example.[24]

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[22] For an easily accessible example of this see the published account of day- to-day plowing activities on the El Destino Plantation of George Noble Jones (see Phillips and Grunt, 1927). He regularly had about 14 to18 plows working (with a like number of slaves) and numerous other groups in other tasks. See below for a further treatment of this issue.

[23] As quoted in Metzer (1975), p. 135. This statement regarding McDuffie was quoted in Gray and thus flagged for researchers. Another "flagged" source that is less favorable to the coordination hypothesis escaped attention. Phillips relates the 1840 observations of an overseer, Eliza Cain of Jefferson County, Georgia: "the increase of laborers and the spread of the fields…often required the working of three squads, the plowmen, the grown hoe hands, and the younger hoe hands. 'These separate classes are frequently separate a considerable distance from each other, and so soon as I am absent from with they are subject to quarrel and fight or to idle time , or beat and abuse the mules…." Cain did not solve the problem by bringing the disparate gangs together; rather he appointed a slave to report to him on such issues. Phillips, (1918, reprinted 1966) p. 237.

[24] Toman, (2005): 310-23, quote is on p. 311. The text on p. 311 continues " The gang system was the central method of intra-field specialization adopted by cotton planters. The slaves were organized into groups based on their physical capability and these groups worked interdependently to plant or cultivate the

This quotation carries a heavy load, so it is important to pay close attention its source. Metzer's citation is to "*De Bow's Review* VI, 149, quoted in [Lewis Cecil] Gray (1933, 1, p. 549)."[25] However in the text (*EEH*, p. 134), he indicates that he obtained the quotation from Gray, 1958. The substance of Metzer's quotation of Gray and *De Bow's* is accurate, but he did introduce several minor editorial changes within the quotation marks. This is only relevant because many later accounts reproduce these editorial changes, suggesting the authors did not consult the original *De Bow's Review* article. Toman is an exception.

A fuller view of original article and related pieces puts McDuffie operation into a new light. The *De Bow's* article appeared in August 1848 and was attributed to "a writer, in Augusta." It was shortened version of an article published in July 4, 1848 in the Charleston *Mercury* over the nom de plume, "Saluda."[26] The longer version includes opening paragraphs touting McDuffie's brilliance as a statesman and setting the scene for Saluda's visit the "Flat Woods" plantation. Saluda states that his visit to McDuffie's plantation lasted only one day, May 24th, and that he saw the stands of growing cotton seedlings. This date is revealing because cotton planting would typically have started by early April and would have been long finished. This means that the author of the *De Bow's* report likely never actually witnessed McDuffie's planting teams at work. The *Mercury* and *DeBow's* articles were just two of a series of laudatory articles about McDuffie dating back to at least 1836 that have gone unnoted in the cliometric literature. Taken a whole these accounts suggest that the politician was keen on tooting his horn as a progressive planter.[27] There are other articles in 1848 also paying tribute to McDuffie's

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crop. To illustrate, consider the description of a planting gang on the McDuffie plantation given in De Bow's Review, De Bow (ed.) (1848, p. 149)".

[25] Metzer (1975) p. 135. It is notable that Gray discusses McDuffie in a section on the division of labor before entering into his section contrasting gang and task labor. The original appears in (DeBow's) *Commercial Review of the South & West*, 5 (1848), p. 149.

[26] Charleston *Mercur*y, (4 July 1848), p. 3. The *Mercury* cited the Augusta *Chronicle and Sentinel* as its source. Our search of the latter paper drew a blank. One possible reason is that issues between June 25th and 30th inclusive were missing in the online series available to us.

[27] As one example, "No author, Gov. McDuffie's Plantation," *United States' Telegraph* (22 November 1836), Issue 306, "We are informed by a gentleman in whom perfect confidence can be placed, that the cotton crop of General McDuffie, this year will average 8 bales to the hand," Fayetteville *(NC) Observer*, 1 January 1840. For a fuller account of his political career, see Edwin Luther Green, *George McDuffie* (Columbia, SC: State Company, 1936). His plantation operations are discussed on pp. 164-168.

plantation practices, but do not mention the three-classes of workers. The most informative of these for our purposes appeared in the *Genesee Farmer* in April.[28]

It is evident that McDuffie was not a typical or representative planter. As an example, he employed a novel form of minimal tillage, and most articles focused on his exceptionally low use of horsepower.[29] The 1848 *Genesee Farmer* and the Saluda articles noted that instead of thinning or "chopping" his cotton seedlings with hoes as most planters did, McDuffie made his slaves uproot the extra shoots by hand. It is possible that this unusual thinning practice may have called for more precision planting than what was commonly practiced and thus the three-team system in which the most astute slaves spaced the holes—essentially laid out the field, with the other two teams following behind. Nothing in the articles specifies the sex of the workers so it impossible to determine the gender division of labor in this operation.

And more to the point: *DeBow's*, the *Genesee Farmer*, and the other sources make it clear that McDuffie was a strong devotee of the task system. Key sections in *De Bow's* article immediately above and below the frequently quoted passage read:

"'…if the ground to be prepared for cotton had been in cotton the previous year, the first operation is to pull up the stalks and lay them in the middle, between the rows; a hand then walks backwards and draws in the soil, leaves, and trash from the ridges, with the hoe, upon the stalks that have been pulled up and deposited in the row, and on which he walks. This operation is called listing in. *The task for a hand is half an acre per day* [emphases added].'"

And: "'The hoe is never permitted to pass between the cotton, it being thinned by hand, and *three-fourths of an acre is a task for a hand a day*…. [emphasis added]'"

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[28] No author, "An Agricultural Excursion to and in Abbeville District South Carolina," *Genesee Farmer* 9:7 (July 1848), p. 165; No author, "Farming and Improvements in Abbeville District, S. C.," *Southern Cultivator*, 6:7 (July 1848), p. 105.

[29] Charleston *Courier*, 38: 11 (2 April 1840), p. 2. He had been using a low horse-power regime this since at least 1840, and in that year another correspondent, writing under the nom de plume Plough in the *Southern Cabinet*, challenged the claims as to the superiority of McDuffie's practices. Plough noted that given the "enormous" prices of slaves it was more economical to employ more mules and plows than what McDuffie advocated. Plough, "Queries to Abbeville," *Southern Cabinet of Agriculture, Horticulture, Rural and Domestic Economy*, 1:7 (July 1840), p. 401.

The article also clearly states McDuffie had "70 task hands" on the Flat Woods plantation. In addition the *Genesee Farmer* lauds McDuffie for the flexibility he allowed his slaves: "The task of a hand is to hoe an acre of corn or cotton a day, which is usually completed by 2 o'clock, P. M. The proprietor said that if his people desired it he would allow them to take their task by the week, in which case they might gain two days in the week to work for themselves."

Tasking was not some experiment just recently introduced in 1848, because an 1840 account notes that the slaves could complete their tasks by 3 P.M. According to the press accounts, McDuffie's slaves were not driven by the fastest slaves in a highly intensive, interdependent, pressure packed, assembly-line in the fields.The *De Bow's* account, when read in its entirety, is a testament to tasking, not to the claim of gang interdependence and coordination.

McDuffie evidently had teams with different attributes during planting, but the claim that this exemplified efficiency is suspect. He was well behind the modernization curve, because in his day southern and northern farmers were mechanizing. Two workers with horses (or mules) and two machines—an opener (or drill) and a coverer—and hand sowers could replace the larger teams that McDuffie employed.

An 1837 letter from "An Observer" in Houston County, Georgia published in the *Southern Agriculturalists* offers a far different view of "efficiency" than that of three classes of slaves equipped with primitive hand tools plodding through the field: "Thus bedded, the drills were opened with a small scutter, or bull-tongue plough, in which the seed was sown; they were covered by a board fastened on the plough-stock, in the place of the mould."[30] Note that in this mechanized account nobody is making individual holes a foot or so apart. The horse powered "drill" is cutting a small trough into which the seeds were placed. A description along these lines of planters using machines is repeated in numerous published sources such as Solomon Northup's famous *Twelve Years a Slave*, and T. B. Thorpe's description of cotton production in *Harper's Magazine*: Thorpe noted that in "the middle of March or the beginning of April,… the 'water furrows' are run from five to six feet apart, and made by a heavy plow, drawn cither by a team of oxen or

[30] An Observer, "On Cotton Culture," *Southern Agriculturalist*, 6:5 (August 1, 1838), p. 269.

mules. This labor, as it will be perceived, makes the surface of the ground in ridges, in the centre of which is next run a light plow, making what is termed " the drill," or depository of the seed: a girl follows the light plow, carrying in her apron the cotton seed, which she profusely scatters in the newly-made drill; behind this sower follows "the harrow," and by these various labors the planting is temporarily completed."[31] There was obviously a sequence of event requiring one person to follow another and there is a division of labor, just as on northern farms, but this vision of the productive relations in cotton planting has little hint of gangs interacting, with one setting an uncomfortable tension driving others to keep up.

Evidence from the Plantation Records

Far more persuasive evidence on production activities and slave management comes from the archival records found in plantation account books. This evidence is overwhelmingly clear that the claims of gang interdependence as a source of plantation efficiency are exaggerated. First, pretty much everyone who has looked at the day-to-day rhythm of cotton production agree that picking was the most important peak-load activity and that picking was not a gang activity. Paradoxically, gangs and teamwork were important features for the small grain harvest where cradlers (or reaper drivers) were followed by rakers, bundlers, and shockers. In addition there was an urgency to get the cut grain shocked daily rather than to leave it on the ground overnight..[32]

Plantation records offer considerable evidence that work groups or gangs existed, but it is hard to find hints of closely-choreographed teamwork between gangs during major field operations. To address the issue of gang interdependency, we begin by examining the records of two plantations—Leak and Capell estates-- that were at the core of Metzer's analysis. Francis Terry Leak's plantation is worthy of special note. Leak had

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[31] T. B. Thorpe, "Cotton and Its Cultivation," *Harper's New Monthly Magazine*, 8: 46 (March 1854), pp. 447-463; quotation from p. 452.

[32] Mechanization (the self raked reaper, the twine binder, and ultimately the combine) progressively integrated or eliminated different tasks. So in the season of the tightest labor constraint, when the opportunity cost of labor was greatest, the gang system was not a factor in cotton production but it was in small grain production.

90 slaves in 1850 according to the Federal Census Slave Schedules.[33] His plantation was located in Tippah, Mississippi, in the north-central part of the state. As such it is not representative of the Mississippi and Louisiana plantations situated on more fertile alluvial soils. However, Metzer and many others have relied heavily on this plantation for examples of how cotton plantations worked.

As a rule in January and February there is little mention of gang activities. In first half of March some references to work in corn and cotton work appear but the weather still made this a slack season for gang-type fieldwork. A closer look at 1853 brings role of gangs in the plowing, planting, chopping, and cultivating into sharper relief. We will concentrate on cotton. On March 31 (p. 164 reel 26) Leak mentions that he had been grading fields and in early April there are more general references without much detail. On April 15 he began to plant cotton with 6 openers and covers. He finished planting cotton on April 28. Allowing for Sundays and rain, he planted for 11 working days using between 3 and 7 sets of openers and covers. He does not mention it, but for each team of two machines there were slaves (we suspect two or three) dropping the seeds. This sounds like the gang precession, alluded to on the McDuffie plantation, albeit with machines. But looks could be deceiving. On April 26th Leak noted that

"The Cotton planted yesterday not having been covered, we ran more covers than usual in order to catch up with the openers. This was the more important because the seed planted yesterday, to day, & those to be planted hereafter, being rubbed seed, require to be covered immediately after being sown, in order to prevent them from drying. If they were allowed to dry before being covered, one of the principal objects had in view in rubbing them, vis. to hasten their coming up – would be defeated."

Thus the coverers had not always directly behind the openers—in fact they had not covered the same ground on the same day in some cases. Leak saw this as unacceptable, but not because of a supposed loss in gang interdependence. Rather there was a technological imperative—unless covered, the seeds would suffer. This was especially so because of the widespread practice of treating the seeds in the hope of accelerating germination.

[33] U.S. Census, 1850 Slave Schedules, Mississippi, Tippah, Division 3, pp. 26-28.

Following planting scrappers began cultivating the fields. The first mention of hoes and machines working on the same day in cotton was on May 9th when chopping stared (for the hoes). The chopping continued until May 21st. During this period the scrapers generally preceded the hoes (as opposed to following as noted in *Time on the Cross*) and there were a few days when the hoes and scrapers went over the same ground. But this seemed to happen because rain had a greater impact in delaying the scrapers. On most days the scrapers outperformed the hoe hands, and the hoes generally followed the scrapers by 10 to 30 acres; this meant that they were often following the scrapers by about 2 to 6 hours.

After the chopping was completed and both the plows (including shovel plows and scrapers) and the hoe hands were cultivating to keep weeds under control. Although Fogel and others have singled out this period of cultivation as crucial to their gang arguments the Leak account suggests that gang interdependence was of minor importance. Starting on May 24th and ending on July 25th when the fields were "laid in," there are almost daily accounts of the location of hoe and plow gangs. In this period there are 40 days when we can identify the locations of the hoes hands and the plows. On 26 of these days, or 65 percent of the time, the hoes and the plows never even worked in the same fields. On the days when they did overlap it was typically not very significant. As an example on May 24th the hoes worked in three fields and the plows in five fields, but only one of the fields was in both sets. Between July 12th and 15th there is a single entry because Leak had been away—the plows worked in 11 fields, the hoes in 3 fields—one field was in both sets (in this case the overlap may not have been on the same day). Over most of this cultivating season one type of gang was not just a day behind the other—there was little noticeable interdependency. As an example on June 1st the hoes were in fields that the plows last visited on May 25th and 26th, and the plows were in fields the hoes had not worked since May 24th or before. To make matters worse for the gang interdependency argument, on most days it is very likely that the plow and hoe gangs were each divided into two or more groups—in these cases there were three, four,

or more teams of slaves in smaller gangs toiling in separate locations.[34] In the roughly two months of the cultivating season between May 24th and July 25th we found one indisputable case of gang interdependence, but it was in the wheat harvest when Leak had three cradlers, supported by two hands shocking and two "small ones" gathering and tying the wheat. But this of course is what northern farmers did regularly.

Metzer (1975) also utilized the records of the Eli J. Capell, a successful planter in Amite Mississippi. How did Capell organize his field operations? Stephenson (1936, pp. 368-69) noted that Capell used the task system: "The main force was divided into hoe and plow gangs with the weaker slave composing the former and often rated as fractional hands…. In 1855 twelve men and one woman composed the plow gang; one man and thirteen women the hoe gang. The latter worked by the task system with three-quarters acre constituting a standard task for males and a half-acre for females." The actual records of his Pleasant Hill Plantation between 1842 and 1859 contain many references to operations that might signify interdependent-efficiency-boosting gang coordination. As an example on April 1, 1843 he commenced planting cotton with 3 openers, 3 corn droppers, 5 or 6 seed sowers, and 3 harrows. For roughly 5 weeks he continued with this procession employing 14 to 15 hands. It seems likely that the efficiency gains from interdependency coordination were largely captured having one team consisting of an opener, corn dropper, 2 sowers, and a harrow. But this and assessing how much adding two other teams mattered is speculation; as is most everything that has been said on this issue. June 12, 1857 Capell noted that "14 ploughs Moulding Cotton…. The Hoes hilling behind them." This statement is representative of many others. But it would be a mistake to read this as a sign of intense inter-gang intensity, because as noted Capell's dominant management style for most hoe operations in cotton and corn was to task his workers. Capell was even more flexible and skillful in this than Stephenson implied. The accounts make clear that year after year Capell regularly surveyed his fields and set a daily task for different categories of workers depending on conditions. As an example on Saturday, July 16, 1842 he set the task for hoers at ¾ to 1 acre per hand, but on Monday the 18th he revised the assignment to ½ to ¾ of an acre. He set the tasks high enough so

[34] We reach this conclusion form Leak's observation that on consecutive days the plow or hoe gang worked in two or more fields not finishing any the first day.

that on some occasions workers had to stay in the field into the night, and on other occasions he noted that no workers could finish. The key point is that when an individual worker finished he/she could leave. On a few instances he complained that it was too grassy to task and that he had the hoes working a together. The common vision of the hoe gang working in a rhythmic procession in unison is just not consistent with Capell's tasking system. But do note this did not prevent Capell from utilizing a division of labor and potentially capturing economies of size by assigning different workers different tasks depending on their physical attributes.[35]

The El Destino Plantation records are also informative. The Journal for 1847 is representative. Daily accounts show the allocation of slaves as they prepared the fields for planting—this included the "listing" and "bedding" operations. Between 14 and 18 plows went from one field to another with one slave to a plow. In this period there were 44 slaves, and on a given day they were divided into many groups doing tasks spread across the plantation. There is not a whiff of any of these slaves preceding or following the plows. Did the gang of roughly 15 plows create within team coordination advantages perhaps by traversing the land 15 abreast? Maybe, but the suspected traffic jam at the end of the row as 15 plows started their turns and then each skipped 14 furrows (that were not yet measured out) to complete their turns, suggests that these plows were likely assigned different parts of the field. In addition, horses (mules) were not all of equal strength. Coordination would thus have limited all to the pace of the weakest animal. It was common for larger plantations to have a score or more plows in a field at once. The diseconomies of coordination if these teams attempted to function as an integrated unit would be magnified as the teams got larger.

Planting on the El Destino in 1847 began on March 25th. The planting crew typically consisted of about 15 slaves who went from field to field. They were in a gang, and might have gained some advantage from coordination—the records are mute on this issue. But it is clear that during this period most slaves were occupied in sundry other tasks in diverse locations. So the gang-coordination advantage, if it existed, would have

[35] Eli Capell Papers, Department of Special Collections, LSU.

only applied to one-third of all the slaves on this plantation for the relatively brief panting season. (See Phillips and Glunt, 1927, pp. 225-34.)

Next came the chopping and cultivating seasons. In *Time on the Cross*, Fogel and Engerman single out cultivating for special emphasis: "Interdependence and tension were also promoted between gangs, especially during the period of cultivation when the field labor force was divided into plow gangs and hoe gangs." Metzer (1975, p. 135) conveys the same message: "Interteam interdependence was crucial during cultivation, when concurrent plowing and hoeing was carried out." However the actual day-to-day record for this plantation yields an impression similar to what we found in the Leak and Capell accounts. On days when hoe and plow gangs are both mentioned, they were often not in the same fields and on many occasions they were working in different crops. There was no assembly line, and it is hard to grasp how the two types of crews were constantly creating "tension" by pushing one another to keep up.[36]

Yet another perspective comes from the records of James Allen who farmed in Warren County, MS. He appears to have had about 57 field slaves and an assortment of other working as servants and the like. His account of the Nanachehaw Plantation for 1860 offers clear evidence of slaves doing different parts of a larger task such as planting cotton or corn or cultivating in a coordinated fashion during and after the planting season. For example, from March 1 through August 10, 1860 when picking kicked into high gear there were 140 workdays—the slaves did not work (for Allen) on Sundays. How important were interdependent gangs moving in a procession interacting with one another? On 64 days Allen mentioned two or more gangs. On the other days it was raining or wet, or there was only mention of one gang, or just no information.

The minimum condition for "rigid" interdependency to have been possible is that the slaves were at least in the same field. On 30 out of the 64 days, this condition was met—that is we could place (or reasonably infer that) two teams (were) in the same field. On many of the days when the gangs were in the same field it only involved a few

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[36] Phillips and Glunt (1927) pp. 242-43. The 1837 Observer cited above evidently had hoes and plows in the same field, but they were not driving each other. Rather the Observer noted that the "daily task of a hoer was 100 rows of cotton 100 yards long." An Observer, "On Cotton Culture," *Southern Agriculturalist*, 6:5 (August 1, 1838), p. 269.

individuals—for example, on April 3rd Allen had 4 plows running in one field—2 were opening and 2 were covering; the next day he had 6 teams in that field "3 opening & 3 covering with harrows." [There were likely also seeders in these groups.] This sounds like a coordinated activity with two types of equipment running one behind the other, but it is uncertain if the three teams were running in tandem. On many other days when we noted two types of gangs in the same field a large crew of either hoers or plowers was also in another field by themselves—so for many, if not most slaves, there was no gang interdependency. We can discount the notion of interdependency on other days when two large teams were in the same field. For example, on April 20th Allen noted: "Working corn at Mill field…25 plows in & 23 hoes behind…." The problem is that the ratio of plows to hoes suggests they were not running in a tight procession of two integrated packs, one forcing the other to keep up. For this to have been the case, these hoers would have had to have been superwomen (or the plowers and/or their animals would have had to have been subpar). It is important to emphasize that the fields were large areas, the "Big" field was 272 acres, the "42" field was 142 acres and the smallest of Allen's eight fields was 37 acres. (To provide perspective an American football field including the end zones is about 1.3 acres.) So just because two crews were in the same field does not necessarily mean that the gangs were very near one another, let along that one gang was struggling under great tension to maintain the pace set by the other. In some cases the sequencing of activities is evidence, but without the minute-by-minute procession—as for example when on July 26th Allen observed that "the sweeps a day ahead of hoe hands, 10 sweeps and 26 hoes…." He rectified this problem by stopping the 10 sweeps and starting 20 plows in other fields—away from the hoe gang.

Out of the 64 days when Allen mentioned two or more types of gangs he explicitly noted that they were in different fields on 34 days. This was not a temporary disequilibrium from some interdependency norm, but rather a normal management practice driven by the technical realities of plantation life. For example of for seven consecutive workdays between July 9th and July 16th, Allen clearly placed his hoe and plow gangs in different fields (there were about 20 plows in the plow gang).

The upshot is that even during the season of heavy plowing, planting, and cultivating, we find little support for the supposed coordination efficiencies of gang labor.

The one source commonly cited to support the assembly-line hypothesis turn out to come from a planter who tasked his slaves. An analysis of actual plantation records, including two of the most important plantations that Metzer studied, paints a far different landscape from that described in much of the cliometric literature. One, Capell, tasked his slaves much of the time (Leak also mentioned tasking occasionally). It was indeed a common practice to have a sequence in planting with a division of labor—an opener, two or three sowers, and a closer. How close they actually followed one another is not known, but given that women and children could drop seeds in a trench, a full gang only required two males at most. It is hard to see how small plantations and free farmers could not capture whatever economies of coordination were available. It is also not clear why three or for that matter ten such crews were significantly more efficient than one. Large planters who on some days did run seven such crews also ran two or three planting crews on other days suggesting that the larger assemblies added little in the way of coordination efficiencies. During the planting season many slaves were assigned to other jobs. This also suggests that larger crews added little. In these planting operations involving two draft animals to a crew there is no evidence that the lead horse and slave set a wrenching pace improving efficiency. There was a logical sequence in the production process and there was a technological need to cover seeds in a timely fashion. Even if one assumes that the sequencing of activities (something that was done on free farms) was evidence of the tension creating coordination efficiencies of an assembly line, this only applied to some of the slaves on a relatively few days during the year.

Once the roughly 10 days devoted to planting passed the evidence of processions and intense inter-team competition becomes even harder to find. Assuming that plow and hoe gangs had to be in reasonably close proximity with one another as a prerequisite for ridged gang interdependence to create assembly line efficiencies, means such economies were a relatively rare event even during cultivating activities. On most days on the four plantations we looked at, these two types of gangs were not even in the same fields most of the time. As everyone agrees gang coordination was not a factor for the three to five months during the cotton-picking season. There was not much gang activity during much of December, January, and February, and some of March. There was not much during the month or so before picking began after the cotton was laid in. Hence for the widespread

claim of gang efficiency to hold it had to occur in a roughly four month period. But even in this narrow window, there is little hard supporting evidence.

Conclusion

We do not believe that the general claims of this paper will surprise anyone familiar with the production of cotton in the antebellum period, namely that (1) for a crop, cotton replied to an unusual extent on labor of women and children; (2) the productivity differentials between females and males were lower than in most other activities; (3) productivity was higher on larger-scale units; (4) picking, not planting or tillage, was a binding constraint on cotton acreages; and (5) that the assembly-line characteristic of gang labor used in planting and cultivation has been exaggerated.

But we think some of our specific findings may be new or noteworthy, especially that (1) in the plantation sector, females picked as much or more of the cotton crop than males; (2) the gender differentials in daily picking rates in the late antebellum period (1840-62) were in the 7-11 percent range;[37] (3) productivity in picking, an activity conducted on an individual basis, was higher on larger-scale units; (4) recent claims that tillage, not picking, was the binding constraint rely on bad numbers with respect to daily picking rates, days spent picking, and yields per acre; and finally (5) George McDuffie and other planters, whose examples are quoted in support of the gang-labor assembly-line-efficiency hypothesis, behaved in ways that either directly contradict the hypothesis or, at best, are in accordance only by happenstance.

It is also important to be mindful of changes over time. Many treatments of the slave family and work life are based on a collage that combines snapshots capturing a brief moment in different time periods. While some of these studies differentiate between the frontier years and the more settled period, there is typically little attention given to the possible evolution of work and family relationships during the post-frontier era. We would expect that technological changes associated with the dramatic increase

[37] This differential is close to the 9.1 percent gender differences in prices that Kotlikoff (1979) finds in the New Orleans slave market.

of picking rates to have differential effects by gender and age. Indeed, it appears the gender productivity gaps of the late antebellum period did not exist before the 1840s.

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Mary Hart Means (1835-1916) Papers, 1846-1865. RASP, Ser. A, pt. 2, reel 4.

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Thomas Cassels Law (1811-1888) Papers, 1810-1865. RASP, Ser. A, pt. 2, reels 7-8.

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Ser. G, pt. 1, reel 33.

Kiger Family Papers, 1820–1885. RASP, Ser. G, pt. 5, reels 25-28.

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Bonaventure Plantation Book, 1850-1851. RASP, Ser. H, reel 1.

David Rees Papers, 1803-1835. RASP, Ser. H, reels 29-30.

Series I, Selections from Louisiana State University.

Alexander Blanche Plantation Journal, 1851-1856. RASP, Ser. I, pt. 3, reel 14.

James A. Gillespie Papers, RASP. Series I, Pt 3, Reel 14.

John H. Randolph Papers, 1822-1865. RASP, Ser. I, pt. 1, reels 14-15.

Joseph Toole Robinson Papers, 1830s and 1853-1861. RASP, Ser. I, pt. 2, reel 20.

LeBlanc Family Papers, 1812-1866. RASP, Ser. I, pt. 2, reel 17.

Lewis Stirling and Family Papers, 1784-1865. RASP, Ser. I, pt. 2, reels 21-25.

Nathaniel Evans and Family Papers, 1791-1865. RASP, Ser. I, pt. 2, reels 1-10.

Pre Aux Cleres Plantation Record Books, 1852-1854. RASP, Ser. I, pt. 2, reel 19.

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Branch Family Papers, 1788-1866. RASP, Ser. J, pt. 4, reels 45-47.

Francis Terry Leak Papers, 1839–1865. RASP, Ser. J, pt. 6, reels 24-27.

George J. Kollock Plantation Books, 1837-1861 RASP, Ser. J, pt. 4, reels 2-3.

Jackson and Prince Family Papers, 1784-1880. RASP, Ser. J, pt. 4, reels 25-36.

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John Edwin Fripp Papers, 1817-1905. RASP, Ser. J, pt. 3, reel 25.

Nicholas Bryor Massenburg Papers, 1834-1851. RASP, Ser. J, pt. 13, reels 1-2.

Philip H. Pitts Papers, 1816-84. RASP. Ser. J, pt 7, reel 6.

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Charles Clark and Family Collection, 1810–1892. RASP, Ser. N, reels 4-5.

Elley Plantation Book, 1855–1856. Series N, Reel 10

James T. Magruder Account Book and Plantation Journal, 1796-1818. RASP,

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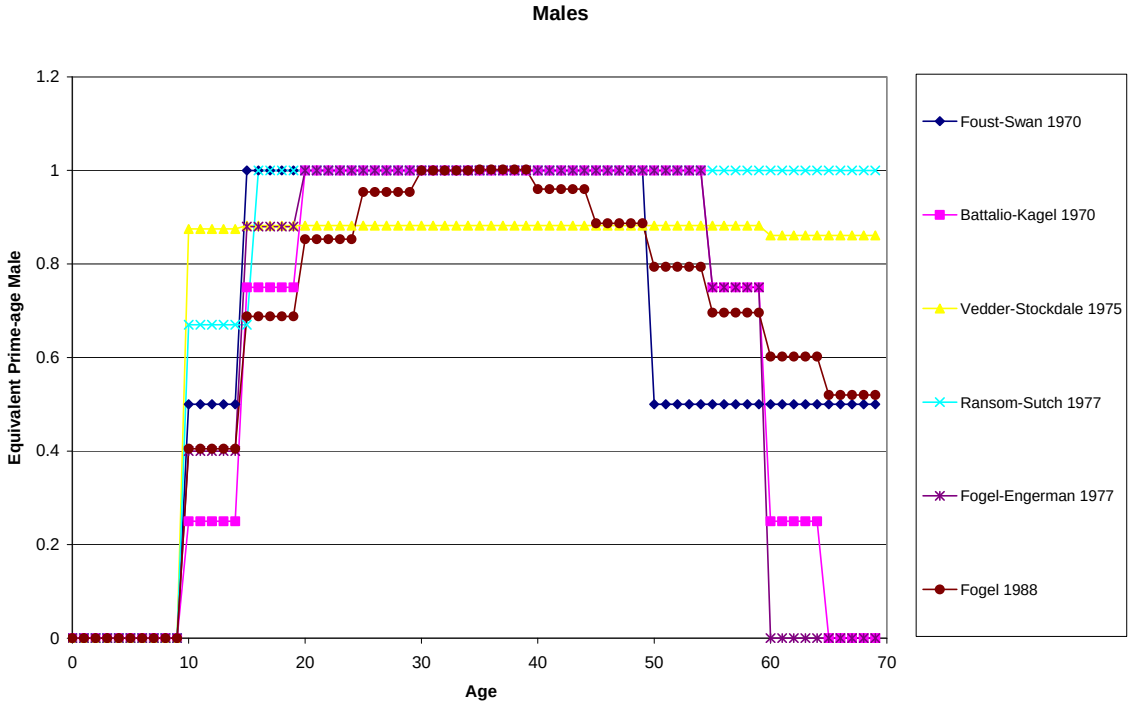
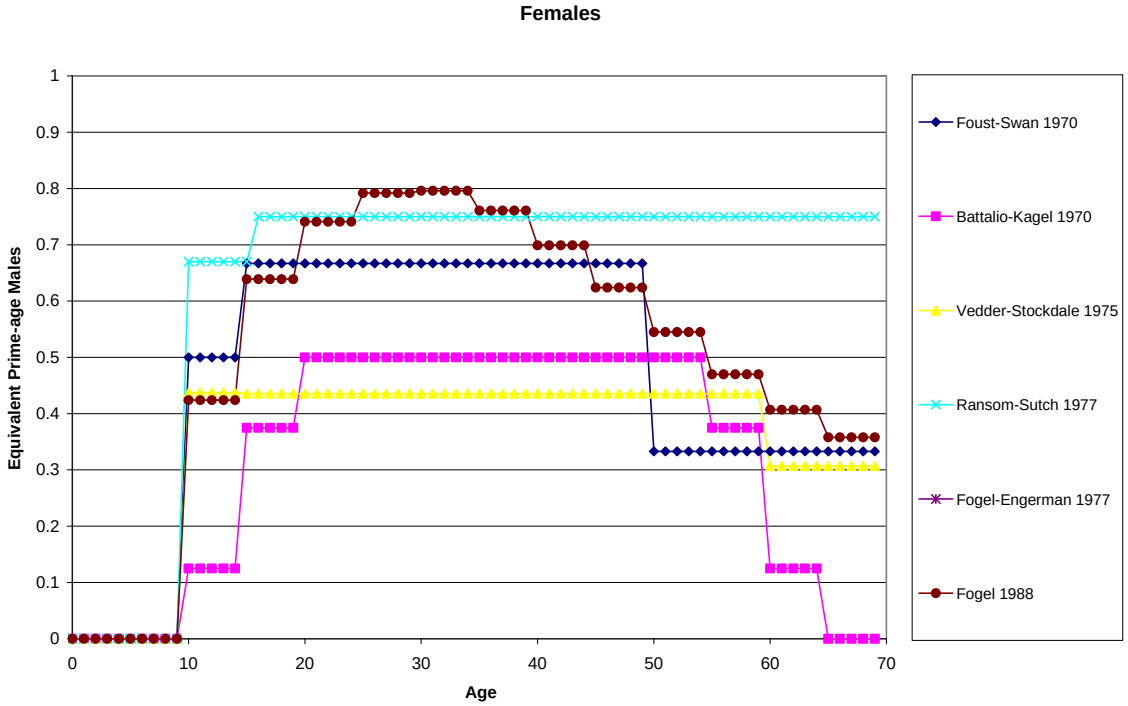
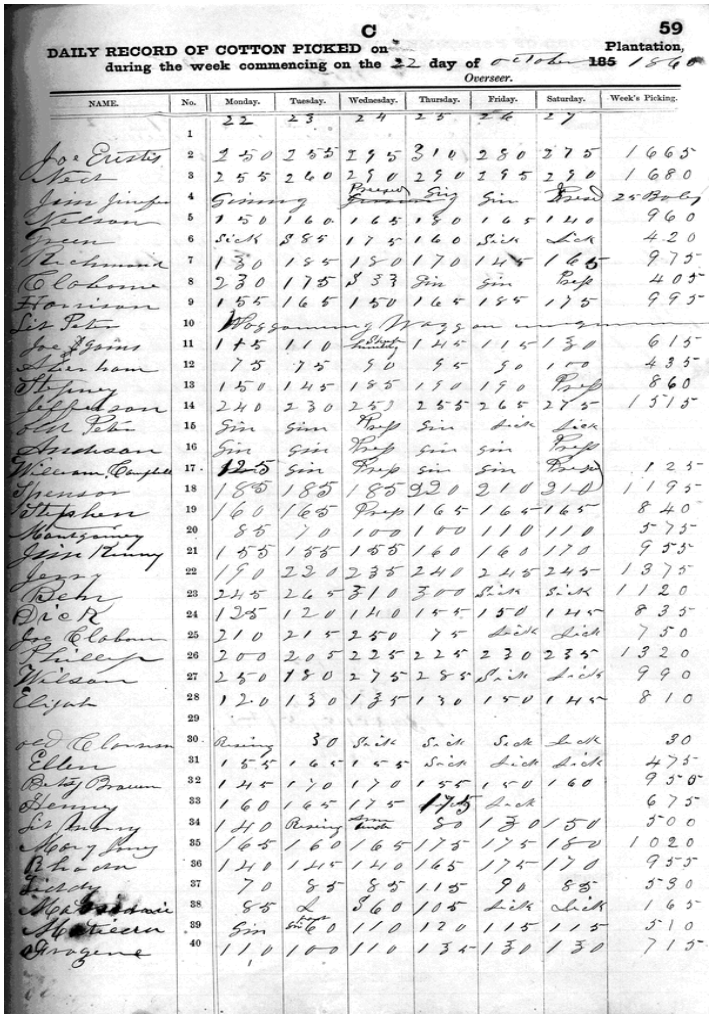
Figure 1: Estimates of age/gender conversion ratios into equivalent prime-age males







C

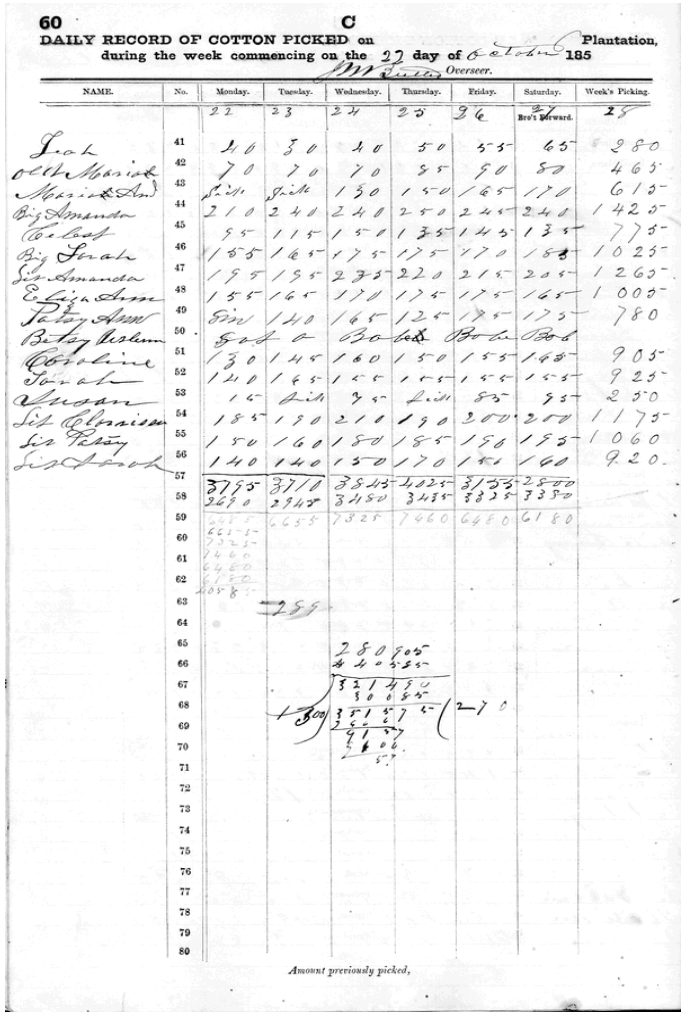
59

DAILY RECORD OF COTTON PICKED on Plantation,

during the week commencing on the 22 day of October 185 1840

Overseer.

NAME.	No.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.	Saturday.	Week's Picking.
		22	23	24	25	26	27	
	1							
Joe Eustis	2	250	255	195	310	280	275	1665
Nace	3	255	260	250	250	295	270	1680
Jim Jim	4	Sinning		Brought Forward	Sin	Sin	Dead	25 Bales
Nelson	5	150	160	165	180	165	140	960
Jem	6	Sick	285	175	160	Sick	Sick	420
Richmond	7	130	185	150	170	145	165	975
Colborne	8	230	175	833	Sin	Sin	Prop	405
Harrison	9	155	165	150	165	155	175	995
Sir Peter	10							
Joe Jems	11	145	110	Sinning	145	115	130	615
Sheerham	12	75	75	50	55	50	100	435
Stepney	13	150	145	185	150	190	Prop	860
Jefferson	14	240	230	250	255	265	275	1515
Old Peter	15	Sin	Sin	Prop	Sin	Sick	Sick	
Jackson	16	Sin	Sin	Prop	Sin	Sin	Prop	
William Cupid	17	125	Sin	Prop	Sin	Sin	Prop	125
Spenson	18	185	185	185	220	210	210	1195
Stephen	19	160	165	Prop	165	164	165	840
Montgomery	20	85	70	100	100	110	110	575
Jem Penny	21	155	155	155	160	160	170	955
Jemmy	22	190	220	235	240	245	245	1375
Bebe	23	245	265	310	300	Sick	Sick	1120
Dick	24	125	120	140	155	150	145	835
Joe Colborne	25	210	215	250	75	Sick	Sick	750
Phillis	26	200	205	225	225	230	235	1320
Wilson	27	250	180	275	285	Sick	Sick	990
Elijah	28	120	130	135	130	150	145	810
	29							
Old Colborne	30	Resting	30	Sick	Sick	Sick	Sick	30
Ellen	31	155	165	155	Sick	Sick	Sick	475
Betty Braun	32	145	170	170	155	150	160	950
Henny	33	160	165	175	175	Sick		675
Sir Antony	34	140	Resting	Sick	50	130	150	500
Mary Jenny	35	165	160	165	175	175	180	1020
Phoebe	36	140	145	140	165	175	170	950
Lizzy	37	70	85	85	115	90	85	530
Mr Broadie	38	85	L	860	105	Sick	Sick	165
Matteera	39	Sin	Sick 60	110	120	115	115	510
Imogene	40	110	100	110	134	130	130	715



60

C

DAILY RECORD OF COTTON PICKED on Plantation,

during the week commencing on the 27 day of October 185

Overseer.

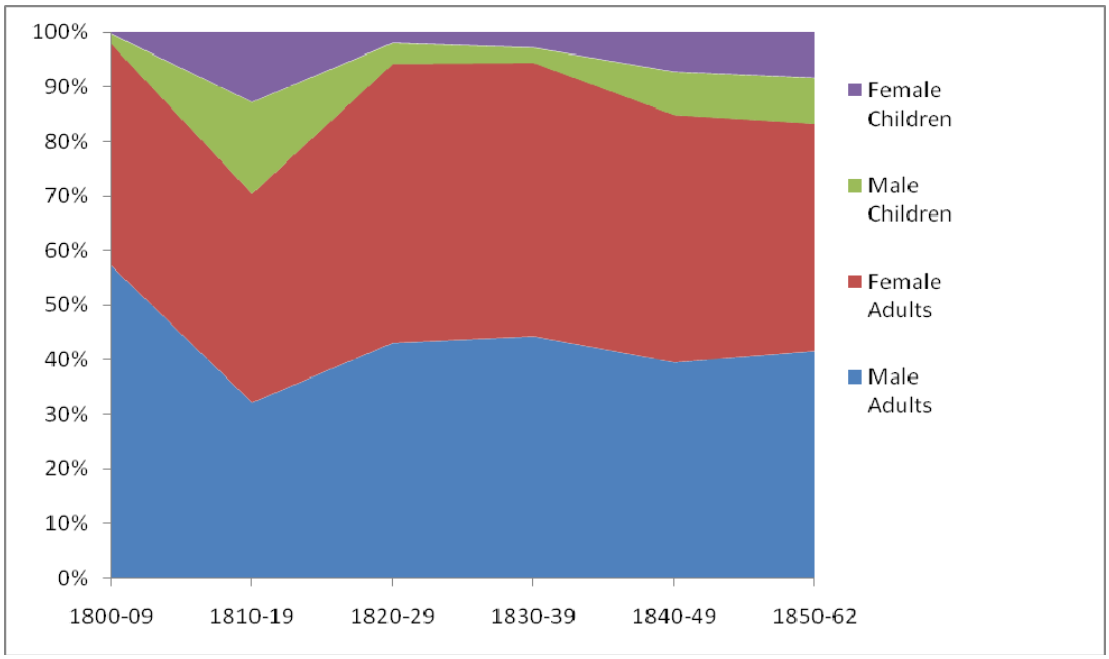
NAME.	No.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.	Saturday.	Week's Picking.
		22	23	24	25	26	27 Bro't Forward.	25
Isaac	41	140	130	140	150	155	165	2880
Old Maria	42	70	70	70	85	90	80	465
Maria & Ann	43	Sick	Sick	130	150	165	170	615
Big Amanda	44	210	240	240	250	245	240	1425
Colcast	45	95	115	150	135	145	135	775
Big Isaac	46	185	165	175	175	170	180	1025
Sir Amanda	47	195	195	235	220	215	205	1265
Eliza Ann	48	155	165	170	175	175	165	1005
Patsy Ann	49	Sin	140	165	125	175	175	780
Betsy Ashem	50	Sick	Boat	Boat	Boat	Boat	Boat	
Caroline	51	130	145	160	150	155	160	905
Isaac	52	140	165	145	145	145	145	925
Susan	53	15	Sick	35	Sick	85	35	250
Sir Clarissa	54	185	190	210	190	200	200	1175
Sir Patsy	55	150	160	180	185	150	155	1060
Sir Isaac	56	140	140	150	170	150	160	920
	57	3795	3710	3845	4025	3755	2500	
	58	2670	2945	3480	3435	3825	3350	
	59	6465	6655	7325	7460	6580	6180	
	60	6465	7325	7460	6580	6180		
	61	7325	7460	6580	6180			
	62	7460	6580	6180				
	63	6580	6180					
	64	6180						
	65			280	905			
	66			405	555			
	67			3215	4560			
	68			3015	55			
	69			3515	57			
	70			2500				
	71			91	57			
	72			5406				
	73			57				
	74							
	75							
	76							
	77							
	78							
	79							
	80							

Amount previously picked,

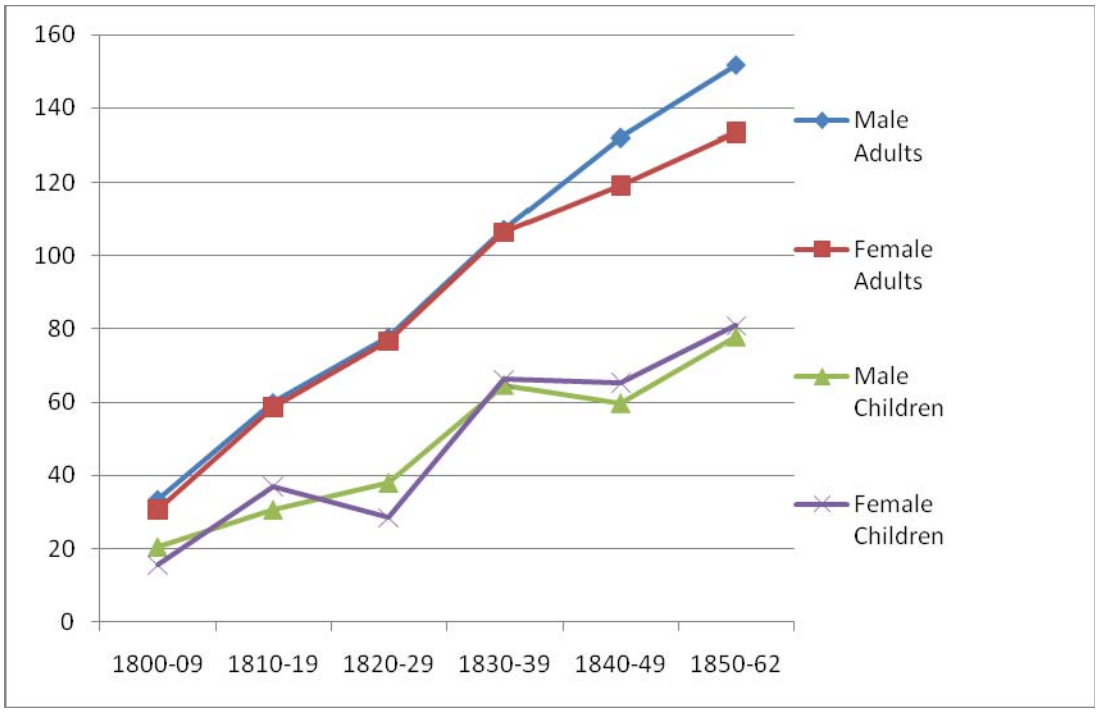
Figure 2: Record from Eustatia Cotton Book

Figure 3:

Panel A: Percent of Total Days Picking Cotton by Age and Gender, 1800-62



Panel B: Cotton Picked Per Day by Age and Gender, 1800-62



Panel C: Percent of Total Cotton Picked by Age and Gender, 1800-62

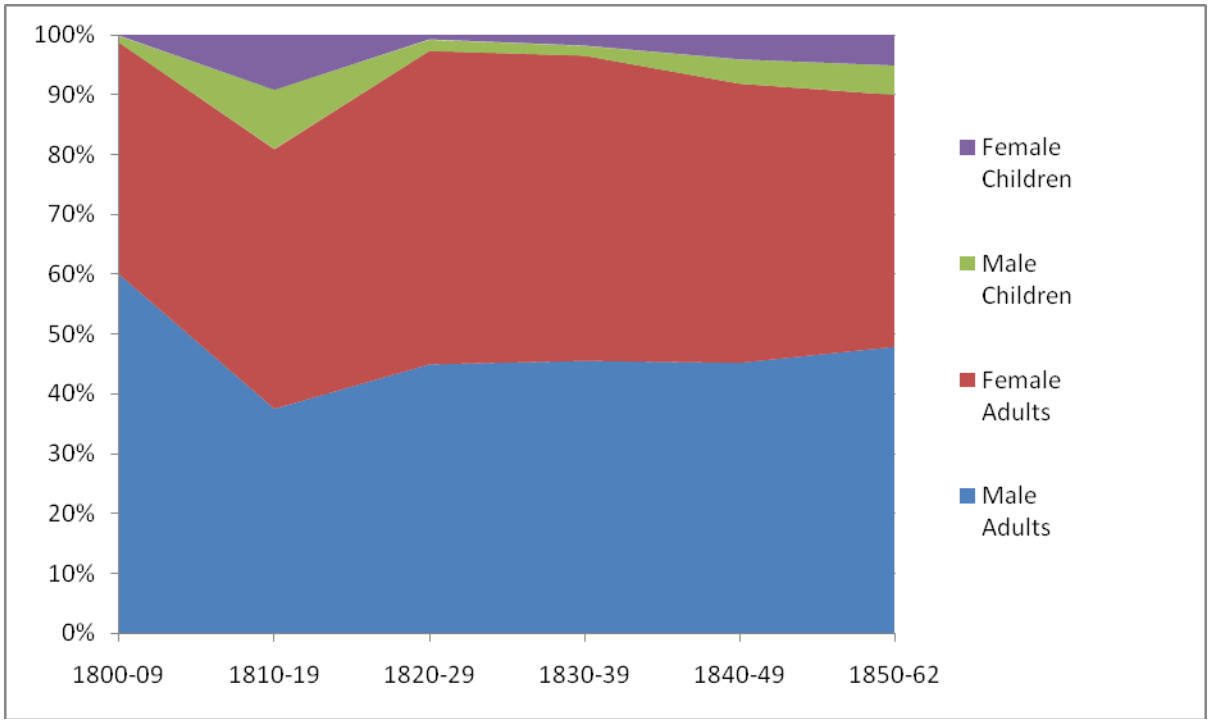
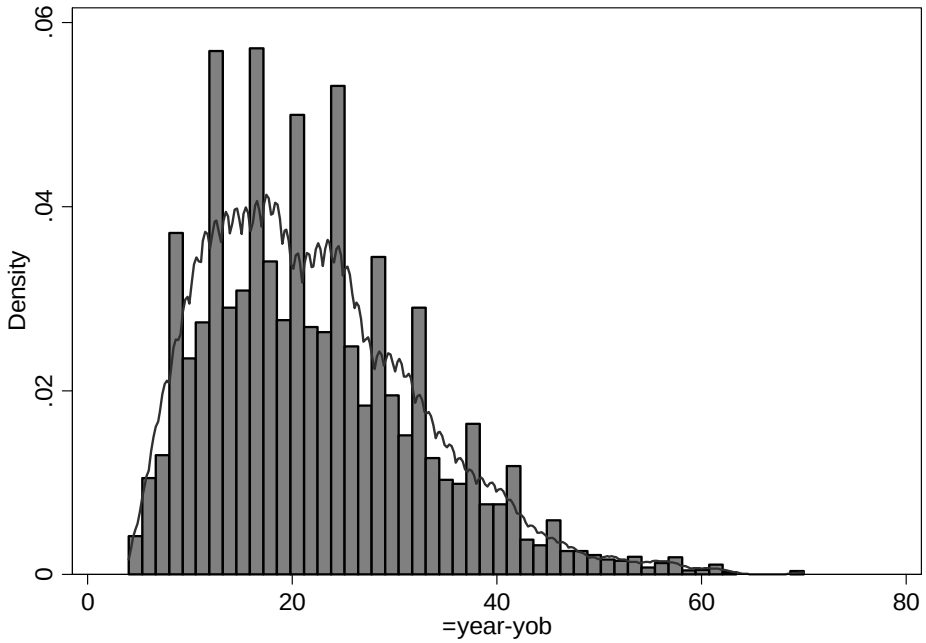


Figure 4: Picking-Age Histograms for 1840-62 observations

Females:



Males:

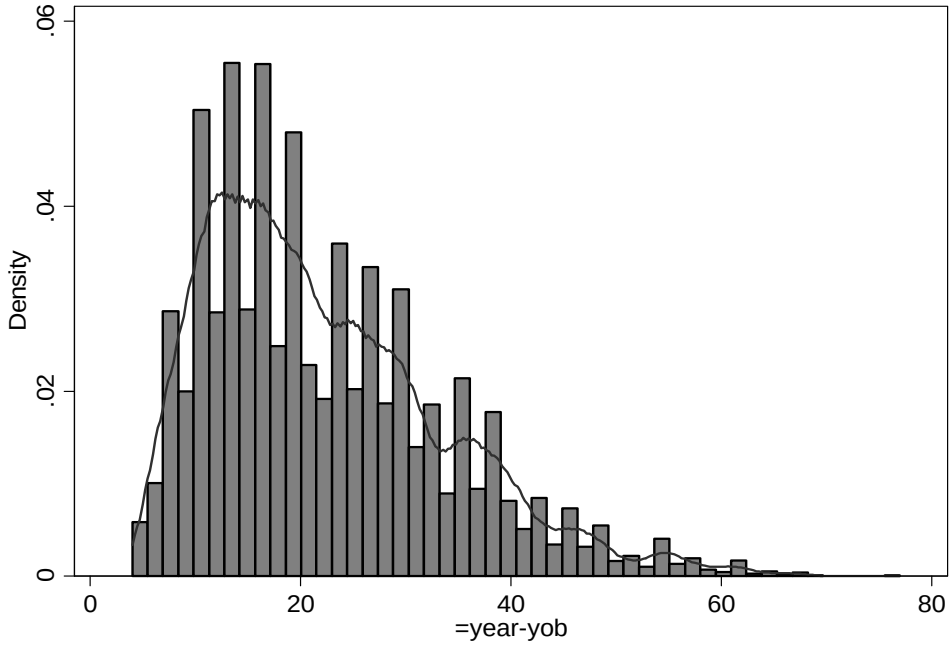
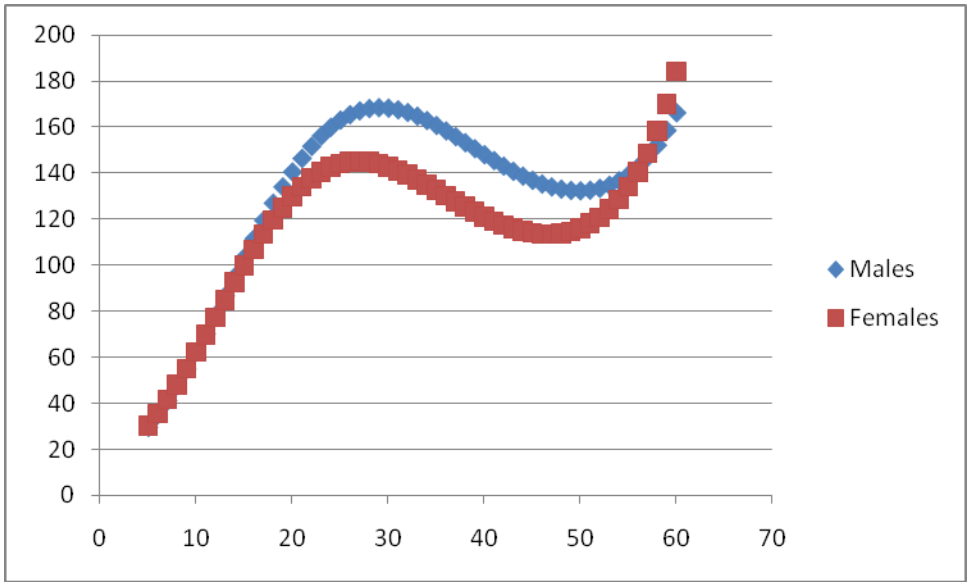


Figure 5: Age-Gender Profiles of Picking Rates

Panel A: Cubit-Fit



Panel B: Lowess Fit

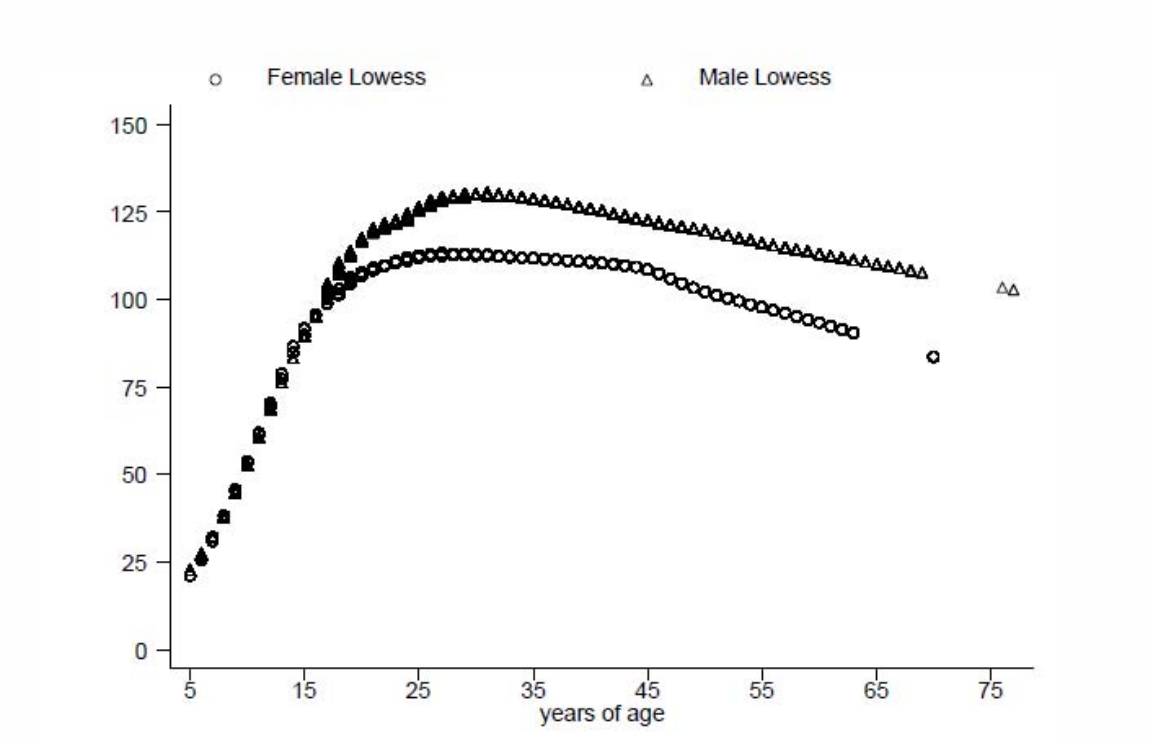
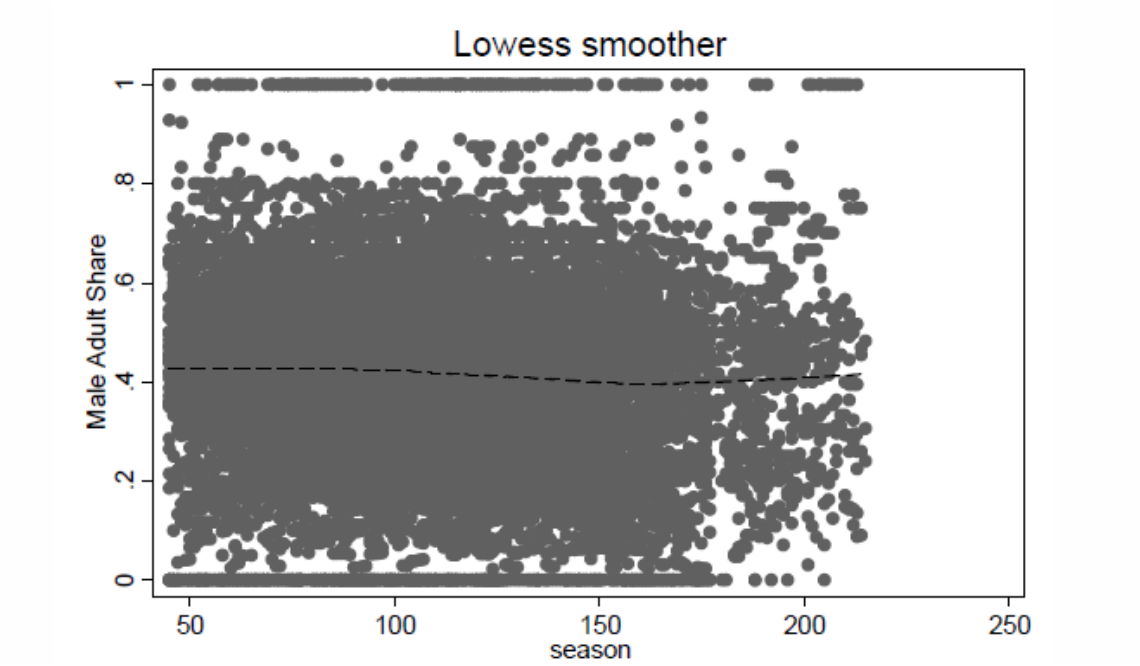


Figure 6: Male Share of Picking Days by Season (July 1= Day 1)



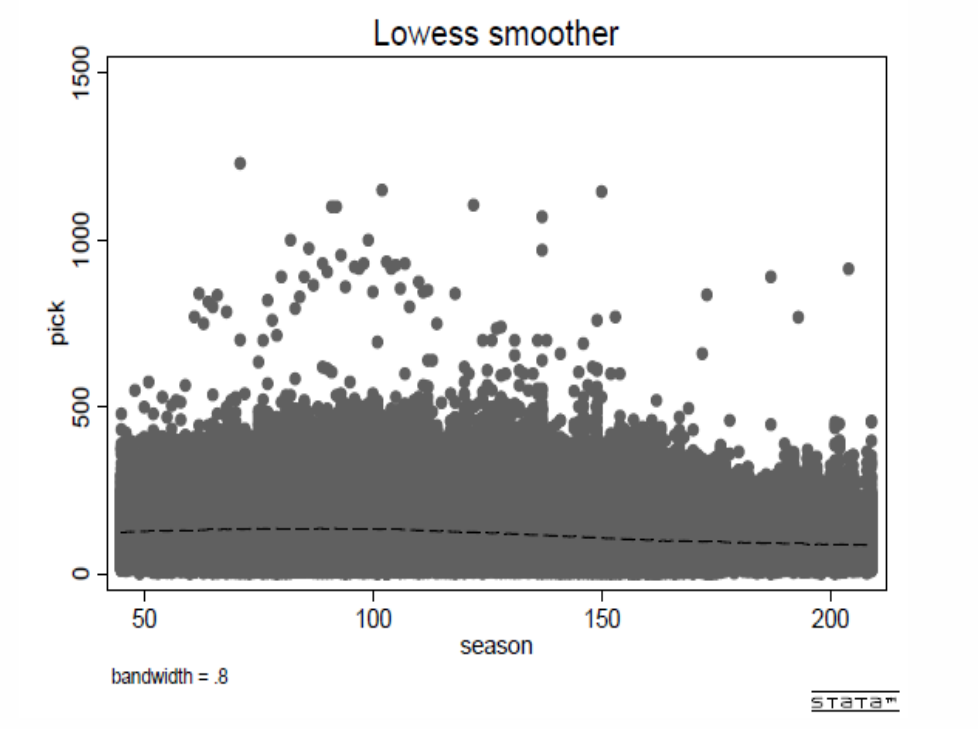


Table 1: Selected Statistics of Sample Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Daily Pick	602219	122.1779	70.05283	1	1230
Log of Pick	602219	4.618243	0.665698	0	7.114769
Female_Adult	602221	0.433656	0.495579	0	1
Female_Child	602221	0.074787	0.263047	0	1
Male_Adult	602221	0.412216	0.492234	0	1
Male_Child	602221	0.078431	0.268849	0	1
Year	602221	1849.981	10.52784	1801	1862
Crop_year	602221	1849.95	10.52763	1801	1862
New South	602221	0.862187	0.344704	0	1
YOB	242639	1830.587	14.08566	1751	1858
Age	242639	22.26264	10.9601	0	77
Female_Age	242639	11.43329	13.37803	0	70
Monday	602221	0.164785	0.370987	0	1
Tuesday	602221	0.168061	0.373921	0	1
Wednesday	602221	0.169499	0.375193	0	1
Thursday	602221	0.170461	0.376037	0	1
Friday	602221	0.164704	0.370913	0	1
Saturday	602221	0.151493	0.358529	0	1
Sunday	602221	0.018032	0.157291	0	1
Half_day	599711	0.007517	0.086374	0	1
Season	602221	107.798	35.84676	1	253
Pickers_Day	602221	37.32165	18.23961	1	97
Pickers_Year	602221	50.31248	22.38272	4	103

Note: Female_Age is coded as 0 for Males with Ages.

Table 2: Determinants of Daily Picking Rates

	Dependent Variable: Log of Daily Picking Quantity					
Time Period	1840-62	1840-62	1840-62	1840-62	1840-62	1801-39
Region	All	Old	New	Leak	New/Leak	All
Constant	-11.543	-33.141	-14.045	2.776	-10.444	-49.608
	(0.220)	(0.619)	(0.229)	(0.700)	(0.700)	(0.360)
Female Adult	-0.1133	-0.1379	-0.1041	-0.0543	-0.0911	-0.0066
	(0.0017)	(0.0048)	(0.0017)	(0.0053)	(0.0017)	(0.0034)
Female Child	-0.7452	-0.2633	-0.831	-0.8168	-0.6002	-0.5464
	(0.0036)	(0.0104)	(0.0038)	(0.0069)	(0.0043)	(0.0107)
Male Child	-0.799	-0.3545	-0.8814	-0.8783	-0.5819	-0.638
	(0.0037)	(0.0104)	(0.0039)	(0.0039)	(0.0043)	(0.0104)
Tuesday	0.0239	0.0379	0.0134	0.0722	0.0074	0.0002
	(0.0027)	(0.0079)	(0.0028)	(0.0072)	(0.0028)	(0.0056)
Wednesday	0.0397	0.0783	0.0307	0.081	0.0258	0.0085
	(0.0027)	(0.0077)	(0.0028)	(0.0073)	(0.0028)	(0.0057)
Thursday	0.0434	0.0815	0.03447	0.0952	0.0243	-0.0066
	(0.0027)	(0.0077)	(0.0028)	(0.0073)	(0.0028)	(0.0059)
Friday	0.0325	0.0965	0.0189	0.0753	0.0098	0.0167
	(0.0028)	(0.0079)	(0.0028)	(0.0074)	(0.0028)	(0.0057)
Saturday	-0.0184	0.0361	-0.0297	-0.0638	-0.0099	-0.0176
	(0.0029)	(0.0080)	(0.0030)	(0.0077)	(0.0029)	(0.0059)
Half-Day	-0.5438	-0.6054	-0.5246		-0.5939	-0.6382
	(0.0081)	(0.0186)	(0.0086)		(0.0085)	(0.0104)
Season	0.0289	0.0387	0.0307	0.0909	0.0291	0.0243
	(0.0004)	(0.0018)	(0.0004)	(0.0015)	(0.0004)	(0.0012)
Season^2	-2.50E-04	-3.20E-04	-2.58E-04	-7.00E-04	-2.43E-04	-1.69E-04
	(3.3E-06)	(1.6E-05)	(3.4E-06)	(1.21-E05)	(3.51-E06)	(1.1E-05)
Season^3	5.93E-07	7.29E-07	5.97E-07	1.64E-06	5.74E-07	2.42E-07
	(9.14E-09)	(4.55E-08)	(9.27E-09)	(3.01E-08)	(9.52E-09)	(2.9E-08)
Cropyear	0.00834	0.0196	0.0097	-0.0009	0.0078	0.029
	(0.0001)	(0.0003)	(0.0001)	(0.0004)	(0.00013)	(0.0002)
No. of Obs.	519506	78939	440567	81773	358794	80205
R^2	0.228	0.108	0.548	0.357	0.154	0.473
				Half-Day dropped due to collinearity		

Table 3: Determinants of Daily Picking Rates, for Sample with Ages

Dependent Variable: Log of Daily Picking Quantity: Sample with Age Data						
Time Period	1840-62	1840-62	1840-62	1840-62	1840-62	1801-39
Region	All	Old	New	Leak	New/Leak	All
Constant	-38.046	-79.39	-28.547	-1.814	17.212	-47.231
	(0.407)	(0.974)	(0.434)	(0.709)	(0.517)	(1.009)
Female Adult	-0.1082	-0.1424	-0.105	-0.0447	-0.0873	0.0693
	(0.0026)	(0.0080)	(0.0028)	(0.0054)	(0.0031)	(0.0112)
Female Child	-0.7125	-0.3351	-0.7616	-0.8254	-0.488	-0.0953
	(0.0044)	(0.0112)	(0.0047)	(0.0069)	(0.0057)	(0.0167)
Male Child	-0.7446	-0.375	-0.8029	-0.877	-0.461	-0.0966
	(0.0044)	(0.0104)	(0.0047)	(0.0069)	(0.0054)	(0.0275)
Tuesday	0.0262	0.0262	0.0285	0.0758	0.0088	0.0213
	(0.0042)	(0.0120)	(0.0044)	(0.0074)	(0.0049)	(0.0173)
Wednesday	0.052	0.0464	0.0531	0.0867	0.0396	0.0233
	(0.0042)	(0.0117)	(0.0044)	(0.0074)	(0.0049)	(0.0170)
Thursday	0.0539	0.0547	0.0528	0.1007	-0.0066	-0.0093
	(0.0042)	(0.0116)	(0.0044)	(0.0074)	(0.0049)	(0.0175)
Friday	0.0364	0.1102	0.0277	0.078	0.0167	0.0349
	(0.0042)	(0.0117)	(0.0044)	(0.0075)	(0.0050)	(0.0169)
Saturday	-0.0447	0.0538	-0.0559	-0.0693	-0.0176	-0.0393
	(0.0042)	(0.0120)	(0.0048)	(0.0079)	(0.0051)	(0.0181)
Half-Day	-0.6187	-0.09455	-0.5554		-0.7039	-0.8332
	(0.0131)	(0.0227)	(0.0154)		(0.0149)	(0.1180)
Season	0.0449	0.0713	0.0429	0.093	0.041	0.0717
	(0.0006)	(0.0032)	(0.0007)	(0.0016)	(0.00071)	(0.0041)
Season^2	-3.77E-04	-5.90E-04	-3.64E-04	-7.22E-04	-3.40E-04	-4.82E-04
	(5.4E-06)	(2.8E-05)	(5.5E-06)	(1.3E-05)	(6.12E-06)	(3.3E-05)
Season^3	8.91E-07	1.46E-06	8.65E-07	1.68E-06	8.32E-07	9.40E-07
	(1.4E-08)	(8.0E-08)	(1.4E-08)	(3.11E-08)	(1.7E-08)	(8.6E-08)
Cropyear	0.022	0.044	0.0172	0.0014	0.0112	0.027
	(0.0002)	(0.0005)	(0.0002)	(0.0003)	(0.00028)	(0.0006)
No. of Obs.	234206	26615	207591	77205	130386	7640
R^2	0.31	0.272	0.324	0.371	0.169	0.416
				Half-Day dropped due to collinearity		

Table 4: Determinants of Daily Picking Rates, with Age-Gender Profile for Sample with Ages

Dependent Variable: Log of Daily Picking Quantity: Sample with Age Data						
Time Period	1840-62	1840-62	1840-62	1840-62	1840-62	1801-39
Region	All	Old	New	Leak	New/Leak	All
Constant	-36.07	-83.52	-26.67	3.448	-20.481	-43.98
	(0.378)	(1.021)	(0.402)	(0.949)	(0.514)	(1.094)
Age	0.2354	0.0969	0.2477	0.2702	0.1442	0.0546
	(0.0022)	(0.0049)	(0.0025)	(0.0151)	(0.0029)	(0.0089)
Age^2	-0.0064	-0.0023	-0.0069	-0.0081	-0.00388	-0.0011
	(0.0001)	(0.00016)	(0.00009)	(0.0076)	(0.0001)	(0.0003)
Age^3	0.000054	0.000015	0.000058	0.000078	0.00003	3.44E-06
	(8.9E-07)	(1.6E-06)	(1.1E-06)	(0.00001)	(0.000001)	(2.9E-06)
Female	0.0082	0.5146	0.0347	0.0755	-0.2415	-0.2614
	(0.0222)	(0.0675)	(0.0237)	(0.0833)	(0.0341)	(0.1214)
Female Age	0.0042	-0.0748	0.0022	-0.00086	0.02646	0.06091
	(0.0028)	(0.0080)	(0.0030)	(0.00077)	(0.00383)	(0.0149)
Female Age^2	-0.00062	0.00246	-0.00052	-0.000008	-0.00119	-0.0029
	(0.0001)	(0.0003)	(0.0001)	(0.00077)	(0.00013)	(0.0006)
Female Age^3	0.0000096	-0.000023	0.00000785	-0.000006	0.000014	0.000034
	(1.1E-06)	(2.9E-06)	(1.3E-06)	(0.00001)	(1.3E-06)	(6.7E-06)
Tuesday	0.0272	0.0281	0.0296	0.0778	0.0089	0.0224
	(0.004)	(0.0119)	(0.0041)	(0.0064)	(0.0049)	(0.0169)
Wednesday	0.0522	0.0482	0.0532	0.0861	0.0402	0.0256
	(0.0039)	(0.0116)	(0.0041)	(0.0065)	(0.0048)	(0.0164)
Thursday	0.053	0.0561	0.052	0.0991	0.0266	-0.0062
	(0.0039)	(0.0115)	(0.0041)	(0.0065)	(0.0048)	(0.0170)
Friday	0.0363	0.1122	0.0277	0.0783	-0.0032	0.03811
	(0.004)	(0.0117)	(0.0042)	(0.0066)	(0.0049)	(0.0167)
Saturday	-0.0438	0.0553	-0.0543	-0.0689	-0.0312	-0.0364
	(0.0042)	(0.0119)	(0.0044)	(0.0077)	(0.0050)	(0.0176)
Half-Day	-0.6456	-0.9411	-0.5934		-0.7094	-0.8039
	(0.0129)	(0.0226)	(0.0150)		(0.0147)	(0.1248)
Season	0.0462	0.0714	0.0443	0.096	0.0417	0.0686
	(0.00062)	(0.0032)	(0.00063)	(0.0014)	(0.0007)	(0.0040)
Season^2	-3.80E-04	-5.90E-04	-3.70E-04	-7.40E-04	-3.50E-04	-4.80E-04
	(5.2E-06)	(2.8E-05)	(5.3E-06)	(1.12-E05)	(6.1-E06)	(3.3E-05)
Season^3	8.99E-07	1.46E-06	8.71E-07	1.70E-06	8.47E-07	9.29E-07
	(1.4E-08)	(7.9E-08)	(1.4E-08)	(2.8E-08)	(1.64E-08)	(8.4E-08)

Cropyear	0.0198	0.0456	0.0148	-0.0029	0.0078	0.0245
	(0.0002)	(0.0005)	(0.0002)	(0.0005)	(0.00013)	(0.0006)
No. of Obs.	234206	26615	207591	77205	130386	7640
R^2	0.39	0.282	0.412	0.511	0.154	0.0453
				Half-Day dropped due to collinearity		

Table 5: Determinants of Daily Picking Rates, with Breakdowns by Size of Picking Labor Force

	Dependent Variable: Log of Daily Picking Quantity: Sample with Age Data					
Size	All	Small (1-10)	Medium (11-50)	Large (51+)	All	All
Time Period	1840-62	1840-62	1840-62	1840-62	1840-62	1840-62
Region	All	All	All	All	All	All
Constant	-11.543	33.226	6.3678	-26.292	-10.584	-10.634
	(0.220)	(3.702)	(0.3319)	(0.2859)	(0.2186)	(0.2154)
Female Adult	-0.1133	0.3193	-0.1249	-0.1135	-0.1164	-0.1121
	(0.0017)	(0.0250)	(0.0023)	(0.00227)	(0.00164)	(0.00162)
Female Child	-0.7452	-0.1064	-0.5503	-0.9241	-0.7581	-0.7591
	(0.0036)	(0.404)	(0.0051)	(0.0049)	(0.00367)	(0.00367)
Male Child	-0.799	-0.1862	-0.6249	-0.9636	-0.8124	-0.8124
	(0.0037)	(0.0326)	(0.0054)	(0.0049)	(0.00373)	(0.00372)
Tuesday	0.0239	-0.057	0.0258	0.0199	0.0228	0.0219
	(0.0027)	(0.0348)	(0.0038)	(0.0038)	(0.0027)	(0.0027)
Wednesday	0.0397	0.00329	0.0462	0.0334	0.04004	0.04004
	(0.0027)	(0.0361)	(0.0038)	(0.0038)	(0.0027)	(0.0027)
Thursday	0.0434	-0.0273	0.0465	0.0426	0.04404	0.044
	(0.0027)	(0.0347)	(0.0038)	(0.0037)	(0.0027)	(0.0027)
Friday	0.0325	0.0146	0.0338	0.0304	0.03296	0.03387
	(0.0028)	(0.00358)	(0.0038)	(0.0038)	(0.0027)	(0.0027)
Saturday	-0.0184	-0.0987	0.00387	-0.0375	-0.0176	-0.0134
	(0.0029)	(0.00392)	(0.0039)	(0.0040)	(0.0029)	(0.0028)
Half-Day	-0.5438	-0.139	-0.6132	-0.4036	-0.5247	-0.5147
	(0.0081)	(0.1173)	(0.0100)	(0.0121)	(0.00782)	(0.00774)
Season	0.0289	0.03514	0.02131	0.04177	0.0282	0.02604
	(0.0004)	(0.0091)	(0.00056)	(0.00054)	(0.00039)	(0.00039)
Season^2	-2.50E-04	-1.98E-04	-2.04E-04	-3.43E-04	-2.43E-04	-2.26E-04
	(3.3E-06)	(7.7E-05)	(5.0E-06)	(4.6E-06)	(3.4E-06)	(3.4E-06)
Season^3	5.93E-07	2.70E-07	5.29E-07	7.87E-07	5.71E-07	5.71E-07
	(9.14E-09)	(2.0E-07)	(1.38E-08)	(1.2E-08)	(9.2E-09)	(9.1E-09)
Cropyear	0.00834	-0.0165	-0.00119	0.01609	0.00751	0.00753
	(0.0001)	(0.0020)	(0.00018)	(0.00015)	(0.00012)	(0.00012)
L_pickers_cropyear					0.1628	
					(0.0017)	
L_pickers_day						0.2028
						(0.0015)
No. of Obs.	519506	2321	252152	265033	519506	519506
R^2	0.228	0.164	0.141	0.34	0.241	0.2028

Table 6: Determinants of Daily Picking Rates with Plantation and Plantation Crop Year Fixed Effects.

	Dependent Variable: Log of Daily Picking Quantity			
Time Period	1840-62	1840-62	1801-39	1801-39
Region	All	All	All	All
Constant	-7.099	3.435	-29.67	3.26
	(0.4023)	(0.0131)	(0.8394)	(0.0442)
	<8.8861>	<0.1609>	<9.214>	<0.3540>
Female Adult	-0.08104	-0.08156	-0.00341	0.00588
	(0.00146)	(0.00133)	(0.00316)	(0.0092)
	<0.01586>	<0.00856>	<0.02696>	<0.0179>
Female Child	-0.6194	-0.6024	-0.5489	-0.5546
	(0.0032)	(0.0030)	(0.0094)	(0.0094)
	<0.0727>	<0.0256>	<0.0923>	<0.0534>
Male Child	-0.6539	-0.6405	-0.5671	-0.5604
	(0.0032)	(0.0031)	(0.0100)	(0.0095)
	<0.0907>	<0.0284>	<0.0539>	<0.0503>
Tuesday	0.0313	0.0283	0.0028	0.0014
	(0.0023)	(0.0022)	(0.0052)	(0.0050)
	<0.0080>	<0.0063>	<0.0090>	<0.0086>
Wednesday	0.0442	0.0412	0.017	0.0161
	(0.0022)	(0.0021)	(0.0053)	(0.0051)
	<0.0077>	<0.0071>	<0.01300>	<0.028>
Thursday	0.0497	0.0454	0.001	0.0006
	(0.0022)	(0.0021)	(0.0054)	(0.0051)
	<0.0088>	<0.0073>	<0.01509>	<0.01137>
Friday	0.0391	0.0368	0.0198	0.0194
	(0.0023)	(0.0022)	(0.0052)	(0.0050)
	<0.0087>	<0.0072>	<0.0110>	<0.0114>
Saturday	-0.0032	-0.0053	-0.0156	-0.0153
	(0.0024)	(0.0034)	(0.0054)	(0.0052)
	<0.01312>	<0.00089>	<0.01337>	<0.0145>
Half-Day	-0.578	0.5824	-0.621	-0.6092
	(0.0070)	(0.0068)	(0.0428)	(0.0467)
	<0.0280>	<0.0262>	<0.0721>	<0.1082>
Season	0.0364	0.0394	0.027	0.0311
	(0.00035)	(0.00036)	(0.0012)	(0.0012)
	<0.00539>	<0.00437>	<0.00054>	<0.0088>
Season^2	-2.99E-04	-3.23E-04	-1.94E-04	-2.27E-04
	(3.05E-06)	(3.06E-06)	(1.1E-05)	(1.1E-05)
	<4.45E-05>	<3.66E-05>	<4.0E-05>	<7.1E-05>
Season^3	6.94E-07	7.43E-07	3.12E-07	3.93E-07

	(8.25E-09)	(8.25E-09)	(3.03E-08)	(3.0E-08)
	<1.13E-07>	<9.51E-08>	<1.13E-07>	<1.82E-07>
Cropyear	0.00574		0.0181	
	(0.00022)		(0.00046)	
	<0.00048>		<0.0051>	
No. of Obs.	519506	519506	80205	80205
R^2	0.0476	0.5208	0.522	0.5617
Fixed Effects				
Plantation	X		X	
Pl Crop year		X		X
Plantation	93		26	
Pl Crop year		3.16E+02		78

Table 7: Using Plantation-Day Fixed Effects to Control for Allocation Issues, Broad Age-Gender Categories

Time Period	1840-62	1840-62	1840-62	1840-62	1840-62	1801-39	1801-39	1801-39
Region	All	Old	New	Leak	New/Leak	All	Old	New
Constant	4.793	4.496	4.846	4.51	4.929	4.349	3.629	4.387
	(0.00078)	(0.00190)	(0.00085)	(0.00347)	-0.0008	(0.00181)	(0.0081)	(0.00185)
	<0.00594>	<0.01003>	<0.00646>			<0.0108>	<0.0244>	<0.011>
Female Adult	-0.0673	-0.0132	-0.0774	-0.0599	-0.0853	0.017	-0.0897	0.0226
	(0.00103)	(0.00258)	(0.00113)	(0.0041)	(0.0011)	(0.00248)	(0.0111)	(0.00254)
	<0.00864>	<0.0193>	<0.00946>			<0.01886>	<0.0485>	<0.01937>
Female Child	-0.5804	-0.4287	-0.6083	-0.7729	-0.5117	-0.5328	0.6483	-0.529
	(0.00253)	(0.00594)	(0.00279)	(0.0055)	(0.0031)	(0.00733)	(0.0391)	(0.00743)
	<0.0262>	<0.0416>	<0.0280>			<0.0518>	<0.0645>	<0.0531>
Male Child	-0.6263	-0.4802	-0.6552	-0.8461	-0.509	-0.5401	-0.449	-0.5426
	(0.00265)	(0.00552)	(0.00297)	(0.0055)	(0.0034)	(0.0078)	(0.0424)	(0.0079)
	<0.0281>	<0.0432>	<0.0302>			<0.0561>	<0.1323>	<0.0579>
Plantation Day Controls								
R^2	0.72	0.755	0.692	0.614	0.643	.0.734	0.643	0.716
No. of Obs.	522014	78939	443075	81773	361302	80205	4055	76150
Plantation Dates	17910	3569	14341	1838	12503	4350	484	3866
Clusters	318	74	244			78	14	64

Table 8: Using Plantation-Day Fixed Effects to Control for Allocation Issues, Age-Gender Profiles

Time Period	1840-62	1840-62	1840-62	1840-62	1840-62	1801-39
Region	All	Old	New	Leak	New/Leak	All
Constant	2.596	3.424	2.498	1.7809	3.401	3.149
	(0.0151)	(0.0264)	(0.0174)	(0.0923)	(0.02741)	(0.0776)
	<0.1103>	<0.0848>	<0.1188>		<0.1963>	<0.1630>
Age	0.2054	0.148	0.2136	0.2712	0.1398	0.08216
	(0.00184)	(0.0030)	(0.00229)	(0.0173)	(0.0031)	(0.00834)
	<0.0124>	<0.0094>	<0.01391>		<0.0215>	<0.0198>
Age^2	-0.00568	-0.0041	-0.0059	-0.0083	-0.00382	-0.00216
	(0.00007)	(0.0001)	(0.00008)	(0.00087)	(0.0001)	(0.00027)
	<0.0004>	<0.00031>	<0.00047>		<0.0007>	<0.00077>
Age^3	0.000047	0.000032	0.000051	0.000081	0.000031	0.000017
	(0.0000007)	(0.000001)	(0.0000001)	(0.000012)	(0.00001)	(0.0000027)
	<0.000004>	<0.000003>	<0.000004>		<0.000007>	<0.0000085>
Female	-0.0487	0.591	-0.04871	0.1641	-0.3066	0.04514
	(0.1733)	(0.0441)	(0.0194)	(0.0943)	(0.0319)	(0.1003)
	<0.1083>	<0.2186>	<0.0148>		<0.2221>	<0.2261>
Female Age	0.0138	-0.073	0.0137	-0.01543	0.0349	0.00328
	(0.0021)	(0.0053)	(0.00246)	(0.01757)	(0.0035)	(0.00246)
	<0.0132>	<0.2186>	<0.0147>		<0.0244>	<0.0294>
Female Age^2	-0.000864	0.00223	-0.00081	0.000663	-0.00141	-0.00044
	(0.000008)	(0.0052)	(0.00009)	(0.00088)	(0.00012)	(0.00009)
	<0.00046>	<0.00085>	<0.00052>		<0.00079>	<0.00117>
Female Age^3	0.000011	-0.00002	0.00001	-0.000014	0.000016	0.000007
	(0.0000008)	(0.0000019)	(0.000001)	(0.000012)	(0.000137)	(0.0000049)
	<0.000005>	<0.0000087>	<0.0000055>		<0.0000077>	<0.000014>
Plantation Date Control						
R^2	0.769	0.788	0.766	0.772	0.676	0.774
No. of Obs.	234997	26615	208382	77205	131177	7460
Plantation Dates	9627	1058	8569	1837	6732	782
Clusters	163	23	140		118	17

Table 9: Earle's Estimates of Picking Capacity Constraints

	Yield	Picking Days		Picking Capacity	
	Per Acre	Short	Normal	Short	Normal
High-yield areas	1000 lb	70	92	14ac	18.4ac
Medium-yield areas	500	63	84	25.2	33.6
Low-yield areas	300	71	91	47.33	60.67

Source: Earle (1992), p. 35.