Slave Productivity in Cotton Picking

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Social scientists have devoted considerable effort to measuring and analyzing gender and age productivity differentials. This paper adds to this broad literature by offering a fresh look at the gender productivity gap in antebellum cotton production. We use a vast new data set to provide direct physical measures by gender and age of productivity in cotton picking—the largest user of labor and the critical peak activity of a cotton plantation's production cycle. The goal is to provide a better understanding of the day-to-day regiment of enslaved African-Americans and of the performance of antebellum plantations. It has long been known that slave owners made intensive use of female and child labor. Indeed, Gavin Wright (2006, p. 112) argued that the planters' ability to direct female labor into cotton production was crucial to the economic success of southern plantations. Gender/age productivity differentials also had important ramifications off the plantation, affecting the allocation of the labor force across sectors. Claudia Goldin and Kenneth Sokoloff (1982, 1984) emphasized that early manufacturing used the labor of women and children intensively and that the ratio of female-to-male productivity was much higher in cotton production than in grain production. This relatively narrow female-to-male productivity gap (as measured by slave "earnings" profiles) delayed industrialization in the Cotton South compared with the northeastern United States.

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 2008abc, 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, and had significant distributional effects across regions by increasing productivity in the New South relative to the Old South (Olmstead and Rhode 2008ab, 2010). Here we explore the possibility that the new technologies also had distributional effects altering the relative productivity of different segments of the slave labor force. For example, did the new varieties 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. The gender differentials in picking rates widened over the antebellum period: in the 1801-39 period, these differences were essentially nil, but over the 1840-62 period, adult females picked from 7-11 percent less cotton per day than adult males. Compared with gender gap estimates in other activities, the picking differentials are relatively stable over time and space. During the slave era, cotton picking was an unusual farm activity because females participated as fully as 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 and to rethink the dynamics of slave-plantation efficiency.

Worker-to-Hand and Marginal Product Comparisons

The literature offers a wide range of ratios to convert workers in various gender/age categories into prime-age male (or "full hands") equivalents. As Wright (2006, p. 106) has emphasized, the main findings of the cliometrics literature regarding the efficiency of larger plantations relative to smaller units rest critically on assumptions on the relative importance of female slave labor. The conversion ratio also has important consequences for our understanding of the lives of the people who toiled daily on southern plantations.[1]

[1] Wright (2006) highlights the importance of the labor weights for the empirical outcome of the productivity analysis standard in the cliometrics literature. He 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."

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 their 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, estimating the relative productivity of slaves by age and gender became something of a cottage industry. 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] In these series the productivity of adult females ranges between 43 to 80 percent of that of 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 in cotton production 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 North and South. For the South, they use estimated "earnings" in the Old South in 1850

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[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.

for adult slaves (aged 15-29 years) and for boys (aged 10-14).[4] The "earnings" ratio of slave women relative to men ranged between 0.57 and 0.76 and that of boys relative to men ranged between 0.25 and 0.43. These ratios were roughly double the earnings ratio in the rural North. Goldin and Sokoloff 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 hypothesis, Craig and Field-Hendrey (1993) estimate the marginal product of farm workers by age and gender in 1860 using the 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 free farmers in the North. The gap is very small and of the wrong sign to support the gender-gap industrialization hypothesis. Toman (2005) also provides marginal product estimates of labor in cotton plantations in 1860. Her results indicate that the 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 and 60 percent on large units. Using narrow age/gender categories, she finds that the marginal product of adult females relative to adult males was 32 percent on small units, but jumped to 75 percent on large units. Teenagers of both genders also had higher productivity relative to adult males on large plantations than on small units.[6]

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[4] These are based on Figures 19 and 22 found in Fogel and Engerman, (1974, Vol. I, pp. 76 and 82) 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.

[5] Goldin and Sokoloff (1984, p. 473); Metzer (1975). Continuing this line of inquiry, Sokoloff and Tchakerian (1997, p. 243) find that the South's low levels of manufacturing value added per capita in 1860 was "largely attributable to very low levels of outputs in counties specialized in cotton production." Female-intensive industries, such as textiles and boots-and-shoes, were especially uncommon in cotton producing areas (pp. 250, 254). Other avenues of economic development were also affected. Sokoloff and Dollar (1997) argue that proto-industrialization was more prevalent in places with highly uneven seasonal demands for labor-- high harvest peaks and long periods of slack employment. In the era before mechanization, sharp swings in labor demand would characterize the production of small grains but not of cotton. Our examination of the antebellum plantation records suggests home production-- for example the spinning of yarn and weaving of cloth--was less common in the times and places were cotton cultivation was most intense. The extended cotton harvest also raised the opportunity cost of attending school.

[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.

Serious concerns remain. Wright (2006, pp. 106-113) shows that marginal product by gender estimates are not robust over space and time. Using the 1859/60 Parker-Gallman sample, he found the marginal product of females relative to males in the Southeast was 73 percent, in line with other research. But in the Southwest, it was 113 percent, favoring females. Using the 1849/50 Foust sample, Wright obtained 127 and 307 in the Southeast and Southwest, respectively, suggesting females were vastly more productive than males. Clearly, after decades of research on the slave economy, the relative productivity of females to males remains highly contested.

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. These data are particularly relevant because as most labor intensive of all cotton production activities and picking represented the binding constraint on cotton plantations (see Appendix). Scholars including Jacob Metzer (1975), John Campbell (1988), Marie Schwartz (2000) have examined picking productivity across age and gender categories for a small number of plantations.[7] They generally find that gender differentials were narrow and, according to Campbell, the gap was closing over time. We investigate relative productivity in a vastly larger sample of plantations over a longer time period.

[7] Metzer analyzed on cotton picking by age and gender on one plantation, specifically the north-central Mississippi holdings of Francis Terry Leak. He 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)." Campbell's (1988) studied eight upland cotton plantations in the Old South. He found in the early 1800s, women picked on average 80 to 90 percent as much per day as men. He reckoned that the introduction of Mexican cotton varieties increased the relative productivity of women (Campbell, 1988, pp. 49-65). Schwartz (2000, p. 136) examined records from the Sturdivant plantation near Selma Alabama.

Assembling a New Data Set

To assess the performance of their workers, many masters kept logs detailing the daily work activity, including the amount of cotton picked, 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 picker performance. 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, beginning in 1847 (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 often provide a detailed sense of the pulse of plantation life, including the days lost to rain, absences due to sickness, and the like. Figure 2 shows an example of a "user friendly" page from the Affleck book of the Eustatia Plantation in Mississippi (http://dbs.ohiohistory.org/africanam/page.cfm?ID=13902). These records detail the picking of nearly 60 slaves throughout the 1860 picking season.

Our sample for the period 1801-1862 includes data from 114 separate plantations and a total of 397 plantation-years, covering 602,219 individual observations of daily cotton picking performed by 5,598 enslaved African-Americans. This sample contains only individual-level observations and excludes the aggregate plantation-level averages that we used in our previous work. 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 daily observations for the years before 1820; 17,370 for the decade of the 1820s; 47,757 for the 1830s; 144,681 for the 1840s; 279,271 for the 1850s; and 98,062 for the early 1860s.

Aggregate Results from the Daily Picking Sample

An examination of the aggregate data from our sample yields several noteworthy findings. 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 staple 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 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.[8] Seen in a different light, the degree of gender segregation of cotton picking was remarkably small. Adult males and females and even young children all picked cotton.

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 with the initial diffusion of Mexican cottons before 1840. But a meaningful gap re-emerged later. Among children, the changes in the gender ratios were more uneven, but as a general pattern girls picked more per day than boys. 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 women and children picked a majority of the cotton crop in every period except 1800-09. Moreover, the gender balance of picking output was virtually even.

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[8] But note the patterns in the earliest 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. For slaves in the sample for whom we have information about their date of birth, we are treating those of age 15 and younger as children.

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 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.

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 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. Our finding of a small gap based on a dataset covering over 600,000 worker days on 114 plantations more or less in line with most anecdotal sources and with Metzer's conclusions drawn from one plantation. The productivity differentials for children are less definitive although girls were often more productive than boys.[9]

Comparing the 1840-62 and 1801-39 estimates indicates the gap between adult female and adult male picking rates was even smaller in the early years. Indeed, the gender gap for 1801-39, taken as a single period, 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. This finding is particularly relevant to the Goldin-Sokoloff argument because early manufacturing took root in this formative era. Our finding that the gap widened after 1840 are contrary to Campbell's conjecture that the spread of Mexican varieties increased the relative productivity of women. The growth in the height of the cotton plants ("high cotton") along with heavier picking loads may have given an advantage to males. But

[9] 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.

again, one should not lose sight of the main result: the gender differentials remained small while the productivity of both groups soared.

The day-of-the-week effects are not what we expected. Mondays are the omitted category; so all results are relative to that day.[10] 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 given that slaves generally did not pick for their masters on Sundays. 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 assignment of weekly quotas.

The results regarding 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—this is longer than sometimes asserted. The 1840-62 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 the 1840-62 period differed only by one day.[11] Figure 4 shows the typical seasonal pattern (using an adult male in 1850 as the reference worker).

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

[10] 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. The days-of-the-week effects are to the inclusion of individual fixed effects (results not shown).

[11] Note this discussion refers to picking on picking days allowing for interruptions (rainy days, Sundays, and other non-picking days) during the picking season.

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 (Olmstead and Rhode 2010).

Table 3 presents results of quantile regressions of the individual picking data over the 1840-62 period. This approach allows us to check the robustness of the findings to outliers and to examine the effects of the independent variables at points of the distribution away from the mean. The Table reports results for the determinants of the conditional median for the whole sample and for the Old and New South separately. It also presents results for the 10, 25, 75, and 90 percentiles for the whole sample. Focusing on adult females, the coefficients for the whole sample and the sub-regions for the conditional medians conform to those reported above for the conditional means. Furthermore, in the sample as a whole, the adult female coefficients are remarkably stable across the 10-90 percentile range.

Figure 5 displays the distributions of picking rates for adult females and males over the 1840-62 period. (These distributions are truncated at 400 pounds for the sake of clarity of presentation.) Two points stand out. First, there is considerable overlap between the two densities. They both have a mode at 100 pounds per day. Second, round numbers such as 100, 200, and 300 pounds have higher masses, suggesting the presence of targets or possibly quotas.

We are able to assign the pickers' age for about 45 percent of our daily picking observations. For this group, the plantation records include family registers, ages, and sales receipts allowing us to infer the slave's year of birth. 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 6 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. (Given the size of the total sample, a small share still contains a large number of observations.)

Table 4 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.[12]

Table 4 utilizes 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. Figure 7, Panel A, which traces the implied profiles for males and females from age 5 to 60 from the entire sample over the 1840-62 period, offers simpler way to visualize the importance of age and gender effects. The picking rates for females slightly exceed those for males up to age 10. For both genders, 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 pick about 25 pounds per day more than females. Again, our take-home message is that the productivity gender gap in cotton picking was very small.

Given the fit of the cubic functional 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

[12] 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.

younger ages. Employing the more flexible functional specification allowed by the Lowess locally-weighted regression helps us address this concern (see Figure 7, Panel B). The 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 day whereas the male peak occurs at age 31 at about 130 pounds. The gap between adult males and females was typically in the 12-17 pound range. The Lowess profiles for adults are flatter than those implied by the cubic specification. This observation suggests that small differences in the age composition among the adult labor force will not create great distortions, and we can thus use our broader adult categories without introducing significant biases.

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? For understanding antebellum cotton production, it is clearly the larger operators that matter most.[13] 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 (2005).

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.[14] 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 coefficients are positive, significant, and in the range around 0.15 and 0.20. The coefficient is higher for the (log of the) daily number of pickers; this finding is consistent with the notion that more workers will be allocated to picking if there is more cotton in

[13] Based on statistics compiled from the 1860 Parker-Gallman sample reported in Foust (1975), p. 161, slave-less farms accounted for 4.0 percent of cotton production, those with 1-9 slaves for 9.9 percent, 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.
[14] Fogel (1989), p. 27; Metzer (1975), pp. 123-50; Fogel and Engerman (1974), Vol. I, p. 206.

the field. The findings is not completely transparent because the regressions do control for season, and it is conceivable that adding more workers 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. This implies economies of scale in cotton picking. 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. The regressions reported in Table 7 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.

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 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.[15] As the season progressed, the picked seed cotton that required ginning would build up and the gin workers were called out of the fields. If this occurred during the high picking season, their highest potential picking days are censored from the sample. Given gin workers were typically male, this practice could 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. 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

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[15] 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. He noted 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. Thus according to Metzer, planters understood the principle of comparative advantage.

September 5th; for adult males September 9th. Male labor was also withdrawn in early December at slaughter time. The adult male share is quite stable over the picking season. Again, picking was an operation that was not greatly segregated by gender.

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.[16]

Table 8 presents the results for the major gender/age divisions including plantation-day fixed effects. Table 9 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 was even closer to the male adult productivity than in our results presented earlier. Adding controls for women who are pregnant or likely nursing infants, would probably result in even smaller estimates of the gender gap for women not with child.

On can extend the analysis by linking individuals across seasons. This will allow for the investigation of aging incorporating individual fixed effects. We can also investigate the picking performance of new entrants and the relationship between picking performance and exit. There are many other hypotheses that one can test.

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[16] 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.

The Pushing System

Before concluding, we will use the individual data in the plantation records to comment in Edward Baptist's recent claims in his widely-sold 2014 volume, *The Half Has Never Been Told*. Baptist is a leading contributor to new historical literature on slavery and capitalism. He accepted our estimates that the quantity of cotton picked per slave per day rose significantly over a half century, but rejected our evidence that this change was primarily due to a *succession* of improved cotton varieties. Instead, he argues that masters became ever more efficient torturers, extracting more labor from their chattel under the so-called "pushing system." Baptist (2014, p. 134) makes the direct causal assertion that "Cotton-picking increased because quotas rose."

Baptist (2014, p. 133) writes "on the cotton frontier, each person was given *a unique, individual quota* rather than a limit of work fixed by general custom" [emphasis added].[17] After weighing the cotton picked at the end of the day and recording the individual's total in chalk on a slate, the enslaver (p. 134) "transferred the chalk totals into more lasting ink and paper of a ledger. Then he erased the slate. And then he wrote down new and higher minimums." "On the cotton frontier, however, quotas kept rising (p. 138)." Elsewhere he asserts "picking totals rose continuously" (p. 127); references "dynamically increasing picking quotas" (p. 135); claims there were "the ever-increasing demand made on hands in the field" (p. 166).

According to Baptist (2014, pp. 111-144, esp. 126-28, 134) was this ever evolving "whipping machine" that largely accounted for the growth in picking output per slave—as individuals learned to pick cotton faster and faster. Baptist (p. 130) goes to far as to argue that increases in torture were "the *ultimate cause* of the massive increase in the production of high-quality, cheap cotton: an *absolutely necessary* increase if the Western world was to burst out of the 10,000-year Malthusian cycle of agriculture."

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[17] Baptist (2009, p. 57) is even more explicit: "enslavers *ratcheted up* the demands of the picking 'tasks'" [emphasis added]. He reached this conclusion by stringing together statements by a few ex-slaves that supposedly asserted that as soon as they reached a quota the target was raised. (The most famous of these ex-slaves is Solomon Northup who was immortalized in the 1853 book and 2013 motion picture *Twelve Years a Slave*.) Although Baptist (2014) asserts there were individualized quotas, he also (2014, p. 136) writes "minimums increased for all over time." On p. 149, he elaborates "the pushing system pitted migrants against each other. When picking season came, one person's skill could push up another's quota."

Baptist's claims about the "pushing system" has an important following in the New History of Capitalism (NHC) literature. As an example, Sven Beckert (2014, p. 116) cites Baptist's assertion that "torture … was at the root of the ability of American planters to produce ever more cotton."

The NHC literature has embraced the ratcheting hypothesis apparently unaware of the work by economist on this issue. Economists have extensively studied the quota-setting process—what became known in the twentieth century as the "ratchet effect."[18] Martin Weitzman's classic analysis (1980) found that the agent's (in this case a slave's) optimal level of production does not depend on the prevailing quota. Rather it depends on the current-period reward (punishment) for exceeding (falling short) of the quota, the extent to which the future quota would be adjusted, and the interest rate. In a static deterministic environment, the agent's optimal level of production is constant over time. And in general, the ratcheting of quotas creates a dynamic disincentive that diminishes output in each period. The agent holds back on costly effort that would reduce the prospect of being punished today because working harder today increases the prospect of being punished in every period in the future.[19]

Records detailing cotton picking rates are common; explicit records of quotas are rare. Out of the thousands of plantation books we have examined, we have seen only a handful of plantations where individualized picking tasks were recorded.[20] The Hillyer

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[18] Berliner (1957). See Laffont and Tirole (1994), Ch. 9 for a modern theoretical treatment of these issues; and Indjejikian, Matějka, Schloetzer (2014), pp. 1259-67 for a recent survey.

[19] Weitzman (1980) considers an environment without technical change. The agent's optimal production is independent of the current quota and is constant over time. It depends on long-run incentive parameters—the rewards (punishments) for exceeding (falling short) of the quotas, the extent of adjustment of future quotas, and the interest rate. The bonus/penalty applies on either side of the quota and the future quota can be adjusted down as well as up. In Weitzman's model in the non-stochastic setting without technological change, the agent received a linear bonus (penalty) if current production exceeded (fell short of) the current quota, q_t: $B=b(y_t-q_t)$. The future quota was adjusted by a factor, λ: $q_{t+1}=\lambda(y_t-q_t)+ q_t$. The agent produced subject to a cost function, $C(y_t)$, where $C'>0$, $C''>0$. At the optimum, the agent sets production, y^*, where $C'(y^*)=b/(1+\lambda/r)$. Production with the ratchet, $\lambda>0$, is lower than without it ($\lambda=0$). The results do not require long foresight—Weitzman labels the solution myopic.

The incentive structure that Baptist posits is even starker. There are no positive incentives, only negative consequences from producing less that the quota, $B =f(\min(y_t-q_t, 0))$. And the quota can only go up $q_{t+1}=\max((y_t, q_t)$. The agent in this setting has no incentive ever to deviate the initial quota, q_o.

[20] The records of W. S. Hamilton (UNC SHC) may contain quotas in 1819. There are numbers next to the workers names in the introductory material in the picking records. There is no explicit reference to quotas. And the numbers are far higher than the varying amounts that the workers actually pick.

plantation near Augusta, Georgia kept cotton books from 1817 to 1819.[21] The books reported both individual picking rates for three years and the tasks for 1818. They allow us to investigate how prior picking performance was related to the tasks, and how the tasks were related to subsequent performance. The tasks varied across individuals. But they were large round numbers which showed no variation during the picking season. The tasks were more closely correlated with 1817 *mean* picking rates than with the 1817 *maximum* rates. The tasks were correlated with both the 1818 mean and maximum amounts picked. But the 1818 mean picking rates were below the tasks in all 11 cases where comparisons are possible; the maximum was below in 8 of the 11 cases. In only 6 percent of daily individual picking observations did the quantity picked equal to or exceed the individual's daily task on the Hillyer plantation.

The memorandum books of James A. Tait's plantation in Wilcox County, Alabama also listed picking tasks for individual slaves for 1823, 1824, 1826 and 1850.[22] Tait's books did not record individual-level picking performance, but they did have multiple lists of individual quotas. Tait's records have demographic detail on the specific slaves that allow us to investigate how the quotas varied across individuals, over time, and between different varieties of cotton.[23] Tait reported separate picking tasks for regular Green Seed cotton and for the newly-introduced Mexican cotton in 1823. In line with our statements regarding the greater ease of picking the new variety, individual slaves were expected, on average, to pick 25 percent more Mexican cotton than Green Seed cotton per day. The tasks listed for 1824 were lower than either of the 1823 Mexican or Green Seed numbers: that is, tasks were ratcheted down. The documentary evidence makes the reason clear: "These tasks are small on account of the badness of cotton from long rains 30th Sept." The 1823 and 1824 records do not show changes, or

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[21] The Hillyer accounts (ca. 1797-1860) also include extensive records of payments to slaves for cotton. The tasks listed may have been used in calculations for overwork or to assist in planning production. There are most likely other examples mentioning picking quotas or tasks, but our search indicates they are rare in the surviving records.

[22] James A. Tait papers, Auburn University and Alabama Department of Archives and History.

[23] Sellers (1950), p. 68 errs in his discussion of Tait's tasks. He writes: "Tait lists the tasks for picking Mexican cotton…." He continues: "The above tasks seem small, but Tait notes that this was due to the poor crop of cotton after the long rains." This discussion mixes different years. The tasks for picking Mexican cotton were for 1823. The reduced tasks to pick the rain-damaged crops relate to 1824.

any sign of ratcheting up over the crop year.[24] The tasks varied by gender and age but were not fine-tuned to individuals. The tasks again were large, round numbers, differing by increments of 10 pounds.[25]

It is notable that columns to enter individual picking quotas do not appear in cotton book produced by Thomas Affleck. Nor, to our knowledge, .do places to enter quotas appear in any of the cotton books produced by Affleck's rivals. The omission in cotton books was not an oversight. Affleck also produced account books for sugar plantations. Schedule D in these sugar books allows the manager to track the amount of firewood cut each day by every slave. There is a printed heading and column for entering the "daily tasks" in cords for every slave.[26] The stock of trees left to cut obviously changed very slowly.

But having fixed, not to speak of ever-rising, picking quotas fundamentally did not fit the realities of the cotton harvest. Our data show actual picking rates varied enormously, over the lifecycle, the season, and even from day-to-day.[27] Rates changed from day to day depending on many factors beyond human control: the weather and the condition of the crop (such as how many bolls were open and whether the cotton was damp from morning dew). Daily picking rates also changed over season. Contributing variations with the season was the progressive opening of the cotton bolls from the

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[24] The 1826 record did show internal adjustments during the season. Based on our best efforts to understand the records, the numbers were revised downward for 10 or 11 individuals and upward in 2 or 3 cases. Tait clearly was adjusting picking tasks up and down to meet conditions and slave performance—there is no support for the claim that quotas only increased. Tait also reports tasks for 1850, for picking to 12 noon. The numbers imply higher picking rates per hour of work than in the 1820s. But they have the same general patterns—large round numbers. The increments are 5 pounds instead of 10.

[25] An experienced cotton picker probably could have judged whether he or she was close to quota that was defined in 10-pound increments. Overshooting the target significantly seems unlikely, especially if disposing of the picked cotton (by giving it to others with low weights or leaving it in the field to collect later) was easy.

[26] See for example the 1857 journal for the James P. Bowman's Frogmoor Plantation in Pointe Coupe Parish, northwest of Baton Rouge. The record shows the daily task for 36 individuals for 15 days in July and August and the actual quantity of wood each person cut every day. The summary picture for this one plantation shows tasks for the most part remained constant and that workers met their tasks exactly. Six went up but six went down. There is no sign of ratcheting, and there is no direct indication of punishment for those who were short.

[27] Baptist's own sources testify to this fact: Charles Ball (1859 [1837], p. 212) noted that a "day's work" depended on the quality and condition of the crop: "In a good field of cotton, fully ripe, a day's work is sixty pounds; but where the cotton is of inferior quality…, fifty pounds is the day's work; and where the cotton is poor, or in bad order, forty, or even thirty pounds, is as much as one hand can get in a day."

bottom of the plant to the top. Morning frost was more common later in the season shorting the picking day. The time between sun-up and sun-down of course grew shorter as picking progressed from August to December.[28]

One can use our picking data to conduct another exercise to investigate implications of the purported "pushing system" with ratcheting quotas. We can examine samples for individual pickers, linked over time, over the pre-1840 and 1840-62 periods. Suppose every picker's quota was ratcheted up as Baptist suggested. How frequently did the realized picking rate fall below the hypothetical individual quota? In the starkest case, the individual had to meet a quota reflecting their lifetime personal best. We can add cases where the target was reset each season, where the adjustment occurred only if the increment was above specified thresholds (0, 10, and 20 pounds), and where the adjustment occurred with a probability of less than one (for example, 50 percent chance, 90 percent chance).

The statistics are derived as follows. For each person, the amount of cotton picked each day is listed in sequence. Then a hypothetical target is calculated.

$$Target_{t+1}=Target_t+ P*\max(0, Picking_t-Target_t-Increment).$$

The target ratchets up (with probability P) if the amount picked exceeds the previous target by the specified increment. The initial target is either reset every season or carries over from the past season. If the increment is 0, probability is 1, and the process resets, the target always rises to equal the maximum amount picked that season. If the increment is 10 pounds, the probability is 0.5, and the process resets, the target has a 50 percent chance of rising to the current picking amount if that amount exceeds the previous target by 10 pounds.

Table 10 indicates the fraction of days in the actual picking data that the performance fell below quota ratcheting as specified. We offer the following interpretation: Consider the pre-1840 period. If targets are set by lifetime personal best

[28] At the latitude of Natchez, MS, there are three more hours of sunlight per day on the 22 of August, about when the picking season began, than on the 22 of December, near when the season ended.

(the top left entry where the increment=0 and the probability of adjustment=1), individual pickers fall short 92.7 percent of the days. If targets are set by seasonal personal best (shift over 3 columns), individual pickers fall short 85.2 percent of the days. As the increment rises and the prob. of adjustment falls, the fraction of days when the target exceeds actual picking declines.

The overall conclusion is that even in the less aggressive scenario (new season reset, 20 pound increments, 50 percent probability of adjustment), a deficit occurred *three* days out of *four*. Unless owners intended to whip virtually every slave almost all of the time, planters and overseers who assigned quotas would have had to change them regularly, sometimes daily, over the course of the season to reflect the abundance of the crop, the weather, and the condition of the fields. Even assigning weight quotas in this way ignored the imperatives to pick all the open cotton boll off the plants and to avoid trashy picking (including leaves, stems, dirt, and rocks). The plantation records testify that both light picking (however determined) and trashy picking resulted in harsh punishment.[29]

There can be little doubt that over time, cotton picking output expectations rose; but it is hard to know about effort. The expected quantity picked increased as a worker attained adulthood, and moved from the status of a partial hand to a full hand. However, expectations fell as adult workers entered their later years or when workers were infirmed. The expected quantity picked varied with the crop year. As general picking rates increased because of the diffusion of easier-picking varieties, so did expectations for individuals. There was undoubtedly a process of learning about picking by recent migrants from non-cotton areas. There was a dynamic process of setting work standards for new arrivals. And there were adjustments as more productive areas entered cultivation. But there was a fundamental mismatch between a ridged ratcheting quota system and the realities of the cotton harvest.

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[29] There was much variation in practices across plantations and even on a given plantation under different managers. There was great scope of arbitrary behavior and ambiguity about work expectations. In Solomon Northup's narrative (1853, pp. 253-61), Epps flogged Patsey even though she was a phenomenal picker. In Israel Campbell's account (1861, p. 39), Bellfer's overseer whipped Mary, "an extraordinary hand" and top picker. Bennet H. Barrow whipped the most productive pickers more frequently than the least productive. Davis (1967, pp. 419-22, 431-40).

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 relied 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.

But we think some of our specific findings may be new or noteworthy, especially that (1) in the plantation sector, females and males performed essentially equal shares of the picking work; (2) the gender differentials in daily picking rates were in the 7-11 percent range in the late antebellum period and lower earlier. Compared with other estimates of the gender gap, the picking differentials vary by relatively small magnitudes over time and space.[30] (3) productivity in picking, an activity conducted on an individual basis, was higher on larger-scale units. Given that picking was the binding constraint in cotton production and that picking was not a gang activity, further weakens the claims to the importance of the gang system. Our analysis also raises serious questions about recent claims for the purported "pushing system."

[30] This differential is close to the 9.1 percent gender differences in prices that Kotlikoff (1979) found in the New Orleans slave market. He also observed the male premium tended to increase over time, roughly in line with our picking results.

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David Rees Papers, 1803-35. RASP, Ser. H, reels 29-30.

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

John H. Randolph Papers, 1822-65. RASP, Ser. I, pt. 1, reels 14-15.

Joseph Toole Robinson Papers, 1830s and 1853-61. RASP, Ser. I, pt. 2, reel 20.

LeBlanc Family Papers, 1812-66. RASP, Ser. I, pt. 2, reel 17.

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

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

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George J. Kollock Plantation Books, 1837-61 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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Philip H. Pitts Papers, 1816-84. RASP. Ser. J, pt 7, reel 6.

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Series N, Selections from the Mississippi Department of Archives and History.

Aventine Plantation Diary, 1857–60. RASP, Ser. N, reel 1.

Charles Clark and Family Collection, 1810–92. RASP, Ser. N, reels 4-5.

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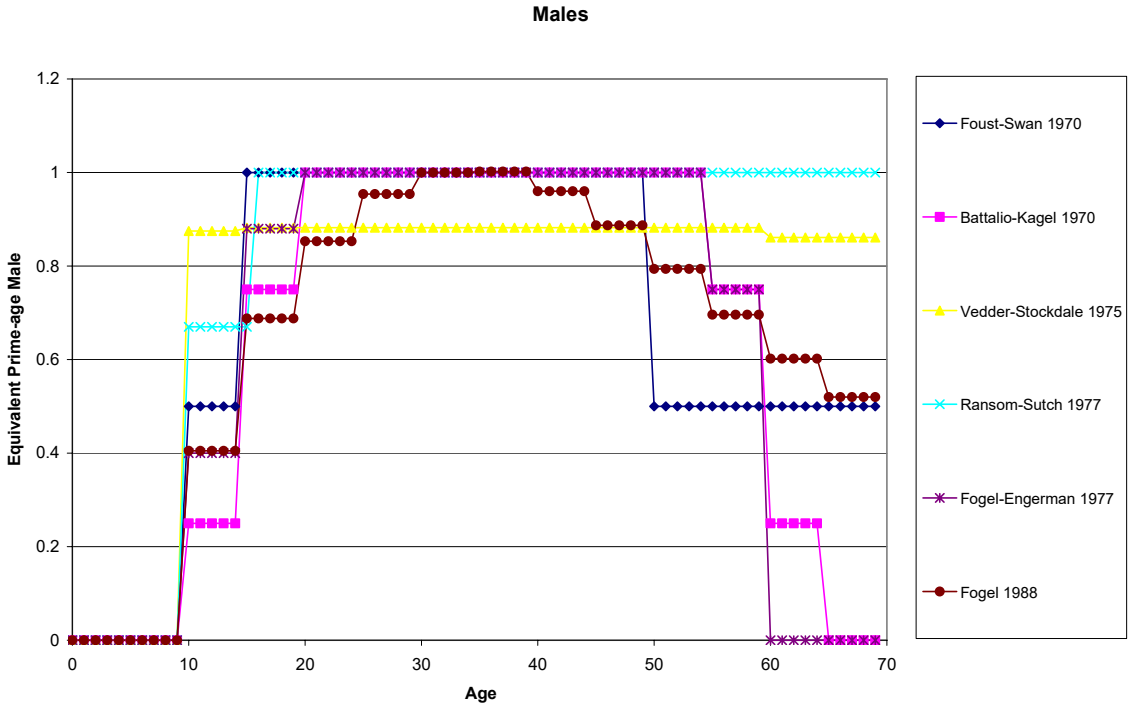
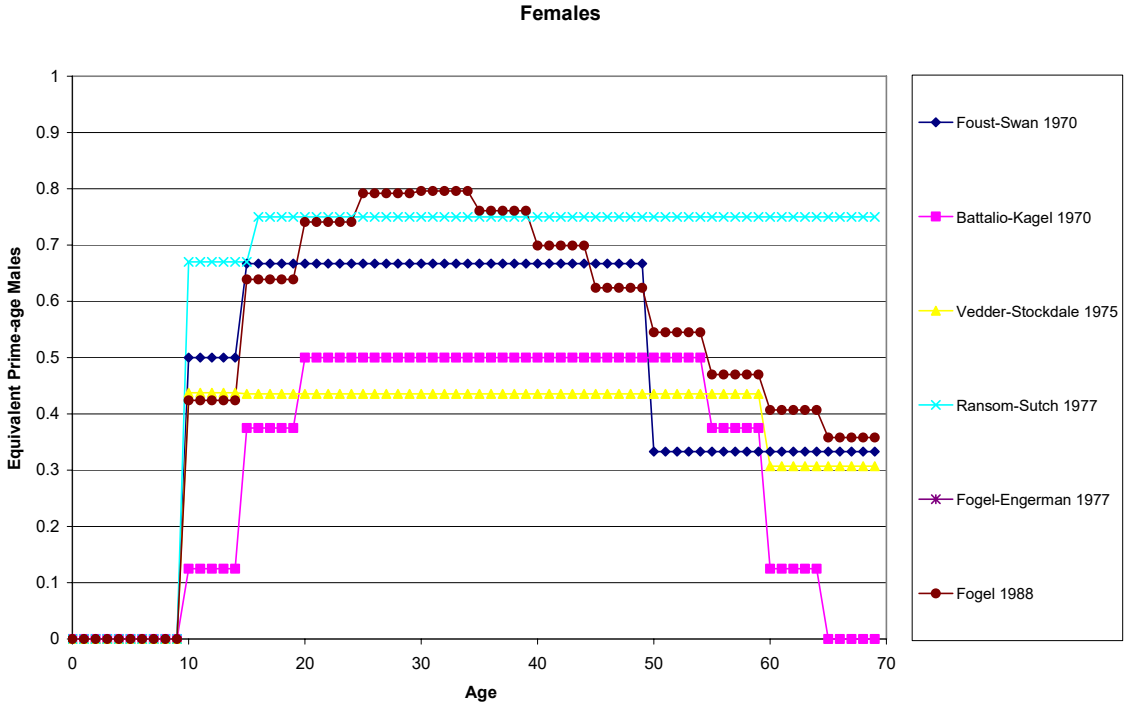
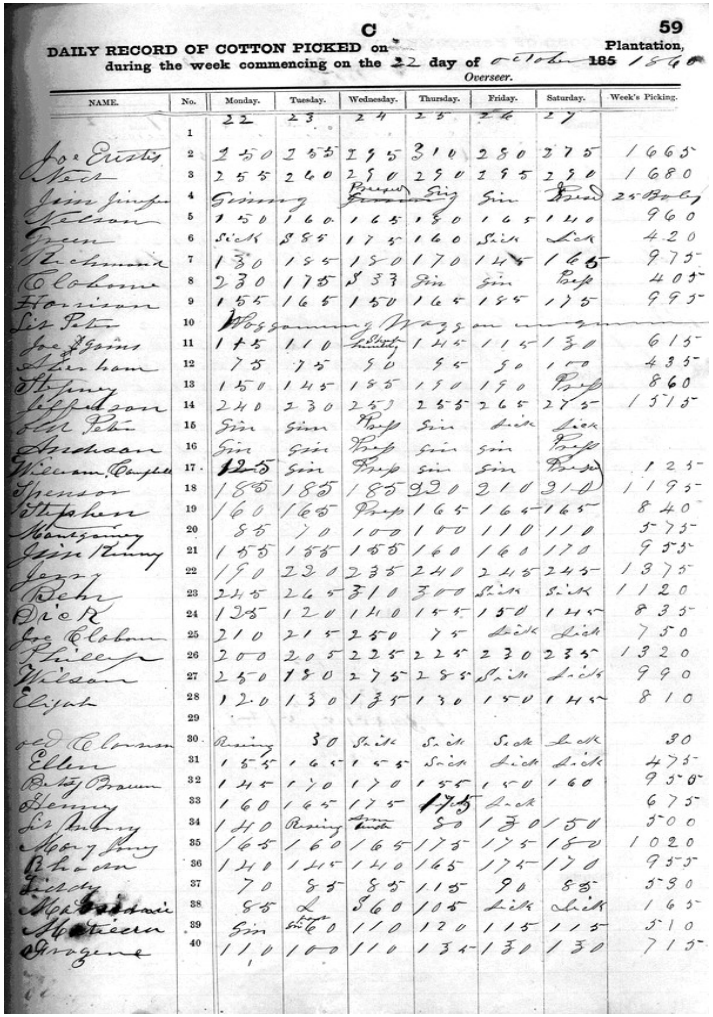
Figure 1: Estimates of age/gender conversion ratios into equivalent prime-age males







C

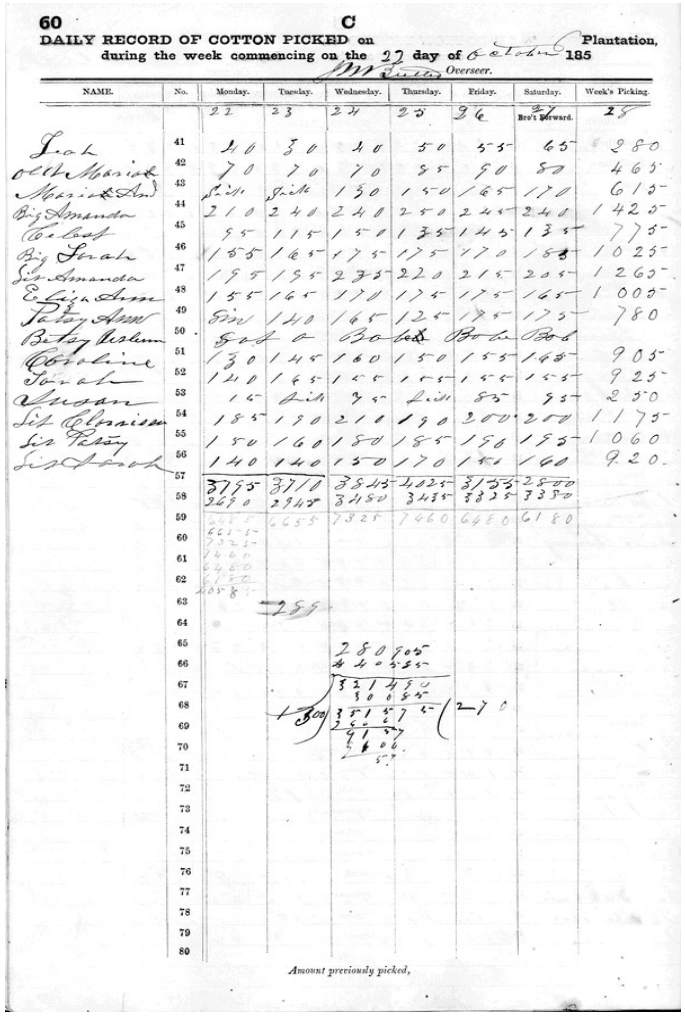
59

DAILY RECORD OF COTTON PICKED on Plantation,

during the week commencing on the 22 day of October 185 1860

Overseer.

NAME.	No.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.	Saturday.	Week's Picking.
		22	23	24	25	26	27	
	1							
Joe Ervin	2	250	255	195	310	280	275	1665
Nick	3	255	260	250	250	295	270	1680
Jim Jim	4	Sinning	Brought Forward	Sin	Sin	Sick	25 Bales	
Nelson	5	150	160	165	180	165	140	960
Jem	6	Sick	285	175	160	Sick	Sick	420
Richmond	7	130	155	150	170	145	165	975
Colborne	8	230	175	837	Sin	Sin	Prop	405
Harrison	9	155	165	150	165	155	175	995
Lis Peter	10	Mossgrowing		Mossgrowing				
Joe Higgins	11	145	110	Sick	145	115	130	615
Fairham	12	75	75	50	55	50	100	435
Stepney	13	150	145	155	150	190	Prop	860
Jefferson	14	240	230	255	255	265	275	1515
Old Peter	15	Sin	Sin	Prop	Sin	Sick	Sick	
Andrason	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
Jerry	22	190	220	235	241	245	245	1375
Bess	23	245	265	310	300	Sick	Sick	1120
Dick	24	125	120	140	155	150	145	835
Joe Coborne	25	210	215	250	75	Sick	Sick	750
Peter	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 Coborne	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
Henry	33	160	165	175	175	Sick		675
Lis Betty	34	140	Resting	Sick	50	130	150	500
Mary Ann	35	165	160	165	175	175	180	1020
Rhoda	36	140	145	140	165	175	170	950
Lizzy	37	70	85	85	115	90	85	530
Maddie	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.

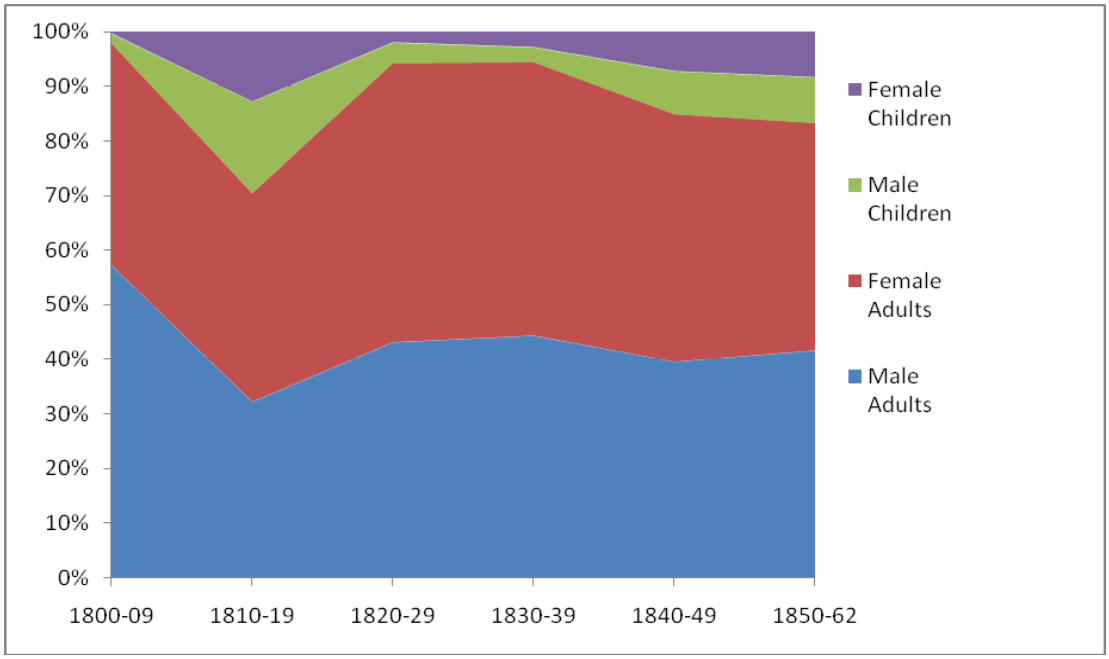
NAME.	No.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.	Saturday.	Week's Picking.
		22	23	24	25	26	27 Bro't Forward.	28
Isaac	41	110	130	140	150	155	165	2850
Old Maria	42	70	70	70	85	90	80	465
Maria & Ann	43	Sick	Sick	130	150	165	170	615
Big Amanda	44	210	240	240	250	245	240	1425
Colcast	45	55	115	150	135	145	135	775
Big Isaac	46	185	165	175	175	170	180	1025
Lis 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 Ann	50	Sick	Sick	Sick	Sick	Sick	Sick	
Caroline	51	130	145	160	150	155	165	905
Isaac	52	140	165	155	155	155	155	925
Susan	53	15	Sick	35	Sick	85	35	250
Sis Caroline	54	185	190	210	190	200	200	1175
Lis Patsy	55	150	160	180	185	150	175	1060
Lis Isaac	56	140	140	150	170	150	160	920
	57	3755	3710	3845	4025	3755	2500	
	58	2670	2945	3480	3435	3825	3350	
	59	6425	6655	7325	7460	6480	6180	
	60	6425						
	61	7325						
	62	7460						
	63	6480						
	64	6180						
	65	34070		280 905				
	66			405 55				
	67			3215 450				
	68			300 855				
	69			3515 7				
	70			2 5 6				
	71			91 57				
	72			5 6 06				
	73			557				
	74							
	75							
	76							
	77							
	78							
	79							
	80							

Amount previously picked,

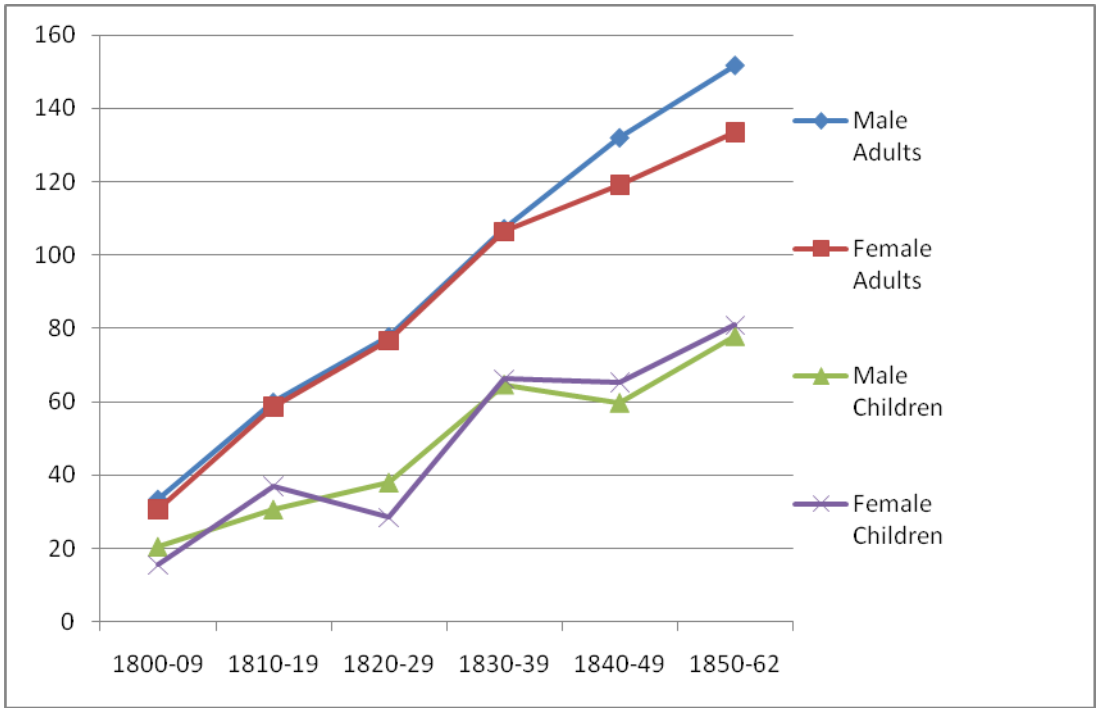
Figure 2: Record from Eustatia Cotton Book

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

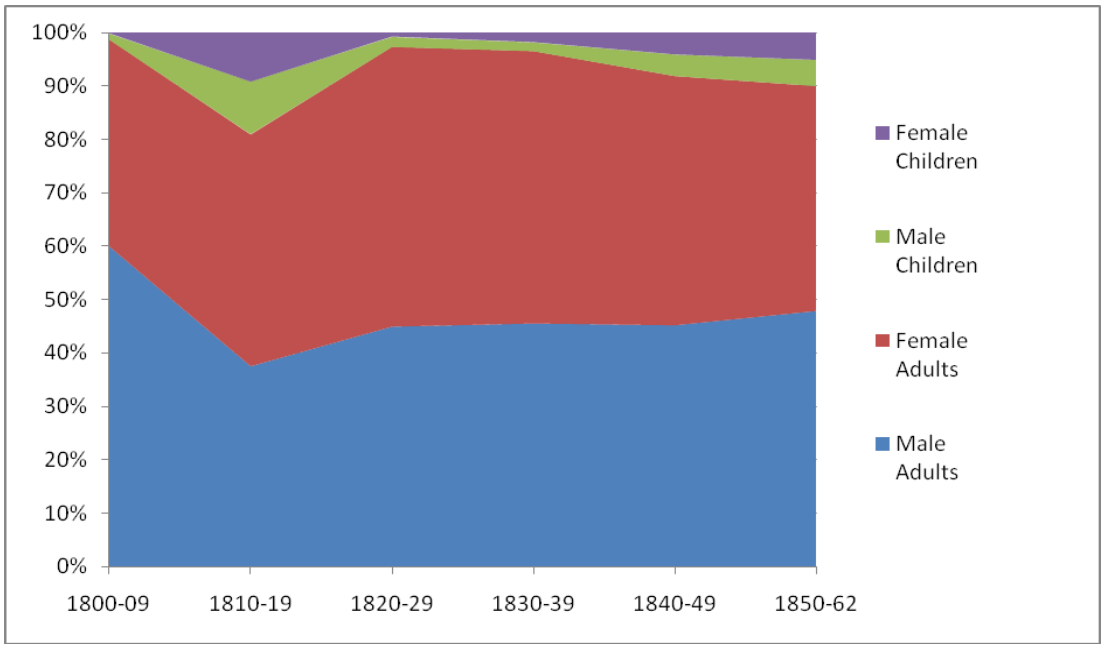


Figure 4: Mean Picking Ratesfor Adult Males over the Seasson (Sept. 28=90)

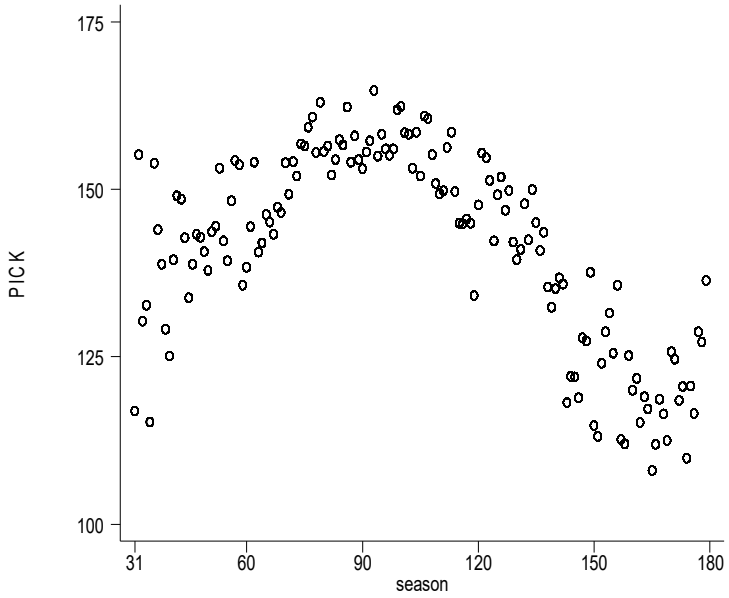


Figure 5: Picking Distributions for Adult Males and Females for 1840-62 observations

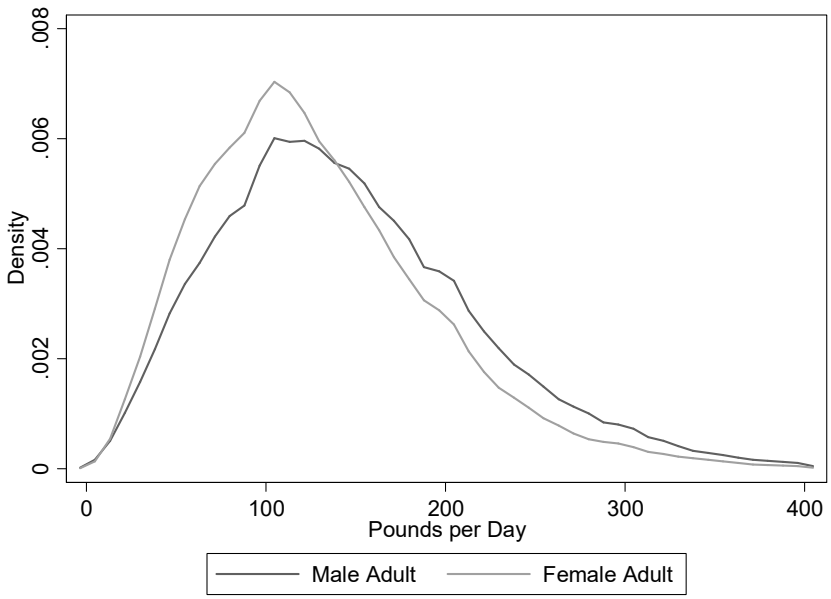
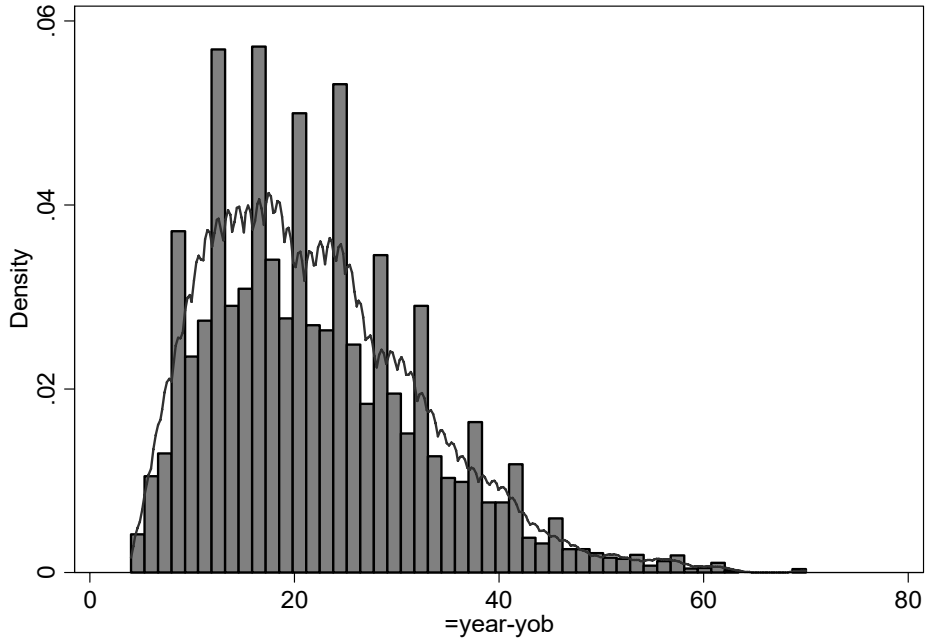


Figure 6: Picking-Age Histograms for 1840-62 observations

Females:



Males:

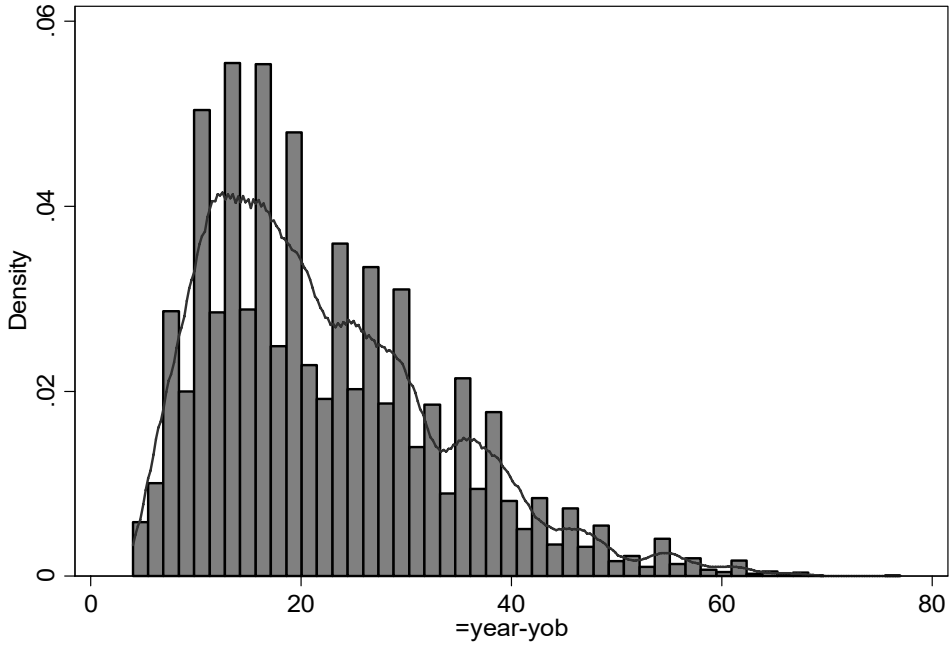
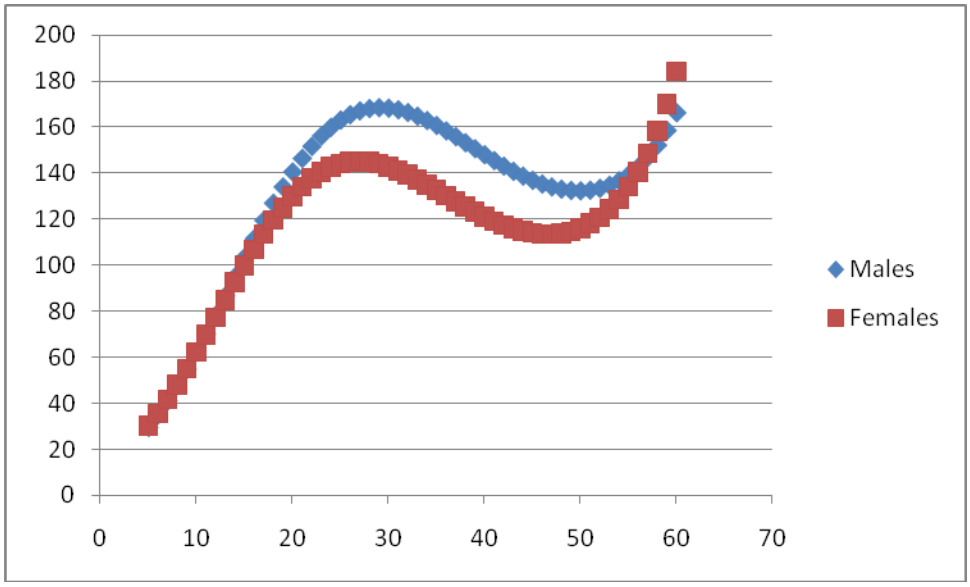


Figure 7: Age-Gender Profiles of Picking Rates

Panel A: Cubit-Fit



Panel B: Lowess Fit

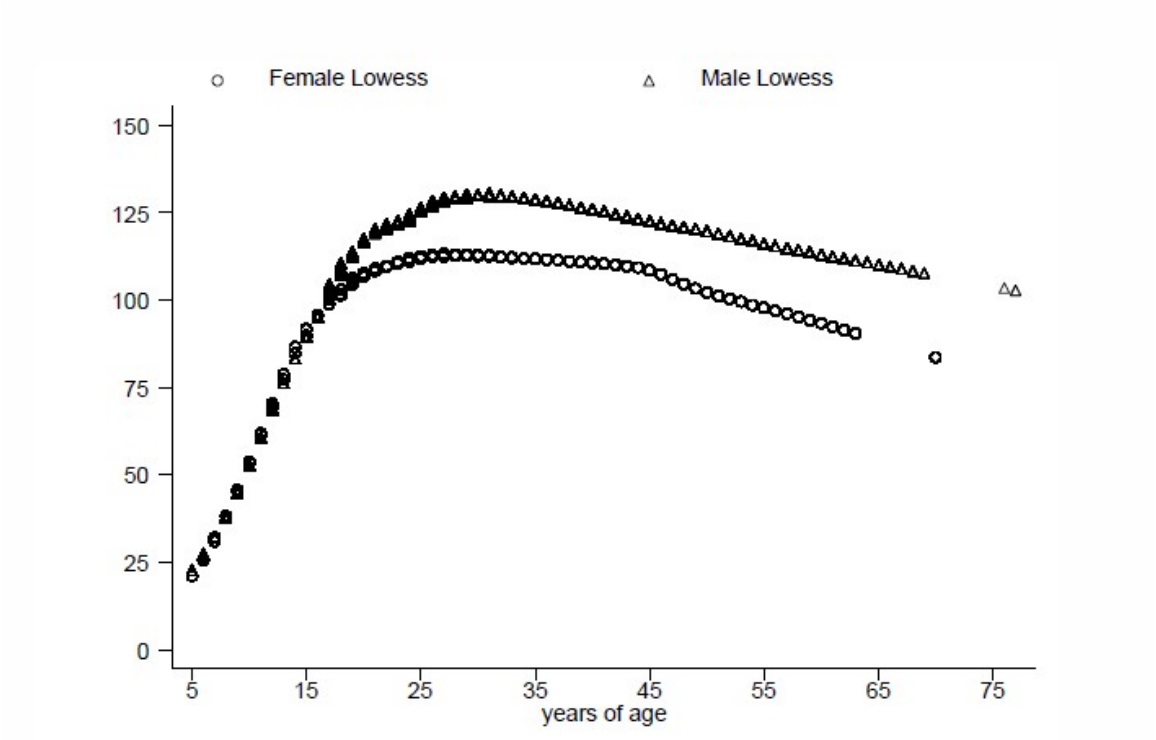


Figure 8: Variations in Picking Rates over the Lifecycle and Season

Panel A: Creesy (born 1836)

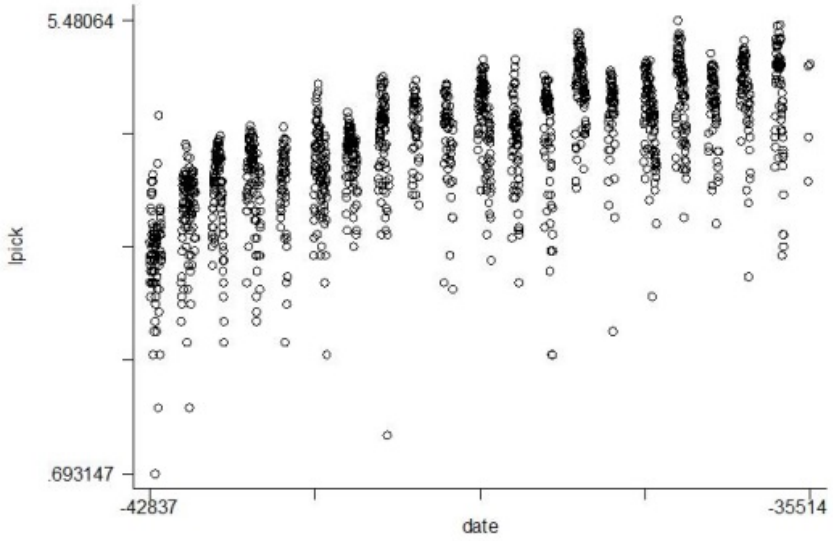


Table 1: Selected Statistics of Sample Variables

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	1801-39
Region	All	Old	New	All
Constant	-11.543	-33.141	-14.045	-49.608
	(0.220)	(0.619)	(0.229)	(0.360)
Female Adult	-0.1133	-0.1379	-0.1041	-0.0066
	(0.0017)	(0.0048)	(0.0017)	(0.0034)
Female Child	-0.7452	-0.2633	-0.831	-0.5464
	(0.0036)	(0.0104)	(0.0038)	(0.0107)
Male Child	-0.799	-0.3545	-0.8814	-0.638
	(0.0037)	(0.0104)	(0.0039)	(0.0104)
Tuesday	0.0239	0.0379	0.0134	0.0002
	(0.0027)	(0.0079)	(0.0028)	(0.0056)
Wednesday	0.0397	0.0783	0.0307	0.0085
	(0.0027)	(0.0077)	(0.0028)	(0.0057)
Thursday	0.0434	0.0815	0.03447	-0.0066
	(0.0027)	(0.0077)	(0.0028)	(0.0059)
Friday	0.0325	0.0965	0.0189	0.0167
	(0.0028)	(0.0079)	(0.0028)	(0.0057)
Saturday	-0.0184	0.0361	-0.0297	-0.0176
	(0.0029)	(0.0080)	(0.0030)	(0.0059)
Half-Day	-0.5438	-0.6054	-0.5246	-0.6382
	(0.0081)	(0.0186)	(0.0086)	(0.0104)
Season	0.0289	0.0387	0.0307	0.0243
	(0.0004)	(0.0018)	(0.0004)	(0.0012)
Season^2	-2.50E-04	-3.20E-04	-2.58E-04	-1.69E-04
	(3.3E-06)	(1.6E-05)	(3.4E-06)	(1.1E-05)
Season^3	5.93E-07	7.29E-07	5.97E-07	2.42E-07
	(9.14E-09)	(4.55E-08)	(9.27E-09)	(2.9E-08)
Cropyear	0.00834	0.0196	0.0097	0.029
	(0.0001)	(0.0003)	(0.0001)	(0.0002)
No. of Obs.	519506	78939	440567	80205
R^2	0.228	0.108	0.548	0.473

Table 3; Quantile Regression Analysis of the Determinants of Daily Picking Rates

Time Period	1840-62	1840-62	1840-62	1840-62	1840-62	1840-62	1840-62
Region	All	Old	New	All	All	All	All
Quantile	50%	50%	50%	10%	25%	75%	90%
Constant	-10.314	-26.576	-12.606	-3.767	-4.924	-17.064	-23.878
	(0.272)	(0.938)	(0.268)	(0.507)	(0.336)	(0.274)	(0.278)
Female Adult	-0.1261	-0.1723	-0.1154	-0.1026	-0.1177	-0.1174	-0.1097
	(0.0020)	(0.0063)	(0.0020)	(0.0039)	(0.0025)	(0.0020)	(0.0021)
Female Child	-0.7564	-0.2980	-0.8229	-0.9341	-0.8694	-0.6468	-0.5382
	(0.0035)	(0.0117)	(0.0034)	(0.0070)	(0.0044)	(0.0036)	(0.0037)
Male Child	-0.7897	-0.3194	-0.8573	-1.0463	-0.9545	-0.6564	-0.5687
	(0.0034)	(0.0111)	(0.0034)	(0.0069)	(0.0044)	(0.0035)	(0.0036)
Tuesday	0.0225	0.0348	0.0134	0.0335	0.0316	0.0144	0.0143
	(0.0031)	(0.0099)	(0.0030)	(0.0062)	(0.0039)	(0.0031)	(0.0032)
Wednesday	0.0372	0.0707	0.0303	0.0577	0.0291	0.0334	0.029
	(0.0031)	(0.0097)	(0.0030)	(0.0061)	(0.0039)	(0.0031)	(0.0032)
Thursday	0.0417	0.0813	0.0334	0.0639	0.0298	0.0346	0.0292
	(0.0031)	(0.0097)	(0.0030)	(0.0061)	(0.0039)	(0.0031)	(0.0032)
Friday	0.0289	0.0982	0.0164	0.0409	0.0201	0.0262	0.0274
	(0.0031)	(0.0098)	(0.0031)	(0.0062)	(0.0039)	(0.0031)	(0.0032)
Saturday	-0.0198	0.0271	-0.0237	-0.0324	-0.04	-0.0023	0.0113
	(0.0032)	(0.0100)	(0.0031)	(0.0063)	(0.0040)	(0.0032)	(0.0033)
Half-Day	-0.5789	-0.5877	-0.5523	-0.4992	-0.5429	-0.5475	-0.5116
	(0.0099)	(0.0279)	(0.0100)	(0.0197)	(0.0125)	(0.0100)	(0.0103)
Season	0.0289	0.0308	0.0300	-0.0137	0.0363	0.0216	0.0138
	(0.0004)	(0.0026)	(0.0004)	(0.0007)	(0.0005)	(0.0004)	(0.0004)
Season^2	-2.4E-04	-2.6E-04	-2.5E-04	1.3E-04	-3.1E-04	-1.8E-04	-1.1E-04
	(3.8E-06)	(2.3E-05)	(3.6E-06)	(5.8E-06)	(4.7E-06)	(3.9E-06)	(4.1E-06)
Season^3	5.9E-07	6.0E-07	5.9E-07	-3.3E-07	7.4E-07	4.2E-07	2.3E-07
	(1.0E-08)	(6.4E-08)	(9.5E-09)	(1.4E-08)	(1.3E-08)	(1.0E-08)	(1.1E-08)
Cropyear	0.0077	0.0162	0.0089	-0.0047	0.0045	0.0116	0.0126
	(0.0001)	(0.0005)	(0.0001)	(0.0003)	(0.0002)	(0.0001)	(0.0001)
No. of Obs.	519506	78939	440567	519506	519506	519506	519506
Pseudo-R^2	0.119	0.0565	0.0148	0.1578	0.1455	0.093	0.0836

Table 4: Determinants of Daily Picking Rates, for Sample with Ages

Time Period	1840-62	1840-62	1840-62	1801-39
Region	All	Old	New	All
Constant	-38.046	-79.39	-28.547	-47.231
	(0.407)	(0.974)	(0.434)	(1.009)
Female Adult	-0.1082	-0.1424	-0.105	0.0693
	(0.0026)	(0.0080)	(0.0028)	(0.0112)
Female Child	-0.7125	-0.3351	-0.7616	-0.0953
	(0.0044)	(0.0112)	(0.0047)	(0.0167)
Male Child	-0.7446	-0.375	-0.8029	-0.0966
	(0.0044)	(0.0104)	(0.0047)	(0.0275)
Tuesday	0.0262	0.0262	0.0285	0.0213
	(0.0042)	(0.0120)	(0.0044)	(0.0173)
Wednesday	0.052	0.0464	0.0531	0.0233
	(0.0042)	(0.0117)	(0.0044)	(0.0170)
Thursday	0.0539	0.0547	0.0528	-0.0093
	(0.0042)	(0.0116)	(0.0044)	(0.0175)
Friday	0.0364	0.1102	0.0277	0.0349
	(0.0042)	(0.0117)	(0.0044)	(0.0169)
Saturday	-0.0447	0.0538	-0.0559	-0.0393
	(0.0042)	(0.0120)	(0.0048)	(0.0181)
Half-Day	-0.6187	-0.09455	-0.5554	-0.8332
	(0.0131)	(0.0227)	(0.0154)	(0.1180)
Season	0.0449	0.0713	0.0429	0.0717
	(0.0006)	(0.0032)	(0.0007)	(0.0041)
Season^2	-3.77E-04	-5.90E-04	-3.64E-04	-4.82E-04
	(5.4E-06)	(2.8E-05)	(5.5E-06)	(3.3E-05)
Season^3	8.91E-07	1.46E-06	8.65E-07	9.40E-07
	(1.4E-08)	(8.0E-08)	(1.4E-08)	(8.6E-08)
Cropyear	0.022	0.044	0.0172	0.027
	(0.0002)	(0.0005)	(0.0002)	(0.0006)
No. of Obs.	234206	26615	207591	7640
R^2	0.31	0.272	0.324	0.416

Table 5: 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	1801-39
Region	All	Old	New	All
Constant	-36.07	-83.52	-26.67	-43.98
	(0.378)	(1.021)	(0.402)	(1.094)
Age	0.2354	0.0969	0.2477	0.0546
	(0.0022)	(0.0049)	(0.0025)	(0.0089)
Age^2	-0.0064	-0.0023	-0.0069	-0.0011
	(0.0001)	(0.00016)	(0.00009)	(0.0003)
Age^3	0.000054	0.000015	0.000058	3.44E-06
	(8.9E-07)	(1.6E-06)	(1.1E-06)	(2.9E-06)
Female	0.0082	0.5146	0.0347	-0.2614
	(0.0222)	(0.0675)	(0.0237)	(0.1214)
Female Age	0.0042	-0.0748	0.0022	0.06091
	(0.0028)	(0.0080)	(0.0030)	(0.0149)
Female Age^2	-0.00062	0.00246	-0.00052	-0.0029
	(0.0001)	(0.0003)	(0.0001)	(0.0006)
Female Age^3	0.0000096	-0.000023	0.00000785	0.000034
	(1.1E-06)	(2.9E-06)	(1.3E-06)	(6.7E-06)
Tuesday	0.0272	0.0281	0.0296	0.0224
	(0.004)	(0.0119)	(0.0041)	(0.0169)
Wednesday	0.0522	0.0482	0.0532	0.0256
	(0.0039)	(0.0116)	(0.0041)	(0.0164)
Thursday	0.053	0.0561	0.052	-0.0062
	(0.0039)	(0.0115)	(0.0041)	(0.0170)
Friday	0.0363	0.1122	0.0277	0.03811
	(0.004)	(0.0117)	(0.0042)	(0.0167)
Saturday	-0.0438	0.0553	-0.0543	-0.0364
	(0.0042)	(0.0119)	(0.0044)	(0.0176)
Half-Day	-0.6456	-0.9411	-0.5934	-0.8039
	(0.0129)	(0.0226)	(0.0150)	(0.1248)
Season	0.0462	0.0714	0.0443	0.0686
	(0.00062)	(0.0032)	(0.00063)	(0.0040)
Season^2	-3.80E-04	-5.90E-04	-3.70E-04	-4.80E-04
	(5.2E-06)	(2.8E-05)	(5.3E-06)	(3.3E-05)

Season^3	8.99E-07	1.46E-06	8.71E-07	9.29E-07
	(1.4E-08)	(7.9E-08)	(1.4E-08)	(8.4E-08)
Cropyear	0.0198	0.0456	0.0148	0.0245
	(0.0002)	(0.0005)	(0.0002)	(0.0006)
No. of Obs.	234206	26615	207591	7640
R^2	0.39	0.282	0.412	0.0453

Table 6: 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 (<10)	Medium (11-50)	Large(>50)	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 7: 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-	<3.66E-	<4.0E-05>	<7.1E-05>

	05>	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 8: Using Plantation-Day Fixed Effects to Control for Allocation Issues, Broad Age-Gender Categories

Time Period	1840-62	1840-62	1840-62	1801-39	1801-39	1801-39
Region	All	Old	New	All	Old	New
Constant	4.793	4.496	4.846	4.349	3.629	4.387
	(0.00078)	(0.00190)	(0.00085)	(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	0.017	-0.0897	0.0226
	(0.00103)	(0.00258)	(0.00113)	(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	-0.5328	0.6483	-0.529
	(0.00253)	(0.00594)	(0.00279)	(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	-0.5401	-0.449	-0.5426
	(0.00265)	(0.00552)	(0.00297)	(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	.0.734	0.643	0.716
No. of Obs.	522014	78939	443075	80205	4055	76150
Plantation Dates	17910	3569	14341	4350	484	3866
Clusters	318	74	244	78	14	64

Table 9: Using Plantation-Day Fixed Effects to Control for Allocation Issues, Age-Gender Profiles

Time Period	1840-62	1840-62	1840-62	1801-39
Region	All	Old	New	All
Constant	2.596	3.424	2.498	3.149
	(0.0151)	(0.0264)	(0.0174)	(0.0776)
	<0.1103>	<0.0848>	<0.1188>	<0.1630>
Age	0.2054	0.148	0.2136	0.08216
	(0.00184)	(0.0030)	(0.00229)	(0.00834)
	<0.0124>	<0.0094>	<0.01391>	<0.0198>
Age^2	-0.00568	-0.0041	-0.0059	-0.00216
	(0.00007)	(0.0001)	(0.00008)	(0.00027)
	<0.0004>	<0.00031>	<0.00047>	<0.00077>
Age^3	0.000047	0.000032	0.000051	0.000017
	(0.0000007)	(0.000001)	(0.0000001)	(0.0000027)
	<0.000004>	<0.000003>	<0.000004>	<0.0000085>
Female	-0.0487	0.591	-0.04871	0.04514
	(0.1733)	(0.0441)	(0.0194)	(0.1003)
	<0.1083>	<0.2186>	<0.0148>	<0.2261>
Female Age	0.0138	-0.073	0.0137	0.00328
	(0.0021)	(0.0053)	(0.00246)	(0.00246)
	<0.0132>	<0.2186>	<0.0147>	<0.0294>
Female Age^2	-0.000864	0.00223	-0.00081	-0.00044
	(0.000008)	(0.0052)	(0.00009)	(0.00009)
	<0.00046>	<0.00085>	<0.00052>	<0.00117>
Female Age^3	0.000011	-0.00002	0.00001	0.000007
	(0.0000008)	(0.0000019)	(0.000001)	(0.0000049)
	<0.000005>	<0.0000087>	<0.0000055>	<0.000014>
Plantation Date Control				
R^2	0.769	0.788	0.766	0.774
No. of Obs.	234997	26615	208382	7460
Plantation Dates	9627	1058	8569	782
Clusters	163	23	140	17

Table 10: Percent of Days of Deficit when Hypothetical Target Exceeds Picking

Pre-1840 Period	Lifetime			New Season Reset		
Increment (Adjust if picking exceeds target by)						
	0	10	20	0	10	20
Probability						
1	92.7	91.3	88.0	85.2	83.0	78.4
0.9	92.3	90.8	87.4	84.6	82.3	77.8
0.5	89.6	87.9	84.0	80.3	78.0	73.8

1840-1860 Period	Lifetime			New Season Reset		
Increment (Adjust if picking exceeds target by)						
	0	10	20	0	10	20
Probability						
1	92.4	91.6	89.6	84.3	83.6	80.4
0.9	92.0	91.1	89.1	83.6	82.8	79.8
0.5	89.3	88.2	86.1	79.3	78.1	75.2

Source: Compiled from Picking Sample.

Interpretation: Consider the pre-1840 period. If targets are set by Lifetime personal best (Increment=0, prob. of adjustment=1), individual pickers fall short 92.7 percent of the days. If targets are set by seasonal personal best (shift over 3 columns), individual pickers fall short 85.2 percent of the days. As the increment rises and the prob. of adjustment falls, the fraction of days when the target exceeds actual picking declines.