results for blacks. The first columns for each race, (1) and (7), reproduce results utilizing our baseline sample, those shown in Table 4, for ease of comparison. Columns (2) and (8) relax match restrictions slightly by allowing matches between individuals that are not unique within three-year age bands. The methodology in this sample is, therefore, identical to Abramitzky, Boustan, and Eriksson (2012). This method results in a match rate of 35.71 (26.56) percent for the white (black) sample, significantly higher than the 27.37 (18.58) percent match rate of the baseline. Relaxing restrictions yields point estimates that are smaller in magnitude by 15 to 29 percent relative to the baseline for the youngest three exposure cohorts, but still statistically significant. This is likely due to attenuating noise introduced by a higher level of false positive matches.

Matching restrictions are increased relative to the baseline, to further reduce the likelihood of false positive matches, in Columns (3) and (9), which require individuals to be unique within five-year age bands. The match rate falls to 23.58 (15.14) percent for the white (black) sample, yet the coefficients are not meaningfully changed compared with the baseline. Columns (4) and (10) show results from a matched sample requiring that individuals be unique within three-year age bands and have absolute differences in year of birth of less than or equal to one year. The latter restriction is also aimed at reducing the frequency of false positive matches, as those with two-year discrepancies in year of birth are more likely to be incorrect. Again, the coefficients are remarkably similar to the baseline. Columns (5) and (11) additionally restrict matches to individuals that are unique within five-year age bands, and present results that are nearly identical. Columns (6) and (12) return to the three-year age band uniqueness restriction, but require matches on exact names rather than standardized versions of names. Results are little changed for blacks here, but point estimates are reduced in magnitude for whites by 19 to 30 percent relative to the baseline for the youngest three exposure cohorts.[44]

Robustness to Weighting

Recall that the baseline sample is not representative of the population, as shown in Table 1. In Table 8, we examine whether the results are robust to weighting the baseline sample to be representative of the population along the characteristics presented in Table 1. Panel (A)

[44] Online Appendix Table A.10 shows the baseline results with eighth grade completion as the dependent variable to be similarly robust. Our estimates are also robust to using only observations in the intersection of the matched samples generated by linking on standardized names and exact names (results not shown).

TABLE 8
ROBUSTNESS OF THE BOLL WEEVIL'S EFFECT ON LONG-RUN EDUCATIONAL OUTCOMES TO WEIGHTING

	Years of Schooling		Completed 8th Grade	
	(1) White	(2) Black	(3) White	(4) Black
Panel (A): Weighting on Childhood Characteristics				
Age exposed:				
4–6	0.2753***	0.3586***	0.0205*	0.0324***
	(0.0626)	(0.0727)	(0.0090)	(0.0095)
7–9	0.2414***	0.2445***	0.0271***	0.0248***
	(0.0514)	(0.0600)	(0.0071)	(0.0074)
10–12	0.1516***	0.1533***	0.0179***	0.0125*
	(0.0390)	(0.0462)	(0.0053)	(0.0058)
13–15	0.1064***	0.1464***	0.0142***	0.0123*
	(0.0296)	(0.0390)	(0.0042)	(0.0048)
16–18	0.0468*	0.0600+	0.0056+	0.0035
	(0.0232)	(0.0307)	(0.0032)	(0.0036)
Observations	429,629	170,835	429,629	170,835
R^2	0.1608	0.0837	0.1166	0.0515
Panel (B): Weighting on Adulthood Characteristics				
Age exposed:				
4–6	0.2359***	0.3453***	0.0173*	0.0311***
	(0.0630)	(0.0734)	(0.0087)	(0.0088)
7–9	0.2281***	0.2311***	0.0269***	0.0229**
	(0.0522)	(0.0602)	(0.0070)	(0.0071)
10–12	0.1415***	0.1477**	0.0168**	0.0119*
	(0.0402)	(0.0474)	(0.0052)	(0.0055)
13–15	0.1030***	0.1407***	0.0137***	0.0114**
	(0.0305)	(0.0387)	(0.0041)	(0.0043)
16–18	0.0385	0.0596+	0.0048	0.0036
	(0.0241)	(0.0308)	(0.0032)	(0.0035)
Observations	427,500	169,335	427,500	169,335
R^2	0.1663	0.0918	0.1198	0.0548

+ = Significant at the 10 percent level.
* = Significant at the 5 percent level.
** = Significant at the 1 percent level.
*** = Significant at the 0.1 percent level.

Notes: The dependent variables are given in the column headings. Standard errors adjusted for clustering by childhood county of residence are in parentheses. All specifications include year of birth fixed effects, childhood county of residence fixed effects, and controls for family background. Family background controls include childhood household head's occupational score, homeownership status, and literacy, as well as indicators for urban location and farm residence. The specifications in Panel (A) use an inverse proportional weighting method to weight our matched sample to be reflective of the population with respect to observable childhood characteristics: census year; state of residence; race; age; household head's occupational score, homeownership, and literacy; household farm and urban status; and year of infestation of county of residence. The specifications in Panel (B) use an inverse proportional weighting method to weight our matched sample to be reflective of the population with respect to observable adulthood characteristics: state of residence; race; age; years of schooling; and occupational income score.
Source: See the text.

presents specifications analogous to the baseline shown in Table 4, but uses inverse probability weights calculated based on family background characteristics provided by childhood census data. Instead, Panel (B) uses inverse probability weights estimated from 1940 census characteristics. The results presented do not meaningfully differ from the baseline results. Therefore, our results cannot be explained by observable differences between the population and the matched sample.

CONCLUSION

We add to an expanding literature exploring the boll weevil's impact beyond its direct effect on cotton production. The spread of the infestation through the South, whose agrarian economy was heavily dependent on cotton, provided an exogenous shock to agricultural productivity, particularly for women and children. Our findings reveal gains in educational attainment for those at young ages when the boll weevil arrived. Whites exposed at ages 4–6 gained 0.2669 years of schooling on average, while comparatively aged blacks gained 0.3579 years. White and black children ages 7–9 also saw significant gains of 0.2364 and 0.2427 years of schooling, respectively. Slightly older exposure cohorts experienced gains as well, but these decline as age at exposure increased to 18.

The magnitude of these estimates can be compared to the findings of several studies of contemporaneous shocks to schooling. Our finding that exposure to the boll weevil at age 7–9 increased educational attainment by nearly a quarter of a year, is comparable to the imposition of compulsory schooling and child labor laws requiring school entrance at age 7 and allowing work permits beginning at age 12.[45] It is important to note, however, that passage of such a law does not imply compliance with the law. Compulsory attendance laws were not well enforced in many locales and often provided myriad exceptions. Another comparison, for black children in particular, is instructive: Aaronson and Mazumder (2011) estimate that going from no (Rosenwald exposure of 0) to full (Rosenwald exposure of 1) coverage of black 7 through 17 year olds by Rosenwald teachers led to a gain in educational attainment of 1.186 years on average for blacks. Therefore, our result is roughly equivalent to having enough Rosenwald teachers to teach 20 percent of black children in one's childhood county during ages 7 through 17, or Rosenwald exposure of 0.20 where the mean Rosenwald exposure in 1930 was 0.27.

[45] Lleras-Muney (2002) shows that each additional year between the school entrance age and work permit age increased years of schooling by 0.05 years. This makes our result roughly equivalent to a five-year gap between the school entrance age and permit age.

Finally, Baker (2019) shows that a 1 percent increase in school resources for the first three years of schooling increased educational attainment by 0.0378 years for white children in early twentieth-century Georgia. Thus, white children would experience approximately the same gains in years of schooling from a 6.25 percent increase in school financial resources. Therefore, our estimates represent economically meaningful gains on the order of a significant funding boost, which seems quite reasonable for an event that so dramatically changed agricultural production in the region.

As the boll weevil itself only directly affects cotton production, any impact of the boll weevil on student outcomes must run through its devastation of the cotton crop. Contemporary observations and empirical evidence have demonstrated that Southern farmers shifted away from cotton production after infestation (Lange, Olmstead, and Rhode 2009; Giesen 2011). This shift from a child labor–intensive crop to alternatives that generated less demand for child labor provides a likely mechanism: a fall in the value of the marginal product of child labor in agriculture, or the opportunity cost of schooling, led to increased enrollment and attendance. For younger exposure cohorts, this accumulated into higher levels of average educational attainment. A potential second mechanism is that the boll weevil made farming a less attractive occupation, causing children at the margin to shift their occupational aspirations and their preparations accordingly. Where fieldwork might have provided suitable training for the farm profession, schooling made available a wider set of occupations.

Both of these mechanisms likely played a role in increasing educational attainment following the weevil's arrival. If the first was at play, then our results are suggestive of the benefits of programs encouraging farmers to switch cultivation to less child labor–intensive crops and to adopt child labor–reducing technologies, which would decrease the opportunity cost of schooling in rural areas. However, if the second mechanism was also at play, then our results might overstate the potential gains from such programs, as such programs generally have neutral to positive effects on the returns to farming. Getting farmers to switch crops would be achieved by compensating them for losses incurred due to switching, and mechanization likely has a positive effect on the productivity of adult farm labor. Still, it should be noted that our estimates are net of the income effect of the boll weevil, suggesting that our results could in fact understate the benefits of these programs.

A third potential mechanism is suggested by the work of Clay, Schmick, and Troesken (2017), who claim that the diversification of crops following the boll weevil infestation reduced the incidence of pellagra, a disease caused by having insufficient niacin, by increasing the availability of locally-grown vegetables that had higher niacin content than imported foods. If those susceptible to the disease were randomly selected from the population or the disease was not commonly fatal, then we would expect increased health might have some positive effect on educational attainment on average for those surviving to adulthood. However, pellagra disproportionately affected the poor, because cheap shelf-stable foods had lower niacin content prior to enrichment. The Louisiana Board of Health noted in their 1928/1929 report, well after the boll weevil infestation began: "As this disease [pellagra] rises and falls with the economic situation, there seems little we can do to prevent its prevalence in localities where crops fail or employment is not remunerative" (1930, p. 10). That same report shows the case fatality rate for pellagra over the 1926–1929 period to be 47 percent in Louisiana. Given the positive relationship between family income and educational attainment (see, e.g., Blanden and Gregg 2004; Taubman 1989), it is unclear whether this channel has a strengthening or attenuating effect on our estimates.[46]

While we find that the boll weevil had a positive effect on educational outcomes overall, through its devastating impact on cotton production in the South, it is important to note that we find positive effects on two distinct outcomes: school enrollment in the short run and educational attainment over the long run. For positive enrollment effects to be interpreted as generating educational attainment gains it is necessary to assume that enrolled students are attending school and completing grades, but this need not be the case. Moreover, it is possible to see educational attainment gains without observing changes in enrollment by decreasing retention rates. Therefore, it is necessary to consider these as separate outcomes, but in many contexts it is not possible, time consuming, or costly to measure educational attainment (which is especially true for studies of modern interventions). Whether observed gains in educational attainment due to boll weevil exposure are generated by changes in enrollment, attendance, retention rates, or all three is unclear, and not discernible from available data. Given the importance of educational attainment in the labor market as a measure of human capital, however, directly estimating the boll weevil's effect on years of schooling and demonstrating sizable gains for both whites and blacks is a significant contribution to the literature.

[46] Indeed, studies of the income neutral health interventions, which disproportionately affected the poor, of iron fortification (Niemesh 2015) and hookworm eradication (Bleakley 2007) fail to find statistically significant effects on years of schooling when accounting for mean reversion. Rather, they find these interventions had substantial educational benefits at the intensive margin.

There is still much work to be done to understand the broader effects of the boll weevil on the Southern economy. Whether the spread of the infestation just prior to an unprecedented wave of migration out of the region represents a causal or coincidental relationship remains unexplored. Additionally, tracing the insects' impact on occupational choice would be instructive, given its likely negative impact on the attractiveness of farming as a profession.

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