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When the Levee Breaks: Black Migration and Economic Development in the American South†

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In the American South, postbellum economic development may have been restricted in part by white landowners' access to low-wage black labor. This paper examines the impact of the Great Mississippi Flood of 1927 on black out-migration and subsequent agricultural development. Flooded counties experienced an immediate and persistent out-migration of black population. Over time, landowners in flooded counties modernized agricultural production and increased its capital intensity relative to landowners in nearby similar non-flooded counties. Landowners resisted black out-migration, however, benefiting from the status quo system of labor-intensive agricultural production. (*JEL* J15, J43, N32, N52, N92, Q54, R23)

Underdeveloped societies often have a large population of low-wage agricultural workers. Economic growth requires a sectoral reallocation of labor, yet various factors may keep workers in rural agriculture (Lewis 1954; Kuznets 1955; Brenner 1986; Banerjee and Newman 1998). Low-wage agricultural labor may discourage labor-saving technological innovation (Habakkuk 1962; Allen 2009; Acemoglu 2010) or the adoption of new capital-intensive technologies (Atkinson and Stiglitz 1969; Basu and Weil 1998).

At the beginning of the twentieth century, Southern white planters dominated areas with concentrated black populations. The Mississippi Delta exemplified this system of racial inequality and discrimination that fostered paternalistic black labor relations and narrowed black economic opportunities. The Great Mississippi Flood of 1927 displaced workers and disrupted the traditional racial labor market equilibrium, leading to an exodus of black laborers and sharecroppers from flooded areas.

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This article examines the impact of the 1927 Mississippi flood on black migration and agricultural development, emphasizing a link between black out-migration and the subsequent development of flooded areas. Empirical estimates support historical accounts of a black exodus from flooded areas. Over time, agriculture became substantially more capital intensive and modernized in flooded counties relative to nearby similar nonflooded counties. This induced agricultural development was not associated with increased agricultural land values, however, which is consistent with white landowners' coercive efforts to resist black out-migration after the flood and maintain the status quo system of labor-intensive agricultural production.

Using county-level data from the Censuses of Agriculture and Population, from 1900 to 1970, the empirical specifications compare changes between flooded counties and nonflooded counties within the same state and with similar pre-1927 outcome values. Estimated increases in capital intensity are smaller in magnitude after controlling for differences in geography and 1930s New Deal program spending, but flooded counties continue to have large relative increases over time in the value of capital equipment and machinery. The analysis of black population declines is supplemented with individual-level census data, matched between 1920 and 1930.

In a similar analysis of counties near other major Southern rivers, compared to counties further from rivers, there is little estimated relative change in black population or agricultural development in the absence of a flood. Counties near other major Southern rivers exhibit some of the same outcome patterns prior to 1927, yet do not experience the subsequent large relative changes estimated in flooded counties.

Our main interpretation of the flood's impacts is that flood-induced black out-migration pushed flooded counties toward higher capital-intensity and larger-scale farm operation, consistent with contemporary and historical qualitative accounts. The empirical estimates appear less consistent with alternative interpretations, such as direct impacts of the flood on capital or land. Further, general equilibrium impacts on nonflooded counties appear to be small.

Following this temporary natural disaster, the persistent decline in black population is consistent with a breakdown of historically segmented labor markets for black workers in the flooded region. While other factors may have also contributed to later economic convergence throughout the US South, the aftermath of the 1927 Mississippi flood illustrates the potential for out-migration to spur economic development. In underdeveloped areas maintaining substantial populations of low-wage agricultural workers, rural out-migration and decreased agricultural labor availability appears to have the potential to encourage subsequent agricultural development.

I. Historical Background

A. *Southern Underdevelopment and the Mississippi Delta*

In the US South, slavery and a geographic suitability for plantation agriculture contributed to a system of labor-intensive agricultural production. Four million slaves were emancipated during the Civil War; by 1900, however, most Southern states had disenfranchised black populations (Naidu 2012). Southern white planters attempted to use their political influence to restrict black labor mobility.[1] Planters often pursued a strategy of paternalism to retain black workers, offering protection from white violence and implicit insurance. Protection was important for black workers "because they lacked civil rights and society condoned violence" (Alston and Ferrie 1999, p. 20). During a period of labor scarcity, a key factor for retaining labor "was the landlord's reputation among tenants with regard to his use of physical violence" (Davis, Gardner, and Gardner 2009, p. 392).

The South remained underdeveloped between the Civil War and World War II, relative to the North. While the North developed large manufacturing sectors, the South remained primarily agricultural.[2] Northern wheat threshing became increasingly mechanized in the nineteenth century (David 1975), while mechanization of Southern cotton-picking was delayed until the mid-twentieth century.

Early cotton mechanization was mainly in planting and cultivation, where replacing mules and horses with tractors was associated with a 30 percent reduction in labor inputs (Hurst 1933; Ellenberg 2007). Tractors and other labor-saving innovations were influential in American agricultural development (Olmstead and Rhode 2001; Gardner 2002; Steckel and White 2012), yet adoption lagged in the South. High demand for harvest labor encouraged annual labor contracts and may have discouraged the partial mechanization of preharvest operations (Fleisig 1965; Whatley 1982, 1987): "not only cheap labor, but also the form of that cheap labor, reduced the profitability of mechanization" (Whatley 1985, p. 1,208).

Wright (1986) describes a 1930 to 1970 economic transition from the "Old South" to the "New South." New technologies allowed full mechanization of cotton production, institutional changes contributed to a breakdown of sharecropping and regional labor markets, and there was widespread black out-migration from rural agriculture. Farm operation sizes increased as agriculture became more capital-intensive (Kirby 1987). Contemporaries recognized a feedback relationship between labor scarcity encouraging agricultural mechanization and technological improvements displacing workers (Raper 1946). For later periods, some have emphasized the role of the mechanical cotton picker in displacing workers (Day 1967; Grove and Heinicke 2003), while others have emphasized the impact of labor scarcity on mechanization of the cotton harvest (Peterson and Kislev 1986; Holley 2000).

The Southern economy experienced remarkable growth in the mid-twentieth century. Much regional convergence in the United States was associated with increased Southern agricultural wages and labor movement out of Southern agriculture (Caselli and Coleman 2001). Potential contributing factors include advances in agricultural technology, the institutional breakdown of sharecropping, the New Deal, World War II, malaria eradication, air conditioning, and Civil Rights regulation (Arsenault 1984; Wright 1986; Heckman and Payner 1989; Donohue and Heckman 1991; Bleakley 2010; Besley, Persson, and Sturm 2010).

This paper focuses on the region surrounding the Mississippi-Yazoo Delta, which has been dubbed the "most southern place on earth" (Cobb 1994). Powerful white

[1] There has been substantial debate over these measures' effectiveness and the degree of black labor mobility (see, e.g., Myrdal 1944; Higgs 1973; Mandle 1978; Wright 1986; Fishback 1989; Margo 1990, 1991; Ransom and Sutch 2001; Alston and Kauffman 2001; Naidu 2010).

[2] In the US South, the share of employment in agriculture was more comparable to Southern and Eastern Europe.

planters recognized their economic dependence on local black labor, yet retaining labor became increasingly tenuous through World War I and the first Great Migration (1910–1930).

B. *The Great Mississippi Flood of* 1927

The Mississippi River historically changed course and spilled into natural floodplains. Over the late nineteenth and early twentieth centuries, levees were constructed to contain the river, and its natural spillways were closed. In 1926, the new chief of the Army Corps of Engineers "for the first time officially stated in his annual report that the levees were finally in condition 'to prevent the destructive effect of floods'" (Barry 1998, p. 175).

In 1927, the levee system failed catastrophically along the lower Mississippi River. Heavy rains throughout the Mississippi River basin accumulated in rising river levels, and enormous pressure created 145 levee breaks that flooded 26,000 square miles. In the three most affected states (Mississippi, Louisiana, Arkansas), flooding hit 36 percent of agricultural land and 29 percent of the population (Red Cross 1928). The flood caused $400 million in property damage and drowned 246 people.[3] The Red Cross coordinated flood relief efforts, which focused on emergency short-term needs (Red Cross 1928).[4] The Red Cross established refugee camps that held 45 percent of the black population from flooded areas in Mississippi, Louisiana, and Arkansas (Red Cross 1928).[5] Refugee camp administration was placed under the control of local counties and, in effect, powerful local white planters.

Southern planters faced the potential exodus of black workers, as the flood temporarily displaced workers and lowered labor demand for cotton harvesting in 1927. Planters tried to retain their workers, turning many refugee camps into centers of repression and racial abuse.[6] Black work gangs were conscripted, and those caught attempting to leave were beaten and returned.[7] Flood aid was withheld unless blacks worked on prescribed tasks, which planters justified on the grounds that rations would "spoil" black workers and weaken the control planters had in "the old system" (Spencer 1994, p. 176). Amid stories of racial abuse, white planters in flooded areas retained little credibility in offering paternalistic protection to their black

[3] There was little flood insurance at this time (White 1945), and "[f]looding in the Mississippi basin in 1927 and 1928 led the few companies that were selling cover to abandon the business" (Parker 2000, p. 413).

[4] Of the $17 million spent, 30 percent was for food, and 14 percent was for livestock feed. The Red Cross spent 16 percent on seed for farmers to replant flooded cropland: two-thirds of this land could be replanted in 1927, though the late planting season required some land to be shifted from cotton to corn, and the remaining lands were replanted in 1928. Building construction, repairs, and household furnishings totaled 15 percent of expenditures, and the remaining 25 percent was mainly for rescue and setup of refugee camps.

[5] Refugee camps held 26 percent of the white population from flooded areas in these three states. The Red Cross also gave relief outside of camps to 33 percent of the white population and 36 percent of the black population from flooded areas.

[6] Following directives from the Mississippi governor and the National Guard commander, the Red Cross issued a memo on the "return of refugees," stating: "Plantation owners desiring their labor to be returned from Refugee Camps will make application to the nearest Red Cross representative," whereupon they "will issue passes to refugees" (Barry 1998, pp. 313–314). The Delta and Pine Land Company, one of the nation's largest cotton plantations, established its own refugee camp and had its workers transferred by special train.

[7] In May 1927, 21 black workers were caught and whipped by the National Guard for trying to escape a relief camp (Spencer 1994, p. 177). In another case, a black insurance officer who refused to work was openly shot and killed by the mayor of Lake Providence, Louisiana (Barry 1998, p. 330).

workers.[8] A circulated black newspaper, *The Chicago Defender*, described abuses in Red Cross camps and listed job openings for blacks in Northern cities.

Despite planters' efforts, or perhaps encouraged by such efforts, many black families left flooded areas in search of better political and economic opportunities. Contemporary accounts describe black families leaving for Chicago and other Northern cities. "The *Afro-American* reported that the relief camp experience had 'inspired many backwoods farm[h]ands to make their first break for better things'" (Spencer 1994, p. 177). Social networks shifted toward favoring migration; in Greenville Mississippi, black leaders left for Chicago and crowds gathered at the local railway station every Saturday night to see who was leaving and say goodbye (Barry 1998).

Landowners' accounts emphasize damages from losing their labor force, rather than direct losses from the flood. One planter reported that "the most serious thing that confronts the planter in the overflowed territory is the loss of labor, which is great and is continuing" (Barry 1998, p. 416). Another planter lamented that "a great deal of labor from the flooded section after being returned to the plantations is going North … and it is going to offer a tremendous problem to all of us" (Barry 1998, p. 416).

White planters in flooded counties were forced to adapt to decreased availability of black labor. In November 1927, the Engineering News Record noted: "In certain sections of the lower Delta … where a crop could not be made this year two-thirds to four-fifths of the families have moved away. In these districts farm-machinery salesmen have been busy…." In 1931, a Mississippi Agricultural Extension bulletin discusses the "serious problem" of black out-migration and explores "the possible solution in mechanical farming," comparing tenant-operated plantations and tractor-operated plantations in the Delta (Vaiden, Smith, and Ayres 1931). Accounts describe a reorganization of agricultural production and increased mechanization in the Delta, even prior to the mechanical cotton picker: "Many planters have turned to the use of wage labor and large-scale machinery in an effort to improve production efficiency and decrease costs" (Langston and Thibodeaux 1939, p. 3).

The Mississippi Delta has often been examined as a microcosm of historical Southern underdevelopment. After the 1927 flood, the Delta and its surrounding region also provide a setting to explore economic development when particular areas lose agricultural labor. Flooded areas lost black population due to the combined effects from temporary displacement and a decline in the opportunity cost of migration, a breakdown of trust between planters and black workers, and a shift in black social networks toward favoring migration.

[8] One infamous Red Cross camp in the Delta was controlled by Will Percy, who forced blacks to work in the camp free and wear laborer tags to receive food. "Following a killing of a black man by a white policeman on the levees, Will Percy gave a condescending lecture to the black community at Mount Horeb church 'Because of your sinful, shameful laziness, because you refused to work on your own behalf unless you were paid, one of your race has been killed.' After this, the bond between the Percys and the blacks was broken" (Barry 1998, p. 333).

II. A Model of Flooding, Migration, and Agricultural Development

A. *Model Setup*

Assume that a representative Southern planter in county c and year t produces agricultural goods for a world market with fixed prices: $A_c F(K_{ct}, L_{ct}^B, L_{ct}^W)$. Each county has a fixed supply of land with productivity A_c. Capital K_{ct} is sufficiently mobile or depreciable that the marginal return to capital r is equalized across counties. Labor is supplied inelastically by resident black workers L_{ct}^B and resident white workers L_{ct}^W.[9]

Capital and labor are assumed to be substitutes, reflecting a choice between "Old South" labor-intensive production and "New South" capital-intensive production.[10] Capital is an important input in older production methods, but newer production methods are embodied in capital goods. Black workers and white workers are also substitutes, and we consider allowing for higher capital-labor substitutability for black workers (e.g., due to differences in average education).[11]

White workers are perfectly mobile and earn a fixed outside "Northern" wage normalized to w^W. Black workers can earn an outside wage w^B or a home county wage w_H^B. Planters have established a reputation for protecting their own workers from racial violence, which is worth a to black workers in each period. Black workers also pay a one-time moving cost M, equivalent to paying m in each future period, reflecting racially biased labor market institutions.[12] As a consequence of black workers' optimal migration decisions, home county wages are set in equilibrium such that $w_H^B = w^B - a - m$. Each county is in an initial steady state with L_{c0} black workers.

In the first period, the Southern planter chooses inputs to maximize: $A_c F(K_{c1}, L_{c1}^B, L_{c1}^W) - rK_{c1} - (w^B - a - m)L_{c1}^B - w^W L_{c1}^W$, subject to $L_{c1}^B \leq L_{c0}^B$.[13] We focus on the case in which this constraint binds and $L_{c1}^B = L_{c0}^B$, consistent with efforts by Southern planters to limit black out-migration. Capital investment and the number of white workers are determined by

$$A_c F_K(K_{c1}, L_{c0}^B, L_{c1}^W) = r \tag{1}$$

$$A_c F_{L^W}(K_{c1}, L_{c0}^B, L_{c1}^W) = w^W. \tag{2}$$

[9] We use agricultural "workers" to refer to wage laborers, share croppers, and share tenants who receive "wages" in the form of cash, production shares, housing, and/or inputs.

[10] In particular, we assume that the above production function represents an upper envelope over "Old South" and "New South" technological choices. Increased use of "New South" methods is assumed to be "strongly black labor-saving" (Acemoglu 2010); that is, in the case where machines replace black labor, the adoption of capital-intensive methods reduces the marginal product of black labor. Note, however, that output per black worker will still increase following a decline in black labor availability and the adoption of black labor–saving technology.

[11] In particular, we assume that: F is increasing and concave in all arguments; $\partial^2 F/\partial L_{ct}^B \partial L_{ct}^W \leq 0$; $\partial^2 F/\partial L_{ct}^B \partial K_{ct} < 0$; and $\partial^2 F/\partial L_{ct}^W \partial K_{ct} \geq 0$. Note that the assumptions on the cross-partials rule out production functions with constant returns to scale.

[12] Anti-enticement laws made it illegal for one planter to hire another planter's workers, while anti-vagrancy laws made it illegal to be unemployed and without housing (Naidu 2010). The threat of force against black workers shaped economic incentives and generated paternalist institutions, as in many other coercive labor markets (Naidu and Yuchtman 2013; Acemoglu and Wolitzky 2011).

[13] The planter could hire more black workers at wage w^B, but this would contradict the assumption of an initial steady state with L_{c0} black workers.

In particular, equilibrium choices of capital and white workers depend on the initial number of black workers: more black workers leads to a lower capital stock and fewer white workers. Paternalism and moving costs both have the effect of lowering planters' labor costs in counties with more black workers.

B. *Comparative Statics after the Flood*

Consider the impact of a flood in some counties between periods 1 and 2. The flood temporarily reduces the moving cost for black workers, either by imposing some share of that cost or by reducing the opportunity cost of migration. Workers are also housed in refugee camps controlled by the planter, and racial abuses in these camps lower the planter's ability to provide credible protection from white violence. Black workers in refugee camps may also receive additional information about Northern job opportunities or, as leaders of the black community migrate, social networks may shift toward encouraging migration. The value of protection falls to some fraction α, and the cost of moving falls to some fraction β, though the planter may use a combination of incentives and threats to induce workers to return at cost $(1 - \alpha)a + (1 - \beta)m$.

After the flood, the Southern planter chooses inputs to maximize: $A_c F(K_{c2}, L_{c2}^B, L_{c2}^W) - rK_{c2} - (w^B - \alpha a - \beta m)L_{c2}^B - w^W L_{c2}^W$, subject to $L_{c2}^B \leq L_{c0}^B$. The flood effectively increases the cost of employing black workers. Assume that the flood's impacts are sufficiently large, i.e., α and β are sufficiently small, that the constraint no longer binds, and the population of black workers declines in equilibrium $(L_{c2}^B < L_{c0}^B)$.

The loss of low-wage black workers increases planters' labor costs, which encourages the adoption of labor-saving capital-intensive production methods. In flooded counties, there will be increases in the capital stock, the population of white workers, and output per black worker. These changes will be especially pronounced if there is a higher substitutability between capital and black workers; for example, if there is capital-skill complementarity and white workers are higher-skilled on average.

This model does not include dynamic adjustment costs. It may take a number of periods to make technological adjustments and to accumulate the desired capital stock, particularly after destruction during the flood. Due to the temporary decline in moving costs and permanent decline in paternalism value, however, the decline in black population is predicted to be immediate and persistent.

Agricultural land values reflect the present discounted value of rents and, in this baseline model, decline immediately due to the loss of exploitable low-cost black labor. Land values would increase if capital investment became fixed to the land, but this is a matter of accounting and does not reflect gains for landowners.

If there were sufficiently large externalities in capital investment, however, the flood may cause a "big push" that increases land values immediately. The private return to capital investment may be increasing in county-level total capital investment due to knowledge spillovers or coordinated investments in new capital equipment and infrastructure (see, e.g., Romer 1986; Murphy, Shleifer, and Vishny 1989; Foster and Rosenzweig 1995). Agricultural modernization and capital investment may also increase over time due to learning-by-doing, but land values would increase immediately after the flood only if there were substantial externalities associated with anticipated agricultural development.

III. Data Construction and Baseline Differences in Flooded Counties

A. *Data Construction and Aggregate Trends*

Historical county-level data are drawn from the Census of Agriculture and the Census of Population (Haines 2010).[14] The main variables of interest include: black population, value of agricultural equipment and machinery, average farm size, number of tractors, number of mules and horses, and value of agricultural land and buildings.[15] The value of agricultural equipment and machinery includes all tools, wagons, cotton gins, threshing machines, and all other machinery used in carrying out farm business (engines, motors, tractors, automobiles, and motor trucks); note that this measure excludes the value of mules and horses, levees, or any land improvements (Census Bureau 1927).

For the 1920s, a direct measure of migration is drawn from matched individual-level census data in 1920 and 1930 (Boustan, Kahn, and Rhode 2012).[16] The match rate of 24 percent is comparable with the existing literature, though false matches will tend to overstate migration rates. Later analysis examines the fraction of matched individuals in 1930 that have left their 1920 county, state, or the South (and differences by race).

The empirical analysis focuses on a balanced panel of 163 counties, from 1900 to 1970, for which data are available in every period of analysis. To account for county border changes, data are adjusted in later periods to maintain 1900 county definitions (Hornbeck 2010). The main sample is restricted to contiguous counties in Arkansas, Louisiana, Mississippi, and Tennessee with a black population share greater than 0.10 in 1920 and a fraction of cropland in cotton greater than 0.15 in 1920.[17] Additional specifications examine counties elsewhere in the South, particularly those near other major rivers.

Figure 1 maps the extent of flooding in 1927, overlaid with county borders in 1900. Our main measure of flood intensity is the fraction of each county flooded (from Figure 1), though the empirical results are robust to using Red Cross reports on the fraction of population affected by flooding in each county.[18]

Figure 2 reports aggregate changes in the sample region from 1900 to 1970. Black population decreased substantially from 1940 to 1970, during the second Great Migration; and decreased somewhat in the 1910s, during the first Great Migration (panel A). Total population increased through 1940, before declining into the 1960s

[14] We thank Michael Haines and collaborators for providing additional data from ongoing collection.

[15] Note that "farm size" refers to the size of farm operator parcels, rather than units of land ownership.

[16] We thank Leah Boustan, Matt Kahn, and Paul Rhode for sharing their matched census data.

[17] As an additional step in focusing the analysis on initially similar flooded and nonflooded counties, the empirical results are robust to controlling for counties' estimated flood propensity score interacted with each year. The probability that a county experienced any flooding is modeled as a probit function of the county's black population share in 1920 and fraction of cropland allocated to cotton in 1920. Only six of the original 163 counties are dropped when limiting the sample to flooded and nonflooded counties with overlapping values of this propensity score.

[18] Alternatively, the estimates are robust to using Red Cross data on the fraction of agricultural land flooded or the fraction of total land flooded (Red Cross 1928). We thank Paul Rhode for sharing these Red Cross data, which we supplemented.

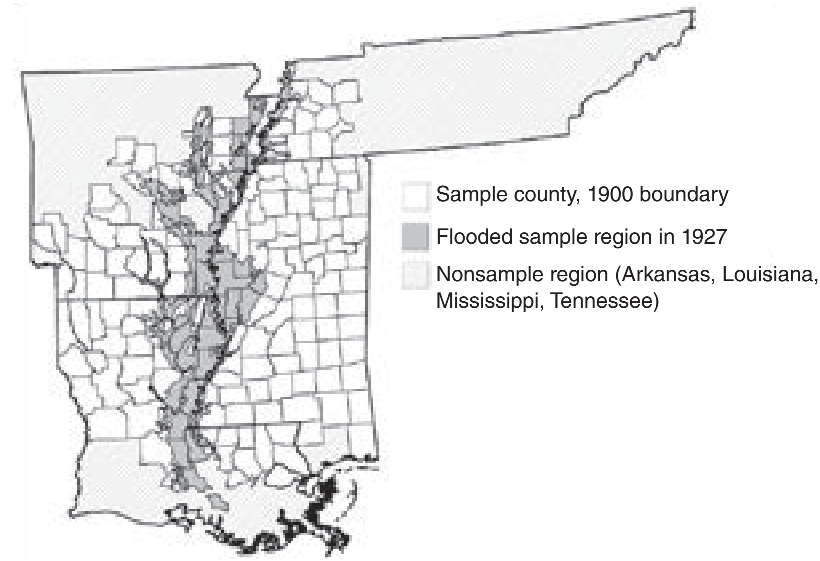

Figure 1. 1927 Flooded Region and Sample Counties (*1900 Boundaries*)

Notes: The 163 sample counties' boundaries are based on county definitions in 1900. County-level data are adjusted to hold these boundaries fixed through 1970 (Minnesota Population Center 2011). The sample region flooded in 1927 is shaded gray, based on a map compiled and printed by the US Coast and Geodetic Survey (1927). The nonsample region is cross-hatched. Excluded counties are missing outcome data in one of the analyzed years, have less than 15 percent of reported cropland in cotton in 1920, or have a black population less than 10 percent of the total population in 1920.

(panel B). The value of agricultural capital increased through 1920 and then after 1940, during the second Great Migration, the introduction of the mechanical cotton picker, and the Civil Rights movement (panel C). The number of mules and horses were mainly constant through 1940, and then declined substantially through 1960 (panel D). Average farm sizes declined through 1930, before increasing substantially through 1970 (panel E). The value of agricultural land per farm acre increased through World War I, and then again with post–World War II technological improvements (panel F). This figure provides some background on regional trends, whereas the main empirical analysis estimates relative changes for flooded counties.

B. *Baseline Differences in Flooded Counties*

In an initial step, the empirical analysis explores predifferences between flooded and nonflooded counties. For 1925 or 1920, depending on data availability, county outcome Y is regressed on the fraction of county land flooded in 1927 and state fixed effects:

$$Y_c = \beta Flood_c + \alpha_s + \epsilon_c. \tag{3}$$

For each outcome variable, the estimated β reflects within-state differences in preflood characteristics for flooded counties and nonflooded counties.

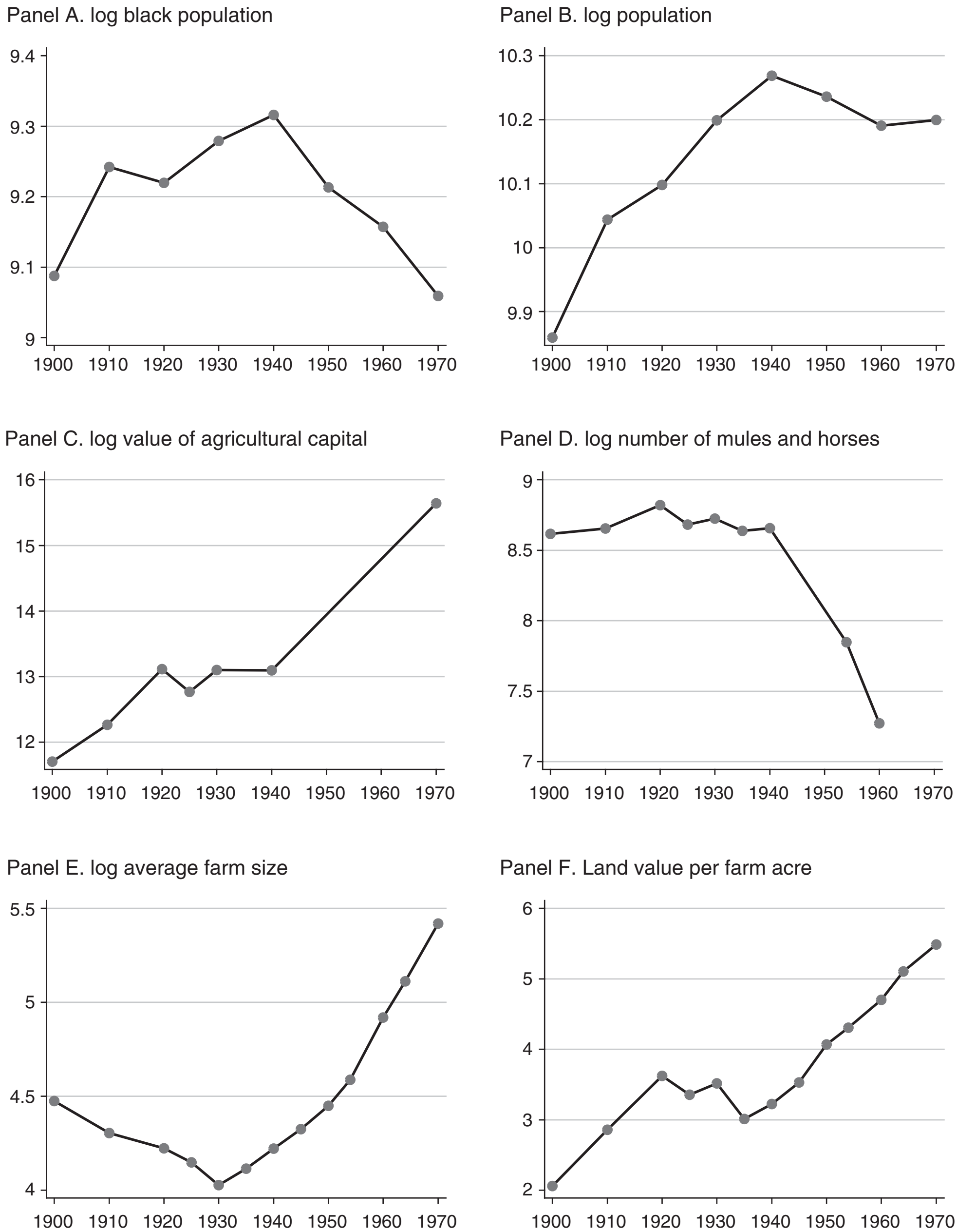

Figure 2. Aggregate Changes in the Sample Region (*Arkansas, Louisiana, Mississippi, and Tennessee*)

Note: Panels A–F report aggregated outcomes for the 163 sample counties in each year (Figure 1).
Source: Data are from the US Census of Agriculture and the US Census of Population.

To explore differences in pretrends between flooded and nonflooded counties, equation (3) is modified to regress the change in outcome Y from 1910 to 1920 (or from 1920 to 1925) on the fraction of county land flooded in 1927 and state fixed effects:

TABLE 1—BASELINE COUNTY CHARACTERISTICS, BY 1927 FLOOD SHARE

		log difference by 1927 flood share			
		Preflood levels		Preflood changes	
	Preflood sample mean (1)	Within-state (2)	Controls (3)	Within-state (4)	Controls (5)
Panel A. Population in 1920					
Black population share	0.46	0.782**	0.449**	−0.003	−0.055
	(0.20)	(0.101)	(0.133)	(0.022)	(0.029)
Black population, per 100 county acres	2.99	1.003**	0.526*	0.033	−0.052
	(2.46)	(0.171)	(0.211)	(0.064)	(0.082)
Population, per 100 county acres	6.24	0.220	0.077	0.037	0.003
	(4.33)	(0.133)	(0.176)	(0.057)	(0.071)
Black operated farm share	0.48	1.168**	0.697**	0.019	−0.039
	(0.26)	(0.171)	(0.201)	(0.026)	(0.034)
Panel B. Agriculture in 1925					
Value of farm equipment, per 100 county acres	95.0	0.554**	0.250	−0.129	0.044
	(60.9)	(0.139)	(0.178)	(0.079)	(0.115)
Number of mules and horses, per 100 county acres	1.56	0.422**	0.080	−0.080*	−0.048
	(0.84)	(0.141)	(0.172)	(0.040)	(0.057)
Number of tractors per 100 county acres	0.008	1.139**	0.479		
	(0.010)	(0.284)	(0.390)		
Average farm size	66.9	−0.618**	−0.417**	0.017	−0.076
	(21.4)	(0.094)	(0.101)	(0.050)	(0.065)
Farmland acres, per 100 county acres	47.4	−0.144	−0.244	−0.077	−0.135*
	(17.3)	(0.102)	(0.127)	(0.045)	(0.060)
Value of farm land and buildings, per 100 farm acres	3,370	1.018**	0.702**	−0.272**	−0.065
	(2,094)	(0.124)	(0.162)	(0.046)	(0.060)
Value of farm land and buildings, per 100 county acres	1,606	0.875**	0.459*	−0.350**	−0.200*
	(1,316)	(0.168)	(0.197)	(0.061)	(0.081)
Number of counties	163	163	163	163	163

Notes: Column 1 reports average baseline county characteristics in 1920 (panel A) and 1925 (panel B). All variables are reported in levels (not logs), and the standard deviation is reported in parentheses. Column 2 reports the within-state difference for each county characteristic (in logs) by the fraction of the county flooded in 1927: the coefficients are estimated by regressing the indicated county characteristic on the fraction of the county flooded in 1927 and a state fixed effect, weighting by county size. Column 3 reports the estimated difference when controlling also for each county's distance to the Mississippi River, geographic suitability for cotton and corn, terrain ruggedness, and longitude and latitude. Column 4 reports the within-state difference in pretrends for each county characteristic (in logs): panel A reports the change from 1910 to 1920, and panel B reports the change from 1920 to 1925. The coefficients are estimated by regressing the change in the indicated county characteristic on the fraction of the county flooded in 1927 and a state fixed effect, weighting by county size. Column 5 reports the estimated difference in pretrends when controlling also for the above six county-level variables. Tractor data are only available in 162 counties and not before 1925. Robust standard errors are reported in parentheses.

**Significant at the 1 percent level.

*Significant at the 5 percent level.

$$(4) \qquad Y_{ct} - Y_{c(t-1)} = \beta Flood_c + \alpha_s + \epsilon_c .$$

For each outcome variable, the estimated β reflects within-state differences in preflood trends in characteristics for flooded counties and nonflooded counties.

Table 1, column 1, reports average county characteristics prior to the 1927 flood. Column 2 reports within-state differences in preflood characteristics for flooded counties, and column 3 reports these differences conditional on six county-level controls (distance from the Mississippi River, geographic suitability for cotton and corn, terrain ruggedness, and longitude and latitude). Column 4 reports within-state differences in preflood trends for flooded counties, and column 5 reports differential trends conditional on the six county-level controls.

Prior to the 1927 flood, flooded counties and nonflooded counties are estimated to have had similar changes in most outcomes. Flooded counties had an initially higher black population and a greater intensity of small-scale agricultural production, though these differences are partly mitigated by county-level controls. To the extent that flooded counties were different in pretrends or levels, the empirical specifications control for preflood differences.

IV. Empirical Framework

The empirical specifications estimate year-specific differences between flooded counties and nonflooded counties, relative to a base year of 1925 or 1920. Outcome Y in county c and year t is regressed on the fraction of county land flooded in 1927, state-by-year fixed effects, and county fixed effects:

$$Y_{ct} = \beta_t Flood_c + \alpha_{st} + \alpha_c + \epsilon_{ct}. \tag{5}$$

Note that β is allowed to vary by year, so each estimated β is interpreted as the average difference between flooded counties and nonflooded counties in that year relative to the omitted base year of 1925 or 1920.

In practice, most empirical specifications control for county characteristics $(\mathbf{X}_c)$ that may predict differential changes between flooded and nonflooded counties:

$$Y_{ct} = \beta_t Flood_c + \alpha_{st} + \alpha_c + \theta_t \mathbf{X}_c + \epsilon_{ct}. \tag{6}$$

The specifications control for preflood values of the outcome variable, flexibly allowing for convergence over time in the outcome variable or otherwise differential changes associated with initially different values.[19] The identification assumption is that, if not for the flood, flooded counties would have changed similarly to nonflooded counties in the same state and with similar preflood values of the outcome variable. An empirical concern is that inherent differences between flooded and nonflooded areas may have caused some county characteristics to change differently after 1927, even in the absence of the flood.[20]

As a consequence, most specifications also control for year-interacted measures of counties' distance to the Mississippi River, geographic suitability for cotton and corn, terrain ruggedness, and longitude and latitude. Controlling for distance to the Mississippi allows for the impact of river proximity to change over time, as counties closer to the Mississippi are more likely to be flooded in 1927 and nearby counties have better river access to markets.[21] Controlling for crop suitability allows for crop-specific changes in technology and prices, or changes that otherwise differentially

[19] Note that this specification is not a lagged dependent variable model; instead, the specification controls only for pretreatment values of the dependent variable.

[20] In particular, the assumption that flooded and nonflooded areas would have changed similarly becomes stronger in later periods.

[21] Alternatively, the estimates are robust to restricting the sample to counties within 50 km or 100 km of the Mississippi River.

affect areas suitable for different crops.[22] Controlling for terrain ruggedness allows for differential changes in areas that may differ in suitability for agricultural mechanization.[23] Finally, controlling separately for longitude and latitude allows for spatial patterns in economic changes that may be correlated with flooding.

The above control variables are fixed county geographic characteristics, but additional specifications also control for locally targeted economic policies. New Deal programs in the 1930s may have impacted agricultural development by displacing tenants and increasing availability of harvest laborers (Whatley 1983; Depew, Fishback, and Rhode 2012). New Deal spending by county may itself be affected by the flood, but results are shown with and without year-interacted controls for counties' per capita spending through the AAA, public works, relief, loan, and guaranteed mortgage programs (Fishback, Horrace, and Kantor 2005). The New Deal is a sufficiently large shock to Southern agriculture, with potentially many of the same effects as the flood, that these controls are a useful robustness check despite the potential endogeneity of New Deal spending.

For the statistical inference in all specifications, standard errors are clustered at the county level to adjust for heteroskedasticity and within-county correlation over time. When allowing for spatial correlation among sample counties, the estimated standard errors generally increase by less than 15 percent.[24] The regressions are weighted by county size, so the estimates reflect changes for an average acre of flooded land.

V. Main Results

A. *Population*

Figure 3 shows estimated changes in black population for flooded counties, relative to changes for nonflooded counties, from estimating equation (5). Consistent with the identification assumption, the black population share changed similarly in flooded counties and nonflooded counties prior to the 1920s. Flooded counties experienced a 14 percent (0.151 log point) decline from 1920 to 1930 in their black population share. Following the 1927 flood, this short-run decline in black population share persisted through 1970.

Table 2, column 1, reports estimated declines in black population share when estimating equation (6) and controlling for counties' black population share in 1920, 1910, and 1900, and the six county geographic characteristics. Column 2

[22] Cotton and corn are the two major crops in 1925 in the sample region. Crop suitability reflects the maximum potential yield of that crop, as calculated by the FAO using data on climate, soil type, and ideal growing conditions for that crop. The FAO's Global Agro-Ecological Zone maps (version 3.0) are used to create county-level average crop suitability for cotton and corn (FAO 2012). Potential yields are calculated using climate averages from 1961 to 1990 and rain-fed conditions with intermediate inputs.

[23] Counties' ruggedness is measured as the standard deviation in altitude across county points, calculated from the USGS National Elevation Dataset (Farr et al. 2007). Estimates are similar when ruggedness is measured by the maximum range in altitude across county points. Estimates are also similar when controlling for interactions between terrain ruggedness and geographic suitability for cotton and corn (and their main effects).

[24] Spatial correlation among counties is assumed to be declining linearly up to a distance cut off and zero after that cut off (Conley 1999). For distance cut offs of 50 miles, 100 miles, or 200 miles, the estimated Conley standard errors are generally less than 15 percent higher than the standard errors when clustering at the county level, depending on the outcome variable and year.

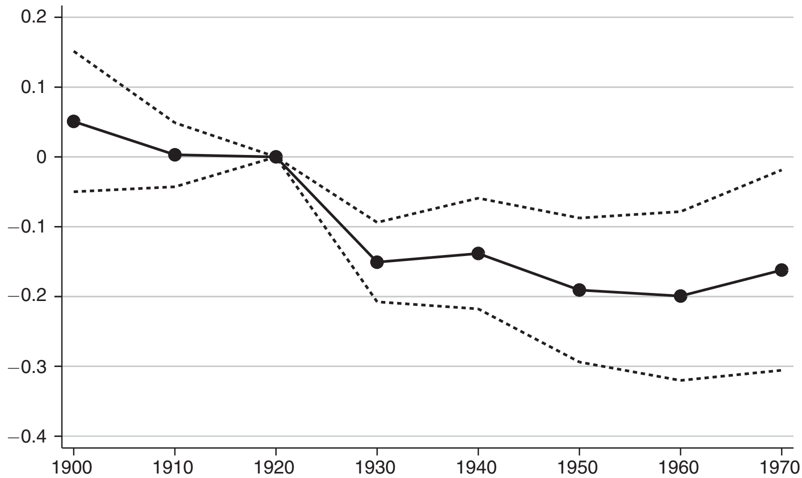

Figure 3. Estimated Differences in Black Population in Flooded Counties, Relative to 1920

Notes: This graph reports estimated differences in log black population share between flooded counties and nonflooded, relative to differences in 1920. From estimating equation (5) in the text, the outcome is regressed on the fraction of the county flooded, state-by-year fixed effects, and county fixed effects. The dashed lines indicate 95 percent confidence intervals, based on robust standard errors clustered by county.

Table 2—Estimated Differences in Population by Flood Share, Relative to 1920

	log fraction black		log black population		log population		log black farm share	
Decade	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1930	−0.144**	−0.155**	−0.170*	−0.181**	−0.008	−0.032	−0.254**	−0.239**
	(0.043)	(0.041)	(0.078)	(0.065)	(0.070)	(0.059)	(0.058)	(0.057)
1940	−0.165**	−0.207**	−0.107	−0.168*	0.061	0.023	−0.245**	−0.259**
	(0.047)	(0.050)	(0.085)	(0.081)	(0.075)	(0.062)	(0.068)	(0.074)
1950	−0.202**	−0.240**	−0.218	−0.226*	−0.006	−0.010	−0.309**	−0.345**
	(0.065)	(0.065)	(0.118)	(0.093)	(0.108)	(0.085)	(0.098)	(0.105)
1960	−0.170*	−0.221**	−0.277	−0.222*	−0.063	−0.005		
	(0.080)	(0.070)	(0.145)	(0.104)	(0.149)	(0.116)		
1970	−0.146	−0.207*	−0.344*	−0.202	−0.207	−0.024		
	(0.096)	(0.088)	(0.170)	(0.115)	(0.178)	(0.144)		
Counties	163	163	163	163	163	163	163	163

Notes: Each column reports estimated changes in the indicated outcome variable: changes in flooded counties relative to changes in nonflooded counties, relative to the omitted year of 1920. Columns 1, 3, 5, and 7 report coefficients from regressing the outcome variable on the fraction of the county flooded in 1927, state-by-year fixed effects, county fixed effects, and lagged values of the outcome variable in 1900, 1910, and 1920 interacted with each year, as well as controlling for six county geographic characteristics interacted with each year (distance to the Mississippi River, cotton and corn suitability, ruggedness, and latitude and longitude). Columns 2, 4, 6, and 8 add five categories of New Deal spending interacted with year as controls. All regressions are weighted by county size. Robust standard errors clustered by county are reported in parentheses.

**Significant at the 1 percent level.

*Significant at the 5 percent level.

reports estimated declines when also controlling for counties' New Deal spending in the 1930s.

The demographic shift was mainly caused by a decline in the black population (Table 2, columns 3 and 4), with little change in total population (Table 2, columns 5 and 6). Theoretical predictions for changes in total population depend on the functional form of the production function, but the offsetting increase in white population is consistent with a complementarity between capital and white labor and/or an inelastic demand for labor.[25]

These changes in population are reflected in the composition of farms, where there was a large decline in the share of black-operated farms (Table 2, columns 7 and 8). Black farm operators tended to be lower on the "tenancy ladder" than white farm operators, with much higher rates of sharecropping.[26] This black population may have the highest moving costs and the most to gain from employer paternalism. The decrease in the supply of black workers and farm operators, and a shift toward white agricultural labor and farm operators, would be associated with increased labor costs for landowners.

The estimated changes in county-level population mainly reflect net migration, but a direct measure of out-migration uses matched individual-level census data from 1920 and 1930.[27] Table 3, panel A and column 1, reports that the fraction of matched people leaving their county between 1920 and 1930 is 11.8 percentage points higher in flooded counties than in nonflooded counties within the same state.[28] Flooded counties also have a higher fraction of matched people leaving their state (column 2), though a similar fraction leaving the South entirely (column 3).[29]

Migration estimates are more striking for the subsample of individuals whose race is observed. Blacks in flooded counties are more likely to leave their county (column 1), their state (column 2), and the South entirely (column 3), while whites are not more likely to leave flooded counties. Column 4 reports estimated differences in migration into flooded counties, with an insignificant and negative effect overall (panel A), little effect on blacks (panel B), and higher in-migration among whites (panel C). Analysis of migration rates is based on smaller samples of matched individuals, however, so the estimates are less precise and more sensitive to county-level controls than estimated changes in county-level population.[30]

Overall, the estimates are consistent with historical accounts of an immediate and persistent decline in black population in flooded counties. The empirical results do not identify whether this decline in population reflects the flood's temporary

[25] Increases in farmland (estimated below) imply subsequent declines in total population per farm acre.

[26] Using data from Jefferson County, Arkansas (Alston and Ferrie 2005) for the period from 1920 to 1927, we calculate that 66 percent of white-operated farms are owner-operated and 74 percent of black-operated farms are either sharecroppers (45 percent) or cash-tenancies (29 percent).

[27] We thank Leah Boustan, Matt Kahn, and Paul Rhode for sharing their matched census data (Boustan, Kahn, and Rhode 2012). Matches are required to be unique by name and place of birth (state or country) within five-year age bands. Average migration rates may be overstated due to false matches, though this would introduce bias only if errors were differential across flooded counties and nonflooded counties.

[28] The county-level out-migration rate is calculated as the number of matched people leaving the county, divided by the total number of matched people originally in the county. The regression is weighted by the number of matched people in each county, so the estimates reflect a change in probability of migration for the average person.

[29] Southern states are defined as Arkansas, Louisiana, Tennessee, Mississippi, Alabama, North Carolina, South Carolina, Georgia, and Florida.

[30] Some of the estimates lose statistical significance when controlling for county geographic differences, but the estimates continue to indicate higher out-migration among blacks than whites.

Table 3—Estimated Differences in 1920–1930 Migration Rates by Flood Share

	Fraction moving out of county (1)	Fraction moving out of state (2)	Fraction moving out of South (3)	Fraction moving into county (4)
Panel A. All matched people				
Mean in nonflooded counties	0.661	0.287	0.161	0.768
	(0.130)	(0.136)	(0.123)	(0.469)
Difference in flooded counties	0.118**	0.113**	−0.003	−0.268
	(0.031)	(0.033)	(0.040)	(0.158)
Number of matched individuals	7,102	7,102	7,102	6,822
Counties with matched people	162	162	162	162
Panel B. Black population only				
Mean in nonflooded counties	0.698	0.245	0.136	0.585
	(0.206)	(0.187)	(0.158)	(0.544)
Difference in flooded counties	0.139**	0.177**	0.068*	0.007
	(0.046)	(0.041)	(0.030)	(0.125)
Number of matched individuals	1,186	1,186	1,186	917
Counties with matched people	153	153	153	153
Panel C. White population only				
Mean in nonflooded counties	0.629	0.296	0.166	0.374
	(0.152)	(0.183)	(0.162)	(0.330)
Difference in flooded counties	−0.069	0.034	−0.032	0.336**
	(0.058)	(0.060)	(0.050)	(0.123)
Number of matched individuals	1,324	1,324	1,324	1,124
Counties with matched people	156	156	156	156

Notes: Column 1 reports the fraction of people, matched between the 1920 census and 1930 census, that left their county between 1920 and 1930. Column 2 reports the fraction of matched people that have left their state from 1920 to 1930, and Column 3 reports the fraction that have left the South from 1920 to 1930. Column 4 reports the number of people moving into that county between 1920 and 1930, as a fraction of people in that county in 1920. Panel A includes all matched people, panel B limits the sample to those people known to be black, and panel C limits the sample to those people known to be white. Each panel and column reports the mean value in nonflooded counties and the standard deviation in parentheses. Each panel and column reports the difference in migration rate for flooded counties, relative to non-flooded counties, controlling for state fixed effects. All regressions are weighted by the fraction of matched people in each county. Robust standard errors are reported in parentheses.

**Significant at the 1 percent level.

*Significant at the 5 percent level.

displacement effect and a decline in the opportunity cost of migration, a breakdown of trust between planters and black workers, or a shift in black social networks toward favoring migration. The persistent decline in black population, following a temporary natural disaster, does suggest a breakdown of historically segmented labor markets for black workers in the flooded region. The empirical analysis following explores the impacts on subsequent agricultural development.

B. *Agricultural Capital Investment and Modernization*

Figure 4 shows estimated changes in the value of agricultural capital equipment and machinery for flooded counties, relative to nonflooded counties, from estimating equation (5). The value of capital had been changing similarly in flooded and nonflooded counties and, following losses sustained during the 1927 flood, mostly recovered by 1930. By 1940, the value of agricultural capital had increased substantially in flooded counties relative to nonflooded counties. Relative increases in

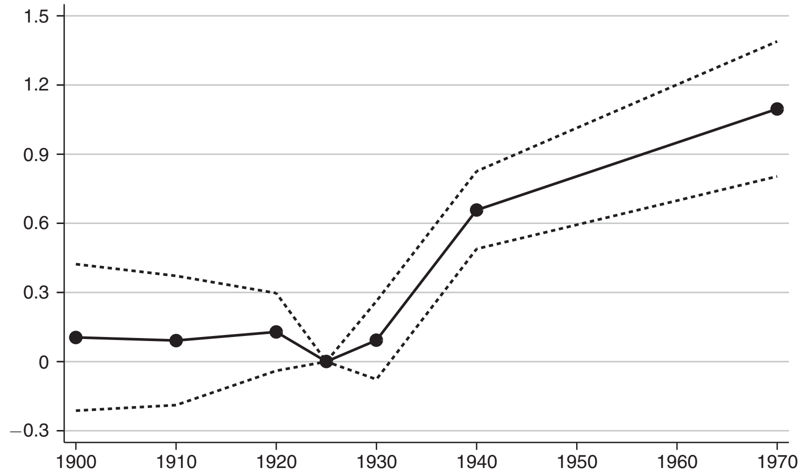

Figure 4. Estimated Differences in Farm Capital in Flooded Counties, Relative to 1920

Notes: This graph reports estimated differences in log value of farm equipment and machinery between flooded counties and nonflooded, relative to differences in 1925. From estimating equation (5) in the text, the outcome is regressed on the fraction of the county flooded, state-by-year fixed effects, and county fixed effects. The dashed lines indicate 95 percent confidence intervals, based on robust standard errors clustered by county.

agricultural capital continued through 1970. While it becomes more difficult to rule out other differential shocks in later periods, capital values do not appear to converge over time in flooded and nonflooded counties. The estimated increases in capital intensity are smaller in magnitude after controlling for differences in geography (Table 4, column 1) and also for 1930s New Deal program spending (Table 4, column 2), but flooded counties continue to have large relative increases over time in the value of capital equipment and machinery.

Table 4, columns 3 and 4, report large percent increases in tractors in flooded counties relative to nonflooded counties through at least the 1940s.[31] Tractors were still rare in the sample region during the 1920s and 1930s, however, so these estimates reflect only small initial increases in the number of tractors per farm.[32]

Traditional sources of agricultural power were mules and horses, which were used by agricultural workers but were overall a substitute for manpower.[33] Table 4, columns 5 and 6, report that the number of mules and horses was relatively unchanged. Despite the large number of animal deaths during the flood, there is no indication of planters reducing use of this older-vintage capital in the immediate

[31] While tractor quality is unobserved, higher agricultural capital in later periods and a more-similar number of tractors may indicate higher tractor quality in flooded counties.

[32] Based on the average number of tractors per farm in nonflooded counties in each year, the estimates in column 3 represent an increase in the number of tractors per farm of 0.01 in 1930, 0.04 in 1940, 0.06 in 1945, 0.17 in 1954, and 0.62 in 1970.

[33] Mules and horses are a form of "capital," but their value is not included in the value of agricultural capital equipment and machinery.

Table 4—Estimated Differences in Capital Intensity by Flood Share, Relative to 1925

	log farm capital		log tractors		log mules and horses		log average farm size	
Decade	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1930	−0.070	−0.101	0.473*	0.505*	0.048	−0.042	0.037	0.042
	(0.108)	(0.109)	(0.193)	(0.202)	(0.058)	(0.056)	(0.059)	(0.064)
1935					0.104	0.014	0.196**	0.187**
					(0.066)	(0.065)	(0.063)	(0.062)
1940	0.378**	0.326**	0.951**	0.910**	0.155*	0.050	0.185*	0.171*
	(0.113)	(0.119)	(0.261)	(0.258)	(0.076)	(0.079)	(0.083)	(0.083)
1945			0.622**	0.530**			0.284**	0.242**
			(0.204)	(0.185)			(0.078)	(0.077)
1950							0.484**	0.416**
							(0.092)	(0.091)
1954			0.403	0.311	−0.242	−0.278	0.609**	0.536**
			(0.209)	(0.181)	(0.130)	(0.142)	(0.108)	(0.107)
1960					−0.460**	−0.468**	0.782**	0.719**
					(0.138)	(0.159)	(0.145)	(0.142)
1964							0.942**	0.891**
							(0.167)	(0.166)
1970	0.807**	0.673**	0.455*	0.262			0.723**	0.644**
	(0.159)	(0.160)	(0.204)	(0.177)			(0.162)	(0.162)
Counties	163	163	162	162	163	163	163	163

Notes: Each column reports estimated changes in the indicated outcome variable: changes in flooded counties relative to changes in nonflooded counties, relative to the omitted year of 1925. Columns 1, 3, 5, and 7 report coefficients from regressing the outcome variable on the fraction of the county flooded in 1927, state-by-year fixed effects, county fixed effects, and lagged values of the outcome variable in 1900, 1910, and 1920 interacted with each year, as well as controlling for six county geographic characteristics interacted with each year (distance to the Mississippi River, cotton and corn suitability, ruggedness, and latitude and longitude). Columns 2, 4, 6, and 8 add five categories of New Deal spending interacted with year as controls. All regressions are weighted by county size. Robust standard errors clustered by county are reported in parentheses.

**Significant at the 1 percent level.

*Significant at the 5 percent level.

aftermath of the flood. By the 1950s and 1960s, however, use of this "Old South" power source declined.[34]

Many agricultural production practices are unobserved in the data, but increased scale of farm operation was strongly associated with a transition from older methods of agricultural production to modernized agricultural production in the South. Table 4, columns 7 and 8, report that flooded counties experienced a gradual and substantial increase in average farm size, relative to nonflooded counties. Farm sizes increased particularly during the 1950s and 1960s as mechanical cotton pickers became increasingly available.[35]

It is difficult to measure the increase in labor productivity associated with reported changes in production inputs and methods. As a proxy, however, data are available for the value of crops per capita. From estimating equation (6), the log value of crops per capita changed similarly in flooded and nonflooded counties from 1910 through 1930. This proxy for average labor productivity increased substantially in

[34] Note that it is more difficult to rule out other differential shocks in these later periods.

[35] Grove and Heinicke (2003) present aggregate data showing that the share of cotton harvested by mechanical pickers in the Mississippi Delta region went from essentially zero in 1949 to 60 percent by the 1960s.

flooded counties through the 1930s, 1940s, and 1950s.[36] While county-level wage data are unavailable, the estimated increases in labor productivity are consistent with increased labor costs in flooded counties.

Overall, the estimated increases in agricultural capital equipment and machinery appear to embody labor-saving technological adoption in the agricultural sector. Initial increases in agricultural capital did not come through replacing older-vintage capital that was destroyed by the flood (i.e., mules and horses). While many agricultural production practices are unobserved, the observed trend toward larger farm operation size would be associated with a bundle of modernized agricultural production methods.

The flooded area was likely too small, relative to national cotton production, for the decline in black labor availability to encourage labor-saving technological innovation (e.g., Habakkuk 1962; Allen 2009; Acemoglu 2010), but decreased labor availability appears to have made flooded counties more suitable for capital-intensive methods of production (e.g., Atkinson and Stiglitz 1969; Basu and Weil 1998). Increases over time in the value of capital and farm sizes may reflect learning-by-doing, increased availability of wage workers during the Depression and New Deal, and/or subsequent increases in the availability of mechanical cotton pickers.

C. *Farmland Acreage and Value*

Table 5, columns 1 and 2, report that flooded counties began to experience substantial relative increases in farmland in the 1940s and 1950s. Thus, as farms became larger and more capital intensive, agricultural production in flooded counties also became more land intensive. One interpretation is that increased capital usage was complementary with clearing and plowing additional farmland.[37] The estimated increases in farmland are smaller in magnitude when controlling for 1930s New Deal program spending, but there remains a substantial relative trend toward increased farmland in flooded counties.

Estimated increases in total farmland complicate an analysis of the value of agricultural land and buildings. In principle, changes in agricultural land values reflect the loss (or gain) to landowners from decreased black labor availability and subsequent agricultural adaptation. New farmland may be of generally lower quality than initial farmland, however, causing a downward bias in the value of farmland per farm acre. By contrast, clearing and plowing new farmland requires some sunk costs and, as these costs are capitalized into land values, there will be an upward bias in the value of farmland per county acre.

Immediately after the flood, flooded counties experienced little change or declines in the value of agricultural land per farm acre (Table 5, columns 3 and 4)

[36] When excluding the New Deal controls, the estimated coefficients (and standard errors) are 0.034 (0.131) in 1930, 0.254 (0.123) in 1940, 0.575 (0.244) in 1950, and 1.272 (0.310) in 1960. When including the New Deal controls, the estimated coefficients are −0.014 (0.135) in 1930, 0.214 (0.123) in 1940, 0.468 (0.242) in 1950, and 1.078 (0.299) in 1960. Estimated relative changes are similar and slightly larger for the log value of crops per person living in rural areas of the county.

[37] The increase in agricultural land may represent a decrease in land under the public domain, or an increase in the fraction of privately owned land that is in operation (or fallow) and captured by census enumerators. Note that the empirical specifications estimate relative changes, so the reported increases may also reflect less of a decline in farmland in some flooded counties relative to nonflooded counties.

Table 5—Estimated Differences in Farmland by Flood Share, Relative to 1925

	log farmland		log value of farmland per farm acre		log value of farmland per county acre	
Decade	(1)	(2)	(3)	(4)	(5)	(6)
1930	−0.023	−0.101	−0.043	−0.007	−0.119	−0.128*
	(0.047)	(0.053)	(0.065)	(0.062)	(0.066)	(0.061)
1935	0.053	−0.009	−0.084	−0.073	−0.074	−0.080
	(0.058)	(0.059)	(0.069)	(0.067)	(0.093)	(0.087)
1940	0.203**	0.096	−0.110	−0.091	0.055	0.033
	(0.059)	(0.069)	(0.056)	(0.055)	(0.074)	(0.075)
1945	0.265**	0.176*	−0.333**	−0.313**	−0.046	−0.058
	(0.080)	(0.085)	(0.078)	(0.079)	(0.089)	(0.097)
1950	0.325**	0.188*	−0.391**	−0.295**	−0.133	−0.128
	(0.086)	(0.091)	(0.080)	(0.070)	(0.100)	(0.097)
1954	0.408**	0.284**	−0.351**	−0.235**	−0.042	−0.007
	(0.101)	(0.105)	(0.078)	(0.070)	(0.102)	(0.100)
1960	0.558**	0.377**	−0.404**	−0.295**	0.013	0.041
	(0.129)	(0.134)	(0.108)	(0.106)	(0.129)	(0.131)
1964	0.669**	0.485**	−0.266**	−0.208*	0.216	0.213
	(0.144)	(0.147)	(0.099)	(0.101)	(0.125)	(0.136)
1970	0.943**	0.701**	−0.301**	−0.223**	0.401*	0.368*
	(0.180)	(0.176)	(0.081)	(0.081)	(0.155)	(0.152)
Counties	163	163	163	163	163	163

Notes: Each column reports estimated changes in the indicated outcome variable: changes in flooded counties relative to changes in nonflooded counties, relative to the omitted year of 1925. Columns 1, 3, and 5 report coefficients from regressing the outcome variable on the fraction of the county flooded in 1927, state-by-year fixed effects, county fixed effects, and lagged values of the outcome variable in 1900, 1910, and 1920 interacted with each year, as well as controlling for six county geographic characteristics interacted with each year (distance to the Mississippi River, cotton and corn suitability, ruggedness, and latitude and longitude). Columns 2, 4, and 6 add five categories of New Deal spending interacted with year as controls. All regressions are weighted by county size. Robust standard errors clustered by county are reported in parentheses.
**Significant at the 1 percent level.
*Significant at the 5 percent level.

and per county acre (Table 5, columns 5 and 6). The value of land per farm acre declined further over time, which may reflect a compositional decline in average land quality. The value of land per county acre increased over time, which may reflect sunk costs in clearing and plowing new farmland.[38] Across all four specifications, however, the estimates reject a substantial immediate increase in agricultural land values that might suggest landowners anticipated benefiting from the forced economic transition.[39]

Overall, the estimates suggest a single equilibrium in which landowners must adapt to decreased labor availability. Landowners' coordinated resistance to black out-migration is consistent with landowners not anticipating economic gains from a "big push" toward agricultural modernization. Black migrants presumably benefited

[38] Landowners in flooded counties may also have unexpectedly benefited from later technological innovations that favored capital-intensive agricultural production.
[39] Data on land values and building values are available separately, by decade, from 1900 to 1940. In 1920, the value of land averages 77 percent of the combined value of land and buildings. Focusing on changes in the value of land only, in 1930 and 1940, the estimates are similar.

from the option to migrate after the flood, though this does not imply that migrants benefited overall from the flood.[40]

VI. Threats to Validity

A. *Falsification Exercise*

An empirical concern is that nonflooded areas may be an inherently poor control group for flooded areas, despite including controls for preflood outcomes and geographic characteristics. As an alternative check on the results, a falsification exercise explores whether there are also differential changes between counties close to other major Southern rivers and counties further from other major Southern rivers. Restricting the analysis to nonflooded states, this sample includes 171 counties within 50 km of a major river and 72 counties between 50 km and 150 km of a major river.[41]

As in the main sample, counties near other major Southern rivers have higher black population in 1920 and a greater intensity of small-scale agricultural production in 1925 than counties further from other major Southern rivers. As in the main sample, these counties had been experiencing similar trends in the county outcomes of interest.[42]

Table 6 reports that counties near other major Southern rivers changed similarly after 1927 to counties further from other major Southern rivers.[43] Of the few statistically significant estimates, counties close to other major Southern rivers experienced some relative declines in capital.

Overall, in the absence of a catastrophic flood, counties near other major Southern rivers do not experience the black out-migration and increased agricultural development that appeared in counties flooded by the Mississippi in 1927. While the Mississippi River is a special river within the Southern United States, other counties near major rivers showed many of the same differences in characteristics prior to 1927. These estimates lend support to the identification assumption that flooded counties would have changed similarly to nonflooded counties in the absence of the flood.

[40] Under free mobility, there would need to be some externality or coordination failure among migrants to generate welfare gains from flood-induced out-migration when the black population had previously chosen to stay in the region. Chay and Munshi (2012) examine Southern black migration networks in the early twentieth century, which are consistent with potential externalities.

[41] These cut offs reflect typical distances to the Mississippi for flooded counties and nonflooded counties, respectively. As in the main sample, the sample is restricted to counties with a black population share greater than 0.10 in 1920 and a fraction of cropland in cotton greater than 0.15 in 1920. The major rivers shapefile was obtained from ESRI (2002).

[42] Analogous to the estimates from Table 1, these estimates refer to modified versions of equations (3) and (4), where the fraction of county flooded is replaced with a dummy variable for whether the county is within 50 km of a major river.

[43] In a modified version of equation (6), the fraction of county flooded is replaced with a dummy variable for whether the county is within 50 km of a major river. The specification controls for changes over each time period that are correlated with state and initial outcome differences. We have omitted three columns due to space constraints (population, mules and horses, value of farmland per county acre), but there are no substantial or statistically significant changes in these outcomes.

Table 6—Estimated Relative Changes in Counties within 50 km of Other Major Southern Rivers

	Fraction black (1)	Black population (2)	Black farm share (3)	Value farm capital (4)	Tractors (5)	Average farm size (6)	Farmland (7)	Land value/ farm ac (8)
1930	0.009	0.018	0.034	−0.045	−0.071	0.052*	0.021	−0.013
	(0.013)	(0.027)	(0.021)	(0.039)	(0.067)	(0.023)	(0.016)	(0.027)
1935						0.014	0.024	0.002
						(0.031)	(0.018)	(0.037)
1940	0.025	0.025	0.042	−0.092	−0.087	0.041	0.029	−0.015
	(0.017)	(0.033)	(0.030)	(0.059)	(0.088)	(0.031)	(0.020)	(0.037)
1945					−0.109	0.065	0.002	−0.042
					(0.093)	(0.037)	(0.022)	(0.041)
1950	0.016	0.007	0.012			0.055	−0.008	0.016
	(0.024)	(0.044)	(0.035)			(0.038)	(0.026)	(0.042)
1954					−0.238*	0.043	−0.006	−0.028
					(0.112)	(0.039)	(0.031)	(0.048)
1960	−0.010	0.002				0.056	−0.011	−0.042
	(0.031)	(0.061)				(0.044)	(0.044)	(0.047)
1964						0.078	−0.009	−0.054
						(0.048)	(0.048)	(0.046)
1970	−0.016	0.019		−0.190*	−0.254*	0.091	−0.031	−0.020
	(0.038)	(0.071)		(0.091)	(0.119)	(0.050)	(0.061)	(0.042)
Counties	243	243	243	243	240	243	243	243

Notes: Each column reports estimated changes in the indicated outcome variable (in logs): changes in counties within 50 km of a major river relative to changes in counties within 50 km–150 km of a major river, relative to the omitted year of 1920 or 1925. The sample is restricted to Southern counties within 150 km of a major river, excluding all counties in the main sample region (Figure 1). The indicated outcome variable is regressed on a dummy for whether the county is within 50 km of a major river, state-by-year fixed effects, county fixed effects, and county outcome values in 1900, 1910, 1920, and 1925 (when available), interacted with each year. All regressions are weighted by county size. Robust standard errors clustered by county are reported in parentheses.

**Significant at the 1 percent level.

*Significant at the 5 percent level.

B. *Plantation Counties*

One particular empirical concern is that flooded counties are more likely to be "plantation counties," as recorded by Brannen (1924) for 1910.[44] In nonflooded Southern states, plantation counties are estimated to have little differential change from 1930 to 1940 in the main outcome variables of interest.[45] Between 1940 and 1970, however, plantation counties do experience some relative declines in black population and increases in agricultural capital, average farm size, and farmland.[46]

[44] A plantation is defined as a "unified agricultural organization of considerable size under one management, of practically a continuous tract of land, operated as a single unit with respect to the methods of control of labor and products, all of which may be worked by wage hands, or all or a part of which may be subdivided and let to tenants" (Brannen 1924, p. 9). Brannen used since-lost census data and judgment to select counties where "plantation farming in these counties is known to be important" (Brannen 1924, p. 69).

[45] In a modified version of equation (6), the fraction of county flooded is replaced with a dummy variable for whether the county is a "plantation county."

[46] In a modified version of equation (6), as described above, plantation counties have some statistically insignificant relative declines in black population. Relative to 1925, agricultural capital is similar in plantation counties through 1940 and higher by 0.23 log points by 1970.

In the main sample of flooded and nonflooded counties, the empirical results are robust to controlling for differential changes in plantation counties.[47] Further, the impacts of the flood on agricultural development are not driven by plantation counties. Allowing for heterogeneous effects of the flood on plantation counties and nonplantation counties, the nonplantation counties experience clear declines in black population and increases in agricultural development.[48]

Related concerns are that flooded counties may have different preflood black tenancy shares or manufacturing outcomes, which could contribute to differential changes over the mid-twentieth century. The empirical estimates are robust to controlling for differential changes over time that are correlated with pre-1927 values for the share of tenants who are black, the number of manufacturing establishments, and average manufacturing wages.[49]

C. *Alternative Interpretations of the Flood's Impacts*

Our main interpretation of the flood's impacts is that flood-induced black out-migration pushed flooded counties toward higher capital intensity and larger-scale farm operation, consistent with contemporary and historical qualitative accounts. However, there are two other main channels through which the 1927 flood may have had lasting economic impacts. First, the flood may have caused general economic disruption and the replacement of vintage capital stocks with more technologically advanced capital.[50] Second, the flood may have changed land productivity.

In the first case, by causing general economic disruption, the flood may have encouraged landowners to reevaluate and update agricultural production.[51] In particular, reconstruction may have replaced destroyed "vintage" capital goods with newer capital goods, leading to a short-run increase in capital investment and modernized capital equipment in flooded areas. As capital stocks depreciated in non-damaged areas, however, natural replacement would have led to convergence in the quantity and age of capital goods.

The empirical results are generally inconsistent with this first alternative interpretation. The value of agricultural capital equipment and machinery is found to diverge over time in flooded counties, rather than increase immediately and converge over

[47] As in equation (6), the specification controls for a dummy variable for whether the county is a plantation county (interacted with year).

[48] In a modified version of equation (6), the fraction of county flooded is interacted with a dummy variable for whether the county is a "plantation county" and a dummy variable for whether the county is a "nonplantation county."

[49] In estimating equation (6) with pre-1927 outcome values and the six geographic controls, the additional year-interacted control variables include: the log fraction of tenants who are black (in 1900, 1910, and 1920); the log number of manufacturing establishments (in 1900 and 1920); and log average manufacturing wages (in 1900 and 1920).

[50] Related alternative explanations are that the flood could have encouraged the coordination and consolidation of land holdings or induced a series of foreclosures that allowed new entrepreneurial farmers to enter. Land ownership was fairly concentrated and stable in this region, so we do not focus on these related alternative explanations. To the extent that landowners attempted to coordinate investments and production, this coordination was mainly in maintaining the status quo labor-intensive system rather than coordinating over land assembly and increased mechanization.

[51] The lower Mississippi region had an unfortunate history of natural disasters in the early twentieth century (Boustan, Kahn, and Rhode 2012); while none were as large as the 1927 flood, this was a volatile region that appears less likely to have settled into economic complacency.

time. There was also no immediate decline in older-vintage capital, such as mules and horses.

Historically high levels of capital depreciation imply that post-flood capital reconstruction would have had few persistent "vintage capital" effects. While tractors are among the more durable capital goods, an approximate annual depreciation rate of 12 percent implies that roughly 85 percent of investment in 1927 would have depreciated by 1935 (Hurst 1933). Investment in agricultural buildings may have been more durable; from estimating equation (6), however, the value of agricultural buildings in flooded counties declined slightly by 1930 and 1940.[52]

In the second case, by changing land productivity, the flood may have directly impacted land values and factor demand. While repeated historical flooding of the Mississippi contributed to the formation of productive soils, one isolated flood would have had limited direct benefits for soil productivity. The flood also damaged land improvements, but these were generally rebuilt quickly and new lands were improved and brought under cultivation in flooded counties.[53] It is difficult to know whether the 1927 flood and the subsequent 1928 Flood Control Act increased or decreased landowners' expected flood risk, though there should be less differential change in perceived future risk once controlling for distance to the Mississippi River or limiting the sample to counties near the Mississippi River.[54]

From estimating equation (6), flooded counties experienced little immediate change in cotton productivity or corn productivity.[55] In subsequent years, cotton and corn acreages expanded, and there was little systematic change in productivity. These estimates are also consistent with literature on early mechanization being labor saving but not yield increasing (Hayami and Ruttan 1985).

Finally, for interpreting the main results, the flood may have had general equilibrium impacts on nearby nonflooded counties. The empirical estimates overstate the aggregate impact of the flood for particular outcomes that are affected oppositely in nonflooded counties. Our interpretation of the results focuses mainly on the flood's relative impacts, however, such as changes in the relative availability of black labor and the relative change in agricultural capital and scale of farm operation.

The flood may be expected to have had little indirect impact on nonflooded counties in subsequent years and decades, even if the flood initially disrupted nonflooded counties. There may even have been small immediate impacts on nonflooded counties' output prices and return on capital, given the degree of integration in agricultural markets and the small share of agricultural output directly affected by the flood. As a test of the magnitude of local economic spillovers, Table 7 reports the estimated change in counties bordering the flooded region, relative to counties 100 km from

[52] Data on land values and building values are available separately, by decade, from 1900 to 1940. The log value of building values, per farm acre or per county acre, is regressed on the fraction of the county flooded in 1927, state-by-year fixed effects, county fixed effects, and county outcome values in 1900, 1910, and 1920, interacted with each year.

[53] Red Cross efforts to introduce new varieties of crops and livestock were generally limited (Red Cross 1928), as reconstruction efforts were focused on emergency needs and temporary relief.

[54] The 1928 Act was mandated to protect all of the potentially flooded counties, not just those that were actually flooded, and thus involved substantial upriver tributaries rather than a sole focus on levees. Further, reconstruction and modification of the levee system had little direct effect on available agricultural land, irrigation, or drainage.

[55] The log quantity of cotton or corn yielded per harvested acre is regressed on the fraction of the county flooded in 1927, state-by-year fixed effects, county fixed effects, and county outcome values in 1900, 1910, 1920, and 1925, interacted with each year (with and without controls for geography and New Deal spending).

TABLE 7—ESTIMATED CHANGES IN COUNTIES BORDERING THE FLOODED REGION, RELATIVE TO COUNTIES 100 KM AWAY

	Fraction black (1)	Black population (2)	Black farm share (3)	Value farm capital (4)	Tractors (5)	Average farm size (6)	Farmland (7)	Land value/ farm ac (8)
1930	0.019	0.003	−0.025	0.010	0.045	−0.022	−0.015	0.060
	(0.023)	(0.048)	(0.036)	(0.064)	(0.140)	(0.027)	(0.028)	(0.039)
1935						−0.029	−0.014	0.022
						(0.030)	(0.037)	(0.050)
1940	0.035	0.007	−0.026	−0.048	0.260	−0.060*	−0.032	0.047
	(0.034)	(0.057)	(0.040)	(0.066)	(0.218)	(0.030)	(0.042)	(0.046)
1945					0.179	−0.035	−0.007	0.102*
					(0.158)	(0.040)	(0.053)	(0.051)
1950	0.075	0.050	0.008			−0.078	−0.048	0.129*
	(0.052)	(0.081)	(0.050)			(0.053)	(0.056)	(0.056)
1954					0.084	−0.112	−0.081	0.114*
					(0.117)	(0.057)	(0.061)	(0.053)
1960	0.101	0.068				−0.105	−0.130	0.076
	(0.064)	(0.107)				(0.064)	(0.073)	(0.055)
1964						−0.070	−0.116	0.151**
						(0.068)	(0.082)	(0.053)
1970	0.102	0.077		−0.036	0.046	−0.001	−0.111	0.118**
	(0.076)	(0.127)		(0.084)	(0.121)	(0.064)	(0.111)	(0.042)
Counties	94	94	94	94	94	94	94	94

Notes: Each column reports estimated changes in the indicated outcome variable: changes in counties bordering the flooded region relative to changes in counties 100 km from the flooded region, relative to the omitted year of 1920 or 1925. The sample is restricted to the 94 main sample counties with no flooding (Figure 1). The indicated outcome variable is regressed on the (negative) distance from the flooded region in 100-km units, state-by-year fixed effects, county fixed effects, and county outcome values in 1900, 1910, 1920, and 1925 (when available), interacted with each year. All regressions are weighted by county size. Robust standard errors clustered by county are reported in parentheses.

**Significant at the 1 percent level.

*Significant at the 5 percent level.

the flood border.[56] Consistent with small local economic spillovers, particularly in the immediate aftermath of the flood, there was little change in counties bordering the flooded region compared to further counties.

VII. Conclusion

The Great Mississippi Flood of 1927 was a transformative event for areas in and around the Mississippi Delta. In a region infamous for oppressive racial institutions, the flood led to an exodus of black agricultural workers. This persistent decline in black population, following a temporary natural disaster, is consistent with a breakdown of historically segmented labor markets for black workers in the flooded region.

[56] Each outcome variable is regressed on the (negative) distance from the flooded region in 100-km units, state-by-year fixed effects, county fixed effects, and county outcome values in 1900, 1910, 1920, and 1925 (when available), interacted with each year. An increase in distance from 0 km to 100 km is equivalent to an increase from the closest counties to the eightieth centile. We have omitted three columns due to space constraints (population, mules and horses, value of farmland per county acre), but there are no substantial or statistically significant changes in these outcomes.

Unable to prevent a decline in black labor availability, planters in flooded counties appear to have been pushed over time toward greater usage of agricultural capital and a modernized scale of farm operation. Estimated increases in capital intensity are smaller in magnitude after controlling for differences in geography and 1930s New Deal program spending, but flooded counties continue to have large relative increases over time in the value of capital equipment and machinery. This induced agricultural development was not associated with increased agricultural land values, however, which is consistent with white landowners' coercive efforts to resist black out-migration after the flood and maintain the status quo system of labor-intensive agricultural production for their own benefit.

The aftermath of the 1927 Mississippi flood illustrates the potential for decreased agricultural labor availability to spur agricultural development. In underdeveloped areas maintaining substantial populations of low-wage agricultural workers, inducing rural out-migration and decreasing agricultural labor availability appears to have the potential to encourage subsequent agricultural development.

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