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

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Abstract

In the American South, post-bellum 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.

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Under-developed societies often have a large population of low-wage agricultural workers. Economic growth requires a 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 20th 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.

This paper 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. Agriculture then became substantially more capital-intensive and modernized in flooded counties relative to nearby similar non-flooded counties. 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 main empirical specifications compare changes between flooded counties and non-flooded counties within the same state and with similar pre-1927 outcome values. The analysis of black population declines is supplemented with individual-level Census data, matched between 1920 and 1930.

The empirical estimates are robust to controlling for other differences between flooded and non-flooded counties, including differential changes associated with: distance to the Mississippi river; geographic suitability for cotton and corn; terrain ruggedness; and longitude and latitude. The estimates are also robust to controlling for differential intensity of plantations or differential impacts of New Deal program spending.

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 many 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 empirical results is that flood-induced black out-migration

encouraged the adoption of capital-intensive technologies 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 investment or land productivity. Further, general equilibrium impacts on non-flooded counties appear to be small.

While other factors contributed to later economic convergence throughout the US South (see, e.g., Wright, 1986), the aftermath of the 1927 Mississippi flood illustrates the potential for out-migration to spur economic development. In under-developed societies with a substantial population of low-wage agricultural workers, it appears that rural out-migration can encourage agricultural development. Whether caused by push factors (e.g., rural natural disasters) or pull factors (e.g., urban labor demand), decreased agricultural labor availability may promote structural economic development.

I Historical Background

I.A Southern Under-development and the Mississippi Delta

Even prior to the revolutionary war, the Southern economy was distinctive. Slavery and a geographic suitability for plantation agriculture contributed to a system of labor-intensive agricultural production. As slavery expanded into new states during the 19th century, political conflict between Northern free states and Southern slave states culminated in the Civil War. Four million slaves were emancipated and enfranchised; by 1900, however, most Southern states had effectively disenfranchised black populations via poll taxes and literacy tests (Naidu, 2012).

Southern white planters attempted to use their political influence to restrict black labor mobility and exert control over black agricultural workers.[1] 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). There has been substantial debate over the effectiveness of these measures and the overall 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); less controversial, however, is that Southern white planters valued black labor immensely and used both carrots and sticks in an attempt to retain labor.

Southern black labor relations were also distinguished by the threat of racial violence (Rosengarten, 1975; Tolnay and Beck, 1995). Southern white planters often pursued a strategy of paternalism to retain black workers, offering protection from white violence and im-

[1] We use agricultural "workers" to refer to both wage laborers and tenant farmers, who received "wages" in the form of production shares, housing, and advances of inputs and/or money.

plicit insurance. "Protection was important .... particularly 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 team of anthropologists observed: "One of the bases of competition between landlords for tenants was the landlord's reputation among tenants with regard to his use of physical violence. At the same time the field evidence reveals that the use of threats of violence by white planters is one of the basic controls upon labor" (Davis, Gardner and Gardner, 2009, p. 392).

The Southern economy remained persistently under-developed between the Civil War and World War II. While the North developed large manufacturing sectors, the South remained primarily agricultural. Northern wheat threshing became increasingly mechanized in the 19th century (David, 1975), while the mechanization of Southern cotton-picking was delayed until the mid-20th century.[2]

Early cotton mechanization was mainly in planting and cultivation, where replacing mules and horses with tractors was associated with a 30% reduction in labor inputs (Hurst, 1933). Tractors and other labor-saving innovations have been influential in American agricultural development (Olmstead and Rhode, 2001; Gardner, 2002; Steckel and White, 2012), yet adoption lagged in the South. "Technology for mechanizing the preharvest operations was available well before the 1930s, yet it was hardly used at all in the South, and least of all in the plantation belt" (Wright, 1986, p. 133).

Early tractors could replace mule-drawn carts in transporting cotton to gins (Ellenberg, 2007), yet continued high demand for harvest labor encouraged annual labor contracts and may have discouraged the partial mechanization of pre-harvest 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. 1208).

Wright (1986) describes a 1940 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 sizes increased as agriculture became more capital-intensive and as mules and horses were replaced with tractors and later harvesters (Kirby, 1987).[3]

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

[2]These differences may not just reflect crop choice, as California mechanized cotton before the US South (Whatley, 1985).

[3]While land ownership was often concentrated, "farm size" refers to the parcel size of farm operators.

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 United States' Southern economy experienced remarkable economic growth in the mid-20th 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). Various factors associated with these trends include advances in agricultural technology, the institutional breakdown of sharecropping, the New Deal, World War II, and Civil Rights regulation (Wright, 1986; Heckman and Payner, 1989; Donohue and Heckman, 1991; Besley, Persson and Sturm, 2010).[4]

This paper focuses on the lower Mississippi region, which embodied historical Southern under-development. The Mississippi-Yazoo Delta has been dubbed the "most southern place on earth" (Cobb, 1994), and became infamous for racial inequality and abuse.[5] However, powerful white planters recognized their economic dependence on local black labor. Some planters experimented with recruiting Chinese and Italian workers, but were unable to find adequate and willing substitutes. Planters, such as Leroy Percy, resisted the Klu Klux Klan to protect their black workers. Retaining a local labor force became increasingly tenuous, however, during World War I and the first Great Migration (1910-1930).

I.B The Great Mississippi Flood of 1927

> *"A great deal of labor from the flooded section after being returned to the plantations is going North. It is thus a serious menace and it is going to offer a tremendous problem to all of us"* – Alex Scott, Delta planter.

The Mississippi river basin stretches into the central United States to channel water down through the winding Mississippi river. The river itself is somewhat undefined, historically changing course and spilling into natural floodplains. Over the late 19th and early 20th 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

[4]Additional important factors include malaria eradication (Bleakley, 2007) and the introduction of air conditioning (Arsenault, 1984).

[5]In 1921, William Pickens, Arkansan NAACP secretary, dubbed the Mississippi River Valley the "American Congo." In 1919 alone, at least 18 black citizens were lynched in the Delta (Woodruff, 2003).

states (Mississippi, Louisiana, Arkansas), flooding hit 36% of agricultural land and 29% of the population (Red Cross, 1928). The flood is estimated to have caused $400 million in property damage and drowned 246 people.[6]

The Red Cross coordinated flood relief efforts, which focused on emergency short-term needs (Red Cross, 1928). Of the $17 million spent, 30% was for food and 14% was for livestock feed. The Red Cross spent 16% 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% of expenditures, and the remaining 25% was mainly for rescue and setup of refugee camps.[7]

The Red Cross established refugee camps that held 45% of the black population from flooded areas in Mississippi, Louisiana, and Arkansas (Red Cross, 1928).[8] Refugee camp administration was placed under the control of local counties and, in effect, powerful local white planters.

Many refugee camps became centers of repression and racial abuse. Black work gangs were conscripted and forced to work on levees or planters' farms; those caught attempting to leave were beaten and returned.[9]

Flood relief mainly refused direct payments to individuals, instead providing in-kind transfers through Red Cross camps.[10] Much of this aid was captured by white planters or withheld unless blacks worked on prescribed tasks. Planters justified withholding rations on the grounds that rations would "spoil" black workers and weaken the control planters had in "the old system" (Spencer, 1994, p. 176).

Amidst stories of racial abuse, white planters in flooded areas retained little credibility in offering paternalistic protection to their black workers. One infamous Red Cross camp in the Delta was controlled by Will Percy, son of LeRoy Percy, who forced blacks to work in the camp for free and wear laborer tags to receive food.[11] "Following a killing of a black man

[6]There was little flood insurance at this time (White, 1945), and "[f]looding in the MS basin in 1927 and 1928 led the few companies that were selling cover to abandon the business. It was not until the 1950s that flood insurance again began to be discussed seriously" (Parker, 2000, p. 413).

[7]An additional $6 million in services and supplies were donated by the railroads, US military, and other Federal agencies, mainly for rescue and setup of refugee camps.

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

[9]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, LA (Barry, 1998, p. 330).

[10]The Bill prefigured New Deal legislation by providing a federal transfer to landowners without requiring local contributions.

[11]Barry (1998, p. 315) recorded a black man saying: "The colored people caught tough times around

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).

A circulated black newspaper, *The Chicago Defender*, provided detailed accounts of racial abuse in Red Cross camps and listed job openings for blacks in Northern cities.[12] Migration costs also declined as a result of the flood, due to temporary displacement and lower labor demand for cotton harvesting in 1927.

Faced with the potential exodus of black workers, white planters made every effort to retain their black labor force. 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 & Pine Land Company, one of the nation's largest cotton plantations, established its own refugee camp and had its workers transferred by special train.

Despite such 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, once displaced from their homes, continuing on to Chicago and other Northern cities.[13] "The *Afro-American* reported that the relief camp experience had "inspired many backwoods farm[h]ands to to make their first break for better things"' (Spencer, 1994, p. 177). Social networks shifted toward favoring migration; in Greenville MS, black leaders left for Chicago and crowds of blacks gathered at the local railway station every Saturday night to see who was leaving and say goodbye (Barry, 1998).[14]

Landowners' accounts emphasize the damages from losing their labor force, rather than direct losses from the flood. LeRoy Percy reported: "The most serious thing that confronts the planter in the overflowed territory is the loss of labor, which is great and is continuing"

Greenville.... Whites were kicking coloreds and beating them and knocking them around like dogs. Hungry people, they wouldn't feed them sometimes." A white woman remembered: "The [National] Guard would come along and say 'There's a boat coming up. Go unload.' If they didn't hurry up, they'd kick them. They didn't mind taking their guns, pistols out, and knocking them over the head."

[12]Commerce Secretary Herbert Hoover gained national prominence through his management of flood relief operations and secured the presidential nomination. However, racial abuses during the flood eventually cost him the support of national black leader Robert Moton, who had been in charge of investigating racial abuses in relief camps, and contributed to the departure of blacks from the Republican party.

[13]This episode was influential in the development of Delta blues and Chicago blues (see, e.g., "When the Levee Breaks" and "High Water Everywhere").

[14]Reverend E.M. Weddington, who pastored Mount Horeb church, left shortly after the flood receded, but not before allegedly writing an anonymous letter saying "All of this mean and brutish treatment of the colored people is nothing but downright slavery" (Barry, 1998, p. 416).

(Barry, 1998, p. 416). The director of the Delta Land and Pine Company reported to shareholders: "Labor was completely demoralized and the plantation was left almost completely without labor."

White planters in flooded counties were forced to adapt to the decreased availability of black labor. In November 1927, the Engineering News Record noted: "In certain sections of the lower Delta above the Arkansas and Yazoo 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, and farm experts are watching the result with some apprehension." In 1931, a Mississippi Agricultural Extension Service bulletin discusses the "serious problem" of black out-migration and explores "the possible solution in mechanical farming," comparing five tenant-operated plantations and five tractor-operated plantations in the Delta (Vaiden, Smith and Ayres, 1931). Contemporaneous accounts describe a reorganization of agricultural production and increased mechanization in the Delta, even prior to the introduction of 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, however, the Mississippi Delta and its surrounding region also provide a setting to explore economic development when particular areas experience a sharp exogenous decline in 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.

II A Model of Flooding, Migration, and Agricultural Development

II.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: $A_c F(K_{ct}, L^B_{ct}, L^W_{ct})$. Each county has a fixed supply of land with productivity A_c. Capital K_{ct} is defined broadly to include equipment and machinery, mules and horses, fertilizer, and land improvements. Capital 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^B_{ct} and resident white workers L^W_{ct}.[15]

Capital and labor are assumed to be substitutes, reflecting a choice between "Old South" labor-intensive production and "New South" capital-intensive production.[16] Capital is an

[15] "Workers" include wage laborers, share croppers, and share tenants who receive "wages" in the form of cash, production shares, housing, and/or inputs.

[16] In particular, we assume that the above production function represents an upper envelope over "Old

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).[17]

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. 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 $L_{c1}^B \leq L_{c0}^B$.[18] 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:

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

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

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.

II.B Comparative Statics after the Flood

Consider the impact of a flood in some counties between periods 1 and 2. Workers are 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. The flood also temporarily reduces the moving cost for black workers, either by imposing some share of

South" and "New South" technological choices. Increased use of "New South" methods is assumed to be "strongly labor-saving" (Acemoglu, 2010); that is, in the case where machines replace labor, the adoption of capital-intensive methods reduces the marginal product of labor. Note, however, that output per worker will still increase following a decline in labor availability and the adoption of labor-saving technology.

[17] 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.

[18] 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.

that cost or by reducing the opportunity cost of migration. 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: $A_c F(K_{c2}, L^B_{c2}, L^W_{c2}) - rK_{c2} - (w^B - \alpha a - \beta m)L^B_{c2} - w^W L^W_{c2}$, subject to $L^B_{c2} \leq L^B_{c0}$. 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 ($L^B_{c2} < L^B_{c0}$).

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. In practice, it may take a number of periods to make technological adjustments and to accumulate the desired capital stock. 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 as capital investments become 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" toward mechanization that increases land values immediately. Allowing for multiple planters in each county, as a single planter internalizes all within-county spillovers, 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 only increase immediately after the flood if there were substantial externalities associated with anticipated agricultural development.

III Data Construction and Baseline Differences in Flooded Counties

III.A Data Construction and Aggregate Trends

Historical county-level data are drawn from the Census of Agriculture and the Census of Population (Haines, 2005).[19] The main variables of interest include: black population, value of agricultural equipment and machinery, number of mules and horses, number of tractors, average farm size, and value of agricultural land and buildings.[20] 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 1920's, a direct measure of migration is drawn from matched individual-level census data in 1920 and 1930 (Boustan, Kahn and Rhode, 2012).[21] The match rate of 24% 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.[22] 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. The shaded area represents the flooded region, as compiled by the US Coast and Geodetic Survey. 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.[23]

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

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

[21] We are grateful to Leah Boustan, Matt Kahn, and Paul Rhode for sharing their matched census data.

[22] As an additional step in focusing the analysis on initially similar flooded and non-flooded 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 6 of the original 163 counties are dropped when limiting the sample to flooded and non-flooded counties with overlapping values of this propensity score.

[23] 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 are grateful to Paul Rhode for sharing these Red Cross data, which we supplemented.

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 1910's, during the first Great Migration (panel A). Total population increased through 1940, before declining into the 1960's (panel B). The value of agricultural capital increased through 1920, remained mainly constant from 1920 to 1940 during a period of relatively few technological improvements, and then increased substantially by 1970 after the second Great Migration, the introduction of the mechanical cotton picker, and the Civil Rights movement (panel C). By contrast, 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).[24] The value of agricultural land per farm acre increased during World War I, declined somewhat through the Depression, and then increased substantially through 1970 as agricultural productivity increased (panel F). This figure provides some background on regional trends, whereas the main empirical analysis estimates within-state relative changes for flooded counties.

III.B Baseline Differences in Flooded Counties

In an initial step, the empirical analysis explores pre-differences between flooded and non-flooded counties. In 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:

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

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

To explore differences in pre-trends between flooded and non-flooded 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:

$$Y_{ct} - Y_{c(t-1)} = \beta FractionFlood_c + \alpha_s + \epsilon_c \tag{4}$$

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

Table 1, column 1, reports average county characteristics prior to the 1927 flood. Column 2 reports within-state differences in pre-flood characteristics for flooded counties, and column

[24]Note that increases in "farm size" refer to increases in the size of farm operator parcels, rather than the concentration of land ownership.

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 pre-flood trends for flooded counties, and column 5 reports these differences in trends conditional on the above six county-level controls.

Prior to the 1927 flood, flooded counties and non-flooded counties are estimated to have had similar changes in most outcomes.[25] Flooded counties had an initially higher black population and a greater intensity of small-scale agricultural production, though these differences are partly mitigated by the six county-level controls. To the extent that flooded counties were different in pre-trends or levels, the main empirical specifications include controls for pre-flood differences.

IV Empirical Framework

The empirical specifications estimate year-specific differences between flooded counties and non-flooded 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:

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

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

In practice, the main empirical specifications control for county characteristics (X_c) that may predict differential changes between flooded and non-flooded counties:

$$Y_{ct} = \beta_t FractionFlood_c + \alpha_{st} + \alpha_c + \theta_t X_c + \epsilon_{ct} \tag{6}$$

Baseline specifications control for pre-flood values of the outcome variable, flexibly allowing for convergence over time in the outcome variable or otherwise differential changes associated with initially different values.[26] The identification assumption is that, if not for the flood, flooded counties would have changed similarly to non-flooded counties in the same state and with similar pre-flood values of the outcome variable. An empirical concern is that inherent differences between flooded and non-flooded areas may have caused some county

[25] The main results tables report pre-flood changes for each outcome variable in all available pre-periods, relative to 1920.

[26] Note that this specification is not a lagged dependent variable model; instead, the specification controls only for pre-treatment values of the dependent variable.

characteristics to change differently after 1927, even in the absence of the flood.[27]

Extended specifications 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.[28] Controlling for crop suitability allows for crop-specific changes in technology and prices, or changes that otherwise differentially affect areas suitable for different crops.[29] Controlling for terrain ruggedness allows for differential changes in areas that may differ in suitability for agricultural mechanization.[30] Finally, controlling separately for longitude and latitude allows for spatial patterns in economic changes that may be correlated with flooding.

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%.[31] The regressions are weighted by county size, so the estimates reflect changes for an average acre of flooded land.

V Main Results

V.A Population

Figure 3 shows estimated changes in black population for flooded counties, relative to changes for non-flooded counties, from estimating equation (5). Consistent with the main identification assumption, the black population share changed similarly in flooded counties and non-flooded counties prior to the 1920's. Flooded counties experienced a 14% (0.151 log point) decline from 1920 to 1930 in their black population share. Following the 1927 flood,

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

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

[29] 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. Potential yields are calculated using climate averages from 1961 to 1990 and rain-fed conditions with intermediate inputs.

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

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

this short-run decline in black population share persisted through 1970.

Table 2, column 1, reports similar declines in black population share when estimating equation (6) and controlling for counties' black population share in 1920, 1910, and 1900. Column 2 reports that the estimates are robust to controlling for the six county geographic characteristics, interacted with year.

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 an inelastic demand for labor.[32]

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.[33] We would expect this black population to 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 more direct measure of out-migration uses matched individual-level census data from 1920 and 1930. Average migration rates may be overstated due to false matches, though any bias should not be differential across flooded counties and non-flooded counties.[34] 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 estimated regression is the same as equation (5), except the regression is weighted by the number of matched people in each county.[35]

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 non-flooded counties. 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).[36]

[32]Estimated increases in farmland, discussed below, imply subsequent declines in total population per farm acre.

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

[34]All successful matches are required to be unique by name and place of birth (state or country) within a 5-year age band.

[35]In weighting by the number of matched people, the regressions estimate the change in probability of migration for the average person.

[36]Southern states are defined as Arkansas, Louisiana, Tennessee, Mississippi, Alabama, North Carolina,

Migration estimates are more striking for the subsample of individuals whose race is observed. Panel B reports estimated differences in black out-migration from flooded counties, and panel C reports estimated differences in white out-migration from flooded counties. Blacks in flooded counties are 13.9pp more likely to leave their county (column 1), 17.8pp more likely to leave their state (column 2), and 6.8pp more likely to leave the South entirely (column 3); by contrast, there are no statistically significant differences in whites' out-migration rates.

Column 4 of Table 3 examines in-migration for individuals in the matched sample, finding an insignificant and negative effect overall (panel A). In the subsample of individuals whose race is observed, there is no effect on black in-migration (panel B). By contrast, there is higher white in-migration to flooded counties, consistent with the estimated aggregate changes in population (panel C).

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 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. Regardless of the mechanism, however, the subsequent empirical analysis explores the impact of decreased black labor availability on agricultural development.

V.B Agricultural Capital Investment and Modernization

Figure 4 shows estimated changes in the the value of agricultural capital equipment and machinery for flooded counties, relative to non-flooded counties, from estimating equation (5). The value of capital had been changing similarly in flooded and non-flooded counties and, following losses sustained during the 1927 flood, recovered by 1930. By 1940, the value of agricultural capital had increased substantially in flooded counties relative to non-flooded counties. Relative increases in agricultural capital continued through 1970. While it becomes more difficult to rule out other differential shocks in later periods, it appears that the increase in agricultural capital investment does not simply reflect earlier investment in flooded counties and convergence over time. Table 4, columns 1 and 2, report similar results from estimating baseline and extended versions of equation (6) that control for differential changes associated with pre-flood and geographic differences between flooded and non-flooded counties.

Important early sources of agricultural power were mules and horses, which were used by agricultural workers but were overall a substitute for manpower.[37] Table 4, columns 3 and 4,

South Carolina, Georgia, and Florida.

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

report that the number of mules and horses recovered or increased in flooded counties after a large number of animal deaths during the flood. The main implication of these estimates is that initial capital recovery after the flood did not merely reflect the replacement of older vintage capital goods with newer capital goods. By the 1950's and 1960's, however, use of this "Old South" power source declined.[38]

Table 4, columns 5 and 6, report larger percent increases in tractors in flooded counties relative to non-flooded counties.[39] Tractors were still rare in the sample region during the 1920's and 1930's, however, so these estimates reflect only small initial increases in the number of tractors per farm.[40]

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 non-flooded counties. Farm sizes increased particularly during the 1950's and 1960's as mechanical cotton pickers became increasingly available.

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 equations (5) and (6), the log value of crops per capita changed similarly in flooded and non-flooded counties from 1910 through 1930. This proxy for average labor productivity increased substantially in flooded counties through the 1930's, 1940's, and 1950's.[41] 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 farm capital appear to embody labor-saving technological change in the agricultural sector. Early increases in capital investment did not come through replacing mules and horses, i.e., older vintage technologies, though subsequent investments appear to reflect increased use of newer labor-saving technologies like the mechanical cotton picker. Gradually increased farm operation sizes are associated with a

capital equipment and machinery.

[38]Note that it is difficult to rule out other differential shocks in these later periods, particularly as the number of mules and horses declined throughout the region.

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

[40]Based on the average number of tractors per farm in non-flooded counties in each year, the estimates in column 6 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.

[41]From equation (5), the estimated coefficients (and standard errors) are 0.395 (0.078) in 1940, 1.235 (0.167) in 1950, and 2.158 (0.246) in 1960. From equation (6), the estimated coefficients are 0.373 (0.067) in 1940, 0.933 (0.138) in 1940, and 1.741 (0.223) in 1960. Estimated relative changes are similar for the log value of crops per person living in rural areas of the county.

bundle of modernized agricultural production methods.

The flood itself was likely too small 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 the adoption of new capital-intensive technologies (e.g., Atkinson and Stiglitz, 1969; Basu and Weil, 1998). Increases over time in agricultural modernization and capital investment 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.

V.C Farmland Acreage and Value

Table 5, columns 1 and 2, report that flooded counties began to experience substantial relative increases in farmland after 1930. 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.[42]

Substantial increases in total farmland, along with increased investment, 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 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 substantial sunk investments; as these investments 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 small declines in the value of agricultural land per farm acre (Table 5, columns 3 and 4) 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, depending on the specification, which may reflect substantial sunk investments in clearing and plowing new farmland. Landowners in flooded counties may also have unexpectedly benefited from technological innovation that favored capital-intensive agricultural production. 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.[43]

[42]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 non-flooded counties.

[43]Data on land values and building values are available separately, by decade, from 1900 to 1940. In 1920,

Landowners' coordinated resistance to black out-migration is consistent with landowners not anticipating economic gains from a "big push" toward increased agricultural mechanization. Indeed, Figure 5 shows that the Delta Land and Pine Company did not experience an increase in reported profits (Dong, 1993).[44]

Overall, the estimates appear consistent with a single equilibrium in which landowners adapt to labor availability. Black migrants presumably benefited from the option to migrate after the flood, though this does not imply that migrants benefited overall from the flood.[45]

VI Threats to Validity

VI.A Falsification Exercise

An empirical concern is that non-flooded areas may be an inherently poor control for flooded areas, despite including controls for pre-flood outcomes and geographical 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 non-flooded states, this sample includes 171 counties within 50km of a major river and 72 counties between 50km and 150km of a major river.[46]

As in the main sample, counties near other major Southern rivers have a higher black population in 1920 and a greater intensity of small-scale agricultural production in 1925 than counties further from other major Southern rivers. Further, as in the main sample, these counties had been experiencing similar trends in the county outcomes of interest.[47]

Table 6 reports that counties near other major Southern rivers changed similarly after 1927 to counties further from other major Southern rivers.[48] Of the few statistically sig-

the value of land averages 77% of the combined value of land and buildings. Focusing on changes in the value of land only, in 1930 and 1940, the estimates are more negative and statistically insignificant.

[44]The Company's return on investment likely declined, as profits remained similar and capital investment increased. The Delta Land and Pine company, however, was special in that given its size, it was reluctant to adopt labor-saving machinery due to public disapproval of the resulting unemployment. While it experimented with tractors in the early 1930s, it did not adopt them until World War 2.

[45]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 20th century, which are consistent with potential externalities.

[46]These cutoffs reflect typical distances to the Mississippi for flooded counties and non-flooded 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 Inc. ("Major Rivers of the United States").

[47]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 50km of a major river.

[48]In a modified version of equation (6), the fraction of county flooded is replaced with a dummy variable for whether the county is within 50km of a major river. The specification controls for changes over each time

nificant estimates, counties close to other major Southern rivers experienced somewhat less capital investment over time.

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 non-flooded counties in the absence of the flood.

VI.B Plantation Counties and New Deal Programs

One particular empirical concern is that flooded counties are more likely to be "plantation counties," as recorded by Brannen (1924) for 1910.[49] In non-flooded Southern states, plantation counties are estimated to have little differential change from 1930 to 1940 in the main outcome variables of interest.[50] 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.[51]

In the main sample of flooded and non-flooded counties, the empirical results are robust to controlling for differential changes in plantation counties.[52] 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 non-plantation counties, the non-plantation counties experience clear declines in black population and increases in agricultural development.[53]

Related concerns are that flooded counties may have different pre-flood black tenancy shares or manufacturing outcomes, which could contribute to differential changes over the

period that are correlated with state and initial outcome differences.

[49] 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).

[50] 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."

[51] 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 mechanization is similar in plantation counties through 1940 and higher by 0.23 log points by 1970.

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

[53] 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 "non-plantation county."

mid-20th 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.[54]

New Deal programs may have displaced tenants from plantations, increasing the availability of harvest laborers and encouraging pre-harvest mechanization in the 1930's (Whatley, 1983; Depew, Fishback and Rhode, 2012). The results are also robust, however, to controlling for differential changes associated with five county-level measures of New Deal spending.[55]

VI.C Alternative Interpretations of the Flood's Impacts

Consistent with contemporary and historical qualitative accounts, our main interpretation of the empirical results is that flood-induced black out-migration encouraged agricultural development. 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.[56] Second, the flood may have changed land productivity.

In the first case, by causing general economic disruption, the flood may encourage landowners to reevaluate and update agricultural production.[57] In particular, reconstruction may replace damaged "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 depreciate in non-damaged areas, however, natural replacement would lead 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 time. Initial increases in capital investment did not immediately replace older capital goods, such as mules and

[54] 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).

[55] As in equation (6), the specification controls for per-capita spending through the AAA, public works, relief, loan, and guaranteed loan programs (Fishback, Horrace and Kantor, 2005). Note that New Deal spending is potentially endogenous to the flood, particularly as networks developed by local politicians to obtain flood relief could be later used to secure New Deal spending.

[56] 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.

[57] The lower Mississippi region had an unfortunate history of natural disasters in the early 20th 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.

horses. Technologically-advanced capital goods, such as mechanical cotton pickers, did not replace older capital goods until well-after the initial reconstruction.

Historically high levels of capital depreciation imply that post-flood capital reconstruction would have few persistent "vintage capital" effects. While tractors are among the more durable capital goods, an approximate annual depreciation rate of 12% implies that roughly 85% of investment in 1927 would have depreciated by 1935 (Hurst, 1933). Investment in agricultural buildings may be more durable; from estimating equation (6), however, the value of agricultural buildings in flooded counties declined slightly by 1930 and 1940.[58]

In the second case, by changing land productivity, the flood may directly impact land values and factor demand. While repeated historical flooding of the Mississippi contributed to the formation of productive soils, one isolated flood would have limited direct benefits for soil productivity. The flood also damaged land improvements, but these were generally rebuilt quickly and substantial new lands were improved and brought under cultivation in flooded counties.[59] 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.[60]

From estimating equation (6), flooded counties experienced little immediate change in cotton productivity or corn productivity.[61] 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 general equilibrium impacts on nearby non-flooded counties. The empirical estimates overstate the aggregate impact of the flood for particular outcomes that are affected oppositely in non-flooded 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

[58]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.

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

[60]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.

[61]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.

capital investment and modernization.

The flood may be expected to have little indirect impact on non-flooded counties in subsequent years and decades, even if the flood initially disrupted non-flooded counties. There may even be small immediate impacts on non-flooded 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 100km from the flood border.[62] 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 around the Mississippi Delta. In a region infamous for oppressive racial institutions, the flood led to an exodus of black agricultural workers. The resulting decline in black labor availability contributed to increased agricultural capital investment and the overall modernization of agricultural production in flooded counties relative to nearby similar non-flooded counties. Landowners resisted black out-migration from flooded areas, however, consistent with their benefiting from a persistent system of labor-intensive agricultural production.

Experiences from the 1927 flood illustrate the potential impact of decreased agricultural labor availability on encouraging agricultural capital investment and the modernization of agricultural production. In under-developed societies with substantial populations of low-wage agricultural laborers, rural out-migration may encourage agricultural development. Whether caused by "push factors," such as rural natural disasters, or caused by "pull factors," such as urban labor demand, decreased agricultural labor availability may promote structural economic development.

[62] Each outcome variable is regressed on the (negative) distance from the flooded region in 100km 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 0km to 100km is equivalent to an increase from the closest counties to the eightieth centile.

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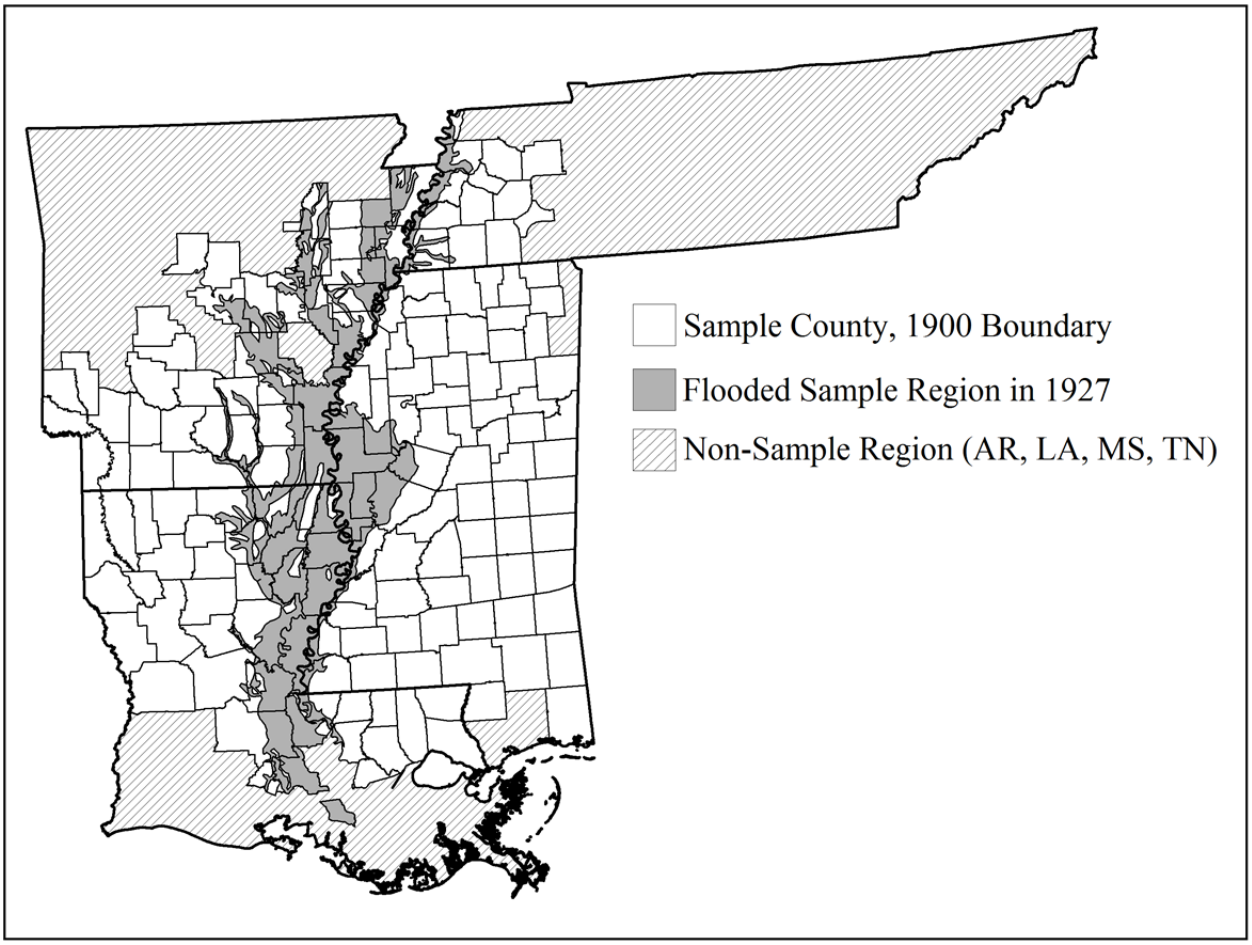
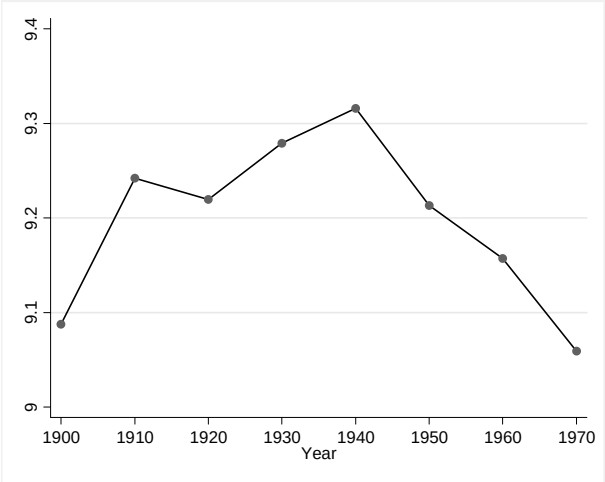
Figure 1. 1927 Flooded Region and Sample Counties (1900 Boundaries)



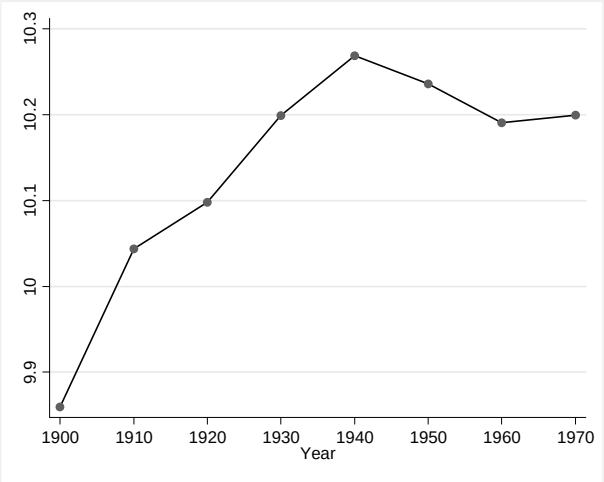
Notes: The 163 sample counties' boundaries are based on county definitions in 1900. County-level data are adjusted to hold these boundaries fixed through 1970. The sample region flooded in 1927 is shaded gray, based on a map compiled and printed by the US Coast and Geodetic Survey. The non-sample region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

Figure 2. Aggregate Changes in the Sample Region (AR, LA, MS, TN)

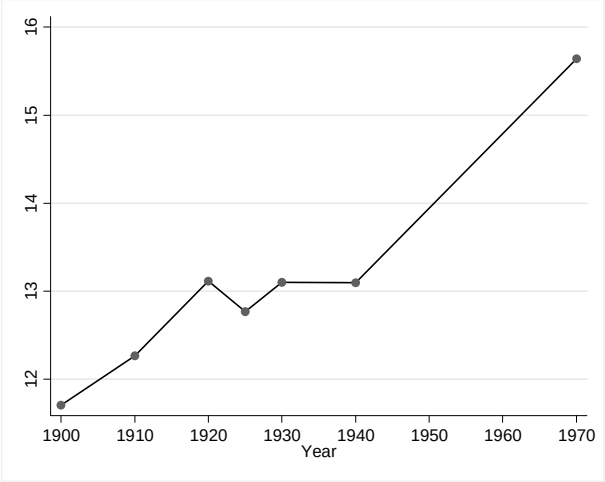
A. Log Black Population



B. Log Population

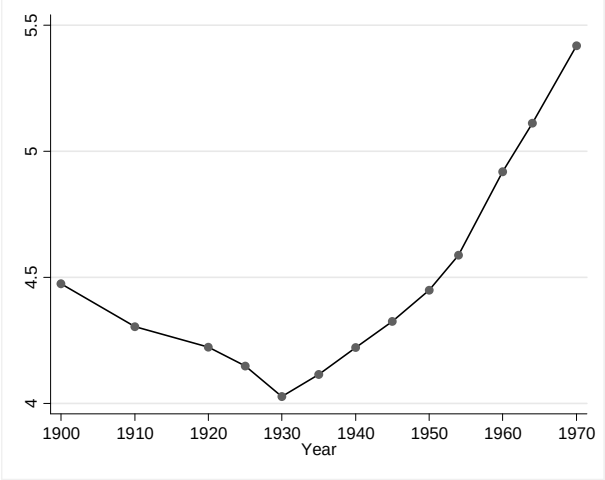


C. Log Value of Agricultural Capital

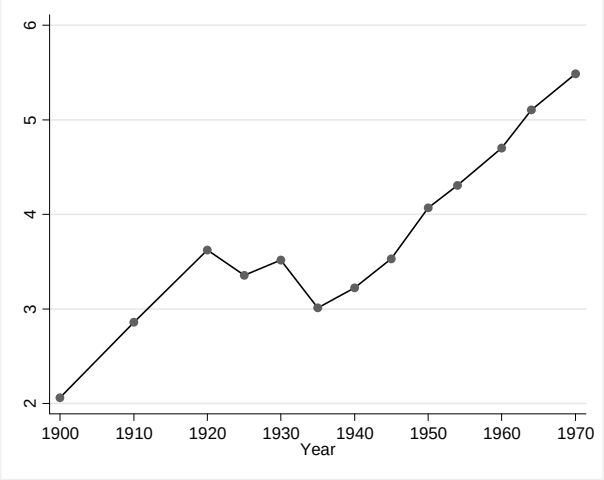


D. Log Number of Mules and Horses

E. Log Average Farm Size

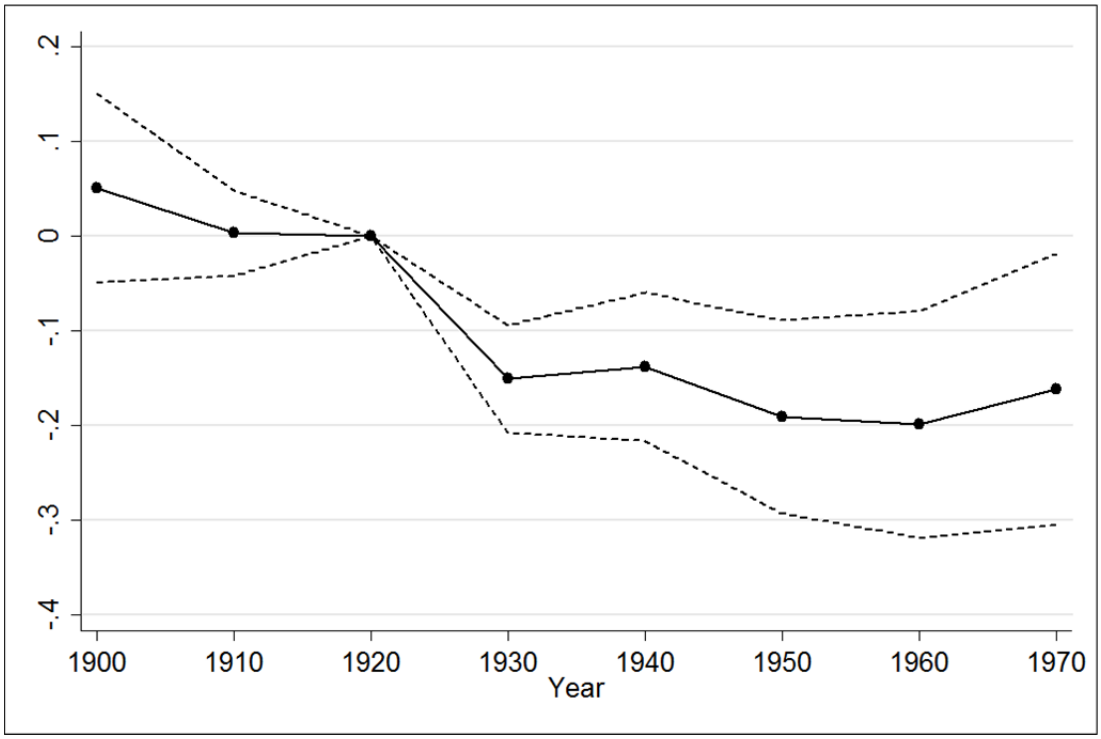


F. Log Land Value per Farm Acre



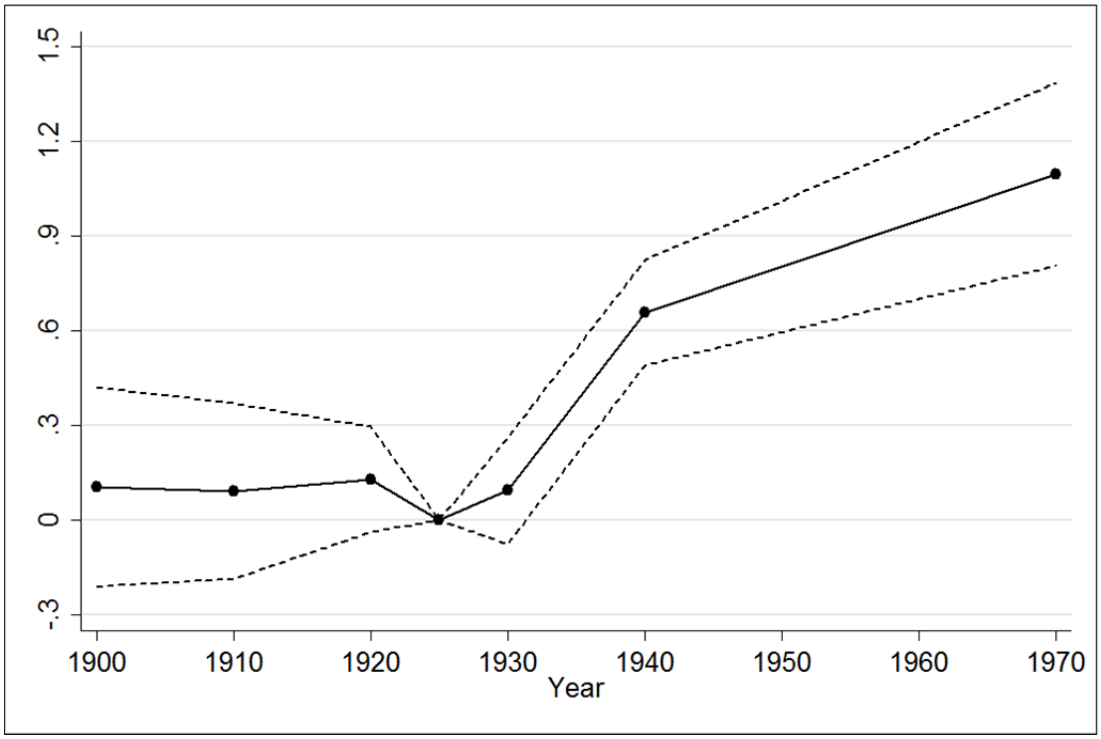
Notes: Panels A-F report aggregated outcomes for the 163 sample counties in each year (Figure 1). Data are from the US Census of Agriculture and the US Census of Population.

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



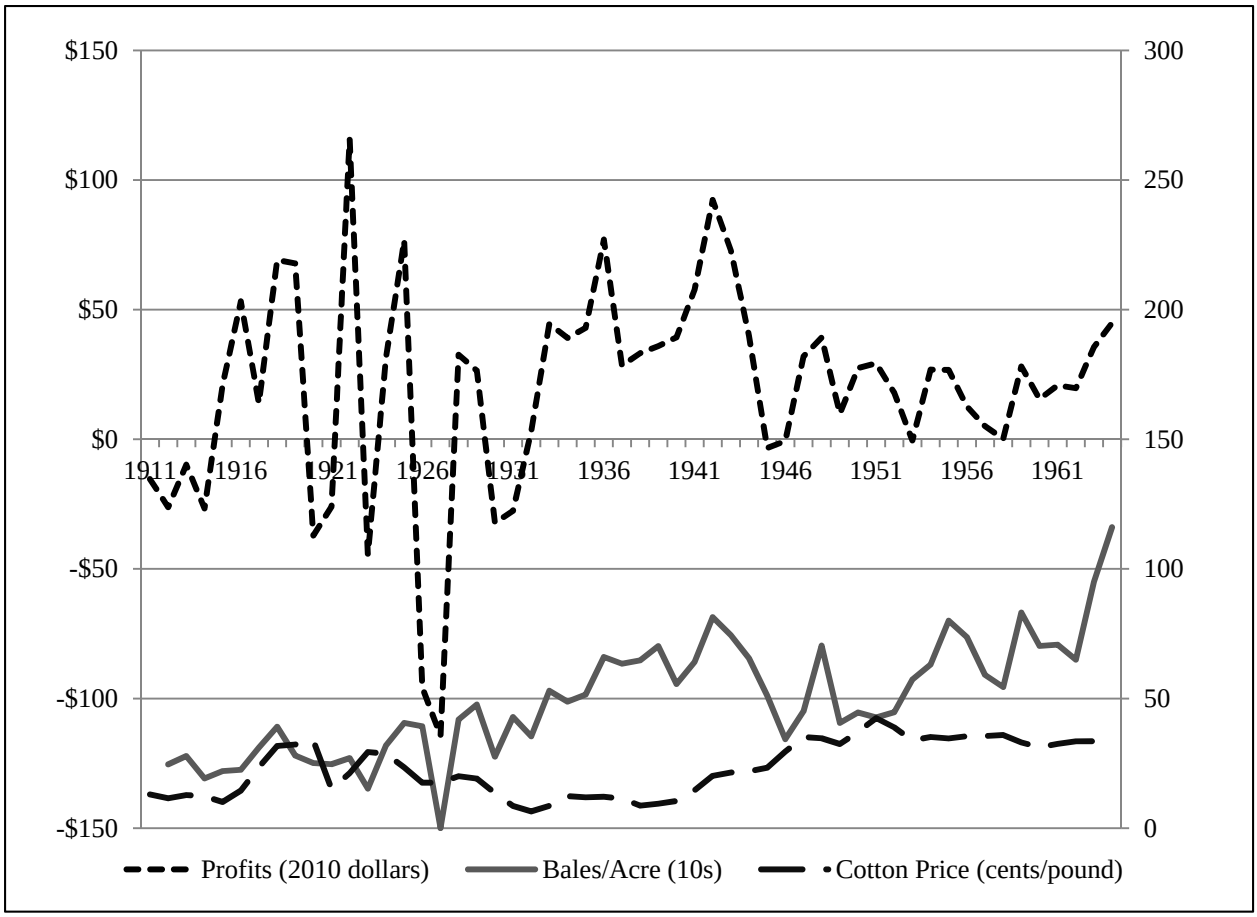
Notes: This graph reports estimated differences in log black population share between flooded counties and non-flooded, relative to differences in 1920. From estimating equation (5) in the text, the outcome is regressed on the fraction of the county flooded, state-by-year fixed effects, and county fixed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

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 non-flooded, 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% confidence intervals, based on robust standard errors clustered by county.

Figure 5. Delta Land and Pine Company Profits and Cotton Production



Notes: Delta Land and Pine Company Profits and Bales per Acre are from Dong (1993). Cotton prices are from Historical Statistics of the United States. On the left axis are profits, measured in 2010 dollars. On the right axis are: cotton prices, measured in cents per pound; and cotton bales per acre, measured in units of 10.

Table 1. Baseline County Characteristics, by 1927 Flood Share

		Log Difference by 1927 Flood Share:			
	Pre-Flood	Pre-Flood Levels:		Pre-Flood Changes:	
	Sample Mean	Within-State	Controls	Within-State	Controls
	(1)	(2)	(3)	(4)	(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,	2.99	1.003**	0.526*	0.033	-0.052
per 100 county acres	(2.46)	(0.171)	(0.211)	(0.064)	(0.082)
Population,	6.24	0.220	0.077	0.037	0.003
per 100 county acres	(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,	95.0	0.554**	0.250	-0.129	0.044
per 100 county acres	(60.9)	(0.139)	(0.178)	(0.079)	(0.115)
Number of Mules & Horses,	1.56	0.422**	0.080	-0.080*	-0.048
per 100 county acres	(0.84)	(0.141)	(0.172)	(0.040)	(0.057)
Number of Tractors	0.008	1.139**	0.479		
per 100 county acres	(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,	47.4	-0.144	-0.244	-0.077	-0.135*
per 100 county acres	(17.3)	(0.102)	(0.127)	(0.045)	(0.060)
Value of Farm Land & Buildings,	3370	1.018**	0.702**	-0.272**	-0.065
per 100 farm acres	(2094)	(0.124)	(0.162)	(0.046)	(0.060)
Value of Farm Land & Buildings,	1606	0.875**	0.459*	-0.350**	-0.200*
per 100 county acres	(1316)	(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 pre-trends 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 pre-trends 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: ** denotes statistical significance at 1%, * denotes statistical significance at 5%.

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	-0.133**	-0.144**	-0.137**	-0.170*	-0.018	-0.024	-0.206**	-0.254**
	(0.029)	(0.043)	(0.046)	(0.078)	(0.055)	(0.074)	(0.038)	(0.058)
1940	-0.167**	-0.165**	-0.075	-0.107	0.044	0.029	-0.240**	-0.245**
	(0.041)	(0.047)	(0.061)	(0.085)	(0.067)	(0.081)	(0.048)	(0.068)
1950	-0.193**	-0.202**	-0.153	-0.218	0.045	-0.042	-0.273**	-0.309**
	(0.068)	(0.065)	(0.086)	(0.118)	(0.099)	(0.113)	(0.068)	(0.098)
1960	-0.123	-0.170*	-0.189	-0.277	0.003	-0.112		
	(0.081)	(0.080)	(0.111)	(0.145)	(0.137)	(0.153)		
1970	-0.110	-0.146	-0.307*	-0.344*	-0.045	-0.186		
	(0.096)	(0.096)	(0.134)	(0.170)	(0.157)	(0.182)		
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 non-flooded 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. Columns (2), (4), (6) and (8) also control for six county geographic characteristics interacted with each year (distance to the Mississippi river, cotton and corn suitability, ruggedness, and latitude and longitude). All regressions are weighted by county size. Robust standard errors clustered by county are reported in parentheses: ** denotes statistical significance at the 1% level, * at the 5% level.

Table 3. Estimated Differences in 1920-1930 Migration Rates by Flood Share

	Fraction Moving Out-of-County	Fraction Moving Out-of-State	Fraction Moving Out-of-South	Fraction Moving Into County
	(1)	(2)	(3)	(4)
Panel A. All Matched People				
Mean in Non-Flooded 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 Non-Flooded 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 Non-Flooded 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 non-flooded 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: ** denotes statistical significance at the 1% level, * at the 5% level.

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

	Log Farm Capital		Log Mules & Horses		Log Tractors		Log Avg Farm Size	
Decade:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1930	0.073	-0.070	0.130*	0.048	0.629**	0.473*	-0.013	0.037
	(0.082)	(0.108)	(0.050)	(0.058)	(0.145)	(0.193)	(0.051)	(0.059)
1935			0.150**	0.104			0.078	0.196**
			(0.051)	(0.066)			(0.062)	(0.063)
1940	0.594**	0.378**	0.182**	0.155*	1.411**	0.951**	0.026	0.185*
	(0.094)	(0.113)	(0.069)	(0.076)	(0.229)	(0.261)	(0.076)	(0.083)
1945					1.097**	0.622**	0.136	0.284**
					(0.185)	(0.204)	(0.078)	(0.078)
1950							0.254**	0.484**
							(0.094)	(0.092)
1954			-0.250	-0.242	0.846**	0.403	0.342**	0.609**
			(0.138)	(0.130)	(0.189)	(0.209)	(0.111)	(0.108)
1960			-0.610**	-0.460**			0.498**	0.782**
			(0.142)	(0.138)			(0.143)	(0.145)
1964							0.733**	0.942**
							(0.155)	(0.167)
1970	1.104**	0.807**			0.711**	0.455*	0.581**	0.723**
	(0.152)	(0.159)			(0.177)	(0.204)	(0.154)	(0.162)
Counties	163	163	163	163	162	162	163	163

Notes: Each column reports estimated changes in the indicated outcome variable: changes in flooded counties relative to changes in non-flooded 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 interacted with each year. Columns (2), (4), (6) and (8) also control for distance to the Mississippi river, cotton and corn suitability, ruggedness, and latitude and longitude, all interacted with each year. All regressions are weighted by county size. Robust standard errors clustered by county are reported in parentheses: ** denotes statistical significance at the 1% level, * at the 5% level.

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	0.071	-0.023	0.012	-0.043	-0.026	-0.119
	(0.043)	(0.047)	(0.053)	(0.065)	(0.055)	(0.065)
1935	0.145**	0.053	-0.007	-0.084	0.034	-0.074
	(0.053)	(0.058)	(0.062)	(0.069)	(0.080)	(0.092)
1940	0.277**	0.203**	-0.031	-0.110*	0.174*	0.055
	(0.060)	(0.059)	(0.057)	(0.056)	(0.073)	(0.074)
1945	0.388**	0.265**	-0.154*	-0.333**	0.247**	-0.046
	(0.076)	(0.080)	(0.075)	(0.077)	(0.084)	(0.088)
1950	0.451**	0.325**	-0.143	-0.391**	0.231*	-0.133
	(0.085)	(0.086)	(0.075)	(0.080)	(0.100)	(0.099)
1954	0.513**	0.408**	-0.143	-0.351**	0.288**	-0.042
	(0.095)	(0.101)	(0.073)	(0.077)	(0.109)	(0.101)
1960	0.651**	0.558**	-0.159	-0.404**	0.375**	0.013
	(0.115)	(0.129)	(0.094)	(0.108)	(0.135)	(0.128)
1964	0.779**	0.669**	-0.003	-0.266**	0.646**	0.216
	(0.125)	(0.144)	(0.084)	(0.098)	(0.137)	(0.124)
1970	1.079**	0.943**	-0.075	-0.301**	0.755**	0.401*
	(0.156)	(0.180)	(0.071)	(0.081)	(0.153)	(0.154)
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 non-flooded 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, 1920, and 1925 interacted with each year. Columns (2), (4), and (6) also control for distance to the Mississippi river, cotton and corn suitability, ruggedness, and latitude and longitude, all interacted with each year. All regressions are weighted by county size. Robust standard errors clustered by county are reported in parentheses: ** denotes statistical significance at the 1% level, * at the 5% level.

Table 6. Estimated Relative Changes in Counties within 50km of other Major Southern Rivers

Decade:	Fraction Black (1)	Black Population (2)	Population (3)	Black Farm Share (4)	Mules & Horses (5)	Tractors (6)	Value Farm Capital (7)	Average Farm Size (8)	Farmland (9)	Land Value / Farm ac (10)	Land Value / County ac (11)
1930	0.009	0.018	0.008	0.034	-0.012	-0.071	-0.045	0.052*	0.021	-0.013	0.001
	(0.013)	(0.027)	(0.022)	(0.021)	(0.022)	(0.067)	(0.039)	(0.023)	(0.016)	(0.027)	(0.024)
1935					-0.004			0.014	0.024	0.002	-0.003
					(0.024)			(0.031)	(0.018)	(0.037)	(0.031)
1940	0.025	0.025	0.001	0.042	-0.035	-0.087	-0.092	0.041	0.029	-0.015	-0.023
	(0.017)	(0.033)	(0.027)	(0.030)	(0.028)	(0.088)	(0.059)	(0.031)	(0.020)	(0.037)	(0.034)
1945						-0.109		0.065	0.002	-0.042	-0.071
						(0.093)		(0.037)	(0.022)	(0.041)	(0.039)
1950	0.016	0.007	-0.016	0.012				0.055	-0.008	0.016	-0.031
	(0.024)	(0.044)	(0.038)	(0.035)				(0.038)	(0.026)	(0.042)	(0.045)
1954					-0.077	-0.238*		0.043	-0.006	-0.028	-0.084
					(0.060)	(0.112)		(0.039)	(0.031)	(0.048)	(0.055)
1960	-0.010	0.002	-0.011		-0.001			0.056	-0.011	-0.042	-0.095
	(0.031)	(0.061)	(0.056)		(0.068)			(0.044)	(0.044)	(0.047)	(0.064)
1964								0.078	-0.009	-0.054	-0.105
								(0.048)	(0.048)	(0.046)	(0.070)
1970	-0.016	0.019	0.003			-0.254*	-0.190*	0.091	-0.031	-0.020	-0.078
	(0.038)	(0.071)	(0.071)			(0.119)	(0.091)	(0.050)	(0.061)	(0.042)	(0.068)
Counties	243	243	243	243	243	240	243	243	243	243	243

Notes: Each column reports estimated changes in the indicated outcome variable (in logs): changes in counties within 50km of a major river relative to changes in counties within 50km - 150km of a major river, relative to the omitted year of 1920 or 1925. The sample is restricted to Southern counties within 150km 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 50km 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: ** denotes statistical significance at the 1% level, * at the 5% level.

Table 7. Estimated Changes in Counties Bordering the Flooded Region, Relative to Counties 100km Away

Decade:	Fraction Black (1)	Black Population (2)	Population (3)	Black Farm Share (4)	Mules & Horses (5)	Tractors (6)	Value Farm Capital (7)	Average Farm Size (8)	Farmland (9)	Land Value / Farm ac (10)	Land Value / County ac (11)
1930	0.019	0.003	0.003	-0.025	-0.033	0.045	0.010	-0.022	-0.015	0.060	0.048
	(0.024)	(0.049)	(0.036)	(0.038)	(0.047)	(0.140)	(0.066)	(0.027)	(0.029)	(0.040)	(0.044)
1935					-0.045			-0.029	-0.014	0.022	0.004
					(0.043)			(0.030)	(0.038)	(0.050)	(0.060)
1940	0.035	0.007	0.010	-0.026	-0.078	0.260	-0.048	-0.060*	-0.032	0.047	0.018
	(0.035)	(0.059)	(0.045)	(0.042)	(0.043)	(0.218)	(0.069)	(0.030)	(0.043)	(0.047)	(0.055)
1945						0.179		-0.035	-0.007	0.102	0.106
						(0.158)		(0.041)	(0.054)	(0.052)	(0.065)
1950	0.075	0.050	0.050	0.008				-0.078	-0.048	0.129*	0.093
	(0.054)	(0.083)	(0.077)	(0.053)				(0.054)	(0.057)	(0.056)	(0.064)
1954					0.052	0.084		-0.112	-0.081	0.114*	0.035
					(0.069)	(0.117)		(0.058)	(0.063)	(0.053)	(0.069)
1960	0.101	0.068	0.064		0.077			-0.105	-0.130	0.076	-0.055
	(0.066)	(0.111)	(0.117)		(0.080)			(0.066)	(0.075)	(0.056)	(0.063)
1964								-0.070	-0.116	0.151**	0.034
								(0.069)	(0.083)	(0.054)	(0.075)
1970	0.102	0.077	0.094			0.046	-0.036	-0.001	-0.111	0.118**	0.027
	(0.078)	(0.131)	(0.146)			(0.121)	(0.088)	(0.065)	(0.114)	(0.042)	(0.100)
Counties	94	94	94	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 100km 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 100km 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: ** denotes statistical significance at the 1% level, * at the 5% level.